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The politics of natural hazard preparedness and infrastructure: lessons for coastal defense and other climate adaptation public works

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Abstract

Climate adaptation public works, such as storm surge barriers and water irrigation networks, are generally conceived, designed, and implemented by governments. Social conflict and politics have been identified in the literature as barriers to breaking ground on adaptation works. However, such broad and superficial labels can conceal deeper complexities, including specifics related to how, why, and when politics can impede implementation efforts. Here, we provide examples from the natural hazard preparedness and infrastructure literatures of how politics can play a role in conceiving, designing, and constructing storm surge barriers and other adaptation works. We highlight political obstacles related to the mobilization of interests, perverse incentives, the use of flexible/adaptable decision-making, and siting opposition. Better understanding of the social and political factors that explain why the implementation of adaptation works fails could encourage strategies and policies that are more politically relevant and feasible, saving valuable time and planning resources.

1. Introduction

Climate adaptation public works (hereafter, adaptation works) are engineered, structural infrastructure projects, generally initiated, designed, and implemented by governments, with the intention of reducing the economic and social burden of climate change. Storm surge barriers are adaptation works that are expected to be technically viable options to manage sea-level rise and coastal flooding in densely populated areas (e.g., the Eastern Scheldt in the Netherlands; Fig. 1) (Aerts et al., 2014; M. Oppenheimer et al., in press; US National Research

Council, 2014). This is in part because these regions often lack the space to take advantage of ecosystem-based strategies (e.g., wetland restoration), and other coastal adaptation options (e.g., managed retreat, informed land-use planning, building codes, and insurance) can conflict with goals for local development. As a result of both recent hurricane disasters and studies highlighting coastal vulnerabilities, several large coastal cities are exploring storm surge barriers and other public works projects to manage floods (Sustainable Solutions Lab, 2018a; USACE, 2016, 2019). However, these projects have yet to be implemented despite being deemed technically feasible and economically warranted (i.e., benefit/cost > 1).

Research into why climate adaptation efforts fail focuses on identifying complex processes and interactions and classifying them into various adaptation "barriers"[1], including those related to social conflict, finance, technology, risk information, and behavioral and cognitive psychology (Klein et al., 2014; M. Oppenheimer et al., in press). These barriers have been identified at different stages of the adaptation process, including conception, design, and implementation (Figure 2) (Moser & Ekstrom, 2010). However, superficial categorization of potential hurdles faced by the adaptation process may overlook deeper underlying complexities at play (Biesbroek et al., 2014; Wellstead et al., 2013). This is particularly relevant for barriers that involve dynamic human interaction at various stages in the adaptation process (Dolšak & Prakash, 2018; Eakin et al., 2017; Eriksen et al., 2015; Sovacool & Linnér, 2016).

Studies detailing political challenges to adaptation works are primarily limited to conceptual assessments (Dolšak & Prakash, 2018; Eriksen et al., 2015; Hinkel et al., 2018), in part because implantation of adaptation works has been slow and so existing cases are few (Woodruff & Stults, 2016). However, detailed political studies from related areas may provide useful analogues. For instance, several decades of empirical research in the natural hazards literature could inform how and why adaptation works initially get placed on government agendas, and existing studies on public works could inform the design and implementation stages. Sovacool & Linnér (2016) demonstrate that coastal adaptation strategies are largely extensions of existing practices to manage flooding outside of a climate change context. This is especially true for storm surge barriers and other engineered coastal defenses (US National Research Council, 2014). Examples of related areas include the politics of siting "mega-projects" in coastal zones (Altshuler & Luberoff, 2003; Buzbee, 2014; B Flyvbjerg et al., 2003), opposition to harbor dredging (Kagan, 1991), and coastal storm protection projects designed and implemented outside of a climate change context (Bligh, 2006; Disco, 2002; Morang, 2016). These experiences could also serve as an important source of strategies for overcoming barriers to adaptation works.

By better understanding the political factors that determine whether adaptation works ultimately break ground or fail to get implemented, scientists, engineers, and practitioners could approach projects in a more efficacious manner, saving valuable time and resources. The following review, while not comprehensive in nature, gives examples from the natural hazard

[1]Barriers have been defined as "impediments that can stop, delay, or divert the adaptation process" (Moser & Ekstrom, 2010). We make the normative assumption that barriers are unwanted errors in producing actions and decisions (i.e., adaptation "successes"). However, failing to build an adaptation project could be a favorable outcome. In some cases projects can have negative impacts, such as encroaching upon environmental protection efforts, worsening social inequalities, transferring funds from public to private groups, or being maladaptive (Barnett & O'Neill, 2010; Sovacool & Linnér, 2016).

preparedness and infrastructure literatures where politics could play a role in the following stages of an adaptation works project: conception (Section 2), design (Section 3), and implementation (Section 4). We note that in reality these steps may not occur in this order or be as clearly defined (Kingdon, 2011; Moser & Ekstrom, 2010). To illustrate, we use a storm surge barrier and draw from political experience in the U.S., but our findings are largely relevant to adaptation works in general and all 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). Following our review, we give suggestions for how future adaptation works could deal with existing political barriers and also recommend future research directions (Section 5).

2. The decision to pursue adaptation works

All adaptation works must start with a decision to begin exploring possible actions. In the U.S., the federal government does not have the authority to coerce states and local communities to meet levels of safety (US National Research Council, 2014); this is in contrast to other environmental domains with compulsory regulations, such as water and air quality (Downing & Kimball, 1982). However, the federal government can indirectly incentivize local preparedness actions by 1) making competitive grants available to states and local communities to finance projects they would normally not be able to afford through local tax revenues and 2) reducing premiums for government-sponsored insurance programs if communities undertake risk-reduction measures. Federal grants are available either following a natural disaster (e.g., FEMA's Hazard Mitigation Program and the Department of Housing and Urban Development's Community Development Block Grants Program) or ex ante (e.g., FEMA's Pre-Disaster Mitigation and Flood Mitigation Assistance Programs). To be eligible in both cases, recipients are required to have a Federal Emergency Management Agency (FEMA) approved hazard mitigation plan. Ultimately, the support offered by these programs is minuscule compared to that needed to fund storm surge barriers and other large public works. For these projects, emergency supplemental appropriations are typically needed (Carter, 2018; US National Research Council, 2014). While not related to financing projects, communities participating in the National Flood Insurance Program that undertake risk-reduction measures are eligible to receive discounts on their premiums through the Community Ratings System (US National Research Council, 2014). The incentives provided by these programs may scale with 1) the level of financial assistance offered and 2) in the case of grants, the perceived competitiveness of a jurisdiction's application.

A perennial challenge for natural hazard preparedness has been mobilizing support for action. Local governments have historically tended to view extreme weather events (e.g., floods, hurricanes, tornados) and other rare natural hazards (e.g., earthquakes, wildfires) as minor problems that take a backseat to more frequent and visible issues like unemployment, crime, housing, and education (Birkland, 1996; Burby, 2006; May, 1985; Rossi et al., 1981, 1982), despite acknowledgement of present and future risks (White et al., 2001). However, the salience—or level of perceived importance—of preparedness can rise through the occurrence of a natural 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. For instance, more frequent coastal floods and other extreme weather events attributed to climate change may increase the salience of responses (Demski et al., 2017). On the other hand, adaptation efforts can be hampered by near-term political incentives of elected officials that discourage action.

2.1. Both the occurrence of extreme weather disasters and activities of advocacy groups can raise the importance of adaptation works

In models 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). During a focusing event, a policy window of opportunity opens for a short time period, and advocates race to push their preferred solutions through before the window closes (Birkland, 1996; Christoplos, 2006; Kingdon, 2011). If no viable solutions are presented while the window is opened, changes are unlikely (Kingdon, 2011). It can sometimes take multiple disasters to increase issue salience enough to push a solution through a window of opportunity (Birkland, 1996; Kingdon, 2011). Cumulative learning can help reinforce lessons (Sadowski & Sutter, 2008). For example, despite a catastrophic hurricane in 1938, New England did not begin to address coastal flooding with public works until Hurricane Carol in 1954 (Morang, 2016). Hurricanes and other focusing events can also encourage the emergence of advocates who stimulate policy change (Olson, 1971).

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). As in the natural hazards domain, climate adaptation advocacy coalitions may be slow to emerge, in part due to the technical nature of projecting future climate impacts, which has limited their study largely to scientific communities in government and academia (Birkland, 1997; May, 1991b). For instance, few public hurricane interest groups exist in the U.S. (Birkland, 1997). Such "policies without publics" (May, 1991a) could 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 can both form and support technical groups that promote natural hazard preparedness in the public's interest (e.g., the U.S. National Earthquake Hazards Reduction Program[2] (Birkland, 1997)). However, creating federal advocacy groups can be challenging; an attempt to create 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). Nonetheless, an increasing frequency of weather disasters due to climate change, growing populations, and expanding development may encourage the emergence of more climate adaptation advocates.

In additional to organized groups, high-profile individuals can also emerge as "policy entrepreneurs" to either raise the salience of an issue or sustain interest. Policy entrepreneurs that are government executives can push their own agendas to address issues that they believe to be important (Kingdon, 2011; Renner & Meijerink, 2018). For example, in the wake of Hurricane Sandy, New York City Mayor Michael Bloomberg came to champion natural hazard

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

preparedness efforts, such as the Special Initiative on Rebuilding and Resiliency and the creation of the Mayor's Office of Resiliency and Recovery[3]. However, subsequent leadership must continue to value climate adaptation in order to sustain implementation, which can sometimes take decades (Section 4). Policy entrepreneurs that advocate for adaptation works may leave office and then new leaders might scrap plans because the projects do not align with their goals (Kingdon, 2011). While focusing events, advocacy coalitions, and policy entrepreneurs can all promote action, perverse political incentives can discourage it.

2.2. Perverse political incentives can hinder efforts to create adaptation works

Perverse political incentives can discourage elected officials from reducing exposure to coastal hazards and also from promoting protective measures. For instance, the short time scales of election cycles can encourage politicians to focus on present welfare at the expense of future (Jacobs, 2016). If the primary goal of an elected official is to get re-elected (Mayhew, 1974), then a rational politician is likely 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 could be distributed in the weeks to months following a disaster, while adaptation projects could take years to plan and implement and may only positively impact a small fraction of the voting population. An electorate may only come to appreciate the preparedness measures after they successfully mitigate a disaster, which could be years—if ever—long after the incumbent vacates office. For example, 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.

Federal democracies that divide power between a central governing authority and constituent units (e.g., states/provinces or municipalities) face a preparedness dilemma that can inhibit adaptation works. On the one hand, central governments seek to protect their citizens from natural disasters, but on the other hand, they have limited control over efforts to do so. Both the vulnerability to and consequences of a coastal hazard are largely shaped by local land use and building codes (US National Research Council, 2014). For instance, local jurisdictions may feel pressured to develop lands exposed to hazards (e.g., coastlines) due to the incentive provided by anticipated economic growth (Peterson, 1981; Stone, 1989). At the same time, they bear reduced responsibility for protecting existing vulnerable and exposed developments, in part due to the expectation of public bailouts (e.g., disaster relief (Rossi et al., 1982)) and the availability of subsidized insurance (Burby, 2001). 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, while the federal government is largely responsible for disaster aid. This misalignment of risks, rewards, and responsibility between federal and local governments can suppress local interest in pursuing adaptation and remains an enduring challenge to overcome (Burby, 2006; US National Research Council, 2014).

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

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 has still occurred in these areas (Climate Central and Zillow, 2018; Lazarus et al., 2018; US National Research Council, 2014).

3. Designing adaptation works

Once governments have decided to address a physical climate hazard (Section 2), they must determine how to do so. Multiple solutions are usually possible. In addition to building surge barriers and other defense measures, options to adapt to coastal floods and sea-level rise include elevating structures to accommodate extreme water levels and moving populations and the built environment away from the coastline (M. Oppenheimer et al., in press). Either a single strategy or combination of strategies could be chosen. Some laws may also require consideration of more than one proposed solution. In the U.S., if a proposed project poses significant harms to the quality of the natural environment, government agencies are required to describe alternative solutions (Luther, 2008). Ultimately, selecting a proposal can be broken into two steps: 1) producing alternative strategies and 2) subsequently choosing amongst them (Kingdon, 2011). Creating a viable project is not simply a matter of skillful engineering and a favorable benefit-cost ratio. Experience with infrastructure projects suggest that social conflict is likely to be a factor (Buzbee, 2014; Disco, 2002; Fukuyama, 2017; Howard, 2015; Kagan, 1991; Sovacool & Linnér, 2016).

3.1. Creating alternatives

Proposed adaptation solutions are likely to be based on aims that reflect their designers' values and beliefs about what constitutes "good" options, not necessarily specific technical objectives (e.g., protecting the greatest amount of assets or the largest number of people while minimizing the net present value of the coastal defense structure; (Sovacool & Linnér, 2016)). It may be impossible to accommodate the values, beliefs, and desires of all stakeholders involved in determining what solution to employ. Disagreements are likely. For example, experience with large public works projects like storm surge barriers has shown that these projects address some risks (e.g., harm from coastal floods) by way of disregarding others (e.g., harm to the natural environment; (Bijker, 2002; Disco, 2002)). Adaptation choices can involve tradeoffs between the present and the future; success in the near-term may be maladaptive in the long-run, and vice-versa (Barnett & O'Neill, 2010). Pareto optimal solutions that benefit all stakeholders are also often nonexistent (Sovacool & Linnér, 2016). While projects may be forecasted to create net social gains, underneath there are likely to be "winners" and "losers" (Sovacool & Linnér, 2016).

3.2. Choosing amongst alternatives

Decision analysis methods are formal approaches designed to help identify project alternatives that perform best with respect to given objectives (M. Oppenheimer et al., in press). Examples include benefit-cost analysis (Chambwera et al., 2014), robust decision-making

(Lempert et al., 2003), and flexible/adaptive decision-making (Haasnoot et al., 2013, 2019; Ranger et al., 2013). The appropriateness of each method depends on policy goals, available information, planning resources, and technical capabilities (M. Oppenheimer et al., in press).

While decision analysis methods appear to facilitate a rational approach for choosing among project alternatives, they involve normative choices that could greatly influence outcomes. For example, the selection of the decision-making objective itself is partly a reflection of the decision-maker's view of how strategies are to be evaluated. In the U.S., the federal government has historically mandated the use of BCA, which uses the objective of maximizing the expected net present value (NPV). BCA has many well-known limitations (Chambwera et al., 2014) including sensitivity to subjectively chosen parameters (e.g., discount rate), what benefits and costs are included in the analysis, and the methods used for monetizing hard-to-monetize variables (e.g., ecology, culture). These could all be deliberately chosen to obtain desired outcomes (Bent Flyvbjerg, 1998; Bent Flyvbjerg et al., 2002; Wachs, 1989, 1990). Competitive grants could increase the likelihood of this "strategic misrepresentation" (Bent Flyvbjerg, 2007).

Instead of selecting projects that maximize expected NPV, robust decision-making (Lempert et al., 2003) and flexible/adaptive decision-making (Haasnoot et al., 2013, 2019; Ranger et al., 2013) identify strategies that perform well under uncertainty. For example, RDM identifies alternatives that perform well (i.e., "are robust") under a wide range of parameter assumptions and plausible future states-of-the-world. However, differences in costs, values, beliefs, and interests could all lead to disagreements between stakeholders over what is the "best" strategy. Even if the same outcome is agreed upon (e.g., protection from a 1000-yr flood), robust decision-making and flexible/adaptive decision-making do not necessarily encourage consensus for choosing the course of action. Ultimately, formal decision analysis methods will always be dependent on value judgements by analysts, policymakers, and stakeholders.

Certain laws, regulations, and arrangements of governing bodies can also influence choices among presented alternatives. For instance, besides being cheaper, small-scale adaptation projects that could be implemented quickly may be favored over larger adaptation works that could take decades to complete, in part due to lengthy government approval processes and long construction times. In the case of coastal adaptation in the US, large, engineered projects like levees and surge barriers require multiple approvals by Congress before construction can begin (Carter & Normand, 2019). On the other hand, simple, small-scale adaptation projects can sometimes be undertaken at the discretion of government agencies, without the need for both approval and appropriations from a busy central governing body (Normand, Anna E., 2019). They may also have local-federal cost sharing schemes that are more favorable to local jurisdictions (Mullin et al., 2018; USACE-IWR, 2003). Smaller projects like dune building, beach nourishment, and aquatic ecosystem restoration are flexible and may be preferred in decision-making frameworks that seek to keep options open (Haasnoot et al., 2013, 2019). Smaller projects can also be completed much faster than structural approaches, which can take several decades (Morang, 2016; US National Research Council, 2014). As such, those seeking more immediate payoffs may be incentivized to favor smaller-scale projects over larger adaptation works.

4. Implementing an adaptation works project

The selection of any adaptation project is not by itself sufficient to assure its implementation. Based on past experiences with public works, the implementation of adaptation works is likely to be challenged in part by environmental protection laws, public opposition, institutional complexity, and leadership continuity (Fukuyama, 2017; Kingdon, 2011; Moser & Ekstrom, 2010; Pressman & Wildavsky, 1984). Compared to smaller-scale adaptation options that are cheaper, reversible, or could be classified as flexible/adaptable (Haasnoot et al., 2013; Ranger et al., 2013), implementation is likely to be more difficult for infrastructure-based adaptation because of high, upfront costs to taxpayers and because infrastructure decisions are long lived and largely irreversible. For these reasons, they may require substantial public confidence in forecasted benefits before implementation becomes politically feasible. In the coastal domain, such confidence is challenged in part by uncertainties in projected ecological impacts of coastal infrastructure (Orton et al., 2019; Swanson et al., 2012) and “deeply uncertainty” in projections of long-term sea-level rise (Kopp et al., 2019). Despite these and other implementation challenges, multiple storm surge barriers have gotten built in the U.S., including at Fox Point (Providence, Rhode Island), New Bedford (New Bedford, Massachusetts) Lake Borgne (New Orleans, Louisiana), among others (Morang, 2016). However, Fox Point and New Bedford did not contend with contemporary environmental laws, and in New Orleans, a congressional emergency declaration as a result of Hurricane Katrina excluded normal policy procedures.

4.1. *Environmental protection laws*

Experience with public works suggests that laws related to environmental protection are likely to provide opportunities to challenge the implementation of adaptation works, particularly in the coastal sector (Biesbroek et al., 2011; Bijker, 2002; Bligh, 2006; Disco, 2002; Scarano, 2013). 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 largely needed to answer was if it would impede maritime navigation (Scarano, 2013). Today, mandatory consideration of environmental impacts has made infrastructure implementation a more complex legal process. In the U.S., under the National Environmental Protection Act (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 (Luther, 2008). While this process is not a direct legal barrier to project implementation per se, the transparency of potential ecological harms it provides can trigger public opposition (e.g., the Westway Project)(Buzbee, 2014). On the other hand, some environmental laws could block projects altogether. In the U.S., 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). This can challenge “concrete and steel” coastal adaptation works if there are nature-based alternatives and no specific protection level is required. While there is little doubt that the emergence of the environmental protection movement greatly reduced air and water pollution, it has led to a number of new laws, regulations and lengthy, formalized processes that may challenge the implementation of adaptation works, much in the same way it has challenged the deployment of public works in general (Fukuyama, 2017; Luther, 2008).

By expanding standing for litigation, NEPA and other environmental laws have been wielded to secure significant litigation powers by citizens that otherwise have no direct influence over the fate of projects (Luther, 2008). These powers have threatened or derailed public works implementation (e.g., the Westway Project, (Buzbee, 2014), some flood protection measures around New Orleans (Bligh, 2006), and dam construction (Murchison, 2007)). In the U.S., NEPA facilitates the filing of lawsuits by the public if they believe the submitted EIS either does not adequately comply with environmental laws or insufficiently accounts for environmental impacts (Luther, 2008). Environmental organizations like the Sierra Club, National Audubon Society, and Environmental Defense Fund have all sued to block public works on the grounds that they could harm coastal wildlife, fisheries, and recreation (Kagan, 1991, 2001). The support of these groups for projects is imperative if “regulatory wars” are to be avoided and adaptation works are to break ground on schedule (Buzbee, 2014).

4.2. *Infrastructure siting*

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; McAdam & Boudet, 2012; Quah & Tan, 2002). Examples of controversial projects that are meant to address broadly supported social objectives are hazardous waste facilities, airports, and wind farms (Aldrich, 2008; Devine-Wright, 2011; McAvoy, 1999).While there is some flexibility in the siting of most projects that stimulate NIMBY responses, adaptation works may be tied to specific geographic areas for technical reasons. For example, the siting of storm surge barriers is largely limited to entrances to tidally influenced rivers or estuaries (Mooyaart & Jonkman, 2017). Siting in these regions could be difficult in part because they are often either already developed due to high land values or are preserved ecological areas. NIMBY opposition to public works projects is expected to increase over time due to less available undeveloped lands, rising educational levels that lead to greater access to technical information and legal resources, increased environmental awareness, and declining confidence in government (Aldrich, 2008).

Incorporating stakeholder values and beliefs can resolve some siting opposition issues (Gregory & Keeney, 1994; Kraft & Clary, 1991). 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, economy, and 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 and therefore minimize the environmental impact (Bijker, 2002; Disco, 2002).

4.3. *Institutional complexity and flexible/adaptive approaches*

Complex arrangements of institutions could hinder the implementation of adaptation works (Fukuyama, 2017; Lubell, 2017). For example, in the U.S. there are at least nine federal agencies with responsibilities for managing coastal storm risks and 16 congressional subcommittees that can authorize projects or appropriate funds (USACE, 2015). Powers can additionally be duplicated at the state and local levels and require that projects pass review not only on the national stage, but also at the state and local level (e.g., the California Environmental Quality Act, the California equivalent of NEPA). Adaptation works in New York City may have to deal with the overlapping jurisdictions of the Port Authority of New York and New Jersey, both the City and State of New York, and the Metropolitan Transit Authority. Each agency may have a unique area of expertise and culture leading to differing political, legal, and scientific lenses through which they view a given project (D. A. Mazmanian & Nienaber, 1979). Fukuyama (2017) has argued that the involvement of too many diverse interests can make it difficult to arrive at a consensus, leading to a so-called “vetocracy”.

When forced to adapt to a changing climate, some long-standing agencies may no longer operate effectively. Without fundamental changes and restructuring, legacy institutions may hinder society’s ability to adapt to a changing climate (Libecap, 2011; Lubell, 2017). This includes reforming institutions to accommodate flexible/adaptive designs (Haasnoot et al., 2013, 2019; Ranger et al., 2013). Uncertainties associated with future climate change are challenges to designing adaptation works. Flexible/adaptive approaches can address this issue by facilitating commitment to adaptive measures despite uncertainty (Haasnoot et al., 2013, 2019; Ranger et al., 2013). They can avoid lock-in and also reduce near-term costs while keeping future options open for adjustments that improve project performance (de Neufville & Scholtes, 2011). In England, the Thames Estuary 2100 project is addressing uncertainty in future flood risk using a flexible/adaptive planning approach (Environment Agency, 2012; Ranger et al., 2013). But while flexible/adaptive approaches have appeared in some climate action strategies in the U.S. (Rosenzweig & Solecki, 2014), they have not been widely implemented (Woodruff & Stults, 2016). Implementation difficulties include the fact that financing for natural hazard preparedness is generally only available following a disaster (Healy & Malhotra, 2009; Sustainable Solutions Lab, 2018b; US National Research Council, 2014) and that current flood protection revenue streams are inadequate for supporting either new construction or regular upgrades that would occur with a flexible/adaptive approach (Knopman et al., 2017; Sustainable Solutions Lab, 2018b). Also, flexible/adaptive approaches that involve sequences of decision and implementation over time may be more expensive than single-decision design, particularly in the near term, and their successful execution depends upon the longevity of appropriately empowered institutions (Fankhauser et al., 1999; Haasnoot et al., 2019).

5. Potential remedies and ways forward

While many scientists, engineers, and economists may frame adaptation works as politically neutral, these projects should instead be viewed as processes that are embedded in struggles over authority, resources, values, and interests across a diverse set of actors (Eriksen et al., 2015). In democracies, social conflict inevitably plays a role in the provision of public goods and figures to be a critical barrier to implementing adaptation works (M. Oppenheimer et al., in press). We use the natural hazard preparedness and infrastructure literatures to provide examples of when political challenges may arise before breaking ground on a project during the phases of conception (Section 2), design (Section 3), and implementation (Section 4). Our analysis also highlights past experiences in which these political obstacles have been overcome and projects have gotten built. While potential remedies are many, we suggest four ways that future adaptation works could deal with existing political challenges:

1. *Prepare adaptation plans in advance of extreme weather events.* Natural disasters can highlight existing policy problems. This can increase attention from elected officials and trigger generous funding from central governments. Having carefully thought out plans for adaptation works in advance can increase the likelihood of implementing solutions when a window of opportunity opens (Kingdon, 2011). Climate adaptation advocacy groups could aid in the effort to produce such plans (Birkland, 1997) by identifying and empowering groups who may benefit from adaptation projects (e.g., populations in harm's way, the construction industry and unions).

2. *Address perverse political incentives that discourage adaptation works.* Federal democracies must work to align risks, rewards, and responsibility between central governing authorities and constituent units (e.g., states/provinces) by 1) creating policies that respect state/province and local autonomy, 2) continuing to provide disaster relief, and 3) promoting local commitments to risk reduction (May, 1991a). Elected officials may be more likely to support adaptation projects if voters perceive a potential risk-reducing project as responsible government action. This is likely to be the case if there is clear and visible potential for disaster (Neumayer et al., 2014). Technical experts could also educate voters or potential future policy entrepreneurs on viable options to protect their communities from climate change. This could encourage elected officials to raise the importance of adaptation on their political agendas.

3. *Reform institutions to accommodate flexible/adaptable infrastructure approaches.* Flexible/adaptive approaches to adaptation works can help address design and planning challenges related to future uncertainties (Haasnoot et al., 2013, 2019). While governments should incorporate flexible/adaptable decision-making approaches into adaptation guidance (Environment Agency, 2012; Lawrence et al., 2018; Rosenzweig & Solecki, 2014), their existing institutions may not be well-suited to implement these techniques. For instance, adaptation works can costs billions of US dollars, yet local jurisdictions often have limited access to the revenue-raising power of central governments, except following a major disaster (Healy & Malhotra, 2009; Sustainable Solutions Lab, 2018b). This complicates efforts to fund flexible/adaptable projects that require scheduled adjustments over time. Numerous local revenue-raising options have

been proposed (Sustainable Solutions Lab, 2018b), including increases in property taxes that are proportional to project benefits. Additionally, establishing standing agencies to carry out flexible/adaptable decision-making approaches could overcome the transient nature of political administrations (e.g., New York City's Office of Recovery and Resiliency).

4. *Engage the public when designing and siting infrastructure projects.* Public opinion should be taken seriously. Environmental laws can elevate the power of citizens and non-profits who may view projects as threats to natural resources or have narrower NIMBY concerns (Buzbee, 2014; Luther, 2008). Rather than top-down, state-directed approaches for the siting of controversial facilities, impacted citizens should be directly involved in decision-making. Pursuing a more deliberate process, with broader stakeholder engagement, could help identify potential "losers" from proposed projects and then work to ameliorate actual or perceived losses (Gregory & Keeney, 1994; Kraft & Clary, 1991; D. Mazmanian & Morell, 1994; McAvoy, 1999; Munton, 1996). Flexible/adaptable decision-making could also be used to resolve stakeholder disagreements by outlining and visualizing multiple pathways that could lead to the same desired future (Haasnoot et al., 2013, 2019).

While our review emphasizes the importance of political complexities in pursuing adaptation works, it stops short of detailing political mechanisms that may be necessary to generate effective policy recommendations. Future research could uncover more detailed mechanisms. 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; Wellstead et al., 2013). Such an approach may be more likely to yield practical advice to policy makers on how to intervene, overcome implementation barriers, and obtain favorable outcomes and could also contribute to theory building. This includes examining how political forces affect decisions (i.e., political economy). Examples of potential case studies include storm surge barriers in urban areas, earthquake building codes and warning systems, and other public works that address societal risks (e.g., renewable energy, drinking water availability, and public transit).

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Data Availability Statement

Data were not used, nor created for this research.

Figures

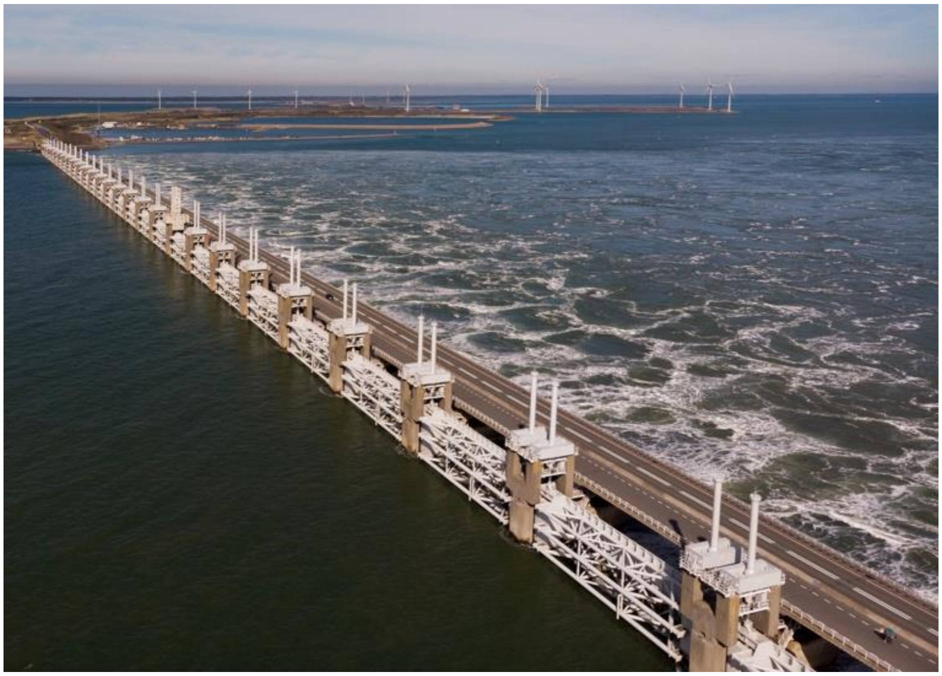

Figure 1. The Eastern Scheldt storm surge barrier located in the Netherlands. Photo taken by the authors.

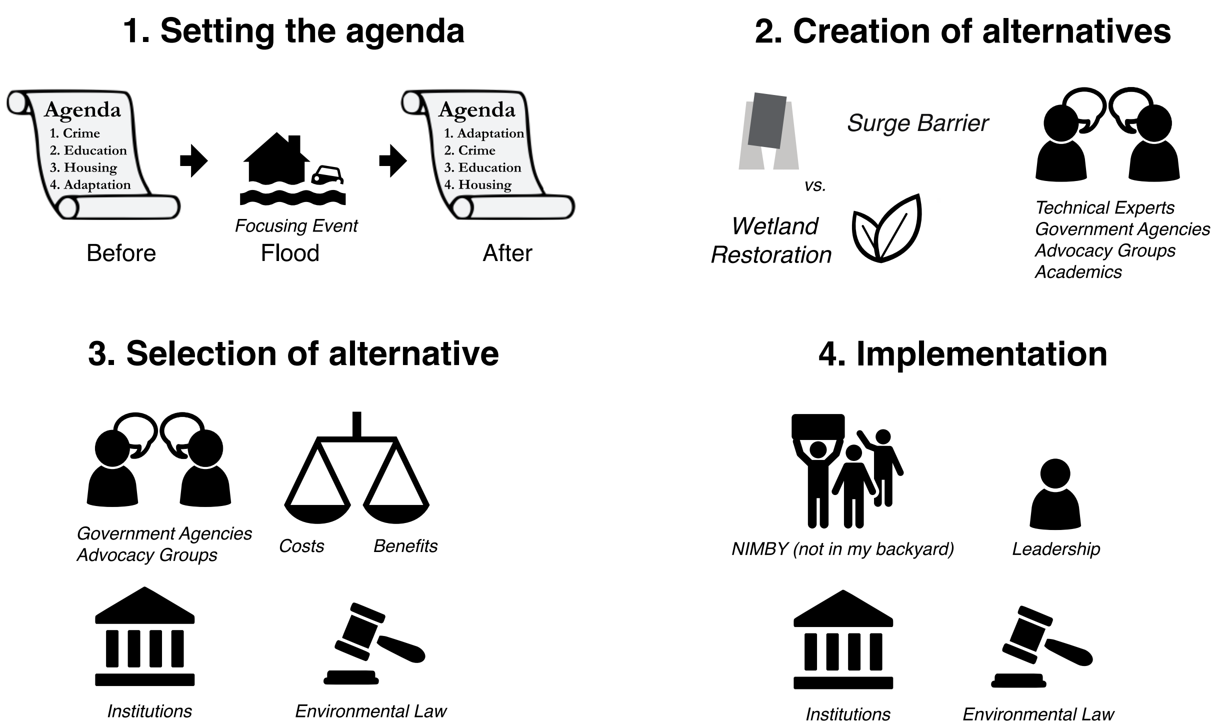

Figure 2. The four steps of Kingdon's model of public policy (Kingdon, 2011), as illustrated for a public coastal flood protection project.

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Figure 1.

Figure 2.


1. Setting the agenda
Agenda
1. Crime
2. Education
3. Housing
4. Adaptation
Before
Focusing Event
Flood
Agenda
1. Adaptation
2. Crime
3. Education
4. Housing
After
2. Creation of alternatives
Surge Barrier
vs.
Wetland Restoration
Technical Experts
Government Agencies
Advocacy Groups
Academics
3. Selection of alternative
Government Agencies
Advocacy Groups
Costs
Benefits
Institutions
Environmental Law
4. Implementation
NIMBY (not in my backyard)
Leadership
Institutions
Environmental Law