



# What would it take to make sure all families can live in a physically secure home and a stable community that's prepared for the effects of global climate change?



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# Contents

<b>Acknowledgments</b>	<b>iv</b>
<b>Advancing Solutions: Local Action and Investment, Advocacy, and Private-Sector Innovation</b>	<b>4</b>
Solution Set 1: Adopt Inclusive Climate Decisionmaking Processes	5
Solution Set 2: Expand Existing Tools for Addressing Physical Disruptions	9
Solution Set 3: Adopt More Comprehensive Site Adaptations	12
Solution Set 4: Relocate to a Safer Location	14
<b>Building Knowledge Changemakers Need</b>	<b>16</b>
Priority 1: Assess the Needs and Framework for a Climate Safety Net	17
Priority 2: Uncover Individual and Household Risk Perceptions and Behaviors	18
Priority 3: Measure Inclusive Engagement and Equitable Outcomes	20
Priority 4: Monitor and Build Local Capacity and Leadership	22
Priority 5: Evaluate the Effects of Climate Governance and Property Law Change	23
Priority 6: Integrate Multiple-Risk Scenarios into Population and Provider Projections	25
Priority 7: Develop Tools for Calculating Value	27
<b>Notes</b>	<b>29</b>
<b>References</b>	<b>31</b>
<b>About the Authors</b>	<b>33</b>
<b>Statement of Independence</b>	<b>34</b>

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# What would it take to make sure all families can live in a physically secure home and a stable community that's prepared for the effects of global climate change?

Thoughtful and thorough preparations for the disruptive effects of global climate change can provide a range of options for communities and households that would respect their historical assets, current and potential levels of social cohesion, desires for their own life outcomes, and opportunities for collective action.

- In some cases, whole communities may defend themselves against climate's effects with major new infrastructure and land planning.
- Other communities may deploy more nuanced combinations of programs, policies, and services, from community emergency networks to alternative housing and transport.
- A few communities may choose to relocate en masse away from the riskiest climate change effects.

In all cases, people and communities should exercise meaningful voice and power over decisions about where, how, and how much to adapt to local climate effects. Regardless of the combination of physical and social interventions communities adopt, inclusion and equity must be fundamental to both the process of selection and the outcomes of the options selected.

Global climate change is profoundly disruptive, bringing more frequent and severe weather events, rising sea levels, chronic precipitation extremes, increased vector-borne disease, and higher ambient temperatures.<sup>1</sup> All regions of the United States are being physically transformed and without massive economic and policy change, these unwelcome transformations will continue unabated. Communities built decades ago face unprecedented challenges, yet some continue to grow and develop land in places that evidence suggests are in harm's way.

American communities are far behind others on the globe in preparing for climate change effects, and they are likely to experience greater pains to catch up. The United States provides almost no examples of implemented climate adaptation solutions (Anguelovski and Carmin 2011). And even fewer solutions have focused on the historical inequities between groups living in the same geographic boundaries or on the likely disparate impacts on these groups from adaptation decisions (Kresge Foundation 2018). Philanthropies, state and local governments, and federal agencies have begun to consider the consequence of already-observable climate effects on US communities in the last decade (HUD 2014; Kresge Foundation 2015).<sup>2</sup> But they need evidence about how the work of disaster mitigation, climate change adaptation, and local infrastructure and regional planning can be woven into equitable climate resilience over the next 50 years:

- Federal and state policymakers working to create a reliable **climate safety net** lack information about coverage gaps (and redundancies) and intersections between public assistance and private insurance programs. Systematic assessments of needs, vulnerabilities, and coverage across the full range of public and private assistance services and programs would enable these policymakers to strengthen existing programs and develop new ones that emphasize preventative measures over recovery and compensation.
- The effectiveness of climate adaptation strategies hinges on the choices of individuals (such as residential location and design choices or insurance take-up). But policymakers know little about how individuals understand and respond to evolving climate risks or how they respond to incentives, regulations, and even immediate environmental hazards. Policymakers need rigorous evidence about **individual risk perceptions and behaviors** to support effective adaptation strategies that work with private-sector regulations and public policies.
- Local officials and community leaders committed to effectively engaging residents in climate change planning and decisionmaking need to know what methods yield **inclusive engagement and equitable outcomes**. Evidence from other domains of planning and rigorous evaluations of new climate planning initiatives would help them create robust processes for all affected people to exercise real voice and power.
- Local leaders and institutions in the public and civic sectors play central roles in the development and execution of climate adaptation strategies. However, their knowledge, staffing, and financial capacities vary widely. Too little is known about how investments by federal and state government or philanthropy could strengthen **local capacity and leadership** to make informed decisions and execute effective programs.



- Public officials across the country confront numerous questions about the legal basis for climate change decisions and how to implement them. These questions arise because climate change does not respect jurisdictional borders and because so much development occurred prior to any awareness of the risks associated with climate change. Public officials need models for effective interjurisdictional collaboration and reliable legal analyses to develop new models of *climate governance and property law*.
- Most public-sector climate planning and community engagement have focused on coastal sea-level rise and the risk to property. Other serious climate change risks, like heat, drought, fires, and changes to local flora and fauna, have received scant attention. Local officials and community leaders need reliable risk projections from *multiple-risk scenarios* in different locations and their implications for the health and well-being of people and places.
- Investments by both public- and private-sector decisionmakers too often rely on “single number” return-on-investment estimates. Such estimates may not consider the full range and distribution of costs and benefits, particularly for marginalized communities and from unquantifiable activities. The range of possible climate change effects and interventions further complicates the accuracy of these estimates. Policymakers need more sophisticated analytic measures for *valuing the costs and benefits* of alternative investments in climate adaptation.

This brief draws on interviews and roundtable conversations with a broad array of changemakers. These discussions highlighted innovative solutions being explored and advanced across the country and identified the gaps in facts and understanding that stand in their way. They also offer priority opportunities for new knowledge-building that could support a national vision for equitable action in response to current and future climate change effects.<sup>3</sup>

# Advancing Solutions: Local Action and Investment, Advocacy, and Private-Sector Innovation

Four colluding trends exacerbate the disruptive effects of climate change: increased urbanization, particularly in coastal and arid or semiarid cities at the frontline of climate change effects; antiquated and insufficient infrastructure, from defensive protections to public roads, water systems, and energy grids; the lack of consistent federal policy on risk assessments and resulting gaps in (or lack of) services and funds; and widely fluctuating capacity and resources across highly vulnerable regions, particularly for lower-income and historically marginalized communities and households (Bullard and Wright 2012; Cutter, Boruff, and Shirley 2003; Fothergill and Peek 2004).

Moreover, although climate change knows no geographic boundaries, the responses vary by social and economic community as well as geographic place (Adger 2010; Bolin 2007; Hardoy and Pandiella 2009; Klinenberg 2002; Thomas et al. 2013; Tierney 2014). Disenfranchised communities typically have less access to information on emergency preparations and the nature of the environmental challenges they face (Mileti and Peek 2002). Vulnerable populations like the poor, disempowered racial groups, the elderly, and physically challenged are less likely to be prepared for disasters, suffer more losses from them, and have a more difficult path to recovery (Fothergill, Maestas, and Darlington 1999). Many studies point to the nature of vulnerabilities and vulnerable communities but we know little about interventions designed to reduce those vulnerabilities and improve community and household outcomes in the face of climate change duress.

Local strategies for climate adaptation draw from three main solution sets. The proposals in solution sets 2, 3, and 4 occupy a continuum from incremental to radical alternatives and from responses to immediate, current climate change effects to longer-term ones. The discussion assumes that the effects will increase over the next 50 years even with global action to reduce greenhouse gas emissions.

- Our first solution set focuses on the engagement and decisionmaking processes needed to select from the remaining three. Inclusive and representative engagement, participation, and decisionmaking at the local level is mandatory to ensure all households are prepared and protected from the effects of climate change.

- The second solution set describes how local leaders can adopt and incrementally extend existing tools and mechanisms for addressing the earliest physical disruptions from climate change. Interventions and policy changes such as expanding insurance and improving infrastructure and emergency preparedness can transition as more severe effects arise.
- The third solution set suggests rethinking and reforming land use, building techniques, property rights, and related governance changes to adapt more comprehensively to climate change effects.
- As a more radical response to the stresses of climate change, the fourth solution set considers how communities can decide to relocate to safer ground.

For each solution set, we offer examples of promising or emerging approaches and identify key questions and debates about their effectiveness and their implications for equity and inclusion.

## Solution Set 1: Adopt Inclusive Climate Decisionmaking Processes

The most vulnerable disenfranchised and marginalized communities typically have the least access to information sources and capacity to participate in climate preparation and planning. As a consequence, vulnerable populations like the poor, disempowered racial groups, the elderly, and the physically challenged are less likely to be prepared for climate change effects. They are more likely to suffer greater losses from climate change and have a more difficult path to recovery after.

These disparities in conditions and outcomes are not the only inequity vulnerable populations face. Another driving inequity has been the lack of consideration of these communities in the planning and decisionmaking processes that shape their environments. This inequity is most obvious in the exclusion of vulnerable populations from these processes. As Atyia Martin noted, “Equity isn’t something that is only about the output or the outcomes, but also the process. The process has to be equitable.”<sup>4</sup> To date, options for adaptation action remain elusive while large swaths of communities continue to be denied a place at the selection table. Consistently, thought leaders in our discussions pointed to the same few examples of participatory practices that are inclusive and comprehensive of all members of a geographically defined population. Regardless of the selection of physical solutions, the need to develop participatory processes is critical.

Lessons and guidance on how to accomplish inclusion abound in the city planning, infrastructure and capital development, and social programming worlds. However, few approaches broach the

existential subject of individual household's physical property and surroundings, particularly in relation to emerging scientific evidence and the policy and program constraints posed by climate adaptation.

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**“There are communities that are unjustly disproportionately affected along lines of race and class. Underlying systems and processes foster the impacts that strip away the resilience, well-being, and dignity of Black, Brown, and poor people. In the next 50 years, it is critical to position those most impacted by climate change [to] have the power to design, own and determine the solutions and outcomes necessary to tackle the impacts. The impacts have dire and immediate consequences for these communities, making them more vested in moving solutions with urgency.”**

*—Helen Chin, Surdna Foundation*

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## **Public Education and Awareness**

In most cases, practitioners rely on public or civic organizations that have been embedded in communities over years and have long-standing trust and credibility with residents. Education and awareness campaigns are notable early activities associated with climate adaptation engagement, particularly when residents are confused over climate projections and challenged by understanding risk ranges and forecasting ambiguity. Over the past year, grassroots organizations have begun to hold conversations with their constituents, such as those held by West Harlem Environmental Action Inc. in New York City and the Gulf Coast Center for Law and Policy in the Gulf states (Louisiana, Mississippi, Alabama, Florida, and Texas). The Seattle-King County, Washington, Public Health Department has sponsored climate health workshops that reflect these two engagement components: leveraging trust and accessible information (APHA 2018).

Elected officials in the City of Satellite Beach, Florida, used climate projections as a vehicle for honest conversations with citizens about land use, the cost of various budgeting options, and collective decisionmaking.<sup>5</sup> Their engagement is one of the few instances in which local public officials have taken scientific information directly to citizens. National organizations such as Climate Central and the Climate Advocacy Lab have provided helpful tools for communicating climate change causes and effects to lay audiences.

However, little is known about the most effective communications and awareness-building techniques. Several types of studies could alleviate this lack of knowledge. For example, knowledge gained by tracking population-specific communication campaigns, culturally appropriate communication practices, and specific engagement scenarios for effectiveness could be used to support and expand the use of strategies for all communities. Similarly, testing the efficacy of information provided after a disaster versus information provided during stable periods would help determine the sustainability of residents' postdisaster decisions.

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**“We have to be able to get past the bias and assumptions we make about people to create space to see their humanity and the humanity of the entire community and to see the shared struggles and hopes as being related to our own.”**

—*Atyia Martin, All Aces*

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## **Public Participation**

Processes, of course, are as important to community engagement as preparation. Traditional community meetings and town halls still dominate, though formats vary across the well-studied community participation ladder from needs assessments, to charrettes, to feedback and presentations on already-formed projects. Few examples exist of the extensive use of social media engagement in climate adaptation planning beyond project-based input and online updates.

There is limited evidence that any one technique works better than others. Little is understood about the effectiveness of efforts to expand the inclusion of vulnerable populations in engagement and decisionmaking. Historical inequities that led to poor representation have not been well-studied. If climate adaptation-focused engagement is intended to lead to capital projects, services, or other programming, then knowledge of the effects of expanded inclusion on the nature of those solutions and the speed and costs of implementing them in relation to less inclusive engagement is needed. Assessments of perceptions of and satisfaction with solutions in relation to engagement levels would help practitioners understand how to balance urgency with democratic processes. The triggers for elected officials to embark on climate-focused engagement with citizenry and the role of governmental and civil-sector entities in conducting this engagement also require further study.

Fortunately, early efforts shed some light. Innovations in this solution set deal primarily with the catalyzing entity or “host” of the engagement. A few grassroots community organizations have developed their own climate plans without any formal public-sector or philanthropic oversight. The Southwest Workers Union in San Antonio, Texas, embarked on this process, leading to their eventual inclusion in the city’s formal planning effort. Catalyst Miami in Florida coordinates community-led input for the use of revenues from the Miami Forever Bond.<sup>6</sup> These engagement efforts are a likely model for others, provided they eventually yield returns and their processes are integrated into comprehensive planning efforts while respecting the integrity and authenticity of the grassroots solutions.

Climate-related community engagement faces three known challenges. The first involves the accuracy and quality of scientific information on the impacts of climate change for local communities. Informed decisions require clear and accurate information to be conveyed and actionable options to be presented. However, researchers have long debated the most effective ways of communicating complicated technical information (especially about the ranges of possible effects) to lay audiences (especially to populations who have been denied access to relevant information and education). Little clear evidence is available about which communication strategies work best for which populations, or when (for example, soon after a climate-related disaster). Numerous participatory tools have claimed success, but often without sufficient evidence of their outcomes.

A second issue is common across all public decisionmaking activities that require community engagement: who is involved. Questions about inclusion and representativeness are particularly complicated under climate adaptation scenarios because exposures to climate effects will vary from neighborhood to neighborhood—and even property to property—in the same communities. Underlying social and economic vulnerabilities ranging from not having hazard and health insurance to living in homes with certain construction exacerbate these disparities. In this context, achieving representativeness would require applying a broad pool of environmental and demographic markers. Some activists argue that given the far-reaching effects of climate change, every community member should be fully included.

The third challenge concerns the tension associated with the urgency of climate change action in relation to the extensive programming requirements, scheduling, and intensity of resources needed for authentic community engagement. Professionals working in climate adaptation noted the painfully slow pace of decisionmaking and the unrealistically low funding for climate change responses. Fully inclusive and trust-based participation requires time and money, neither of which climate responses can afford.

## Solution Set 2: Expand Existing Tools for Addressing Physical Disruptions

Given current projections for the next 50 years, this solution set is particularly relevant in the shorter term (10–25 years) for most American communities. Because the suggested actions build on the status quo in policy and finance, they are likely to be politically acceptable. These solutions minimize disruption in citizens' lives, though they may not sufficiently mitigate long-term disruptions, especially in regions at the frontlines of climate change effects, such as the Gulf Coast and southern Florida.

The obvious concern with this set of solutions is its perceived short-term and tempered approach to the longer-term dramatic challenges the United States faces from climate change. The rate of change of any one solution may also alter the distribution of burden as these tools are currently structured between individuals, private providers such as insurers, and government. For example, there is an implicit agreement between government (which funds defensive infrastructure that secures regions) and insurers (which help secure individual properties in regions). As one solution falters (e.g., current infrastructure gaps), another is affected (actuarially based insurance premiums). Further, many of these tools (such as property insurance) and their proposed revisions (e.g., climate-based municipal bond ratings)<sup>7</sup> can foreseeably perpetuate or worsen existing social and economic disparities. Unless mechanisms are implemented to ensure equitable access to the funds and knowledge resources associated with each tool, this solution set will be ultimately ineffective in addressing the question this Catalyst brief asks.

With some reform, expansion, and tweaking, however, many of the tools in this solution could have wider application. Some early examples of possible solutions are described below.

### **Stabilizing and Expanding Property Hazard and Health Insurance**

Current homeowners and hazard insurance policies for properties have limited coverage. If their purchase is voluntary because the properties lie outside narrowly defined geographic bounds, they are rarely taken up (Kousky 2016). As publicly provided insurance is reformed (including the National Flood Insurance Program and state-coordinated wind insurance pools), private insurance is expected to fill the void. Both, however, are increasingly unaffordable. Growing costs will serve as disincentives for the development and purchase of high-risk properties, and they will disadvantage existing owners and communities with few other options.

Insurance take-up associated with the clarity of requirements and benefits in different risk conditions is an ongoing question in the scholarly literature. Much of this work, which lies in the field of behavioral economics, considers the gaps in knowledge related to individual perceptions of risk and consequent behaviors and actions to address those risks (Kunreuther, Pauly, and McMorow 2013). A more practice-focused set of insurance questions centers on the spillover effects of insurance policy changes on other outcomes (e.g., housing costs). New, parametrically defined insurance pools and cooperatives are one proposed but untested solution among others as the industry is transformed (Ogden, Bovarnick, and Hoshijima 2015).

### **Scaling Technical Retrofits of Existing Infrastructure**

Most large cities and states are experimenting with additional requirements on infrastructure (transportation, water, storm water, energy, and defensive protections) in response to likely climate change effects like coastal sea-level rise and increased temperatures (CACC 2018). Typically, these requirements are applied to all new infrastructure, but they are increasingly specified for existing infrastructure that continues to be maintained, repaired, or retrofitted. These technical solutions vary according to the nature of local infrastructure networks. For example, Miami Beach, Florida, installed new water pumps to remove increased loads from sea-level rise and is currently elevating major roads.<sup>8</sup> Other jurisdictions have begun to increase the heights of dikes and levees. Still others, like Philadelphia and Washington, DC, are rethinking their entire storm water systems to reduce increased loads from projected climate change effects in sustainable, cost-effective ways (Kessler 2011).<sup>9</sup>

### **Enhancing Emergency Management Services**

The expected increase in severe hazard events such as hurricanes, tornadoes, and wildfires due to climate change has called into question the existing emergency management framework and the budget and operations associated with it. At the federal level, this reconsideration involves the authorities and the continuum of disaster mitigation through recovery. The statutory relationship between current emergency agencies like the Federal Emergency Management Agency, Housing and Urban Development, and the Army Corps prohibits comprehensive reform to the point where there is duplication of funding without sharing of data and other resources (Martín 2018). Many states (e.g., California) and large counties such as Memphis and Shelby County in Tennessee have begun to coordinate across existing governmental silos, especially between emergency management; housing, planning, and community development; and economic development authorities.<sup>10</sup>



## Scaling Current Infrastructure Finance

Jurisdictions have recently begun to issue climate-specific bonds (often labeled green or resilient bonds) that passed with major voter margins. Locations include San Francisco, California (for a sea wall retrofit); Houston, Texas (for Hurricane Harvey recovery infrastructure); and Miami, Florida (for multiple projects).<sup>11</sup> These bond issuances, like conventional general obligation bonds, are usually predicated on the jurisdiction's financial capacity and overall ability to repay the bond. With current bond raters threatening to consider climate risks in their jurisdictional scores, low-revenue jurisdictions will be at a severe disadvantage. Consequently, efforts are growing to expand existing federal grant programs (e.g., use of the Community Development Block Grant Disaster Recovery programs explicitly for disaster mitigation in community infrastructure). Some attention has been paid to “pay for performance” finance schemes and revisiting public-private partnerships for climate adaptation projects as well, though there are few examples given the limited revenue potential from community protections.

## Revisiting Property Law

More communities are experiencing chronic effects from climate change, like “sunny day” floods. Public infrastructure in these communities, such as roads and water networks, are subject to daily damage, leading some jurisdictions to forgo their maintenance and reconstruction. Consequently, property owners serviced by this infrastructure have threatened legal action for effectively taking the properties.

Many questions surround the currently dynamic state of legal evidence and precedent, particularly around public-sector property law in relation to individual takings, service provision, and acquisition. These gaps will be filled both by legal ruling and by the type of evidence used to justify it. At present, however, jurisdictions that have made no decisions or taken no action in these conditions are subject to legal action for not conducting appropriate predictive risk assessments. Buyouts, typically with federal funds and subject to rules like the Uniform Relocation Assistance and Real Property Acquisition Policies Act, are the current go-around. As more properties and communities face these concerns in the next 20 years, the legal challenges will increase. Cases are still working their way through the courts, so no precedents or examples exist. These cases, as well as the demographic, economic, and behavioral profiles of the legal parties in question, are unexplored terrain.

## Solution Set 3: Adopt More Comprehensive Site Adaptations

The third solution set involves comprehensive rethinking of land use, building techniques, property rights, and related governance changes that respond adaptively to climate change effects. These tools and solutions innovatively reconsider community design, architecture, and engineering. Their underlying assumption is that fundamental change is needed to respond to local climate change effects beyond tweaking of current services and resources. Physical interventions such as wetlands restorations and water conservation require increased social awareness, civil participation, governance, and collective action to function satisfactorily. Unfortunately, conventional political, industrial, and social attitudes make place-based climate adaptation solutions much rarer than the revision of existing tools.

### Green Infrastructure

Wetlands restoration projects, the most common adaptation technique, have the added benefit of storm defenses beyond their original flora and fauna protection. Many projects were initiated in the aftermath of crises. Flooding in the Midwest led to the acquisition of riverbanks for water protections that could be used as recreational parks.<sup>12</sup> A notable recent example includes the Gentilly Resilience District currently undergoing final planning stages in New Orleans, Louisiana, in the post-Katrina context, with funding from federal disaster recovery grants.<sup>13</sup> The project allows for water storage and discharge amid recreational and transportation networks. Similarly, the planned Hudson River project in Hoboken, New Jersey,<sup>14</sup> coordinates with neighboring municipalities to jointly store excess flood water in bioretention infrastructure tied to the cities' storm water drainage and combined with urban green infrastructure like recreational berms. Funds for this project came from post-Sandy recovery combined with the technical resources from the Rebuild by Design competition. Direct public-sector support could be complemented with revenue-generating efforts for these site adaptations, such as special assessment districts or fee-based "cobenefits" (like parks or fisheries).

Climate effects beyond sea-level rise and increased storm severity will receive different adaptation interventions. A few projects are underway. Phoenix, Arizona, is embarking on a major urban tree-planting initiative intended to both reduce the city's heat island effect (a climate mitigation action) while providing shade to reduce ambient temperatures on the street.<sup>15</sup> California experimented with water conservation techniques that, while not sustained, provoked conversations about how to develop water retention and access programs for future drought.

The design and engineering fields are rapidly exploring adaptation alternatives. For social scientists, though, theoretical questions arise from both physical and social solutions. Most of these questions have not been aired in practice, namely: Which communities (as opposed to an entire city or jurisdiction) are likely subject to adaptation strategies? How do inconveniences, costs, and benefits accrue to these communities? Some researchers have speculated that high-opportunity, “high-amenity” places will benefit from adaptation investments in the future while low-income communities will be displaced (Kahn 2010). A corollary to this debate is the concern over how neighboring jurisdictions will be affected by or cooperate with the adaptation efforts of a given community.

## **Retrofit and New Building Innovation**

Other place-based adaptation projects responding to rising sea levels include mass elevation, conversions to water-based transport (like navigable canals), and aquatic architecture. None of these adaptations have occurred in the United States. Indeed, there are no examples of broad adaptation developments, particularly in existing residential neighborhoods. Current examples generally are restricted to stringent regulations on new buildings or redevelopment of public and commercial spaces. Much like the infrastructure retrofits, individual residential structures could be redeveloped to better protect households while maintaining their financial stability with reduced insurance premiums. This residential redevelopment model is used in Alabama’s implementation of IBHS’s Fortified Home program.

Debates around the nature and quality of adaptation initiatives are rare because comprehensive site adaptation projects beyond single buildings or developments are rare. The few questions that have been raised have more to do with the operational and administrative costs of the analysis, design, and construction of multibenefit projects than conventional project development.<sup>16</sup>

Ultimately, debates about adaptation are primarily concerned with whether intentional development efforts coordinated for whole communities by their governments should be employed over market-based individual decisions about single properties facing the same climate challenges (Knappenberger and Michaels, n.d.).

## **Social Participation and Governance**

Both collective action and governance require additional development if adaptation is to be a feasible solution and not result in vastly disparate outcomes for communities. Except for traditional emergency preparedness exercises (such as a climate-related version of the “Great Shakeout” for earthquake

preparations) and nascent regional government coalitions (such as the Southeast Florida Climate Compact and Bay Area Climate Adaptation Network), examples of this type of solution don't exist.

The nature and processes of site selection for adaptation projects in relation to environmental risk, local demographic variation, and politics are unknown. As more projects take shape, patterns in decisionmaking should become evident. Until then, the process for redevelopment in existing neighborhoods, including land acquisitions, temporary relocations, and continuity of services (or, in the case of underserved populations, the expansion of services through the project's auspices) is unknown. Precedents in public housing redevelopment and urban renewal may shed light on research in this area and provide helpful technical assistance for future projects. Once projects are completed, numerous questions will arise about residents' outcomes, environmental performance, and economic benefits in relation to project costs.

## Solution Set 4: Relocate to a Safer Location

The final solution set involves abandoning the most high-risk geographic areas and resettling elsewhere. New settlements will face climate risks, but theoretically ones that can be addressed sufficiently with solution sets 2 and 3. Relocations of people and places, property buyouts, and the subsequent effects on receiving communities' housing, employment, economy, and culture will all be accelerated by climate change effects in places like low-lying coastal and river communities and deserts. Changing the fundamental pattern of human settlements may be more cost effective, politically expedient, and ethical in some cases than adapting current settlements.

The United States has a handful of planned relocations. Isle de Jean Charles, Louisiana,<sup>17</sup> and Newtok, Alaska,<sup>18</sup> both received federal funding in 2016 and 2018, respectively, for relocation of their residents. Relocation funds for several other Alaska Native villages are under consideration.<sup>19</sup> Both communities are small, and their residents are predominately indigenous. Their planned relocations have been highly contentious and are far from complete.

Individual household relocations can occur through "buyout" programs that typically rely either on disaster mitigation or recovery funds or because of repeat losses to federal insurance programs. This small pool of individual relocations is supplemented with county and city decisions to acquire properties because of perceived or realized environmental risk. These risks are often climate related though not necessarily documented as such. The process and outcomes of formal buyout programs vary widely (Brokopp Binder and Greer 2016).

Like adaptation decisions, the selection processes for relocation communities face many questions, particularly regarding consistent sets of criteria for relocation versus adaptation. Because the number of projects is so few, however, patterns can only emerge later. Current speculation suggests that low-income and disadvantaged communities are more likely to face relocation than higher-income communities, which will adapt.

Much debate has been generated about how fair compensation for original properties in Isle de Jean Charles and Newtok is monetized and the terms for ownership for relocated properties. The timing and stages of relocation are still in question for both, as well. Because these two examples involve a complete relocation from an original site to a new one, the decisionmaking associated with the location of the new site has been particularly controversial (and difficult to manage given public-sector transparency about land purchases working at odds with real estate speculation).

For the buyout programs, few restrictions exist on where recipients move. Debates around these programs focus on the incentives for moving. Yet, for both full relocation and partial buyout programs, numerous questions arise about the processes for selecting, coordinating with residents, and the operational stages for moving. Whether the choice is through community self-selection or eminent domain, the criteria and engagement processes are not well documented. Another notable knowledge gap is the process of valuation of assets, which determines whether a place or household is “salvageable” for adaptation purposes. A valuation of properties and possessions (not to mention non-monetized livelihoods, historic ties, and access to needed services) is also used to determine an individual household’s compensation in their new locale.

Outcomes for life opportunities, health, and service access are widely unknown. These factors are likely to be explored in more detail over the next decade despite the relocation and buyout cases not necessarily being representative of future moves. Along with basic descriptions of outcomes, comparative outcomes based on the type of movers (self-selected, assisted, or forced) and on single-property buyouts versus entirely relocated communities are unknown and will need significant study on the scale of past urban renewable and housing mobility projects.

Move destinations are also vastly understudied. Receiving communities are likely unprepared to provide the public services and private resources (e.g., housing, employment) for the newcomers. Future receiving communities have few resources or incentives to estimate, build capacity for, and integrate newcomers. Little is known even about nonformal movers (such as postdisaster resettlers) and how they have fared and whether the early welcome communities provided wanes over time.

# Building Knowledge Changemakers Need

Because there are so few cases of planned interventions in response to climate change risks (especially in the United States), vast areas of risk, communications, process, planning, and outcomes remain unstudied. Drawing on interviews and roundtable conversations with a broad array of changemakers, we identified seven priority areas in which knowledge-building could help inform and accelerate action that supports inclusive and equitable climate adaptation.

These knowledge-building priorities are relevant to all four solution sets. Understanding what mix of evidence is pertinent to the increasing risks levels is, in fact, an underlying component of the knowledge-building enterprise.

- **Assess the needs and framework for a climate safety net** so federal and state policymakers can identify critical gaps, strengthen existing programs, and develop new ones.
- **Uncover individual and household risk perceptions and behaviors** so local policymakers and planners can anticipate how people will respond to new incentives, regulations, and even immediate environmental hazards.
- **Measure inclusive engagement and equitable outcomes** so local officials and community leaders can create robust processes for affected people to exercise real voice and power.
- **Monitor and build local capacity and leadership** to develop and implement equitable climate adaptation strategies.
- **Evaluate changes in climate governance and property law** so public officials in regions across the country can develop and apply new models that span jurisdictions.
- **Integrate multiple-risk scenarios into population and provider projections** so local officials and community leaders have access to reliable risk projections that encompass multiple climate effects and their implications for people and places.
- **Develop tools for calculating value** so both public- and private-sector decisionmakers can assess the full range of costs and benefits (particularly for marginalized communities) of alternative investments in climate adaptation.

These knowledge-building priorities do not aim to address every interesting or unanswered question about climate change effects or adaptation. Rather, they seek to fill critical knowledge gaps for policymakers, practitioners, advocates, and philanthropists working to advance equitable and inclusive solutions. Each priority is discussed below. We focus on how new data, analytic tools, and evidence could help accelerate solutions to ensure all families can live in a physically secure home in a stable community prepared for the effects of global climate change.

## Priority 1: Assess the Needs and Framework for a Climate Safety Net

Combining public assistance services and programs that effectively address climate change vulnerabilities and effects is a work in progress. This combination includes general social safety net programs (e.g., unemployment and health insurance, housing assistance) and disaster mitigation, response, and recovery assistance programs that are offered only in times of acute crises (i.e., federally classified natural hazards) and not from chronic effects like sea-level rise. The brunt of long-term uninsured financial, health, and property shocks will be borne by low-income households. This imbalance is as true for climate-related disasters (Ratcliffe et al., forthcoming) as for climate-related chronic effects. Climate effects require looking at the intersection and redundancy in these programs or, as risks rise, developing an entirely new approach to protecting citizens.

Virtually all components of the safety net require determining which populations are eligible for assistance. This formula is complicated because some communities that fall outside traditional assistance programs (like middle-income households) may be at the highest risk of exposure to climate change effects (e.g., a household's occupancy of a repeat-loss home). Nonetheless, numerous instances have been documented of high-capacity households that have received assistance from related federal programs, such as the Federal Emergency Management Agency's Individual Assistance program. To provide an accurate framework for the climate safety net, documenting the current range of assistance programs must be combined with a needs assessment for low-income households that are particularly vulnerable to climate change effects.

Public-assistance programs must also be considered alongside private assistance, typically in the form of private hazard insurance but also through debt and foreclosure relief. A criticism of past disaster assistance is the moral hazard it creates by providing disincentives for insurance and other mitigation actions and behaviors. Combined with the issues addressed by priority 2 on risk perceptions

and behaviors, the safety net studies can help build a policy framework that supports efficiency and cost effectiveness while ensuring that no population is left behind due to climate change effects.

## Applying Knowledge to Accelerate Solutions

Laying out the precedents and potential format of effective solutions for individuals is a task for executive and legislative federal policymakers. Preliminary mitigation benefit studies focus solely on property savings and do not account for the plethora of other social and economic conditions requiring expenditures to maintain or alter. Federal decisions will inform state and local government contributions to local adaptation costs.

## Approaches to Knowledge-Building

*Program evaluation* is the driving approach to creating an evidence-based safety net. A primary start to building the evidence base around climate safety is the assessment of previous program expenditures and assistance receipt over time. Comparisons across similar moments of assistance (typically, after major disasters) would be particularly useful. This assessment could benefit from a variety of extant impact evaluations and cost-benefit analyses. With this foundational information, a new climate safety net could be constructed and tested. Scenario testing in which climate effects, populations, and assistance programs vary would help determine the appropriate mix of services that the federal government should employ under its current disaster authorities.

## Priority 2: Uncover Individual and Household Risk Perceptions and Behaviors

Historically, decisions about climate change effects have been privatized. Individuals have been left on their own regarding their selection in housing location and quality, their use of mitigating tools like hazard insurance, and the methods they employ to overcome chronic climate effects (such as alternative transit routes during “sunny day” floods or spending recreational time indoors during heatwaves). Too often, people avoid necessary climate-related decisions because of diminished memory and lack of understanding of the risks of future events. These factors create a perfect storm of inaction for individuals. Too many questions remain about what individuals choose to do and how they respond to incentives, regulations, and even immediate environmental hazards.



The literature regarding climate change communications tends to focus on interventions that build awareness of future climate change scenarios. The purpose of these interventions is developing a constituency for climate mitigation policies and rules or changing personal behaviors to reduce greenhouse gas emissions. Almost no studies consider how climate communications lead to changes in individual's climate adaptation. This gap will provide questions for researchers for the next 50 years as adaptation becomes a decreasingly sensitive subject in environmental advocacy and, in turn, environmental communications.

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**“I think the issue is what motivates people.... All the levers are different.”**

—**Debra Ballen**, *Insurance Institute for Business and Home Safety*

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Insurance take-up is a key subject in uncovering risk perceptions and behaviors. The behavioral challenges associated with sustained insurance policy coverage and the temporary effects of acute events in creating peaks in policy purchases and valleys in claims adjudication and customer satisfaction have not been well studied. By joining with colleagues in the insurance research field, researchers who study human adaptation to climate change could generate fruitful opportunities for demonstrations and pilots for testing insurance behaviors. Describing current insurance actions is a first order of business.

There are numerous corollary opportunities to build evidence, particularly related to the relationships between risk communication, risk behavior, and risk ownership across different demographic groups. Climate mitigation research, for example, includes many examples of testing the levers of interest (e.g., property maintenance costs, health, intrinsic environmental benefits) for different groups. Some experiments have been conducted regarding the balance of emotional, financial, and policy-based appeals. Similar studies on climate adaptation could be employed to better assess which groups are more likely to engage in climate adaptation individual actions or community planning, and when, in relation to foreseen versus realized climate effects.

## **Applying Knowledge to Accelerate Solutions**

Increased knowledge of individual decisionmaking motivators and incentives would be useful to both public- and private-sector entities. Public-sector agencies could use this information to help identify and implement the most effective awareness-building and behavior-changing techniques. Private-

sector organizations (specifically, health and property insurers) could use the information to help consumers make informed decisions about the risks to which their possessions are subject.

## Approaches to Knowledge-Building

*Pilots and demonstrations* that build off current evidence are likely to yield the substantial and applicable knowledge needed to move this field forward. To be successful, many of the solutions proposed above require targeted interventions to issues such as responses to actual risk and property valuations. Pilots will require testing in different geographic and demographic conditions as well as significant cross-disciplinary expertise from behavioral economists and psychologists.

## Priority 3: Measure Inclusive Engagement and Equitable Outcomes

A range of questions exists regarding how, when, and who should be involved locally in decisionmaking. Community participation in neighborhood, city, and regional developments has a long history of poor representation from affected stakeholders and poor practices and timing that led to perfunctory, typically required activities. As climate change effects are felt by all, these engagement strategies must be reformed. Evidence is necessary to understand how to increase inclusive engagement.

Process evaluations of current inclusive climate-change planning engagement activities could help shed light on how these activities differ from contemporary practice in other areas (like place-based redevelopment). These preliminary evaluations would be followed by implementation studies and technical assistance for pilots of new engagement actions. Subsequently, output and outcome evaluations would be conducted of the inclusive and science-rich planning processes on, respectively, actual representation and community satisfaction and on the resulting solution set decisions (enhancement of status quo, adaptation, retreat) defined in this paper. The tendency for certain engagement processes to lead to certain physical and program solutions is fundamental evidence for public-sector planning and budgeting.

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“Communities do have the solutions but, when it comes to planning, those voices are not included.”

–Tiffany Eng, California Environmental Justice Alliance

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All these evaluative priorities must coincide with another series of questions to define fundamental terms and needs assessments, starting with the following considerations:

- how vulnerable populations within a community are identified and how historical inequities are integrated into vulnerability definitions
- whether cultural and geographic variations in the engagement practices need to be employed
- what the capacity and credibility of local civil-sector organizations are to facilitate engagement and participate in coordination
- whether existing, statutory requirements for public input in federal, state, and local decisionmaking need to be modified
- what the effects of leadership and term limits have on the willingness of the public sector to formally engage in long-term planning and consequent community engagement

On this last point in particular, numerous anecdotal reports from our contributing changemakers refer to the effect of “not in my term of office” attitudes that require more exploration. Priority 4 focuses on the study of leadership in cities and regions for even initiating the process of climate adaptation.

## Applying Knowledge to Accelerate Solutions

Civil- and public-sector entities that have struggled with the robustness and representativeness from their community engagement efforts need better tools and communication strategies to plan for climate change effects. This need is particularly true for involving communities that have been especially marginalized and have long-term distrust of formal planning efforts.

## Approaches to Knowledge-Building

Effectively measuring engagement and outcomes will require **community-based participatory design research** along with rigorous qualitative data collection and observation analysis around the variety of

formats and language used in current and pilot community participation efforts. Reviews of past engagement improvements (e.g., in New Orleans post-Katrina) could also provide the needed findings to train the engagement officials of the future.

## Priority 4: Monitor and Build Local Capacity and Leadership

A consistent concern aired during changemakers' discussions was the inability of local communities to tap into the knowledge and financial resources necessary to make and implement decisions. This concern was most obvious in places with large gaps between revenue and risk or with term-limited leadership. The capacity of both public- and civil-sector entities is particularly critical to understand and eventually enhance because unlike private-sector organizations, these entities are directly responsible for citizens' outcomes. They have the power to make decisions that either integrate or ignore the effects of climate change in their communities.

Knowledge-building in this area is complicated by the number of contributing factors that can lead to communities' selection of solutions, including solutions that may exceed individual capacity and leadership indicators. A combination of preliminary explorations of effective capacity-building and technical assistance for the civil and private sectors will help uncover successful strategies as well as potential methods for measuring and analyzing these capacity considerations across communities.

Fortunately, some preliminary indicators provide low-hanging fruit for exploration. For example, communities' bond ratings are generally public. Assessing bond ratings against climate risks is an early way to define which communities are least able to address the greatest climate risks—particularly as those communities are increasingly likely to be “punished” by bond rating agencies simply for being at risk. Data regarding expenditures are available from virtually all US cities, counties, special districts, and states through Comprehensive Annual Financial Reports. Information on staffing in various governmental functions is also available, though less readily. Some data are available for nonprofits in these areas through other sources (such as Urban's Nonprofit Almanac). In short, researchers can piece together a picture of communities' capacity by using multiple sources of existing data. Similarly, demonstrations and technical assistance can help understand how that capacity can increase in relation to climate change effects.

Ultimately, this work can lead to evidence-based improvements in the curricula offered by advocacy intermediaries in the United States on nonprofit capacity. It can also provide concerned citizens

with methods to assess their community's financial, operational, and leaders' capacity to create climate policies and programs more transparently. It could also lead to guidance for elected officials on how to broach engagement and action, particularly regarding honest conversations on the costs and benefits of different solutions, while responding to the needs of various populations within that community.

## Applying Knowledge to Accelerate Solutions

State and federal entities are well aware of gaps in the local capacity to define, prioritize, and enact solutions in other program areas. The requirements of climate change action will exacerbate current gaps in staff, knowledge, finance, and strategy. If state and federal entities had the tools to identify and assess those gaps, they could design technical assistance programs and harness other program resources or expertise. They could also develop incentive programs to ensure that the communities most in need develop those capacities and sustain them over the long term while addressing the pressing short-term actions.

## Approaches to Knowledge-Building

Ultimately, the goals of climate-related capacity-building knowledge are to ensure that communities have the necessary internal skills and resource networks. Little is known about how these skills and networks vary in different places. Several research channels already exist for documenting some components of local governmental capacity (such as municipal bond ratings for financial capacity). However, many other components (such as staff knowledge and operational efficiency) are still primarily theoretical. Testing these potential measures through *demonstrations* and, more important, evaluating their disparate effect on community outcomes could ensure that external aid providers develop the right mix of capacity assistance.

## Priority 5: Evaluate the Effects of Climate Governance and Property Law Change

A complement to priority 4 on local capacity involves the regional coordination and national precedents that jointly determine the authorities and legal frameworks that will define that capacity in the long term. Currently, the constitutional and legal framework for addressing large-scale environmental change is insufficient for two major reasons: climate change effects ignore jurisdictional borders, and

much development occurred prior to most communities' awareness of the risks associated with climate change. Changing the nature of local land use law around potential climate change-related risk has few precedents. Norfolk, Virginia, approved changes in land use law in response to coastal flooding only.<sup>20</sup> A multitude of questions persists regarding the legal basis for climate-related decisions and how to implement them.

The effectiveness of regional governmental coalitions such as those in Southeast Florida and the San Francisco Bay Area needs assessment. These coalitions are intended to share information and resources and, in turn, expedite climate decisionmaking. Effectiveness, however, extends beyond time and costs and even the cobenefits that may come from any solution's selection. Effectiveness also rests on the disparate outcomes that communities with preexisting vulnerabilities may experience. Analysis of these efforts is critical to informing regional government policies or noting how regional coalitions between jurisdictions exacerbate challenges.

A corollary to the collaboration between jurisdictions in a region is the exploration within jurisdictions' own functional boundaries. Functional authorities, bureaucracies, and operational silos are noted as key challenges to climate-related decisionmaking and implementation. Yet little is known about how an ideal local government would be structured, much less how it would look for cities of different sizes, citizen composition, and resource constraints. A wealth of questions need to be answered to map governmental structure and resource capacity against climate-related actions as the latter evolve in the next decade.

Local land use rules and law are another major administrative constraint to local climate decisions. This constraint requires extensive and ongoing monitoring and documenting of how cities are making—or not making—regulatory and land use decisions. In many cases, vulnerability analyses and comprehensive plans may expedite decisions that consider appropriate legal and financial avenues.

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**“Climate change and sea-level rise pose challenges to a legal system that assumed nature was basically static. Law—especially law on property, land use, and infrastructure—will often serve to allocate the costs of climate change and sea-level rise. Local governments should be creative and proactive in understanding how law can achieve or derail their desired policy directions.”**

*—Thomas Ruppert, Florida Sea Grant*

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## Applying Knowledge to Accelerate Solutions

Legal counsel for virtually every jurisdiction is in need of improved tools and criteria for encouraging or discouraging growth and public investments. As precedents are determined, additional guidance about the potential options faced by jurisdictions and their expected fiduciary risks will also be needed. High-capacity jurisdictions may be limited by the authority they imbue to individual agencies and the complex relationships they maintain with neighboring jurisdictions. Local regional government authorities can use information about climate stakeholder entities to promote de-siloing in specific activities. Breaking down silos would also improve longer-term public efficiency beyond climate challenges.

## Approaches to Knowledge-Building

The components of evidence that constitute legal proof are a work in progress. These varied components need to be monitored to determine how they will apply to other low-resource communities and to low-income, vulnerable populations in all communities. *Comparative studies* on land use laws and governance structures (and their effects on core outcomes such as property values and insurance coverage) will help provide the tools for proposing interventions.

## Priority 6: Integrate Multiple-Risk Scenarios into Population and Provider Projections

Much of the research on climate change effects has focused on sea-level rise and increased storm severity. Yet, there are many other climate effects that will disproportionately burden communities. Further, many groups within those communities also suffer from other historical environmental disparities such as poor air quality from legacy manufacturing sites, limited environmental amenities (e.g., tree canopies) and few emergency facilities (including cooling shelters). Understanding how these less well-known scenarios play out and intersect for disadvantaged communities is as critical as the major property and geographic changes at the nation's coasts.

Most public-sector climate planning and community engagement for climate actions, however, reflect climate change research and focus on sea-level rise. At best, some general awareness programs introduce the multiple consequences associated with climate change effects without necessarily leading to direct actions or selections of solutions across the status quo–adaptation–relocation continuum. This narrow focus ignores many fundamental opportunities to explore provider capacity in communities with regard to other potential climate effects and consequences (e.g., increased frequency

and severity of heatwaves and storms, duration of droughts and pestilence, and spread of vector-borne diseases). Complementary explorations would identify the populations most likely to suffer from these other climate change effects.

Evaluating the capacity of public and private health providers to respond to new health challenges in their communities is a prime early research opportunity (Robert Wood Johnson Foundation 2017). Assessing local emergency facilities like cooling stations and disaster shelters is another. Each of these questions about local capacity ties into the second set of questions about disparities in access to providers, services, and technologies by different groups. For example, the effects of heatwaves on health and mortality can be tempered by indoor air conditioning, but not every household has air conditioning or can afford it. Describing these disparities is critical to identifying current vulnerabilities and appropriately informing public decisions about where and how to spend resources.

Finally, the introduction of multiple risks from climate change extends beyond public responses to individual households and populations and jurisdictions' constituencies. Infrastructure decisions that focus solely on one effect (like sea-level rise) may exacerbate other effects (like salinity or pests). Building knowledge around all effects can help promote multipurpose infrastructure.

Understanding the effectiveness of services (e.g., public and private health providers, emergency management) and how to finance them is complicated because their control lies with different governmental levels and agencies and different actors from the public and private sectors. The few examples of these solutions provide a limited statistical sample for more rigorous evidence-building. Although quantitative data are lacking, qualitative data from these examples fuel case studies concerning who controls existing tools, to what degree, and at what financial and societal costs.

## **Applying Knowledge to Accelerate Solutions**

Though all local government and quasi-government entities could benefit from multiple-risk scenarios, actors who traditionally do not receive the same level of attention in climate planning (like health providers) will particularly benefit from understanding the breadth of challenges their communities will face as climate change effects increase.



## Approaches to Knowledge-Building

*Population simulation* models have yet to be overlaid with the broad and varied risks associated with climate change. Such empirically based work could be used to highlight which risks pose disparate challenges, and how, so communities can invest accordingly.

## Priority 7: Develop Tools for Calculating Value

Much evidence is needed to develop tools for determining the costs and benefits for any of the solution sets. More importantly, we need to know how these costs and benefits are determined based on existing valuations of assets that historically have disadvantaged communities and households. Anecdotes abound regarding “climate gentrification” on the one hand combined with disparities in funding for climate adaptation and defensive infrastructure in existing, wealthier communities on the other. This priority is as much about uncovering ways to support action in disadvantaged communities as it is to measure disparities in resources going to all communities.

The first order of knowledge-building is the documentation of how cost-benefit analyses have been used by federal and private funders to determine the feasibility of climate adaptation-related actions. Funders’ use of cost-benefit analyses and “single-number” decisionmaking in climate adaptation is murky. They must integrate a significant amount of uncertainty due to climate effect projections. They cannot easily monetize many of the benefits from the proposed development, either because benefits are communal or are not revenue-producing. Moreover, they do not often consider valuations of properties and conditions in different stakeholder communities fairly or accurately. Asset identification and measurement in traditionally disadvantaged communities, including cultural and historical facilities and social ties, are typically undermeasured if measured at all. Poor determinations of value could too easily result in arbitrary decisions to relocate some households, invest in others, and leave others to the free market and the elements. Describing how this process occurs currently and whether it evolves over time as climate risks increase is critical.

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“When you ask people to prepare for climate change, they are making a financial decision. If they can’t afford to leave, they have to put themselves at risk. How do we create financial safety nets for them when bad things happen? I’m confident with better data, technology, and computational power the insurance industry will soon be able to address these challenges.”

—Alex Kaplan, SwissRe

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The opportunity for building knowledge around valuation centers on looking at the price signals sent out by insurers and real estate markets regarding climate risks to assess whether there are patterns of investment (personal, private, and governmental) that favor climate decisions in some places while disadvantaging others. These patterns could lead to valuations that encourage public relocation or a status quo disinvestment for poorer neighborhoods. Lessons from this evidence-building could be used to experiment with policy levers to encourage appropriate expenditures, such as a pay-for-success program between governmental entities in which emergency management authorities pay for improved infrastructure, adaptation, or relocation before acute events.

## Applying Knowledge to Accelerate Solutions

Local governments are faced with hard choices regarding investments in climate adaptation solutions and the location of those investments in relation to all options and communities in their jurisdictions. Providing a neutral starting point of criteria and assessments could help local governments make reasoned choices or, at the least, introduce monetized costs and benefits into the pool of information shared with residents.

## Approaches to Knowledge-Building

Foundational work for this priority involves the study of compensation and valuation in relation to individual properties in a community and the collective value of a community in a region. Unlike past litigation regarding appropriate compensation at a given time, there is a need to run *projections* of compensation to future risks from climate effects in addition to the information local governments are receiving currently on the nature of those risks.

# Notes

- <sup>1</sup> See “Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments,” IPCC (Intergovernmental Panel on Climate Change, press release, October 8, 2018, <https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/>); and National Climate Assessment, “Fourth National Climate Assessment: Summary Findings,” U.S. Global Change Research Program, <https://nca2018.globalchange.gov/>.
- <sup>2</sup> Also see Ashvin Dayal, “The Need for Climate Change Resilience,” Rockefeller Foundation blog, August 27, 2014, <https://www.rockefellerfoundation.org/blog/need-climate-change-resilience/>.
- <sup>3</sup> Our focus on climate change adaptation is not meant to diminish the scholarly or policy focus on climate change mitigation. Opportunities are ongoing for knowledge-building and exploring solutions in climate mitigation (e.g., equitable energy-efficiency and renewable energy programs, nonfossil fuel transportation access, and sustainable city design), especially with a focus on vulnerable populations. However, research gaps are wider in climate adaptation, and actions to reduce effects on vulnerable populations are that much more pressing. We have chosen not to let current debates regarding the nomenclature for adaptation solutions inhibit possible actions as presented in this brief.
- <sup>4</sup> Emily Peiffer, “Bouncing Forward: An Interview with Dr. Atyia Martin about Equity, Resilience, and Climate Change,” Next50 blog, Urban Institute, January 23, 2019, <https://next50.urban.org/article/bouncing-forward-interview-dr-atyia-martin-about-equity-resilience-and-climate-change>.
- <sup>5</sup> Deepa Fernandes, “One Small Florida City Tries to Adapt to Climate Change, Mostly Alone,” PRI’s *The World*, December 1, 2017. Available at <https://www.pri.org/stories/2017-12-01/one-small-florida-city-tries-adapt-climate-change-mostly-alone>.
- <sup>6</sup> Michael Hu, “Climate Resilience and Local Resilience, Catalyst Miami, July 19, 2017, <https://catalystmiami.org/climate-resilience-local-engagement/>.
- <sup>7</sup> Christopher Flavelle, “Critics Say Bond Rating Agencies Ignore Municipalities’ Climate Risk,” *Insurance Journal*, November 5, 2018, <https://www.insurancejournal.com/news/national/2018/11/05/506538.htm>.
- <sup>8</sup> Alex Harris, “Miami Beach’s Future Is ‘Uncertain,’ Experts Say, but Sea Rise Pumps Are a Good Start,” *Miami Herald*, April 19, 2018, <https://www.miamiherald.com/news/local/community/miami-dade/miami-beach/article209328849.html>.
- <sup>9</sup> “Residential Stormwater Billing,” City of Philadelphia, accessed March 21, 2019, <https://www.phila.gov/water/wu/stormwater/Pages/ResidentialSWBilling.aspx>; and “Stormwater Retention Credit Trading Program,” Washington, DC, Department of Energy and Environment, accessed March 21, 2019, <https://doee.dc.gov/node/648432>.
- <sup>10</sup> “California Climate Strategy,” State of California, accessed March 21, 2019, <https://www.climatechange.ca.gov/>; “NDRC,” Memphis-Shelby County Office of Sustainability, accessed March 21, 2019, <https://www.sustainableshelby.com/ndrc>.
- <sup>11</sup> John King, “SF’s Embarcadero Seawall Measure Wins Easily,” *San Francisco Chronicle*, November 6, 2018, <https://www.sfchronicle.com/politics/article/SF-s-Embarcadero-seawall-measure-on-track-to-13369575.php>; Gavin Dillingham, “We Passed the Flood Bond. Will It Be Enough?” *Houston Chronicle*, September 10, 2018, <https://www.houstonchronicle.com/local/gray-matters/article/hurricane-harvey-houston-flood-bond-investment-13217782.php>; and “Miami Forever Bond,” City of Miami, accessed March 21, 2019, <https://www.miamigov.com/Government/Departments-Organizations/Capital-Improvements-OCI/Miami-Forever-Bond>.

- <sup>12</sup> Barb Ickes, "Flood of '93: How It Changed the Quad-Cities," *Quad-City Times*, July 6, 2018, [https://qctimes.com/news/local/flood-of-how-it-changed-the-quad-cities/article\\_f07f2394-8c7d-5bf1-8f80-53397e13e7ec.html](https://qctimes.com/news/local/flood-of-how-it-changed-the-quad-cities/article_f07f2394-8c7d-5bf1-8f80-53397e13e7ec.html).
- <sup>13</sup> City of New Orleans, "Gentilly Resilience District," last updated September 14, 2018, <https://nola.gov/resilience/resilience-projects/gentilly-resilience-district/>.
- <sup>14</sup> Rebuild by Design, "Hudson River Project: Resist, Delay, Store, Discharge," accessed March 21, 2019, <http://www.rebuildbydesign.org/our-work/all-proposals/winning-projects/nj-hudson-river-project-resist-delay-store-discharge>.
- <sup>15</sup> William Yardley, "In Phoenix, an Ambitious Plan Aims to Cover 24% of the Metropolis with Tree Shade," *Los Angeles Times*, July 26, 2016, <https://www.latimes.com/nation/la-na-sej-phoenix-arborist-20160715-snap-story.html>.
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- <sup>20</sup> "Zoning Rewrite in Norfolk Offers Potential Breakthrough on Adaptation," Wetlands Watch blog, December 30, 2018, <http://wetlandswatch.org/directors-blog/2018/5/29/zoning-rewrite-in-norfolk-offers-potential-breakthrough-on-adaptation>.

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