



# WATER AND DISASTERS: RISK, RESILIENCE, AND ADAPTATION

A Report from the 2022 Aspen-Nicholas Water Forum



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**The 2022 Aspen-Nicholas Water Forum** is the eleventh water forum in the Aspen Institute and Nicholas Institute partnership. The first, in 2005, on water, sanitation, and hygiene in the developing world, produced *A Silent Tsunami*, which made a material contribution in advancing priorities in U.S. foreign assistance for basic water services. The report ultimately helped spur passage of the Paul Simon Water for the Poor Act. The third forum, in 2015, on water and big data, catalyzed a dialogue series that led to the 2017 report: [Internet of Water: Sharing and Integrating Water Data for Sustainability](#) whose recommendations are currently being implemented by the [Internet of Water](#) project at the Nicholas Institute. The 2020 and 2021 forums on water affordability led to a dialogue series culminating in the 2022 report: [Toward a National Water Affordability Strategy](#). The success of these endeavors provided the impetus for additional forums focused on water concerns in the United States. <https://www.aspeninstitute.org/programs/energy-and-environment-program/aspennicholaswaterforum>

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# PREFACE

Disasters, both natural and anthropogenic, have shaped water management and policy in the United States over the last 100 years. Federal, state, and local water-related policies, practices and infrastructure have often been designed and implemented in the wake of disasters. The response and recovery to disasters has consumed substantial spending at all levels of government, the private sector and individuals. In some areas, frequent flooding is outpacing the ability for communities to respond, while in other areas the wildfire season has expanded to create a “fire year” instead of a “fire season”. Cyber-security and terrorism threats require continual training of water sector employees, and expand the needed expertise of utilities and agencies. The emergence of contaminants, coupled with new regulations to protect public health, require enormous additional resources and technology development. Back-to-back catastrophes (such as Hurricanes Harvey, Irma, and Maria in 2017) can overwhelm not only local and state capacity, but also the federal government’s capacity to respond. Emergency responders, communities and homeowners can become entrenched in a perpetual cycle of response and recovery rather than proactively managing for the future. As more individuals are exposed to hazards, how we respond to and recover from disasters has a significant impact on the well-being of the community.

The 2022 Aspen-Nicholas Water Forum explored **what must be done to ensure the water sector becomes more resilient to water-related disasters and how can communities navigate and prepare for the impacts of increasingly common water-related disasters?** How do we reconcile different values as individuals, businesses and government negotiate who receives resources to mitigate, adapt, and recover?

The annual Aspen-Nicholas Water Forum convenes thought leaders to address ongoing challenges to water sustainability in the United States. Participants come from the private sector, government, academia, and non-governmental organizations—representing expertise in industry, finance, philanthropy, government, academia, agriculture, food and technology companies, investors and entrepreneurs. Topics discussed include big data, innovative financing, water quality, and water affordability. The common thread linking each forum is the fundamental question of **what does good water governance look like for the United States?**

Each year, the Nicholas Institute and Aspen Institute coauthor a summary of the forum. Not all views were unanimous nor was unanimity and consensus sought. Forum participants and sponsors are not responsible for this summary’s content.

**We thank the following sponsors for their generous support of the forum:** BHP Foundation, Innovyze – an Autodesk Company, ByWater Institute at Tulane University, The Freshwater Trust, Xylem, The Refuge Resource Group, Esri, and The Water Research Foundation.

# VISION

The Aspen-Nicholas Water Forum seeks to explore the fundamental question of “what constitutes good governance for water?” What are the values and principles shaping water governance in terms of equity, liberty, efficiency and community? What is the ideal scale of decision-making for water? How are resources allocated? What is the legacy of these values on water governance, and what do we want our future to be? Traditionally, we have framed these types of questions through O’Toole’s (1993) governance compass (**Figure 1**). However, several participants noted that liberty is not inherently opposed to equity, nor are community-based approaches opposed to efficiency. In response, we are reframing the compass to reflect a series of governance choices that occur along a continuum – such as the scale of decision-making and activities, resource allocation, and incentives. There is a plethora of governance choices that are continually being made and implemented at multiple scales. For example, individuals may choose to flood proof their home, local communities determine how floodplains are developed, and the federal government may develop flood insurance programs (and all of these may occur at the same time). However, different scales of governance or different branches of government many have competing goals and objectives that inhibit the ability to meet desired goals and create an intractable gridlock into the status quo.

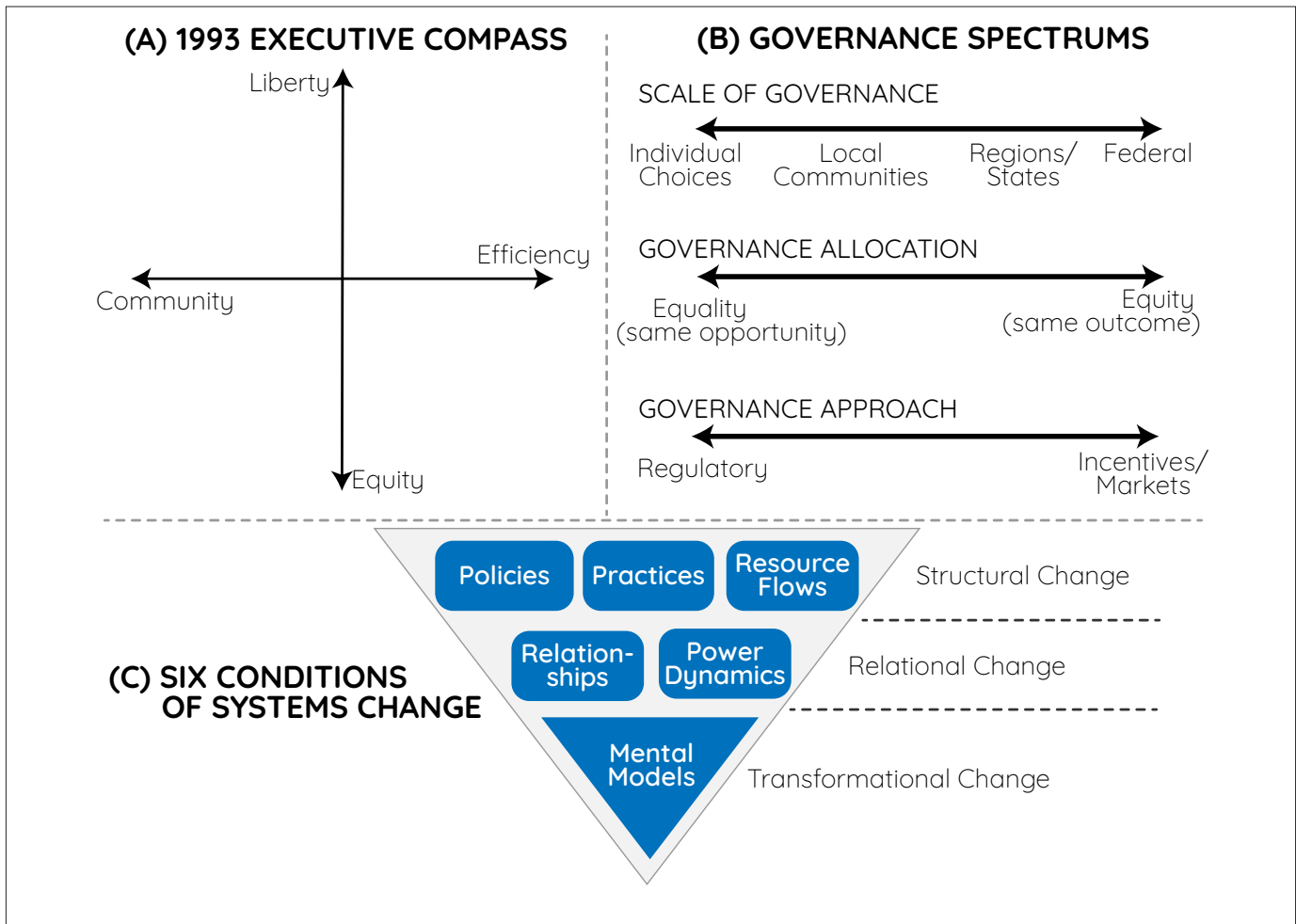
The question of what constitutes good governance remains at the forefront of disasters and resilience. Disasters present complex challenges that expose where governance is less effective than we would hope. Complex problems, like how we respond and adapt to disasters, remain intractable due to a myriad of constraints held by different actors within the system (here the system refers to the disaster cycle as described in the Introduction). Kania *et al.* (2018) proposed that six independent conditions tend to hold intractable systems in place, each of which must be addressed.<sup>1</sup> The first three conditions are policies, practices, and resource flows that require structural changes to move the system. Here, we explore the policies, practices, and resource flows that keep us locked into the current disaster cycle and continue to undermine our ability, as a society, to be resilient when confronting disasters.

The next two conditions require relational change and focus on addressing relationships and power dynamics. What new connections must be formed and how is decision-making power distributed in ways that thwart our ability to become more disaster resilient? In short, who makes decisions, and at what scales are those decisions being made? What are the intractable actors and how can they be aligned? Are we prioritizing equity of end results, or are we prioritizing equality of processes and programs?

Underpinning the structures and relationships that constitute governance are mental models that form our fundamental conceptualization of, and approach to, complex problems. There are often two mental models at work – (1) explicitly stated values and verbal goals (e.g. we want to become disaster resilient) and (2) implicit and often unconscious values that are shown by current outcomes (e.g. we continue to incentivize rebuilding back to normal). To get at the root of these challenges, and how we conceptually frame possible solutions, we must explore the underlying beliefs and assumptions that shape our response to disasters in the U.S. Can we make some of those underlying beliefs more explicit so that we can begin to address and potentially reform the structures and relationships needed to reach desired outcomes?

The 2022 Aspen-Nicholas Water Forum **sought to understand our current mental models to disasters and to re-imagine how the water sector and communities could become more resilient in a rapidly changing world.**

<sup>1</sup> J. Kania, M. Kramer, and P. Senge. 2018. [The water of systems change](#).



**Figure 1.** (A) Adopted from *The Executive's Compass* (1993).<sup>2</sup> (B) Translating governance choices from a compass to spectrums. (C) Adopted from Figure 1 in *The Water Systems of Change* (2018).<sup>3</sup>

<sup>2</sup> J. O'Toole. 1993. *The Executive's Compass: Business and the Good Society*.

<sup>3</sup> J. Kania, M. Kramer, and P. Senge. 2018. *The water of systems change*.



# EXECUTIVE SUMMARY

This forum focused on **understanding our current mental models and governance approaches to disasters and how to make the water sector and communities more resilient in a rapidly changing world.** The policies and practices for disasters were developed in an era when disasters were relatively rare. In recent years a disaster was impacting some community once every three days. If we rely on the status quo, reacting to disasters and rebuilding, we will exacerbate long-term nascent societal problems. Some communities will never recover. Disaster refugees will change the social fabric of communities across the U.S. Indeed, disasters and population migration are two problems that seem to lack solutions. In the U.S., 2/3 of counties have lost population, creating slow disasters of maintaining infrastructure to reliably serve the remaining population. Post disasters, populations may migrate and create a similar situation of rebuilding infrastructure that will be under-utilized and create financial hardships for the remaining population. Population loss on top of climate disasters will be a reality for most of America and often results in negative public health outcomes, of which water is one facet, as the revenue base supporting services disappears.

The mindset that disasters are rare and the goal is to recover back to the status quo must change as the number and cost of disasters have increased, populations have become more migratory (eroding social fabric and resilience of the community to respond), and wealth inequities have expanded that leave a third of the population without the ability to afford insurance or respond to an emergency. Policies need to shift from prioritizing recovery post-disaster to prioritizing resilience through better preparedness, mitigation, and adaptation. Governance is needed to make structural changes in policies, practices, and resource flows.

How disasters affect local governments, particularly water and wastewater utilities, merits particular focus across the U.S., and across sectors. Too often, and by necessity, utilities focus on their current condition and getting through the coming year, or even months. They lack the ability or impetus to envision the challenges of their situation in a warming climate with more precipitation extremes and water uncertainty. Yet water and wastewater utilities are anchor infrastructure in any community; if they fail or are disrupted, the impact on the community can be crippling.

More generally, disasters reveal a growing reality across the U.S.: too many families, too many utilities, and too many communities are financially fragile. They lack the resources to recover in any way from disruptions, but particularly from disasters. Without such resources, these families or communities will never be able to rebuild to even pre-disaster conditions, thus leaving them in a constant spiral, stumbling from one crisis to the next, with no ability to invest in moving forward.

There is a need to adjust policies across levels of government and across sectors of the economy. Current policies and practices do not incentivize the right behaviors – whether insurance or buy-outs – resulting in funds dedicated for specific behaviors to be under-utilized. As droughts cripple the Mississippi and Colorado Rivers, and as atmospheric rivers pummel California, it is time a different model for how the water sector responds to disasters.

# INTRODUCTION

Disasters, both natural and anthropogenic, have shaped water management and policy in the United States over the last 100 years. Federal, state and local water-related policies, practices and infrastructure were designed and implemented in the wake of disasters, whether flooding of the early-20th century or water contamination in the mid-century. The response and recovery to disasters has consumed substantial spending at all levels of government, the private sector, and individuals. And yet, disasters are outpacing the ability for communities to respond. In California, the wildfire season has expanded by 75 days to create a “fire year” instead of a “fire season”. In Florida, “sunny-day” flooding is making areas within some communities uninhabitable. Cyber-security and terrorism threats require continual training of water sector employees, and expand the needed expertise of utilities and agencies. The emergence of contaminants, coupled with new regulations to protect public health, require enormous additional resources and technology development. Back-to-back catastrophes (such as Hurricanes Harvey, Irma, and Maria in 2017) can overwhelm not only local and state capacity, but also the federal government’s capacity to respond. Emergency responders, communities and homeowners can become entrenched in a perpetual cycle of response and recovery rather than proactively building a future.

Disasters are shaping our society as the vulnerable are placed in high risk areas, in harms way. Continued pursuit of growth and expansion has too often led to unrestrained development in vulnerable locations coupled with limited regulations for building codes and business practices. In many instances, the natural ecosystems that provided protection (trees and root systems that prevented landslides, wetlands that absorbed and cleaned water, dunes that protected coastal erosion, etc.) were degraded in favor of development.<sup>4</sup> People want to live near water, which exacerbates hazardous conditions: today over 40% of US residents live along coastlines, an area prone to flooding and deeply affected by sea level rise. As more individuals are exposed to hazards, how we respond to and recover from disasters has a significant impact on the well-being of any community.

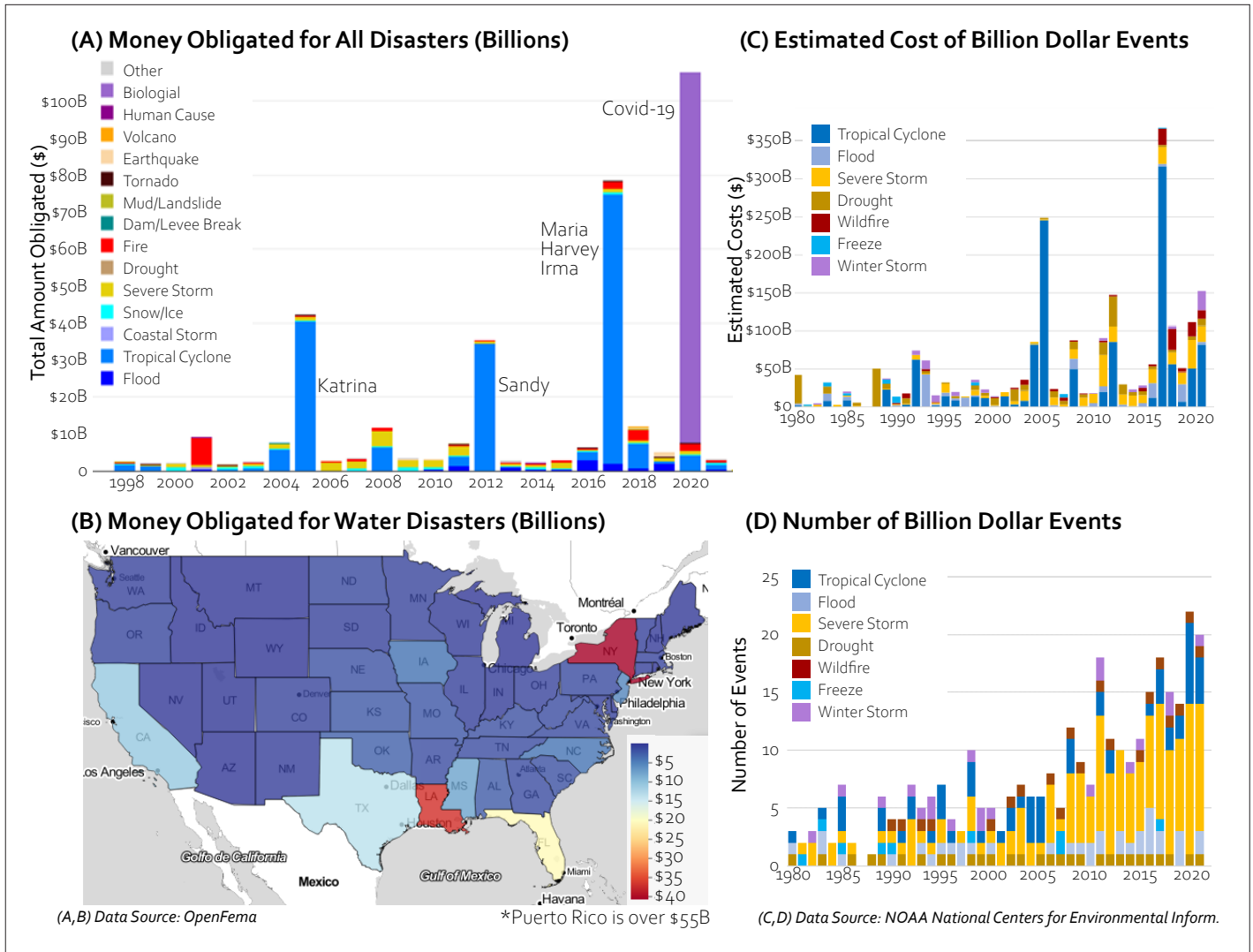
This forum focused primarily on water-related disasters. While some disasters, such as floods are punctuated events that require response and recovery efforts, other disasters, such as droughts create chronic conditions that require adopting to a new normal. Emerging contaminant driven disasters can be both punctuated events (such as Flint, MI or when boil advisories occur) and chronic conditions that require new treatment technologies (such as PFAS/PFOA) that can create financial shocks to the community. At this year’s water forum, we explored **what must be done to ensure the water sector becomes more resilient to water-related disasters and how can communities navigate and prepare for the impacts of increasingly common water-related disasters?**

## Disaster Context

Disasters are a serious disruption of the functioning of a community or a society. The risk or impact is shaped by how a hazard intersects populations, infrastructure, and businesses (i.e., who is exposed to the event) and the capacity of the community to respond (i.e., who does and does not have resources or capacity to recover). Disasters are by definition traumatic as they, at least for a time, overwhelm the capacity of a household, a business, a local community, or perhaps even a state or a nation to respond.

<sup>4</sup> Montano, S. 2021. Disasterology: Dispatches from the frontlines of the climate crisis.

In the U.S., the number of disasters receiving federal aid has increased over time as policies (particularly the 1988 Stafford Act; Appendix IV) and the risk landscape have changed. Both the number and cost of disaster declarations are trending upwards with costs growing at an alarming rate. The federal government obligated \$349B in major disaster declarations alone since 1998 (Figure 2A), of which 61% was accrued from 2015 onward. Excluding the Covid-19 pandemic, which impacted water service providers across the country, over half (53%) of water-related disasters were concentrated to a few states and territories: Puerto Rico (over \$55B), New York, Louisiana, Florida, Texas, California, and Mississippi (Figure 2B).



**Figure 2.** (A) Federal dollars obligated for all types of major disasters. (B) Federal dollars obligated for water-related disasters (Coastal Storm, Flood, Drought, Fire, Hurricane, Severe Storm, Snow/Ice). (C) Estimated cost and (D) number of billion-dollar weather and climate related events.

The amount spent by the federal government in a major disaster declaration is a fraction of the actual costs incurred. For a sense of scale and to track impacts of weather-related disasters, the National Oceanic and Atmospheric Administration (NOAA) tracks a specific subset of disaster costs – large weather and climate related disaster events (defined as costing more than \$1B to recover).<sup>5</sup> This NOAA data shows that, adjusting for inflation, since 2011 only one year had fewer than 10 weather-related events costing over \$1B (2014 had 9 events). Prior to 2011, only two years had 10 or more events (1998 and 2008) (Figure 2D). The last 5-years cost an average of \$157B per year, or \$473 per person in the U.S. for weather-related disasters.

<sup>5</sup> NOAA NCEI. 2022. U.S. Billion Dollar Weather and Climate Disasters.

At the individual level, the costs of any disaster can overwhelm households. A third of Americans could not afford a \$400 emergency<sup>6</sup>, making many Americans exceptionally vulnerable to any disaster because they lack the financial resources to create a disaster preparedness kit, purchase insurance, evacuate in a disaster, or navigate layers of paperwork following a disaster. Recovery for these households, if recovery ever occurs, is achieved in years or decades, if at all. **Being perpetually under-resourced is an on-going, chronic disaster for some households that is intensified during a punctuated event.** One of the primary ways to build resilient communities may be to begin addressing the source(s) of wage stagnation and poverty.

Climate projections suggest global temperatures could reach 2.4°C to 3.2°C (4.3°F to 5.8°F) warmer in a few decades with more extreme precipitation events (both flood and drought). Global temperatures are 1°C warmer now and current precipitation extremes are more frequently overwhelming infrastructure that was built decades earlier and designed to handle less frequent extremes. Precipitation extremes are complex because we need infrastructure that can manage opposing hydrologic extremes that can occur in the same geographic area. For example, in July of 2022 the US Army Corps of Engineers was issued a new directive to assist in addressing drought and within four months there were six 1,000-year precipitation events in the U.S. that impacted the Corps of Engineers infrastructure.

Our future will need to accommodate climate extremes, yet most disaster recovery policies still incentivize or require communities to build back to pre-disaster conditions, i.e., to replace the very infrastructure that was overwhelmed. These infrastructure decisions set the trajectory of communities for decades, a time scale that is incapable of adapting with changing climate and demographic migration. Infrastructure that is required to rebuild post-disaster can become a stranded asset if the population never returns. We are in an era of necessity, an era of extremes and disasters, and it is critical for policies and finances to move towards mitigation, adaptation, and resilience. We cannot continue to rebuild back to a normal that no longer exists and expect to exit a crisis and recovery model.

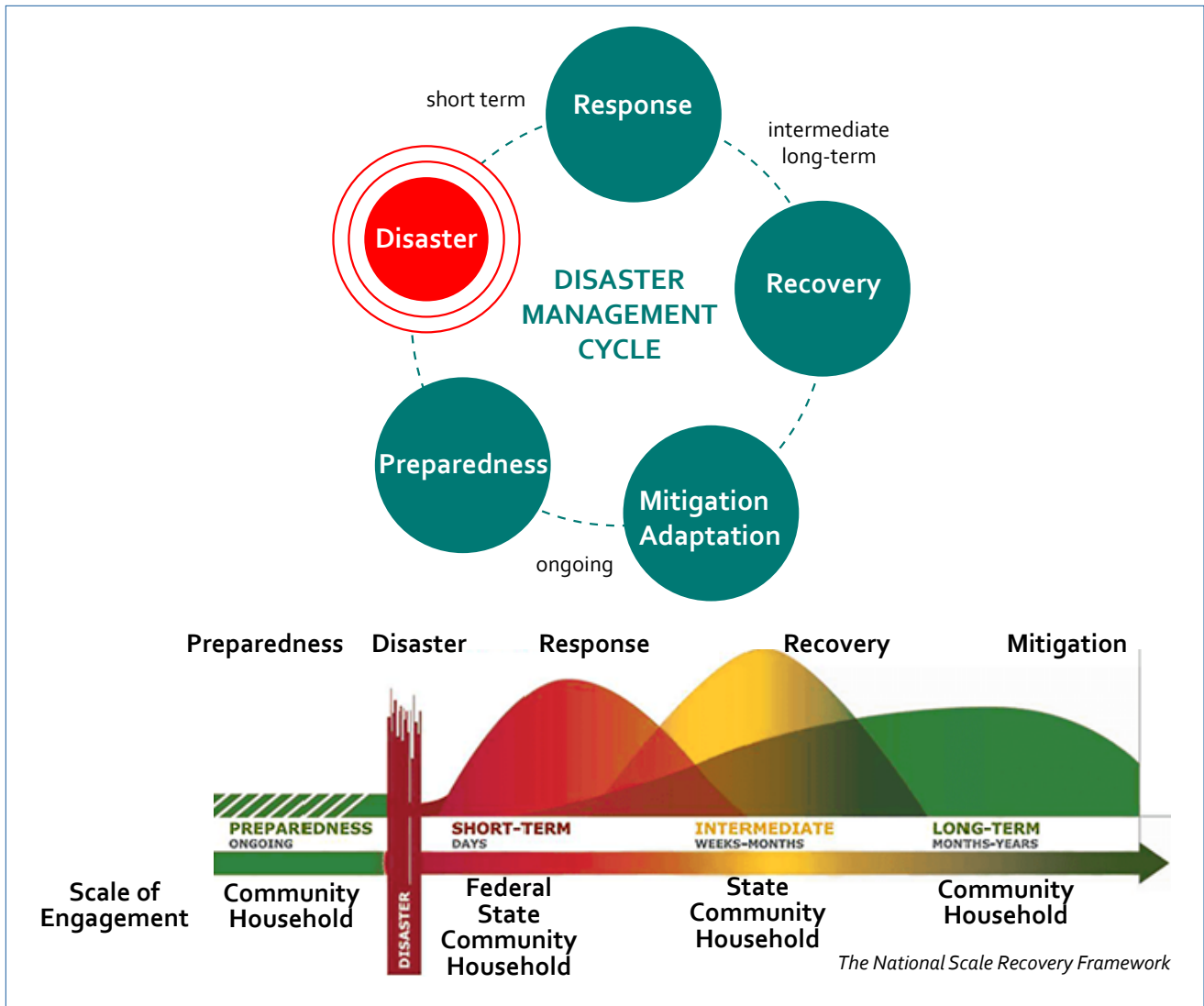
## What happens after a disaster: current mental model

The current approach to disaster recovery prioritizes a “do it yourself recovery” where households and businesses must rely on their own resources first to meet their needs (Figure 3)<sup>7</sup>. This approach presumes that most households have sufficient financial means to purchase insurance to provide financial protection in the wake of a disaster. However, most Americans do not have extensive financial reserves, and many do not participate (regardless of reasons) in flood, earthquake, or wildfire insurance programs. This means that immediate resources at the household level can be quite limiting, raising the importance of local communities, non-profits, volunteers, and donations in supporting immediate response and long-term recovery activities. State and federal aid are available, but only when the damage is deemed by the Governor and the President to be severe enough to receive federal resources; around 75% of requested federal disaster declarations are granted.

The Federal Emergency Management Agency (FEMA) was created in 1979 and was designed to respond during and immediately following a disaster. Short-term response and recovery efforts led by FEMA focus on debris removal, restoring critical infrastructure, and providing emergency shelter. The resources for this effort are provided by the 1988 Stafford Act via the Disaster Relief Fund obligations (individual and public assistance), federally backed insurance programs (e.g. the National Flood Insurance Program (NFIP) and U.S. Department of Agriculture (USDA) crop insurance), federally backed loans from the Small Business Administration, and FEMA hazard mitigation grants. While short-term response is taking place, states develop a recovery plan that they submit to the U.S. Department of Housing and Urban Development (HUD) to provide intermediate and long-term recovery (Figure 3). This plan must be approved and receive congressional appropriations through the Community Development Block Grant Disaster Program. Intermediate and long-term recovery activities occur months to years after a disaster due to the time required to develop and submit plans, have plans approved, receive funds, allocate funds, and begin rebuilding. Thus, reliance on government for disaster recovery will, at best, be a delayed form of recovery for most households.

<sup>6</sup> Federal Reserve. 2022. *Economic Well-Being of U.S. Households*.

<sup>7</sup> Montano, S. *Disasterology: Dispatches from the Frontlines of the Climate Crisis*.



**Figure 3.** (Top) Disaster management cycle. (Bottom) Scale of engagement during different phases of the disaster management cycle.<sup>8</sup>

Even when government resources are available, individual assistance is typically only available for homeowners (not renters) following major disasters that receive federal declarations. Individual assistance does not take the place of insurance – it is designed to assist, not to cover the full costs of repairing damage. Applying for assistance from multiple sources requires time and energy during a period where people are trying to secure a stable living situation and are not in a good position to manage the complexities of bureaucracy. This can exacerbate already-existing financial and social disparities, as those with resources can access recovery funding, while those without are unable to access resources intended to facilitate their recovery.

FEMA has kept its focus primarily on recovery and historically has had a small role in long-term preparedness and mitigation activities. However, FEMA's Building Resilient Infrastructure and Communities (BRIC) program is moving towards a resilience mindset. BRIC identified seven facets of a community that must work well for the community to be healthy: (1) safety and security, (2) food, water, & shelter, (3) health & medical, (4) energy, (5) communications, (6) transportation, and (7) hazardous materials. However, the data are not easily collected to understand how successful this effort is or to translate lessons learned between communities. It remains to be seen whether the policies and practices that established FEMA for disaster recovery can be changed to prioritize resilience.

<sup>8</sup> Adapted from: [National Disaster Recovery Framework](#).

# STRUCTURAL CHANGES

Early federal disaster policies were developed in response to rare and catastrophic events. Today, the U.S. public is made aware of a few disasters every year, such as the Memorial Day Floods in Texas (2015), Hurricane Maria in Puerto Rico (2017), and the Camp Fire at Paradise, CA (2018), to name but a few. In recent years there have been new disasters every three days that had significant impacts for local communities, many of which never received federal or perhaps even state aid.

The mindset that disasters are rare and the goal is to recover back to the status quo must change as the number and cost of disasters have increased, populations have become more migratory (eroding social fabric and resilience of the community to respond), and wealth inequities have expanded that leave a third of the population without the ability to afford insurance or respond to an emergency. Policies need to shift from prioritizing recovery post-disaster to prioritizing resilience through better preparedness, mitigation, and adaptation. Governance is needed to make structural changes in policies, practices, and resource flows.

## Policies

Governance sets a vision to where we want to go and establishes the policies and practices for how to get there. Disasters create significant pressure on governance, revealing fragilities in any community, whether large or small. Any systemic problems in policy design or implementation can be made more apparent in the wake of a disaster.

For example, water policies are incredibly fractured with many competing interests as water is handled separately from land, surface water from groundwater, quantity from quality, between states, and so on. Policies, practices, funding, and even agencies are built around these silos. The result of many siloed policy is a complex system of inconsistent goals that are difficult to reconcile, let alone coordinate quickly. Fragmented governance creates unintended consequences that require additional policies and costs to address. **We have unintentionally become focused on solving the problem of unwieldy bureaucracy rather than ensuring resilient water systems**, finding ourselves navigating procedures rather than reaching outcomes. There is a need to “**decomplexify**” or “**radically simplify**” water governance, and this also holds true for disasters.

The overwhelming complexity of disaster governance undermines the ability for many communities to access resources in a timely fashion, delaying recovery and inhibiting efforts to prepare for disasters. For example, current policies cover all costs to the community if they rebuild as before the disaster, but if the community shares in the costs they can build back in a more adaptive or resilient manner. However, because disasters wreak financial havoc on communities, communities often have little choice but to rebuild as they were before.

The Stafford Act is the primary act governing federal and state responsiveness based on disaster declarations. However, the process of declaring disasters is politicized and has led to historically under-resourced, marginalized and rural communities continuing to be under-served by this federal policy. The process for determining if damages are sufficient to receive aid creates perverse incentives and essentially penalizes communities that insure public infrastructure, adopt more stringent building codes to mitigate damage, and invest in land-use planning. Essentially, our policies are not effective at the scale and pace of change in disasters, and are creating particular challenges for individuals and communities that are most in need of government assistance.

## Practices

Policies may advocate for resilience, but practices shape implementation. The key practices related to water disasters are (a) land use planning, (b) adaptation planning, and (c) prioritizing outcomes over standardized processes.

### Land use planning

Water starts on the land and land management practices can reduce flood risk, improve water quality, and allow water to reach soils and recharge. Land use planning influences property rights, as well as determining the location and types of infrastructure and housing that are built and last for decades. Planning has long-term consequences and must consider likely climate and water scenarios, along with potential changes in population, demography, or other aspects of surrounding conditions. We will fail to be resilient if we plan assuming future water conditions will be the same as the past or the present.

Creating a resilient landscape requires planning and making new choices at the level of private property and local communities. There are two mechanisms to affect planning at the local level: planning and zoning. **Planning** is the exercise of legislative power and policy formation. **Zoning** is the application of those policies to a particular geography (e.g. permitting). States have an important role in shaping and incentivizing the process and implementation of planning and zoning at the community level. Local decision-makers rarely have a background in water resources and so it is important for states to educate and set planning criteria that integrates water and land use management.

For example, the state of Florida both requires and incentivizes conversations around resilient development through their planning process. Each municipality must create and adopt a comprehensive plan that includes specific elements aligned with regional and state plans. The state of Florida incentivizes communities to implement plans by making funds available for communities that comply. These layers of planning require building and maintaining a framework of relationships and coordination between multiple levels of government prior to making decisions around land use development. Similarly, the state of Arizona incentivizes local leaders to include water in land use planning. The state will only provide permits after a proposed development secures sufficient water resources for the next 50 to 100 years.

### Adaptation planning

A second essential practice in addressing water disasters is the use of buyouts and adaptation. Punctuated, and even chronic disasters can require individual households, neighborhoods, or even whole communities to migrate temporarily or permanently. While the movement of people and properties is most visible form of buyouts and migration, it is worth noting agricultural migration is also occurring, particularly in the western US. In 2022, drought in the western U.S. created **cattle refugees** as cattle were shipped to wetter areas with land and vegetation to support livestock. The on-going migration of wineries from California to Oregon and Washington are effectively grape refugees, seeking cooler areas with more secure water supplies.

The migration of produce, livestock, and people can be unmanaged, individually focused, or planned, managed retreats of communities. Unmanaged retreats occur when a community is destroyed by a disaster and households move elsewhere during the rebuilding process. For example, Hurricane Andrew struck Southern Florida in 1992, resulting in unmanaged retreat as many families moved from Dade County to Broward County (just as in Katrina, many families relocated from New Orleans to other areas in Louisiana and Texas). The migration was not intentional, but many had already formed new lives in Broward County by the time money arrived to rebuild in Dade County. The communities hit by a disaster and those that receive an unprepared influx of refugees face significant challenges. Communities with high population mobility may lack a cohesive social fabric as individuals do not have a strong sense of place or a desire to return post-disaster.

Buyouts are most commonly associated with FEMA’s floodplain buyout program, which has engaged in over 40,000 buyouts since 1989<sup>9</sup>. This program moves people out of hazardous conditions, and also reduces the costs for repairing or rebuilding homes or infrastructure in hazardous locations. However, ad hoc buyouts are difficult for many reasons: (1) it often takes years to complete a buy-out – long after a family has had to move or rebuild, (2) the voluntary nature means some will leave and others remain, (3) the patchwork of remaining homes still requires infrastructure to be maintained and prevents fully converting the area into green space or other uses that might further mitigate risk for nearby communities, and (4) under-resourced households are likely to only be able to afford housing in a high risk area. Any kind of buyouts or migration can exacerbate trends related to gentrification or segregation. There are significant equity implications in any situation where families are forced to leave their homes – whether by disaster, by gentrification, or by planned retreat (see box: types of infrastructure).

## Types of Infrastructure: What Makes a City?

At the foundational level, cities are places where physical and social infrastructure co-exist. The ability to remain in a location requires physical infrastructure and services that deliver goods like water, electricity, education, health care, and safety. Social infrastructure is built overtime as people remain and form relationships and networks – a social fabric. Building and maintaining physical infrastructure requires access to materials and expertise, which requires financial infrastructure to collect and distribute funds. All three types of infrastructure are critical for communities to remain healthy and exist. Long-standing communities develop a strong social infrastructure as they form a sense of place, a relationship with the environment and a sense of stewardship. If large numbers of people move or experience disruption (as in a disaster), it undermines the social and financial infrastructure. It takes time to cultivate a sense of place. The loss of social fabric is detrimental, but so too can rapid population growth or consistent migration of households that have not formed a sense of place to the community. The more disconnected we are from a location, the easier it is to exploit the environment and disregard our footprint and our responsibility to one another. For places consistently losing population there is an erosion of financial infrastructure (lost tax base), which leads to an erosion of services and physical infrastructure. Those who remain are often too poor to afford to move and/or large businesses providing private services to their employees.

Managed retreat means thoughtfully relocating communities and then putting the land they once occupied to use to create benefits that can hold water, provide public green space, and create habitats. Property rights are a source of personal wealth. Managed retreat jeopardizes personal wealth and the tax base of the community unless it is well planned, compensates, and keeps the tax base within the jurisdictional boundaries of the community. The relocation of an entire community would require large amounts of undeveloped land and the ability to generate new jobs, schools, and infrastructure. It is unlikely for communities to relocate as much as populations to migrate to new communities. This creates challenges for recipient communities that may not want to, or be able to, accommodate growth. If and when managed retreats are necessary, intentionally investing resources in cities accommodating climate refugees would allow for land use planning and proactively creating the infrastructure and services required to accommodate a growing population in a sustainable manner.

One participant noted that: **“Buyouts are for poor people. Managed retreat is for rich people.”** Buyouts are usually reserved for those without resources to move on their own. If they could have moved, they likely would have done so. Often, these individuals have resided in the same community for generations and want to remain near their families. However, the way buyouts are conducted does not incentivize participation. Buyouts rely on a cost-benefit analysis to determine the value of the home, which is often suppressed in high-risk areas (i.e. many marginalized communities have been pushed into high risk areas). The value of the house is often too low for homeowners to participate and move

<sup>9</sup> Mach et al. 2019. [Managed retreat through voluntary buyouts of flood-prone properties.](#)



to a nearby location with lower risk. There are inequities in how buyouts are conducted and there are moral hazards to rebuilding in high risk areas and attempting to sustain what is ultimately unsustainable.

The importance of local governments in shaping the hazard landscape cannot be over-emphasized as local governments determine land use, zoning, and building codes. Future managed retreats can be avoided if we stop new developments in floodplains and other high hazard areas. Luxury developments in high risk areas are still being approved and are not retaining water on the property; exacerbating flooding in surrounding communities. There is not the political will to say “no” to projects that are high risk and bring money to the surrounding community. Investors and property developers bare little risk and profit from development with homeowners and businesses bearing the long-term risk and costs of developing in high-hazard locations. There is a need to address incentive structures that facilitate development in high risk areas and put developers and investors on the hook to pay the costs of future disasters when they knowingly develop in high risk locations without the appropriate supporting infrastructure and building codes to ensure resilience to known risks.

## Prioritizing Outcomes

Regulations, such as the Clean Water Act in 1972 (CWA), Endangered Species Act in 1973 (ESA), and Safe Drinking Water Act in 1974 (SDWA) – are an important tool for protecting social and environmental interests from harm, but fall short of proactively pursuing societal and environmental health. These Acts were designed 50 years ago to be adaptive; however, the accumulation of legislative complexity made it difficult for regulators to keep up with changing conditions. For example, technology makes it possible to move from procedural regulations (i.e. paying for a particular treatment technology) to more cost-effective outcomes-based regulations (i.e. paying for certain outcomes). Transitioning towards an outcome based regulatory framework requires modernizing regulations and permitting.

## Resource Flows

Resource flows refers to how resources are shared between different entities – whether state governments or local communities or private individuals. Resources can refer to finances, market access, education, or capacity (human or technical) to support plans and practices for resilient communities and disaster recovery. How do we prepare and equip local leaders and individuals that have no formal training in emergency management or resilient development? Once local leaders have a plan, how do we provide resources to implement the plan and achieve desired outcomes– particularly for under-resourced communities and individuals.

## Human Resources

Many water utilities and local officials do not have education or training in disasters, resilience, watershed planning, financial risks, and other key aspects disaster response and recovery. The individuals responsible for making infrastructure and financing choices, particularly in smaller utilities or smaller agencies, do not often have the time or training to navigate complex systems to access resources that may be available in the wake of a disaster, or resources available to build resilience in a system (e.g., pre-disaster planning). In many cases, under-resourced communities have old infrastructure and lack the capacity to proactively pursue resilience as they are reactively preventing or responding to previous disasters. **An unforeseen and on-going disaster for many communities may be a lack of capacity** – whether human, technical, or financial.

Many of the state and federal programs that were created to provide technical and financial aid to communities are experiencing staff turnover as the generation that created these programs retire. **People support what they build.** As these individuals retire, relational networks and trust erode as newer employees are often unwilling to assume risk to innovate within these pre-existing programs. Alternatively, staff turnover may create the opportunity to integrate and streamline programs, reducing transaction costs and the need to continually increase capacity. In an age of mass communication and technology, we have the capacity to share learnings and lower transaction costs to adopt new practices.

Most any challenges related to personnel and human resources are amplified in rural communities. For disasters, rural communities face wide-ranging challenges, beginning with the reality that they rarely qualify for state or federal aid because the damage is dispersed across political jurisdictions. Rural America is under-banked, under-insured, and under-educated that come from decades of disinvestment, making any prospects of recovery from disasters all the more challenging. And these challenges have been exacerbated by water disasters, particularly drought, which along with higher water prices may overwhelm any remaining resilience of some rural communities. The agricultural footprint is likely to shrink in the western U.S. and along with it, agricultural communities and rural America as less water is delivered from the Colorado River (see Drought in the Colorado River box), and as similar disasters impact rural communities throughout the U.S.

## Drought in the Colorado River Basin

The United States Bureau of Reclamation (BoR) formed 120 years ago with the purpose of building the water and power infrastructure needed for the population and economy to grow in the Western U.S. Today, the BoR serves as the largest water deliverer in the nation and the second largest provider of hydropower through decades of infrastructure investments. However, the lengthy and severe drought in the Colorado River Basin is jeopardizing the reliable delivery of water and power with reservoirs at 28% of their collective capacity at the start of water year 2023.

Drier conditions are the new normal for the Colorado River basin as warmer temperatures are reducing the amount of precipitation that reaches reservoirs. For example, in 2021 and 2022, the Colorado River Basin received 90% of its normal rainfall, but only 29% to 59% of its normal runoff. In short, the Colorado River Basin must adapt to lower water availability to create pathways to save molecules of water. Congress has responded through bipartisan infrastructure funding that BoR will use to increase transparency, improve dam safety, increase reservoir storage to provide more flexibility for more extreme hydrology (i.e. floods and droughts), invest in water recycling projects, and tribal rights settlement. States and local governments are investing in solutions that include alternating crop patterns, pulling up artificial turf, and improving water efficiency.

## Insurance

Financial risks associated with disasters cannot be covered by individuals or by government alone. Insurance is one tool to spread the costs of recovery and is the primary source of protection for individuals. Insurance is an agreement whereby a company or government agency provides a guarantee of compensation for specified loss, damage, illness, or death in return for payment of a premium. Insurance is designed to provide risk assessment, risk education, risk communication, and ensure the financial means to recover from risk realized. There are two primary benefits of insurance: (1) send market signals to shape behaviors that incentivize reducing risk and (2) increase recovery speeds from an unforeseen event. However, insurance only benefits those who have entered agreements (i.e. they are aware of the risk and have the financial means to participate) and as a nation we are grossly under-insured.

For example, the 2019 Mississippi River flood caused more than \$20B in losses across 19 states, of which only \$200M were insured.<sup>10</sup> Nationwide, the number of National Flood Insurance Program (NFIP; see NFIP box) policies in the U.S. have decreased over the last decade from 5.1 million to 4.4 million<sup>11</sup>, with some regions, such as the Midwest, having less than one percent of homeowner coverage.<sup>12</sup> However, there are 15 million households located in the high risk 100-year floodplain, where those with a federally backed mortgage are required to have flood insurance. This phenomenon is not unique to flood hazards – almost 90% of California homeowners do not have earthquake insurance, and with the

<sup>10</sup> TNC. 2021. [Improving Flood Resilience through Community Insurance and Nature-Based Solutions](#).

<sup>11</sup> Kalman et al. 2020. Assessing flood mitigation, management, and enforcement using insurance data. JAWRA.

<sup>12</sup> TNC. 2021. [Improving Flood Resilience through Community Insurance and Nature-Based Solutions](#).

rising number of wildfires in recent years, private insurers may cease providing wildfire coverage altogether.<sup>13</sup> Globally, only 30% of losses were covered by insurance, meaning the remaining 70% of estimated losses must be covered by individuals, businesses, and governments, jeopardizing the financial stability for all.

## National Flood Insurance Program

Private insurers lobbied Congress to establish the 1968 National Flood Insurance Program (NFIP) to help homeowners and businesses recover after a flood event, stepping more fully into assisting communities with post-disaster recovery. The NFIP subsidized household premiums regardless of the ability for households to afford insurance. Artificially suppressing rates for all homeowners does not guarantee affordable premiums undermines sends the wrong market signals. Rather than subsidizing all premiums, the NFIP could adjust premiums based the ability to afford insurance, allowing more households to participate in the NFIP and recover post-flood. This may also lower premiums since the risk of flood would be spread over a larger market.

The NFIP relies on static Flood Insurance Risk Maps (FIRMs) that are known to be inaccurate and outdated. FIRMs were initially developed to inform individuals if they were located in a high-risk flood zone for flood insurance purposes and to prioritize floodplain management activities. FIRMs are not a good way to communicate risk and creates a binary of no risk to high risk that is not reflective of reality and creates moral hazards. Any location can flood. Flood insurance needs to expand coverage to include in-situ flooding from overwhelmed drainage systems. Similar to health insurance and car insurance, it is likely that disaster insurance would need to be mandated to gain widespread participation.

The massive under-insurance gap contributes to the protection gap, which is the gap between the economic losses from disasters and the amount insured. The protection gap is largely borne by the public sector, private households, and businesses.<sup>14</sup> The result is that those who don't have the resources to participate in insurance markets experience both immediate and long-term financial setbacks. Many never recover from a disaster and experience long-term difficulties, such as lower credit scores, that hamper future opportunities.<sup>15</sup> Those reliant on government assistance may wait months or years to receive financial assistance for a portion of recovery costs (currently capped at \$35,000).

The cost of insurance premiums balances the risk of the unforeseen event occurring (mitigation can reduce risk and keep premiums from escalating), the size of the risk pool (i.e. how many people are sharing the risk and recovery costs), and the ability for customers to afford the premiums. Insurance is a risk pool that must be managed to keep costs affordable. For example, flood insurance premiums were estimated to increase by 4.5 times to cover the risk on the nation's most flood prone homes in 2021 given the increase in insured losses and claims.<sup>16</sup> In order to keep flood insurance premiums from escalating, there needs to be (1) more mitigation to reduce risk and (2) greater participation in flood insurance to spread risk across a larger pool.

One of the most important components of insurance is that it speeds recovery. Those who have insurance have access to capital quickly following losses. But those without insurance must rely on community or government sources; it can take months to years for communities to obtain funds from state and federal resources. This delay in funds creates high chances for under-resourced individuals to migrate: many households and businesses may leave during the time it takes from the community to procure recovery funds. Renters have no mechanism to participate in disaster insurances, leav-

<sup>13</sup> Leefeldt. 2019. [After wildfires, hundreds of thousands of Californians can't get insurance](#). CBS News.

<sup>14</sup> Swiss re. 2019. [Closing the Protection Gap](#).

<sup>15</sup> Urban Institute. 2019. [Insult to Injury: Natural Disasters and Residents' Financial Health](#).

<sup>16</sup> First Street Foundation. 2021. [The Cost of Climate: America's Growing Flood Risk](#).

ing an estimated 36% of households without access to recovery resources. This impact scales up beyond the individual to the communities. Communities with high insurance coverage have more budget stability than those riding disaster cycles, while those with low insurance coverage may take years to recover, if ever. Out-migration from heavily impacted areas undermines the tax base, causing further fiscal harm to the community.

### *The future of insurance*

Insurance is underperforming for disasters because it has low participation, is reactionary (meaning it deals with past risk and not future risk), and has been primarily relegated as a tool for recovery rather than actively used for risk communication and mitigation purposes.

Reinsurance companies are global companies that insure insurance companies. Reinsurance companies have data to show that risk is increasing and is likely to increase as the atmosphere continues to warm over the next 20-30 years. However, the insurance industry is a highly regulated market and few allow for probabilistic models of future risk when setting premiums. As a result, insurance is short-term (annual renewals) and reactive to events of the previous 10 to 20 years. It is critical to mitigate risk and adapt now in order to reduce future losses and enable rapid recovery. A different insurance model is needed for insurance to be proactive and to shape development than can reduce risk instead of only transfer risk.

One approach could be to bind disaster insurance to mortgages. This creates a stable line of revenue for insurance companies, protects households should a disaster occur, and incentivizes households to mitigate risk to lower premiums. Alternatively, community-based insurance products could be developed that insure an entire community to cover all homes and businesses.<sup>17</sup> This would enable risk to cover more homes and lower the per household cost. The community is incentivized to invest in risk mitigation activities that reduce risk and lowers premiums. For example, a community that flooded in 2019 explored purchasing community insurance and building a levee setback to mitigate flood risk. The insurance company estimated premiums for 1,455 homes would decrease from an average of \$1,100 to \$300 annually, with 23% in the reduction of insurance premiums due to the levee setback and 77% due to enrolling all households within the community.<sup>18</sup> Savings on insurance premiums can be used by the community to invest in other benefits or mitigation strategies. For every \$1 spent on mitigation, an estimated \$6 in losses are prevented.<sup>19</sup> Creating sustainable revenue funds to support insurance and mitigation activities could be established through a disaster SRF through which the revolving loans could be used to obtain upfront capital to mitigate risk and reduce high insurance premiums in perpetuity. The savings from reduced premiums could then be reinvested into the community.

### **Markets and Municipal Bonds**

Resources can flow from individuals to corporations and municipalities through the market and is one avenue to pursue investing in resilient communities. There are \$4T in outstanding tax-exempt municipal bonds with 33,000 different issuers of municipal debt in the U.S. To date, municipal bonds have financed 2/3 of our nation's infrastructure such as roads, schools, and water systems in urban areas. Rural areas are less likely to receive municipal bonds because of the credit rating process and the emphasis on the potential to make a return on investment.

Markets have the potential to raise immense capital for resilient infrastructure, but the market is not designed to adapt to climate change or respond to disasters. Markets are about investing and protecting financial assets and managing fiduciary risk. Investors want low-risk bonds and are more likely to purchase bonds from affluent communities that are more secure in their ability to repay debts. This means that relying on market mechanisms alone will not likely promote disaster resilient infrastructure or address under-investment in communities, particularly when those communities are in disaster-prone (i.e., risky) areas.

<sup>17</sup> TNC. 2021. [Improving Flood Resilience through Community Insurance and Nature-Based Solutions](#).

<sup>18</sup> TNC. 2021. [Improving Flood Resilience through Community Insurance and Nature-Based Solutions](#).

<sup>19</sup> Multi-Hazard Mitigation Council. 2019. [Natural hazard Mitigation Savings: 2019 Report](#).

The municipal bond market is also not adequately pricing climate risk because investors believe that risk will not materialize for a few decades, after the debt is paid.<sup>20</sup> Rating agencies are key to informing investors about risk, but their time horizon for risk is 2-3 years, the bond is 10 to 20 years, and infrastructure lasts 50 to 100 years. This disconnect in time horizons enable unstable, or at-risk communities, to issue debt at low interest rates compared to what a real, risk-adjusted rate might be. While current debt instruments may not be pricing climate risk appropriately, there are some innovations in using finance to address some forms of climate risk. For example, forest resilience bonds are being developed to enable financing nature-based solutions and to return some wealth to chronically disinvested communities. The Securities and Exchange Commission (SEC) is beginning to establish financial disclosure regulations around climate change and disaster risk is coming to the public sector. However, it is unclear whether greater transparency will generate behavioral change and accountability without including an educational component around risk and understanding disclosures.

## Federal Funding Streams

The federal government is the backstop when local and state governments are overwhelmed. The federal government has substantial resources, but the deployment of those resources has not always meant improved resilience, mitigation, or successful disaster recovery.

The federal government has two main levers to encourage its constituents to move towards more resilient practices: (1) incentivize ideal behaviors and (2) regulate harmful practices. The federal government performs best with established tools that have been proven to work and are easy to scale and replicate. New tools and processes require time to obtain bureaucratic approval, and they need to be transferrable across a wide diversity of conditions that exist in the U.S. Policies and practices that facilitate rapid adoption, support of, or repurposing of successful programs are needed to support building resilient communities.

The federal government has dedicated a significant amount of resources to fund resiliency through State Revolving Funds (SRFs) and the 2017 Water Infrastructure Finance and Innovation Act (WIFIA). The 2014 SRF amendments emphasized resilience considerations and many states have expanded definitions to include climate considerations. WIFIA was designed with resilience considerations and today has invested \$34B in 94 projects, of which 1/3 have a resilience component. The federal government is also intentionally dedicating substantial portions of this funding towards underserved communities. The flexibility on WIFIA allows those funds to invest in nascent resilience projects, local communities apply directly to the federal government, and enables different loan structure with little interest paid in the first 10 years.

<sup>20</sup> Smull et al. 2019. *Climate, race, and the cost of capital in the municipal bond market.*

# RELATIONAL CHANGES

Relational changes focus on addressing relationships and power dynamics to enable better decision-making around building resiliency and disaster recovery. Resilience is not a matter of solving insurance problems or decision-making around mitigation practices, but it is about solving intractable issues that create many symptoms. We build structures to manage systems and those structures are creating new symptoms. Solving intractable issues requires dedicated leadership.

**Trust is how you get things done. When there is broken trust we retreat to well-defended silos.** Disasters occur in space and time. Governments create the container within which individuals and local governments make decisions that shape our ability to be resilient and respond to disasters. Local communities are key to building resiliency and need to be carefully considered and fully included because they are ground zero for where policies and practices materialize, and where unintended consequences are realized. Community based solutions are most likely to succeed when many of the residents have a strong sense of place and generational knowledge. Such knowledge and commitment is valuable and must be taken into account even if it does not come in a format that is considered scientifically rigorous. It is therefore critical that we have ways to incorporate the knowledge of the community into decision-making processes, as well as equip and educate community members about risk and resilience. Communities with substantial migration and gentrification have less familiarity with the place in which they live, as well as less developed networks to draw on when disasters do occur. Deeply rooted, long-term residents in a community know their community well, and often know where to go to identify problems and implement solutions. However, having access to communicate that knowledge to those with the power to implement change is often a barrier.

Relational changes must also occur well outside the scale of communities, and well beyond the bounds of a single agency. Fragmentation in both water and disaster governance makes it difficult to build, maintain, and stabilize relationships needed for effective response and recovery. There are more than 11 federal departments working on some component of water resources and more than 20 federal programs that receive money from Congress to respond to disasters, which requires significant collaboration and coordination between federal agencies that is difficult to maintain. For example, the Department of Interior is focused on responding to drought disaster while FEMA is focused on responding to more acute disasters such as floods, tornados, and earthquakes. The fragmentation and silos make it difficult to plan holistically, to align resources, and to communicate with state and local governments. In some instances, federal programs might disagree, making it nearly impossible for private, local, or state interests to know how to move forward. The complexity of accessing federal and state funding also undermines the ability to prepare, mitigate, and recover. Overly complex processes have high transaction costs that cannot be paid by people and communities with limited capacity.

However, accessing coordinated resources, and involving communities, does not guarantee that the resources available will go to the communities or individuals that need it most. It is not a matter of federal entities having money or local communities accessing money as much as how money is distributed by the state, county, and municipality. State and local governments play a critically important role in determining how resources are distributed and the ability for households and communities to recover and become more resilient. Indeed, post-disaster funding can both calcify existing inequities, and can even exacerbate trends toward greater disparities within and between communities.

# TRANSFORMATIONAL CHANGES

The framework of institutions and decision-making processes for addressing water disasters were created centuries ago and are repeatedly falling short in meeting the expectations of today's society and the pressures from 21st century problems. Mental models for how the world work are deeply ingrained and embedded throughout government and society, creating essentially a train track that has been laid and constrains the capacity to turn the train and pivot in a new direction. Laying new tracks requires transforming our mental models so that we can implement new structures (policies, practices, and resource flows) and form new relationships. New policies lead to new projects that demonstrate the value of change, highlight successes, and provide lessons learned. Communities of practice follows. We are on a moving train, the tracks have been set, and we need to rebuild tracks while the train is in motion to avoid going over a cliff we are rapidly approaching. We have the resources and materials to build the track, but we often lack the vision of how to build

the track and where to aim the train (Figure 4). How do we build a future that belongs to this century and stops repeating the mistakes of the past?

The systems in place today reveal our mental models and implicit values. **We have the outcomes we want. Perhaps the system is not broken, but it is working as designed. What is the design achieving?** For example, why does disaster recovery prioritize single family homes? Why do policies and funding resources primarily go towards new capital infrastructure that emphasize growth, or to rebuild what was there rather than building what is needed in the future? Why are federal disaster declarations based on media attention and damage losses? Why do we incentivize rebuilding back to normal rather than rebuilding resiliently? It is important to understand the values under-pinning these questions and the purposes these policies are seeking to serve in order to intentionally change the trajectory of a well-worn track.

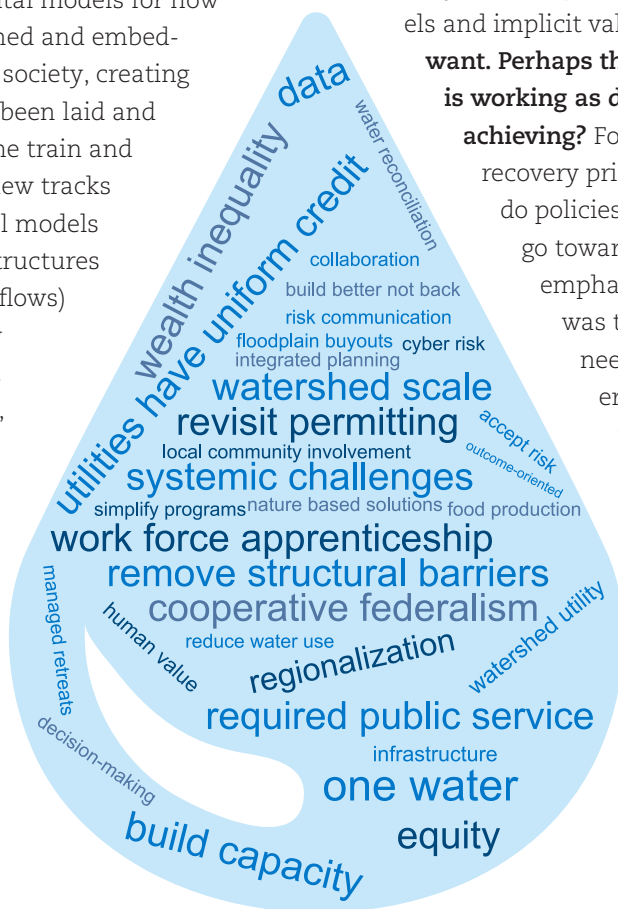


Figure 4. Word cloud of focus points for participant from the forum.

## Inflexible infrastructure to flexible, resilient infrastructure and operations

Adapting to new conditions requires challenging conventional thinking and this takes courage. Much of our water infrastructure was built through large federally, supported legislation or was built in response to large, federal regulations. The legacy of these large projects are: (1) reliable water supplies and services, (2) aging infrastructure that requires re-investment, and (3) stranded assets when populations and businesses have moved. As we re-invest in infrastructure, do we keep large projects and re-invest in infrastructure that will last another 50 to 100 years while knowing populations move and workforce migration occurs? How do we design for a more flexible and adaptive future rather than aiming for a future of perpetual, continued, unsustainable growth?

One avenue may be to recognize the public health component of deteriorating infrastructure to make public and private health care dollars available for investment in critical infrastructure to improve health outcomes. There are public health crises occurring in many cities in the U.S. where households, neighborhoods, or adjacent communities have fragile or no water infrastructure. These communities are under-represented and often invisible. Financial reliance on local communities to fund critical infrastructure (such as schools and water systems) creates inequities as populations and wealth cluster, and we increasingly recognize that these patterns are exacerbated after disasters. Poor neighborhoods and cities do not have enough resources to fund these systems, making these areas less attractive to live and perpetuating cycles of poverty and disinvestment. These communities require significant care and resources to break decades of disinvestment. Not only do we need to invest in infrastructure, we also need to develop sustainable and equitable financing models. We must instill a societal view of water as a public good and create a growing community of practice as part of an integrated water movement.

### **Paying for procedures to prevent negative outcomes to paying for outcomes that benefit broad society**

The mental maps that were established over the past decades and centuries are not adequately addressing current challenges. We regulate around processes and procedures to prevent specific negative outcomes from occurring (e.g. prevent flooding in a specific neighborhood) rather than producing desired outcomes for the public and environmental good (e.g. improve water movement across the landscape throughout a watershed).

### **Complex silos of governance to simplified, holistic, integrated governance**

Water is integrated and flows and does not operate in silos. Water is a public good necessary for life, but we have built financial systems around water resources that treat water as a commodity. This creates a mismatch between cost drivers and cost payers. For example, the costs of water pollution are passed onto utilities to treat water to an acceptable quality, which is becoming prohibitively expensive and has limited benefits to the environment. Those costs are passed along to tax-payers while polluters profit from the products they make at the expense of environmental and public health. Another example is allowing development to occur in high risk areas to the profit of developers and investors, and ultimately the harm of people and communities.

How do we integrate functionality, legislation, infrastructure, etc. across current governance and finance silos that are process-based? We cannot without adding layers of additional bureaucracy. Integrated approaches means finding solutions that work best for communities of different sizes, capacities, and needs. It decomplexifies and disentangles intractable policies to allow new movement. We must move away from consultant welfare (professionals navigating complex processes) and towards simplified, integrated approaches that enables communities to advocate for their own solutions.





# APPENDICES





# APPENDIX I: Forum Agenda

## WATER AND DISASTERS: RISK, RESILIENCE, AND ADAPTATION OCTOBER 25 - 28, 2022 | ASPEN, COLORADO

The **2022 Aspen-Nicholas Water Forum** will explore the growing role of disasters - natural and anthropogenic - in shaping the future of water planning, management, and policy in the United States. Many policies and practices were designed and implemented in the wake of disasters, and response/recovery to disasters consumes substantial spending at all levels of government, along with the private sector and individuals, whether farmers or homeowners. How we recover and rebuild will shape future exposure and vulnerability to disasters. Investors, from institutional to individuals, are exposed to considerable risk related to water disasters, yet this risk is poorly understood, quantified, or communicated. Moreover, water-related disasters inordinately affect disadvantaged, and often minority communities, adding to already pressing challenges. And while climate change is amplifying disaster-related challenges like droughts, floods and wildfires, water systems are increasingly affected by algal blooms, COVID-related lockdowns, toxic contaminants, and cyber attacks. Disasters impacting the water sector are not black swans; they are frequent, regular occurrences outpacing our policies and resources.

This forum will continue the ongoing Aspen-Nicholas Water Forum theme of, “What does good water governance look like for the United States?” The Aspen-Nicholas Water Forum seeks dialogue that will probe how we as a society can balance the competing demands of equity with liberty, and community with efficiency. Of particular interest in this theme is how society - individuals, communities, corporations and governments - are planning for and adapting to disasters of the future. Is resilience a realistic goal, or do communities need to begin more purposeful investments in adaptation beyond resilience? For any of these responses, is there capital at the scale of the problem, and from where might leadership come?

### TUESDAY, OCTOBER 25

**Opening Reception and Dinner – Walter Isaacson Center**

### WEDNESDAY, OCTOBER 26

*All sessions will take place in the Lauder Room of the Koch Building.*

**Breakfast – Walter Isaacson Center**

**Welcome and Introductions:**

A brief introduction from the hosts around the focus and goals of the Forum.

**Greg Gershuny**, Energy and Environment Program, Aspen Institute

**Martin Doyle**, Duke University

### **SESSION ONE: Water disasters and risk: status and trends**

This session will provide a review of water-related disasters, policies that have been implemented in response to disasters, trends in spending (public and private), and a general overview of trends in the number, scale, and cost of water-related disasters. The history and trajectory of disasters and responses will provide context for understanding our current approach to acute and chronic disasters.

**Discussants:**

Water disasters of the 2000s  
 Trends in insurance costs  
 Ongoing Drought in the West

**Brock Long**, Hagerty Consulting (former FEMA Administrator)  
**Melissa Roberts**, American Flood Coalition  
**Camille Touton**, Commissioner, USBR

**Moderator: Martin Doyle**, Duke University

**Break****SESSION TWO: The Business-as-Usual Approaches: How Did We Get Here and What Are Better Alternatives?**

There are “business-as-usual approaches” that have evolved for responding to and recovering from disasters. These approaches exist at the household and community level, at the level of agencies and corporations, and at the state and federal policy level. These approaches have been questioned in the past, e.g., the availability of funds to recover back to normal post-disaster but not to proactively invest in mitigation prior to disaster, or the inability to enforce proactive or resilient zoning practices. Decades of habits and policies have accumulated into a business model that creates systemic risk across sectors and regions. Why are we stuck in these repeated cycles of disaster-recovery-rebuild? How can we break out of these cycles and build more resilient and healthy communities and adapt to our new reality? What new approaches are emerging in the private sector, public sector, or community-based organizations? How might we move from reacting to proactively planning and implementing strategies that enable resilience?

**Discussants:**

Resilience vs Recovery  
 Revisiting and Rethinking Insurance  
 Land Use, Zoning, and Resilience

**Mike Connor**, Assistant Sec. of Army  
**Raghuveer Vinukollu**, MunichRe  
**Jeff Bass**, Shubin Bass

**Moderator: Newsha Ajami**, Lawrence-Berkeley National Labs

**Lunch – Walter Isaacson Center****SESSION THREE: Inter-Governmental and Inter-Sector Responsibilities**

When there is a disaster, resources are needed quickly and at scale, often from those external to the disaster. Large-scale disasters - those that impact large areas or occur over long time-scales - pose particular challenges. When communities are overwhelmed by the size or duration of a disaster, there is a need/desire for higher levels of government (particularly the federal government) to respond and provide relief. However, the frequency and scale of disasters has become overwhelming in terms of size and frequency. Yet there is often a significant mismatch between what communities think the government should do vs what the government actually can do. What are the appropriate types and scales of risk transfer, and when do these become problematic or create cascading crises? What is the government doing well that needs to be replicated and transferred elsewhere? What are strategies for building resilience within and across communities at different scales?

**Discussants:**

Inter-governmental Challenges  
 Inter-sector Risk Transfer  
 Regulatory Responsibilities

**Chuck Podolak**, Salt River Project  
**Phil Saksa**, Blue Forest  
**Deborah Halberstadt**, CA Dpt of Insurance

**Moderator: Martin Doyle**, Duke University

**Forum Reception and Dinner – The Aspen Meadows**

## THURSDAY, OCTOBER 27

### Breakfast – Walter Isaacson Center

#### **SESSION FOUR: Real, Hard Questions About Adaptation and Resilience**

The conditions affecting almost every aspect of water management are changing. Climate change and sea level rise are altering the distribution and quality of water supply sources. Changes in precipitation patterns impact water availability, with too much water flooding properties and agriculture and too little water undermining our ability to meet demand. And amidst these changes, our economies and demography are moving, as some regions grow beyond capacity while other regions experience stagnant or declining populations. At some point, many cities, regions, and sectors will need to begin to address very difficult, fundamental questions. How much longer can some coastal communities persist before retreating? Is mining groundwater supplies sustainable to support agricultural economies in some areas? Do some utilities have the revenue base to ensure their ability to provide safe, affordable water services, particularly when the costs of moving toward resilience are internalized? What does a just transition look like?

#### **Discussants:**

Utilities and Changing Demography  
Transitions for Rural Communities  
Coastal Communities

**Palencia Mobley**, Mode Collective (formerly, Detroit Water & Sewer)  
**Catherine Flowers**, Center for Rural Enterprise and Environmental Justice  
**John Sabo**, Tulane Univ

**Moderator: Newsha Ajami**, Lawrence-Berkeley National Lab

### Break

#### **SESSION FIVE: Capital for Adaptation or Resilience: Where Will it Come From?**

Disasters are inordinately expensive, but adapting to changing climate or altered economies creates its own set of financial challenges. Resilience is an attractive concept, but the costs of building truly resilient communities or facilities (at scale) are unknown, and thus risky for any group to take on. While the federal government and state governments are providing some funding for resilience, the water sector is predominantly dependent upon local and state government spending, and the municipal bond market for finance. The path to adaptation and resilience for the water sector is also not as well defined and clear, making it difficult for private capital and corporate investment to support this transition process. What is the cost of inaction to businesses and communities? How exposed are emerging industries to water risk? How and at what level can private investment reduce risk and enhance resilience? How can the current trends in private and federal investment in climate be leveraged to adapt and build a more resilient water future?

#### **Discussants:**

Role for Private Capital in Water  
Pricing the Risk of Action or Inaction  
Making Limited Dollars Count

**Tom Doe**, Municipal Market Analytics, Inc.  
**Erika Smull**, Breckinridge Capital  
**Joe Whitworth**, Freshwater Trust

**Moderator: Martin Doyle**, Duke University

### Lunch - Walter Isaacson Center

#### **Optional Outdoor Activity**

#### **Optional Participant-Led Thematic Dinners**

*Reservations have been made at restaurants in town to facilitate thematic discussions in small groups. Details and sheets to sign up will be presented at the start of the Forum.*

*\*Please note that these are unofficial dinners, and participants are responsible for covering their own expenses. Please sign up for the dinner of your choice during Forum session breaks.*

## FRIDAY, OCTOBER 28

**Breakfast – Walter Isaacson Center**

### **SESSION SIX: What Is the Vision For the Future?**

In this closing session, we will pull together threads from the different conversations that have occurred over the course of the forum. What did participants from different sectors hear? What themes are consistent? What issues are chronic? Where are there opportunities to move in small, incremental ways, and where are there opportunities for large, structural changes? What are some tangible next steps, and what groups or organizations need to make the first move?

#### **Discussants:**

A New Vision for Flood Recovery

**Adam Riggsbee**, The Resource Refuge Group

A New Vision for Utilities and Cities

**Emily Simonson**, US Water Alliance

A New Vision for Rural Communities

**Alan Boyce**, Materra

A New Vision for Governance

**Tim Male**, EPIC

#### **Moderators:**

**Newsha Ajami**, Lawrence-Berkeley National Lab

**Martin Doyle**, Duke University

**Break**

**Closing Session: Wrap Up**

*Forum Adjourns*

**Optional Lunch – Davis Commons, Walter Isaacson Center**

# APPENDIX II: Participant List

**Joseph Abramson**, Vice President, Tax-Exempt Project Finance and Sustainable Infrastructure Group, Morgan Stanley

**Newsha Ajami**, Chief Research and Development Officer for the Earth and Environmental Sciences Area, Lawrence Berkeley National Laboratory (*co-chair*)

**Christopher Angell**, Strategy and Business Development, Xylem, Inc.

**Marisela Aranguiz**, Deputy Director, Planning, Regulatory Compliance and Capital Infrastructure, Miami-Dade Water and Sewer Department

**Jordana Barrack**, Executive Director, Mighty Arrow Family Foundation

**Jeffrey Bass**, Founding Member, ShubinBass PA

**Alan Boyce**, Executive Chairman & Co-Founder, Mattered, LLC

**Christa Campbell**, Director, Industry Solutions: Water, ESRI

**Robyn Colosimo**, Director, Policy and Legislation, Office of the Assistant Secretary of the Army (Civil Works)

**Michael Connor**, Assistant Secretary, Army for Civil Works

**Heather Cooley**, Director of Research, Pacific Institute

**Arthine Cossey van Duyne**, CEO and Founding Partner, Water Funder LLC

**Samantha Danchuk**, Climate and Coastal Resilience Lead, APTIM

**Disque Deane**, Chief Investment Officer and Co-Founder, Water Asset Management LLC

**Sheila Deely**, Assistant General Counsel and Senior Director, Corporate Environmental Affairs, Freeport-McMoRan Inc.

**Thomas Doe**, President and Founder, Municipal Market Analytics, Inc.

**Martin Doyle**, Director, Water Policy Program, Nicholas Institute for Energy, Environment & Sustainability, Duke University (*co-chair*)

**Richard Farthing-Nichol**, Project Manager, Centre for Indigenous Environmental Resources

**Ron Fleming**, President and CEO, Global Water Resources

**Catherine Coleman Flowers**, Founding Director, Center for Rural Enterprise and Environmental Justice

**Derek Gardels**, Project Manager, Utility Management Services, HDR

**Greg Gershuny**, Executive Director, Energy & Environment Program, The Aspen Institute

**Peter Grevatt**, Chief Executive Officer, The Water Research Foundation

**Deborah Halberstadt**, Senior Climate Policy Advisor, California Department of Insurance

**Ann Hayden**, Associate Vice President, Climate Resilient Water Systems Program, Environmental Defense Fund

**Jim Holway**, Director, Babbitt Center for Land and Water, Lincoln Institute of Land Policy

**Alex Johnson**, Vice President of Initiatives, The Freshwater Trust

**Dan Keppen**, Executive Director, Family Farm Alliance

**Evan Kodra**, Senior Director, Climate and ESG, Intercontinental Exchange

**Erika Korosi**, Risk and Resilience Advisor, BHP Foundation

**Allison Lassiter**, Assistant Professor of City and Regional Planning, University of Pennsylvania

**Henrietta Locklear**, Vice President, Raftelis

**April Long**, Clean River Program Manager, City of Aspen

**Brock Long**, Executive Chairman, Hagerty Consulting  
**Joshua Mahan**, Director, Government and Industry Relations, Xylem Inc.  
**Tim Male**, Executive Director, Environmental Policy Innovation Center  
**Simrat Mand**, Country Director, U.S. and Canada, BHP Foundation  
**Joe Mannion**, Senior Vice President, Property & Marine Claims, Chubb North American Claims  
**Oluwole (OJ) McFoy**, General Manager, Buffalo Sewer Authority  
**Josee Methot**, Senior Policy Specialist, International Institute for Sustainable Development  
**Palencia Mobley**, P.E. Water Infrastructure and Utility Management Consultant, Mode Collective  
**Taiontorake (Max) Oakes**, Wildlife Biologist, Confederated Tribes of Warm Springs  
**Lauren Patterson**, Senior Policy Associate, Nicholas Institute for Energy, Environment & Sustainability, Duke University  
(*rapporteur*)  
**Margaret Peloso**, Partner, Vinson & Elkins LLP  
**Tim Petty**, Professional Staff, House Committee on Transportation and Infrastructure  
**Merrell-Ann Phare**, Executive Director, Centre for Indigenous Environmental Resources  
**Chuck Podolak**, Director, Water Rights and Contracts, Salt River Project  
**Rebecca Power**, Program Officer, Walton Family Foundation  
**Sumedha Rao**, Sustainability Specialist, Louisville Metro Government  
**Emily Read**, Chief of Web Communications Branch, USGS Water Mission Area  
**Rachael Reed**, Assistant Professor of Public Health, and Chair, School of Populations and Health Services, Dillard University  
**Terese (T.C.) Richmond**, General Counsel, Cascade Water Alliance  
**Adam Riggsbee**, President, The Resource Refuge Group, and President, RiverBank Conservation  
**Melissa Roberts**, Founder and Executive Director, American Flood Coalition  
**Dimple Roy**, Director, Water Management, International Institute for Sustainable Development  
**John Sabo**, Professor and Director, ByWater Institute, Tulane University  
**Phil Saksa**, Co-founder and Chief Scientist, Blue Forest Conservation  
**Andrew Sawyers**, Director of the Office of Wastewater Management, Environmental Protection Agency  
**Emily Simonson**, Director, Strategic Initiatives, US Water Alliance  
**Erika Smull**, Municipal Research Analyst, Breckinridge Capital Advisors  
**Fee Stubblefield**, Founding Member, Pendleton Beef  
**Anne Thebo**, Senior Researcher, Pacific Institute  
**David Totman**, Innovyze Thought Leadership Strategy, Autodesk  
**Camille Touton**, Commissioner, U.S. Bureau of Reclamation  
**Raghuveer Vinukollu**, Senior Vice President, Climate Resilience and Solutions Lead, Munich Reinsurance America, Inc.  
**Emily Warren Armitano**, Director, Land Conservation and Water Programs, The Cynthia and George Mitchell Foundation  
**Joe Whitworth**, President and Chief Executive Officer, The Freshwater Trust

#### **THE ASPEN INSTITUTE**

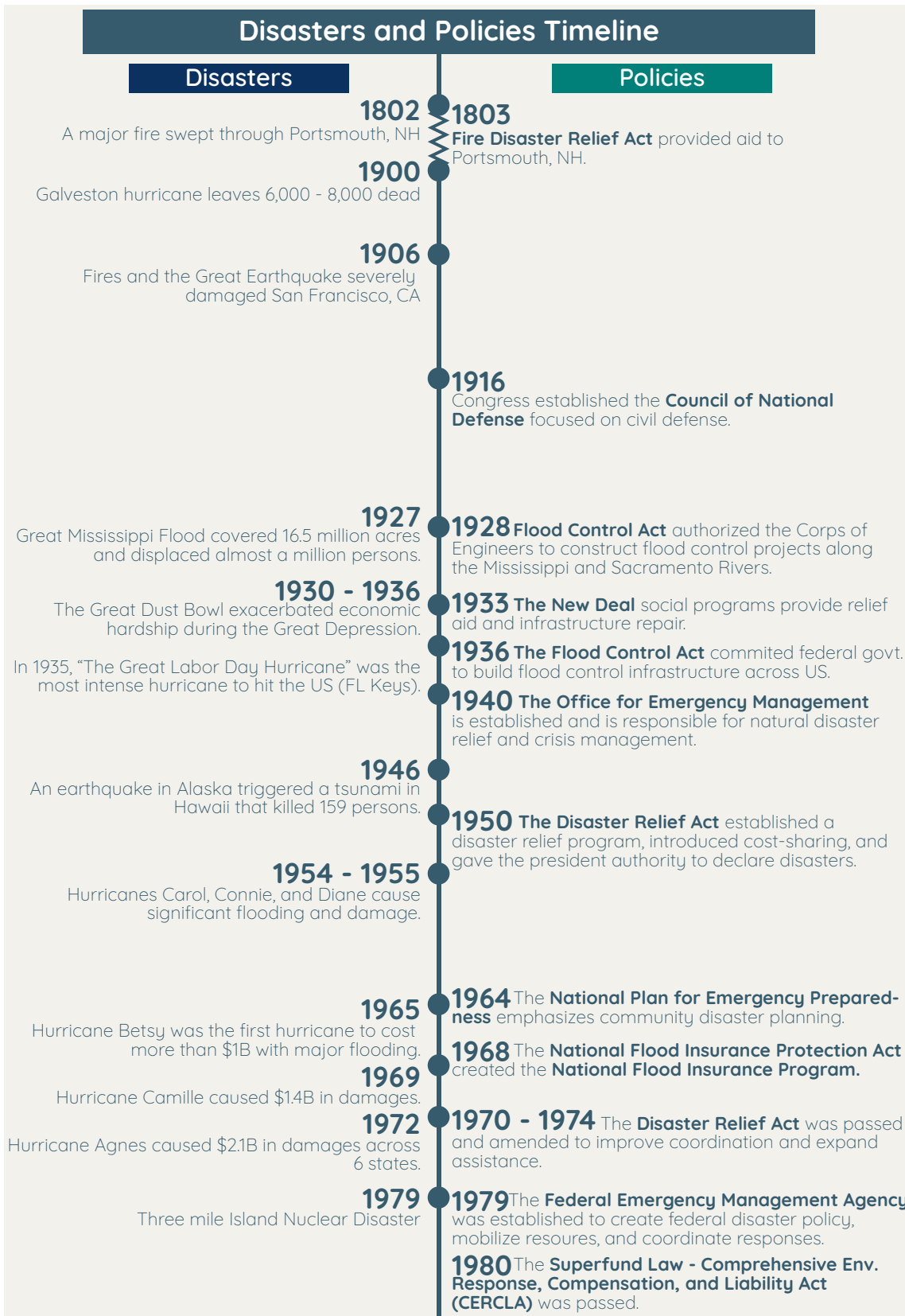
**Greg Gershuny**, Director, Energy & Environment Program, The Aspen Institute  
**Kate Jaffee**, Assistant Director for Environment & Climate, Energy & Environment Program, The Aspen Institute  
**Bea Kuijpers**, Program Associate for Environment & Climate, Energy & Environment Program, The Aspen Institute



# APPENDIX III: Acronyms

<b>Army Corps</b>	Army Corps of Engineers
<b>AWWA</b>	American Water Works Association
<b>BRIC</b>	Building Resilient Infrastructure and Communities
<b>BoR</b>	Bureau of Reclamation
<b>CWA</b>	Clean Water Act
<b>EPA</b>	Environmental Protection Agency
<b>ESA</b>	Endangered Species Act
<b>FEMA</b>	Federal Emergency Management Agency
<b>HUD</b>	U.S. Department of Housing and Urban Development
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NFIP</b>	National Flood Insurance Program
<b>SEC</b>	Securities and Exchange Commission
<b>SDWA</b>	Safe Drinking Water Act
<b>SRF</b>	State Revolving Fund
<b>USDA</b>	United States Department of Agriculture
<b>WIFIA</b>	Water Infrastructure Finance and Innovation Act

# APPENDIX IV: Timeline of Disaster and Policy Cycles







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