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SUMMARY REPORT

Data for Climate Risk Assessment in Vulnerable Communities

CODE

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FOREWORD

The world will long associate 2020 with the worst global pandemic in over a century. But that year also set a record on climate change: a total of 22 weather and climate events cost the U.S. over $96 billion.

Our nation's economic well-being is inextricably tied to climate change, and the U.S. Department of Commerce is prioritizing climate research and integrating climate data and information in every aspect of the Department's activities. The Department of Commerce is often thought of as the department of business, but it's actually a department of science, data, and innovation, all of which drive our economy and support people and communities. Scientists from the Department of Commerce and the National Oceanic and Atmospheric Administration (NOAA), which is part of the Department, are at the forefront in providing world-class data and innovative solutions to address the climate crisis.

The use of data and innovation has to account for equitable climate considerations. Tragically, climate change, extreme heat and cold, and water scarcity disproportionately affect low-income households and communities of color. Communities need localized data to make decisions about their own climate risk. Integrating data from across the government and private sectors, acting on that data, and then sharing best practices is inherently challenging. But this type of information will help to build stronger and more resilient communities, ensure smarter investments, and will be particularly important to those that are most at risk from climate threats.

Fortunately, data sharing is increasing across the country. For example, this summer NOAA, along with partner scientists, seasoned volunteers, and community coordinators, embarked on an urban heat mapping campaign in 11 states. Together they produced detailed local maps that give city officials and community groups life-saving information they need to protect people from extremely high temperatures. That's just one example of incredible efforts that not only make data more accessible to local decision makers but also help build productive public-private partnerships around climate risk data more broadly.

The Department of Commerce and other Federal agencies can do more than analyze climate risks: We can also prioritize blue-green economic initiatives - focused on the potential for environmental initiatives both on land and in the oceans - that will help our economy build back better. NOAA and Commerce's other bureaus, including the National Institute of Standards and Technology, the U.S. Patent and Trademark Office, and the Economic Development Administration, can all contribute to the Department's efforts and those of the Federal government in that regard by marrying the data and the science with decisions around our economy. But to truly confront this challenge, we must take a whole-of-government approach. Every Federal agency has to become a climate agency.

The *Roundtable on Data for Climate Risk Assessment in Vulnerable Communities* was an important piece of the broader effort to foster collaboration and drive the use of data towards meaningful climate action. As we heard at the Roundtable, climate change is a multifaceted issue that has to be dealt with and addressed with a multidisciplinary and all-hands-on-deck approach. It's not just a job for an individual bureau like NOAA. It's not just a job for the Department of Commerce. It requires all of the Federal government working in concert with our partners in the private sector, in our research institutions, and in the nonprofit sector.

The Department of Commerce is well positioned to bring all of these different disciplines, diverse perspectives, and diverse sets of partners together to address the climate crisis and do so in a way that is economically viable and equitable. We look forward to continuing and strengthening our partnerships on this important issue moving forward.

Don Graves
Deputy Secretary of Commerce
U.S. Department of Commerce



EXECUTIVE SUMMARY

On June 23 and 24, 2021, the nonprofit Center for Open Data Enterprise (CODE) and the National Oceanic and Atmospheric Administration (NOAA) co-hosted a *Webinar and Roundtable on Data for Climate Risk Assessment in Vulnerable Communities*. The Webinar set the stage for the Roundtable's expert discussions and presented valuable case studies of how communities are using data to conduct climate risk assessment and planning across the U.S.

Discussions at the Roundtable built on the Webinar and CODE's Briefing Paper and explored data for climate risk assessment through the lenses of *climate hazards* and *community needs*, which together were used as a framework for participants to have a shared understanding of climate risk. This paper begins by presenting that framework and providing an overview of the major climate hazards and issues related to community capacity explored at the Roundtable. It then dives deeper into the major themes that emerged from discussions at the Roundtable, including community needs and how to meet them, the potential role that the federal government can play, and data-related-issues.



Roundtable participants identified a number of essential priorities for meeting community needs and accurately conducting climate risk assessments. These needs include technical expertise and capacity to conduct accurate assessments, community engagement and consultation, trust building, localized education initiatives, and improved infrastructure and economic flexibility.

The Federal government can help fulfill these and other needs in a number of ways. It can direct resources down to state and tribal governments that can then ensure money and other resources flow to local communities. It can also make policy and develop guidance to help state, tribal, and local governments use data to make decisions and implement approaches to deal with climate change. To do all this, there is a need for more cross-agency and interagency collaboration as well as new partnerships between the Federal government and organizations in the private, academic, and nonprofit sectors as well as directly with community groups and local governments. Finally, the Federal government can make its own data more available while encouraging use of all high quality data.

A large portion of the Roundtable discussion was devoted to data related challenges. Using the climate risk data value chain presented in CODE's Briefing Paper, Roundtable participants helped clarify a number of challenges and opportunities across themes including data access, quality, analysis and use, and data needs -- or how to develop new data sources. They also identified a number of specific needs including particular datasets, opportunities for new models, forecasts, and projections, and infrastructure improvements that can be found in more detail in this paper's section on Improving the Climate Data Value Chain. CODE has also developed the *CODE Climate Risk Data Hub* with information shared during the Roundtable process, to present data models and other relevant resources for communities working on climate risk assessment.

Finally, this paper presents several recommendations to help Federal, state, tribal, and local governments collaborate with partners in the private, nonprofit, and academic sectors to improve the delivery of relevant and authoritative data and help communities conduct climate risk assessment and planning. These recommendations are:

1. Use partnerships to address data gaps and meet data needs
2. Apply open data policies and principles to climate and climate-relevant data
3. Standardize data through public-private standards development approaches
4. Develop more "downscaled" datasets with Federal leadership and support
5. Use existing and new funding mechanisms to support community-level data use
6. Create technical assistance and training programs to put Federal data to use
7. Apply climate data in the larger context of socioeconomic and other community factors
8. Engage citizens in data collection and use
9. Develop communities of practice to understand, integrate, and apply data from different sources
10. Develop regional, cloud-based climate data hubs
11. Conduct return-on-investment (ROI) analyses of the benefits of climate risk reduction

INTRODUCTION

Increasingly frequent and severe extreme weather events, growing populations, and ongoing urbanization are creating new strains on governments and communities. Climate change is already having devastating impacts at the local scale, as coastal flooding, water scarcity, heat waves, and a host of other hazards interrupt supply chains, interfere with food access, create new human health risks, and destroy property. These impacts are felt most strongly by vulnerable communities, which lack the capacity to plan for and the resources to recover from climate disasters.

Policymakers at all levels need access to meaningful, timely, and authoritative data and information to effectively measure climate-related risks and understand the compounding factors that make communities more likely to suffer during climate disasters and struggle to recover in their wake. Just as important, they need access to tools they can use to analyze that data and the expertise to put the derived knowledge into action.

On June 24, 2021 the nonprofit Center for Open Data Enterprise (CODE) and the National Oceanic and Atmospheric Administration (NOAA) co-hosted a *Roundtable on Data for Climate Risk Assessment in Vulnerable Communities*. CODE's work on this project was supported by the Amazon Sustainability Data Initiative and Amazon Web Services, which also provided input and insights into the Roundtable at every stage.

The Roundtable brought together nearly 100 participants from multiple Federal agencies, state and local governments, academic institutions, nonprofit organizations, community groups, and private companies. They met to discuss and identify types of data needed to address climate risks in vulnerable communities and explore strategies for enabling Federal, state, tribal, and local governments and communities to apply the data. Discussions at the Roundtable were organized around the themes of *Climate Hazards* and *Community Capacity*, which together can help illuminate the risks of significant climate-related impacts in a given area. While climate change is a global issue, the Roundtable focused on its impact on the United States and its territories, and tried to identify existing gaps in data, knowledge and expertise for building climate resilience.

This report presents insights and information from the Roundtable as well as CODE's recommendations for further action. The report was produced by CODE and represents CODE's synthesis and interpretation of Roundtable discussions and other research. It is not a U.S. government report. Information and opinions in this report do not necessarily reflect the opinions of each participant at the Roundtable, the U.S. Department of Commerce, NOAA, or any other component of the Federal government.

The Roundtable explored how data is produced, processed, distributed, analyzed, and put into action across a "climate risk data value chain" that stretches from Observation, Collection, and Generation to Assessment and Revision. The day's discussions identified existing data resources as well as gaps in data collection and highlighted opportunities to improve data quality, dissemination, and analysis. Participants ultimately articulated ways that vulnerable communities can be empowered with data to understand, prepare for, and recover from the growing threats that they face from climate change.

The Roundtable participants identified a wide range of data sources, analytic data models, and other resources that can help identify and predict climate risks in vulnerable communities. To make these more easily accessible, CODE has created the ***CODE Climate Risk Data Hub*** with more than a dozen data models and more than 50 additional resources in a searchable, sortable format. This report describes many of these resources as well, with examples of how they can be put to use. The Hub is designed to be a curated set of high-value resources, prioritized on the basis of Roundtable discussions, that can complement more extensive collections of resources such as the **Climate Resilience Toolkit**. CODE welcomes suggestions for additions to the **Hub via this form**.

When assessing community vulnerability and climate risk, policymakers and planners need to take a holistic view that includes not only access to knowledge derived from familiar climate variables like temperature, precipitation, and drought conditions, but also from other factors that are important in dealing with climate change. This *climate-relevant data*, can include everything from economic conditions, to information on transportation infrastructure, to data on community health and well-being. Roundtable participants stressed that this data is needed at a geographic resolution as granular as the Census block level. For example, planners need to know which households lack access to air conditioning in order to respond where the need is strongest during a severe heatwave.

The complexity of analyzing climate risk requires collaboration between disparate parts of government as well as a wide range of non-governmental actors. NOAA, which has deep expertise in the physical sciences, will have to collaborate with agencies like the **U.S. Department of Health and Human Services** (HHS) and the **Census Bureau** to understand the social determinants and neighborhood factors that can turn a climate event from a minor inconvenience into a matter of life and death. The Biden Administration has recognized this need through its "**whole-of-government approach**" to climate change.



From this perspective, every Federal agency will become a climate agency. To some extent, every community will have to become a climate focused community as well. However, for communities where good jobs are scarce and health is precarious, the impacts of climate change may seem like an abstract concern. Planners and policymakers must find ways to build climate resilient communities by addressing important local concerns and framing these issues around people's lives and livelihoods. As climate change worsens, communicating these impacts to the most vulnerable populations will become critical. Discussions at the Roundtable provided hope that it is possible to create good jobs, improve health, and address other high-priority community concerns while preparing for present and future climate risks.

The Roundtable discussions built on previous work done by CODE and its partners to help prepare Roundtable participants for the event and to develop public resources to improve the understanding of climate risk. Shortly before the Roundtable, CODE published a **Briefing Paper** providing a review of frameworks for analyzing climate risk, research on climate hazards and community capacity, case studies for addressing climate risk nationally and locally, and climate data resources and risk models.

On June 23, CODE and NOAA co-hosted a public Webinar with presentations from the U.S. Department of Commerce, NOAA, the White House Council on Environmental Quality, Amazon, and representatives of regional and nonprofit organizations addressing climate risk. The Webinar Agenda is included as Appendix 2 of this report, and the video and a transcript of the Webinar are available here.

The Webinar highlighted case studies that demonstrate the importance of collaboration and coordination across levels of government and sectors. For example, the city of Charleston, South Carolina worked with two federal agencies - including multiple offices within NOAA - state level programs, an academic institution, and a private sector partner to understand and respond to their growing flood risk. Similarly, the Southeast Florida Regional Climate Change Compact is a four-county effort that has developed planning tools, guidance, and shared climate change adaptation and mitigation strategies across a range of communities in the region.

CODE encourages readers of this report to read the Briefing Paper and access the Webinar for more information and insight on this topic.

HAZARDS, COMMUNITY CAPACITY, AND CLIMATE RISK

A framework for understanding climate risk

Low-income communities and communities of color have a higher likelihood of being impacted by climate-related hazards due in part to low financial, political, and socioeconomic capacity. Many of these communities face challenges in accessing, processing, and sharing locally-relevant datasets that help them identify, manage, and adapt to climate risks and build climate resilience. CODE and NOAA structured discussions at the Roundtable around two types of concerns: *climate hazards*, defined here as the physical hazards most likely to strike a geographical area (e.g. fires and floods), and *capacity*, which reflects the level of a city or community's resources to deal with those hazards.

The Roundtable used a framework for understanding climate risk that CODE presented at length in its Briefing Paper. In this framework, the combination of low capacity and likelihood of exposure to hazards determines climate risk. This model can be scaled to any geographic size, from regions that may face higher levels of climate risk to block-by-block neighborhoods that face higher climate risk within a large metropolitan area.

	HIGH LIKELIHOOD OF HAZARD	LOW LIKELIHOOD OF HAZARD
LOW CAPACITY	***High Risk*** Communities that have poor infrastructural and financial capacity and also face high likelihood of exposure to climate-related hazards.	***Medium Risk*** Communities that have low likelihood of exposure to climate-related hazards but also low infrastructural and financial capacity.
HIGH CAPACITY	***Medium Risk*** Communities that have strong financial and infrastructural capacity and relatively high likelihood of exposure to climate-related hazards.	***Low Risk*** Communities that have strong financial and infrastructural capacity and face low likelihood of exposure to climate-related hazards.

The ability to prepare for, respond to, and recover from the impacts of climate change are largely connected to a community's resilience and vulnerability. Minority communities have high rates of poverty: 20.8% of Black Americans, 17.6% of Hispanic Americans, and 25.4% of Native Americans live in poverty, compared to only 8.1% of non-Hispanic Whites, due in large part to a legacy of institutional racism and government-sanctioned redlining, which excluded communities of color from receiving mortgages and loans, and created lasting effects on the ability of people of color to build wealth. Because these populations disproportionately face poverty, they are more likely to reside in communities that have less resilient infrastructure, fewer natural barriers to climate hazards, and lower financial capacity to face and recover from climate disasters.

Certain communities are inherently more at risk of suffering the physical effects of a changing climate. These include areas prone to coastal flooding, wildfires, severe pollution, and other conditions exacerbated by climate change. The New York Times and the American Communities Project have produced interactive maps to help counties visualize the types of hazards that will impact their communities. These maps help measure a county's susceptibility to heat stress, hurricanes, sea level rise, and other risks. Indigenous people in the U.S. and around the world may experience particularly bad impacts from climate change, due to "their dependence on, and close relationship, with the environment and its resources," according to a United Nations report. These communities already face a high degree of political and economic marginalization, loss of land and resources, human rights violations, discrimination, and unemployment. All these factors increase the risk of negative impacts from the changing climate.

CODE's Briefing Paper describes the nature of increasing climate hazards and the regions and cities they are most likely to impact. Major current hazards include the following.

Hurricanes. The risk of severe hurricane damage can vary by geographical area. States and areas at higher risk of experiencing hurricanes include Southeast Florida and the Florida Panhandle, Louisiana, Texas, the coastal areas of Mississippi and Alabama, and Puerto Rico. Climate change is both putting more communities at high risk of experiencing a hurricane, and increasing the chances of property destruction and human casualties from hurricanes as well.

Wildfires. Fires are becoming more intense, larger, and more devastating. In the past 20 years, more acres of land have been burned by wildfires than in the 40 years before that. This trend appears to be increasing: Four of the five largest wildfires in California's history occurred in 2020 alone.



Droughts. The impact of drought is already causing detrimental effects on water access and food security. Projected increases in global temperatures will lead to significant decreases in freshwater sources and agricultural development in the near and long-term future. Access to clean water is becoming increasingly difficult, particularly in areas that already experience high water vulnerability, meaning they lack sufficient fresh water to meet daily needs.

Sea-Level Rise and Flooding. The average of global sea levels has risen about eight to nine inches in the past century and a half. In certain ocean basins, sea levels have risen six to eight inches since 1993. Rising sea levels pose a high risk to American cities because almost 40 percent of the population resides in coastal areas with high population density, which will see increased flooding, shoreline erosion, and storm hazards. Sea-level rise also poses risks to water access for some coastal communities, as saltwater intrusion associated with sea-level rise can impact groundwater availability.

Heat Waves. As the climate continues to warm, heat waves in the U.S. are becoming longer and more frequent, increasing from an average of two heat waves per year in the 1960s, to over six during the 2010s. Additionally, the average heat wave season has extended to 47 days longer than it was in the

1960s across 50 major cities in the U.S. These increases in hotter days are leading to more heat-related deaths and illnesses, particularly in vulnerable communities. Urban areas are already more vulnerable to challenges related to heat, as they experience hotter surface air temperatures than rural and suburban areas, an occurrence known as urban heat island effect.

Climate hazards across the U.S.

The intensity and frequency of climate hazards is increasing with climate change. Meanwhile, vulnerable populations, including minorities, the elderly, those who are low-income, and those who live in tribal communities, are impacted disproportionately by the effects of climate change. Roundtable participants emphasized the difficulty of assessing climate risk due to the intersectionality of issues pertaining to climate hazards and community vulnerability. A combination of systemic geographic, economic, and infrastructural factors can all make it more difficult for communities to recover from climate-related disasters. The effects of compounding climate hazards, plus the various dimensions of financial, technical, and infrastructural capacity create major challenges.

Many areas throughout the United States face especially high levels of climate risk. Roundtable participants highlighted many of these risks, including the following.

- Low-lying coastal areas such as the Virgin Islands, New Orleans, and communities along the east coast are among the most at risk of experiencing devastating impacts. Currently 360 major U.S. ports are located in these low-lying coastal areas, representing a severe risk to local, state, and national economies.
- Western states face higher risks of devastating wildfires and longer droughts. Colorado, for example, has a risk of drought due to albedo changes, or changes in the amount of sunlight reflected by a surface, from loss of snow cover.
- States in the southeastern region of the U.S. have the largest share of billion-dollar disasters, as well as some of the highest levels of social vulnerability. Coastal cities like Miami face more severe tropical storms and inundation from rising sea levels. The Gulf Coast is experiencing the effects of sea level rise, intensifying hurricanes, and warmer waters in the Gulf of Mexico which are fueling storms and flooding.
- Elsewhere along the east coast, coastal North Carolina and Philadelphia are experiencing extreme heat and flooding due to storm surges. Northeastern areas are facing increasing precipitation trends and extremes, and more fluvial (river) and coastal flooding.
- Native Alaskan communities face special difficulties managing climate hazards and recovering from their impact. They are increasingly suffering from the effects of thawing permafrost, loss of sea ice, and increased wildfire risk.

Roundtable participants noted a number of challenges in combining information on climate hazards with community vulnerability to assess climate risk. These challenges include the inability to quantify compounding factors, including the impacts of climate hazards and various vulnerability factors. For example, there is no standard way to quantify and cross-analyze the effects of intensifying heat waves and poor air quality, particularly with households that don't have air conditioning. Differential risk at the neighborhood level also makes it hard to assess climate hazard data. Certain hazards like extreme heat or flooding can vary on a block by block basis.

Community capacity: The social context

In order to achieve a comprehensive understanding of a community's current climate risk profile, needs, and future risk, climate data analysts must combine hazard data with information on a community's capacity to respond to climate threats. Community capacity includes many factors, ranging from physical infrastructure to the technical capacity to analyze complex data. It is also impacted by social factors, particularly the factors known collectively as the social determinants of health (SDOH).

Many SDOH factors, including neighborhood level determinants, housing, healthcare, economic stability, education, and food security, are essential and must be included in climate risk analyses. CODE has conducted research and worked with the U.S. Department of Health and Human Services to explore the use of SDOH data to respond to crises like the COVID-19 pandemic as well as in the health system more broadly. CODE is currently expanding this work to understand how SDOH factors impact well-being in ways that go beyond the context of health and healthcare.



Roundtable participants noted a number of SDOH factors that play a role in a community's ability to survive and recover from climate disasters and should be considered when analyzing community climate risk. Neighborhood-level SDOH factors like access to transportation and street management at granular geographic levels are critical factors. These determinants shed light on a neighborhood's ability to evacuate if need be, and which Census tracts will require extra resources during and after a climate-related emergency. The combination of a high likelihood of climate hazards and low capacity to respond to hazards, whether because of SDOH or other factors, mean that a city or community will have a more difficult time recovering from climate disasters. Lastly, experts at the *Roundtable* emphasized the importance of understanding a community's ability to survive a threat, which will require data on an area's access to water, food, healthcare, and other essential resources. Minority and low-income communities in many cities are under-resourced and have not had their needs prioritized, decreasing their socioeconomic capacity. For example, in Miami Dade County there are major disparities in socioeconomic status as well as exposure to hazards across neighborhoods. Detroit, another example, is at risk from the combination of heat stressors, large dense populations, and a demonstrated historical inability to respond to hazards.

MEETING COMMUNITY NEEDS

Roundtable participants identified a number of essential priorities for meeting community needs and accurately conducting climate risk assessments. These needs include technical expertise and capacity to conduct accurate assessments, community engagement and consultation, trust building, localized education initiatives, and improved infrastructure and economic flexibility. Roundtable participants shared resources including data warehouses, reference systems and tools, community risk models, and academic studies that are included in CODE's Climate Risk Data Hub. Many of these resources can potentially be scaled for broader use.

Technical capacity, infrastructure, and resources

Communities at high risk from climate hazards are often at a double disadvantage: They need better infrastructure and resources to manage the impact of hazards and recover from them, and they need better technical capacity to analyze, assess, and predict their risk of hazards to begin with. Roundtable discussions highlighted ongoing efforts and existing resources to improve local capacity for both hazard management and recovery and for risk assessment.

President Biden's Executive Order on Tackling the Climate Crisis at Home and Abroad addresses the first need by promising to provide direct assistance to underserved communities. The Executive Order includes a requirement to develop a geospatial Climate and Economic Justice Screening Tool, with interactive maps that will highlight disadvantaged areas. This tool will be used to allocate the proper resources, funds, and expert practitioners to the areas that most need it as part of the Justice40 Initiative, which directs 40 percent of relevant Federal spending to under-resourced communities.

The Roundtable surfaced ideas to meet the second need by boosting local technical capacity. Roundtable participants suggested that local officials should work with trained climate service practitioners, ideally funded by the Federal government, who can help develop and conduct accurate climate risk assessments. Chief Resilience Officers or individuals in a similar role can also benefit local communities by analyzing the best ways to direct investments in planning and leading climate action in their communities. Closer relationships with County or regional governments may also be able to provide technical services to rural and under-resourced communities.

The Roundtable also highlighted existing resources that could be leveraged by communities, such as Gulf TREE, a decision-support search engine designed to help users identify the best climate tools for their community needs. NOAA and Climate Central's Sea Level Rise and Coastal Flood Web Tools Comparison Matrix is another useful tool that can be used to measure the effects of compounding climate hazard events. At the local level, one participant shared the example of the Baltimore Neighborhood Indicators Alliance, which provides meaningful, accurate, and open data.

Engagement and trust-building

Trust-building is an essential priority for communities. Underserved and disenfranchised communities often lack trust in government due to decades of neglect and mistreatment. Indigenous populations, for example, often distrust the government due to a legacy of broken promises, making it more difficult to collect the necessary data and promote community changes needed to build resilience.

Roundtable participants proposed a number of strategies to build trust. To start, government agencies should leverage community-based organizations as critical partners, since they are trusted by their communities and have the skills to engage with community members. Residents trust and absorb information from their community leaders more than outside officials. Town halls can be an effective way to build trust within a community and improve climate efforts. Above all else, government and other outside experts need to treat individuals in the community as owners of their own data and engage with them to determine how their information will be used for climate risk assessment and management.



Resources and support for community engagement and data collection should be prioritized using an equity lens, with a focus on underserved groups. Many states and large cities have big disparities in socioeconomic status, climate risk, and other vulnerabilities across their geographies. Data on demographics, income, access to transportation, and other social determinants is needed at the neighborhood and Census tract level to properly allocate resources to those who need them most.

Roundtable participants recommended that external experts from the Federal government, private sector, and other entities collaborate with community leaders, community-based organizations, and similar stakeholders to build trust while prioritizing local needs. Roundtable participants specifically recommended climate risk assessments be conducted based on highly localized data on attributes like home value, and allocate more resources towards more underserved areas - building on the effort that is already underway via the Justice40 Initiative.

Education

Many Roundtable participants urged increased support for localized climate education initiatives. In particular, they emphasized the needs for youth education, technical training for the wider community, and a specific focus on Indigenous communities. Community members should be knowledgeable about what climate hazards are likely in their community and how to respond accordingly. They need to be able to access and utilize data on local climate hazards to inform their approach to climate risk.

Local policymakers should increase support for STEM education at early ages, particularly on climate science, to enable students to understand climate science and possibly even pursue careers in the field. Youth and other community members should also be educated on the climate hazards that pervade their area, steps they can take to prepare for them, and ways they can help mitigate climate change in their everyday lives.

One way under-resourced communities can increase their technical capacity is by engaging with "sister cities" that face similar climate hazards and have already implemented robust climate risk assessment models. These communities can provide training and best practices to underserved communities.

Finally, education in Indigenous communities is especially important given these populations' lack of

resources and poor infrastructure. Roundtable participants made a number of recommendations to support education in these populations, including increasing access to and reducing the cost of high-speed internet, and ensuring that K-14 schools, as well as tribal colleges, have abundant computer resources. Featuring Indigenous scientists from their tribes in teaching materials, including pictures, audio clips, and other forms of media, can help Indigenous children learn about the impact of climate on their community through positive role models. Lastly, teachers and students should be engaged in hands-on, field-based, citizen science activities that relate to local resources and activities, central to the tribe's culture and traditions. This approach can work across communities - not just in tribal nations.

THE FEDERAL ROLE

The Federal government has a vital role to play in addressing the impacts of climate change broadly and helping communities cope with those impacts. Discussions at the Roundtable laid out a number of ways in which Federal agencies can be most helpful to at-risk communities.

Perhaps most importantly, the Federal government has the power to direct resources to state and tribal governments that can distribute money and other resources to local communities. The Federal government can also make policies and develop guidance to help state, tribal, and local governments use data to make decisions and implement approaches to mitigate and adapt to climate change. Roundtable participants highlighted the need for more intra-agency and interagency collaboration as well as new partnerships between the Federal government and organizations in the private, academic, and nonprofit sectors as well as directly with community groups and local governments.

While some communities may distrust or be unaware of the actions and tools of the Federal government, Roundtable participants pointed out that local governments do trust and use Federal data sources, often more than they trust private or nonprofit sources. At the same time, the sheer amount of Federal data can be overwhelming, and the data can be especially difficult to use because it is often siloed or hard to access. To fulfill its role as a vital data provider, the Federal government needs to improve its data access and data usability. The government can also help validate qualified sources of information from non-governmental organizations so that communities can trust and use those sources as well as Federal data.

Resources

One of the Federal government's most important functions related to climate risk assessment is its ability to gather and distribute financial, technical, and human resources. Discussions at the Roundtable highlighted the ways that government resources can make a significant impact in areas including scientific research, data collection and infrastructure, and community capacity and engagement.

To ensure that communities have access to the highest quality and most accurate information for risk assessment, the Federal government should continue to invest in scientific research, data collection, and data infrastructure. Models and risk assessments are only as good as the data they are built on. Multiple Roundtable participants pointed out that NOAA's current observation infrastructure is at risk, with far less than the recommended number of weather buoys currently operational, issues to be resolved with the Next Generation Weather Radar System (NEXRAD), and needed support for the National Spatial Reference System.

Similar issues exist at other key agencies. Notably, the Census Bureau dealt with well publicized challenges as it carried out its decennial census during the height of the COVID-19 pandemic and has faced opposition to its American Community Survey (ACS), an important source of social, demographic, and economic data about local communities. These programs should be not just maintained, but expanded. For example, the ACS does not cover Guam, American Samoa, and other U.S. territories that face significant climate-related challenges. Overall, NOAA and other agencies need more resources dedicated to data collection specifically and climate change more broadly. Roundtable participants estimated that NOAA's budget alone would have to more than double to meet its climate-change related demands.

In addition to funding its own efforts, the Federal government can provide needed resources to build capacity and engagement around climate risk assessment in local communities. The government can support innovative projects, training and data resources, and local infrastructure to support data analysis including Internet and communication tools. It can also dedicate specific resources to help communities engage in broader efforts, including fostering better connectivity between agencies and the local community through relationships with local partners. This sort of funding and relationship building can also help support citizen science, which has the compounding benefit of producing new, highly localized data, and increasing trust by bringing citizens together with academics and the government around a shared goal.

While NOAA already works with communities through a range of climate services, Roundtable participants suggested roles for other agencies to play as well. For example, a collaboration between NOAA and the Department of the Interior could be effective at community outreach. Participants also suggested that states and local governments partner with the U.S. Geological Survey to advance efforts in water and other climate models.

Funding and support for programs at both the Federal and local levels has to be ongoing and consistent. One-off grants will be inadequate to support in-depth strategic planning, especially in communities that are most likely to struggle to recover from climate disasters. Partnerships between governments, academic institutions, and community groups are more likely to survive and thrive if they are given appropriate runway to evolve and stabilize.

Policy alignment and guidance

The Federal government can make a positive impact in various ways by setting and aligning policy. Roundtable participants pointed out that Federal policies can help support socioeconomic research, information sharing, sound regulatory practices, and the specific goal of climate justice at the Federal level and across sectors. The Federal government can also make an impact without making formal policy change by developing guidance that can be used by state, tribal, and local governments as they conduct climate risk assessments and plan for the future.

The Biden administration has already leveraged its policymaking powers to orient the Federal government to combat climate change through the Executive Order on Tackling the Climate Crisis at Home and Abroad. At the same time, the administration is supporting underserved communities through the Justice40 Initiative. The Roundtable identified a number of other potential policy goals for the current administration, including changes to policies at NOAA, the Department of Commerce, and the White House Office of Management and Budget that would make it easier for the Federal government to conduct primary socioeconomic research. The Roundtable also highlighted the power of writing desired outcomes into policy. For example, participants highlighted a recent call for the U.S. Global Change Research Program (USGCRP) to include risk management in the organizational structure of its next National Climate Assessment.

The Federal government can also support climate risk assessment and response efforts without formal changes to law or regulations. Agencies can identify local best practices and develop standards and guidance to help cities and communities apply them across the country. They can also develop common approaches to assess exposure, vulnerability, and risk, and can work with states and local communities to implement them. There would be great value in a consistent national approach to risk assessment that can be taken and adjusted to meet the needs of local communities.

Federal guidance is also needed to ensure that ambitious policy goals can be achieved. For example, Roundtable discussions made it clear that there needs to be clear guidance on how to measure the investments made through the Justice40 Initiative to ensure that agencies are living up to the Executive Order's promise. Overall, the Federal government can use policy and guidance to lay out ambitious goals and help stakeholders from the smallest communities across the country to administrators' offices in Washington achieve them.

Intra-agency and interagency collaboration

Intra-agency and interagency collaboration is essential to make progress on climate issues. Collaboration and coordination can lead to powerful analyses using combined data sources, better long-term project planning, easier access to information for non-governmental stakeholders, and other benefits.

Currently, multiple agencies hold data that is highlighly relevant to climate risk assessment, but silos and lack of coordination limit their ability to analyze these datasets together. For example, NOAA has some of the best climate and weather models in the world, while the Census Bureau sees where and how people live, and the Federal Reserve knows how people spend on their credit cards. Roundtable attendees urged these and other agencies to work together to combine climate and social data for a more powerful understanding of how climate change will impact individuals. For example, data from NOAA, the Census, and the Federal Reserve could be combined to help understand where shortages may be more likely to occur in the wake of future disasters. Similarly, the Justice Department can combine climate data with crime data to better understand how events like heat waves impact crime rates in different areas. Agencies that have not traditionally dealt with climate data should be encouraged to integrate it into their existing workflows and analyses. This approach will have a positive downstream impact by ultimately providing communities with new, more powerful data and analyses to understand their local conditions.

Improved collaboration between agencies can help long-term planning while creating new, continuous data sources for analysis. For example, agencies like the U.S. Army Corps of Engineers and the U.S. Department of Transportation collect valuable data while they are carrying out construction projects but stop once those projects are finished. NOAA is now working with both agencies to take over and continue data collection. This sort of collaboration should be encouraged, continued, and expanded. Improved coordination and collaboration should have the added benefit of making more and better information available to non-Federal actors working on climate issues.

Partnerships with the private sector, academia, NGOs, and state and local governments

As important as intra-agency and-interagency collaboration are, the Federal government also has the opportunity to create new partnerships and strengthen existing ones with state, local, and tribal governments, the private sector, academic institutions, and nonprofit organizations. Discussions at the Roundtable emphasized the importance of connecting with external stakeholders to improve capacity, accelerate risk assessment and planning activities, and increase trust in local communities. Community engagement can also strengthen Federal efforts by helping agencies understand local needs and identifying future leaders and emerging opportunities. States can also play a crucial role as a bridge between the Federal government and localities, and can help promote knowledge sharing and disseminate best practices.

For this approach to work, communities need more representation at the agency level. It is symbolic, for example, that weather forecast offices are often staffed only by fluent English speakers, leading to a lack of forecasts in languages like Spanish, Samoan, Chinese, and other languages. Roundtable participants also suggested setting up working groups so that community stakeholders and Federal representatives can have ongoing conversations around core issues.

A variety of existing initiatives already provide a good foundation to build on. These include government activities like NOAA's Regional Integrated Science Assessment (RISA) program, citizen science efforts, and a current partnership between NOAA and The Census Bureau's Opportunity Project (TOP) to address the climate crisis through "Climate-Smart Communities." Outside of NOAA, the Federal Emergency Management Agency's (FEMA) Building Resilient Infrastructure and Communities (BRIC) program can support similar goals, although Roundtable participants recommended an effort to better coordinate between FEMA staff and communities seeking grants to ensure that the program maximizes its potential.



The Partnership for Resilience and Preparedness (PREP) is a prime example of collaboration between the nonprofit sector, private organizations, and governments at the local, national, and global levels. PREP was formed in 2016 with the goal of making climate and socioeconomic data more accessible and usable. They seek to do this through their online map-based platform, which uses open data to allow users to visualize future climate scenarios to inform adaptation and resilience planning. PREP participants include nonprofits like the World Resources Institute and Future Earth, private companies like AWS and Microsoft, and government agencies including NOAA, NASA, and the U.S. Department of the Interior.

Roundtable participants particularly cited the value of the Steps to Resilience, which are part of the U.S. Climate Resilience Toolkit. They described the Steps to Resilience as a strong model that provides a "comprehensive planning framework" to help address climate risks and stressors. More than 60 local governments already use the Steps to Resilience, and use of the program could be expanded across the country.

There are also many opportunities for regional collaboration to co-develop models at a larger scale. For example, the West Coast Ocean Alliance is a regional collaboration that promotes community engagement and provides guidance on effective consultation, communication, and engagement.

Overall, Roundtable participants highlighted the value of communities of practice. Specifically, participants recommended establishing communities of practice that are targeted to regions and issues and provide resources like data sources, best practices, templates, and other guidance to easily implement resilience planning.

Ultimately, government-community partnerships have the potential to create replicable frameworks for action, build trust, surface high-value resources to the right people, and spread valuable climate risk assessment activities to under-resourced areas around the country.

Federal data

The Federal government plays a key role in the climate data value chain. The Federal government is one of the primary sources of climate data, and it can also serve as a validator for outside data, helping to build trust and increase the overall range of data being used for risk assessment and planning.

Local governments tend to trust data from the Federal government over other sources. Their trust places a responsibility on agencies to provide free, high quality, and timely data, and provides an opportunity for them to ensure that their data has a high impact. NOAA and other Federal agencies can develop validated regional datasets, increase awareness of and access to data in vulnerable communities, and build data systems, portals, and other data services and tools. They can also provide specific analyses, develop models, clean datasets, and combine different datasets that local communities don't have the capacity to analyze together.

The government can validate external and privately held datasets produced by nonprofit organizations, academic institutions, or private companies, making them trustworthy in the eyes of local communities. For example, First Street Foundation's product FloodFactor, which was highlighted in CODE's Webinar, is a high-quality source of analysis and information that improves on the information now available from FEMA. Local governments may not be aware of FloodFactor, or may be hesitant to use it because it is not a Federal government product. Federal validation could make this valuable tool more widely known and widely used.

The Federal government also has the scope and ability to provide data and services to smaller units of government. Federal agencies can build data systems, portals, and services for sharing data that cross Federal, state, tribal, and local sources and even incorporate traditional knowledge and citizen science. The government can also provide information on climate science and climate-relevant factors that local communities can combine with their own data and knowledge.

The Federal government can develop specific models, analyses, and combinations in support of local efforts. A variety of Federal agencies already do work in this area that could be expanded or improved. For example, the Army Corps of Engineers has developed storm surge maps to help identify risk during hurricane season. NOAA is working on projects to improve flood plain mapping for the entire country. Federal agencies should build on these examples by expanding existing, and developing new, analyses that model climate hazards and risks at the regional and national scale.

Roundtable discussions also identified several NOAA efforts that could be improved or reintroduced. These include the Atlas 14 Point Precipitation Frequency Estimates, which need to be updated, and climate prediction and projection reports that can be re-funded. More broadly, participants argued that the Federal government should ensure that all relevant data are openly available and well organized.

IMPROVING THE CLIMATE DATA VALUE CHAIN

Beyond the issues specific to Federal data, climate data and climate-relevant data of all kinds need to be improved to be more applicable and useful. CODE's Briefing Paper on Data for Climate Risk Assessment described how climate risk data can be mapped along a "value chain" that analyzes the various stages and stakeholders involved in the climate risk data production process. Using the value chain as a framework, discussions at the Roundtable helped clarify a number of issues and opportunities across themes including data access, quality, analysis and use, data needs, and opportunities to develop new data sources.

Data distribution and access

Climate data takes many forms. NOAA's Digital Coast platform, Yale's Climate Opinion Maps, First Street Foundation's API, the decennial Census, and more all provide data that can be applied to climate risk assessment. Roundtable participants broadly agreed that while a wide range of climate and climate-relevant data is available for risk assessment, it can be difficult to locate and apply the data because it covers multiple disciplines and is often spread out and siloed. Vulnerable communities especially may lack the capacity to find, combine, and analyze the most relevant data for them. To be most useful, data on climate risk assessment needs to be consolidated, linked to democratized tools for analysis, made available under the principles of open data and open source, tagged with appropriate metadata, and standardized.

It may not be necessary to create a single point of access for all of the varied data that can contribute to climate risk assessment, but there is a need for some form of additional data aggregation and distribution, perhaps on a regional scale. There are also opportunities to make data available alongside analytic tools or with analysis already available to make it easier for underresouced communities to use. Cloud technologies may play a role here, as they require less local infrastructure and can be made widely available. NOAA's Big Data Program (BDP) is already providing access to more than 200 datasets, greatly increasing access to NOAA Climate Data and opening the door to leveraging the cloud to conduct regionally focused climate analysis.

Whether centralized on one data portal or distributed across regional networks, climate data will have to be made available to the widest possible range of users. To that end, Roundtable attendees highlighted the importance of open data and open source software and tools.

A lot of data is already available openly, but some important datasets are private, or difficult for communities to access. For example, data on infrastructure vulnerability may be unavailable for security reasons, while utility companies are often hesitant to share data - sometimes to protect customer privacy, but just as often out of business self interest. Insurance and financial firms conduct their own climate risk assessments, often with expensive, proprietary data, but don't share the results with the communities that would benefit. Even the Federal government charges for some data, which can limit its use. Roundtable attendees suggested that the Federal government make its own data available for free and work with industry to make more data publicly available to the communities it is relevant to.

Leveraging open source software can help agencies and communities share knowledge, develop capacity, and save money. For example, when the Forest Service was required to begin incorporating expected changes from climate variability into their planning, they adopted code from an existing NOAA product to build a tool for Forest Service managers, enabling them to save $250,000. Roundtable attendees suggested expanding this sort of collaboration by identifying agency tools that can be shared.



Open source efforts can also create connections between various levels of the government, the private sector, nonprofits, and other stakeholders. For example, organizations like Azavea and Headwaters Economics have contributed open source code to Climate Explorer, which is the result of a partnership between government and academia.

Making data available is important, but the data has limited value if it isn't standardized and organized so that it can be used. Roundtable attendees pointed out that much of the most relevant data for climate risk assessment is in different formats, doesn't adhere to accepted standards, hasn't been peer reviewed, and is not optimized for modern technologies, like the cloud.

Some progress has been made on these fronts. For example, as one of the speakers at CODE's Webinar described, practitioners in Florida have worked to develop regionally unified projections that downscale data from the Intergovernmental Panel on Climate Change (IPCC) and NOAA. They have had success getting the state to use certain NOAA projections.

Data quality

Having clear and consistent metadata and data standards is an important step towards ensuring that the data available for climate risk assessment is of high quality. The Roundtable identified several other data quality priorities including timeliness, granularity, and appropriateness (fitness for purpose). Broadly speaking, data collection activities should be better funded, with quality assurance built into data collection budgets.

It is difficult to trust data that is not timely. The Roundtable identified time lag in data collection, which can lead to skepticism and hesitancy to use information that may be out of date. Timeliness is especially important as analyses become more localized.

Similarly, hyper-local analysis requires appropriately granular data. Most climate-relevant data is tracked at the global, national, or regional level. There is a significant need for downscaled data - data that has been adapted from global or regional models to be applicable at a highly local level - in order to help communities understand their risks and how hazards may impact them, independently of the region or nation in which they are located. For example, rainfall, heatwaves, and wildfires can all have different impacts in different communities, not only in different regions. It is important to understand their impacts at the most granular level possible.

It will also be important to make different local datasets interoperable. Existing data at the local level is often on mis-matched scales. For example, some data may be available at the state level, some at the Census tract level, and some at the ZIP code level, which makes analysis and modeling with combined datasets difficult.

There are currently several public sources of downscaled climate data including Localized Constructed Analogs Statistical Downscaling (LOCA), Multivariate Adaptive Constructed Analogs (MACA), and bias correction constructed analogs (BCCA). Well-resourced communities have also been increasing their own investments in higher resolution data, which benefits them but has the unintended consequence of increasing the equity gap between high and low resourced communities.

Despite these limitations, there is so much data available from different sources that it can be difficult to find, navigate, and determine which data is most appropriate for a given use case. Better metadata standards for climate risk assessment data will make it easier to distinguish what is useful, relevant, and recommended for community risk and resilience planning, with emphasis on equity and other important values. Metadata and standards should be tackled throughout the process of distributing climate data and making it more accessible.

Analysis and use

Once data is available, accessible, and usable it can be leveraged for climate risk assessment and other applications. End users, especially in under-resourced communities, need decision support tools and help with analysis rather than just raw data. Stakeholders in the value chain, including the Federal government and organizations in the private and nonprofit sectors, can look for ways to build new tools and expand existing ones that are aimed at helping local decision makers leverage climate data. Roundtable participants discussed several ways to help local communities with data analysis and risk assessment, including a decision tree for selecting the most relevant and useful data to inform decision making, tools that package data for localized analysis, best-practice guidance, and decision-level analytics. Even something as simple as "threshold" information - for example, identifying threshold temperatures where heat can become a threat to human health - can help communities interpret the data they have access to.

While analyzing all the factors involved in climate risk is a complex challenge, city and community planners can take some immediate steps to link human factors with information on climate hazards to more fully understand community vulnerability. For example, they can incorporate basic public health data into climate risk analyses, adding valuable information on the state of community health and resilience. They can also use sources of social vulnerability data such as the Centers for Disease Control and Prevention's (CDC) Social Vulnerability Index (SVI) and the similarly named Social Vulnerability Index (SoVI), developed by the Hazards and Vulnerability Research Institute at the University of South Carolina. However, Roundtable participants noted that social vulnerability data and its applicability can be improved. These data sources are not always user-friendly, and many potential users don't yet understand how best to integrate them with climate hazard data.

An overall goal is the ability to combine different kinds of data in analysis that can be valuable beyond risk assessment activities themselves. Journalists, artists, and researchers have found unique ways to communicate and educate the public on data use and build data literacy by showing analyses that combine different datasets to highlight important information or trends. Climate Central has worked with the American Meteorological Society to educate local communities about the impacts of climate change. Researchers at the Massachusetts Institute of Technology have even studied the power of art to build data literacy.

Specific data needs

While there is a wide range of data available for climate risk assessment, the Roundtable identified areas where more may be needed or existing data may need to be improved. Attendees also discussed approaches to developing those data sources including a focus on citizen science and more thoughtful "co-production" of data. Data needs identified at the Roundtable include the following.

Data on Hazards

- Event-based risk or hazard data: There is currently no unified set of information to address specific extreme events and their associated data or standards for defining specific events and screening their data
- Flooding impact including losses, mobility data, communications infrastructure, and social media interactions
- Data on tornadoes for trend analysis
- Increased data on wildfires and associated environmental features
- Windfield data for hurricanes

Basic Environmental Data

- More data needed on remote regions like the Arctic and in the Northern Plains and rural western U.S. (e.g. for grassland vegetation). Need a denser network of meteorological tools
- More weather buoys needed, by a factor of one or more orders of magnitude
- Accurate and detailed elevation data
- Temperature reported with health and forestry perspective
- Increased soil moisture data for drought monitoring and heat stress
- Increased atmospheric circulation data
- Increased historical precipitation data

Infrastructure, Economic, and Population Data

- Land coverage and landscaping at the block or individual building level
- Data on variables like damageability curves, building stock and information (to the rooftop level), defensive structures
- Data on transient and undocumented groups
- Data on climate-related health conditions
- Community level data on cultural resources, heritage, and traditional knowledge

Modeling Forecasts and Projection Needs

- Need for improved precipitation projections at regional scales
- Need for specific precipitation indexes to cover questions like "how hard could it rain in a 15-minute stretch"
- Need for more integrated flood perspective including coastal hazards, floodplain changes, sea level rise, etc.
- Need more accurate and timely subseasonal to seasonal forecasts
- Need to consolidate physics and impacts data for each major disruption event, including spatio-temporal information, in one location

Approaches to data improvement

A major theme that emerged from the Roundtable - both for improving data resources and putting existing data to use - is the need for more "co-production" of data and data analyses. The goal of co-production is to put people and their communities at the center of climate risk assessment and planning, and not treat climate risk as a problem only for infrastructure experts and data analysts. Data needs to be developed and applied collectively with climate scientists and data scientists working with community members and individuals. Methodologies and models need to be developed with stakeholders rather than just brought to communities for comment - and often fixing - after they are developed.

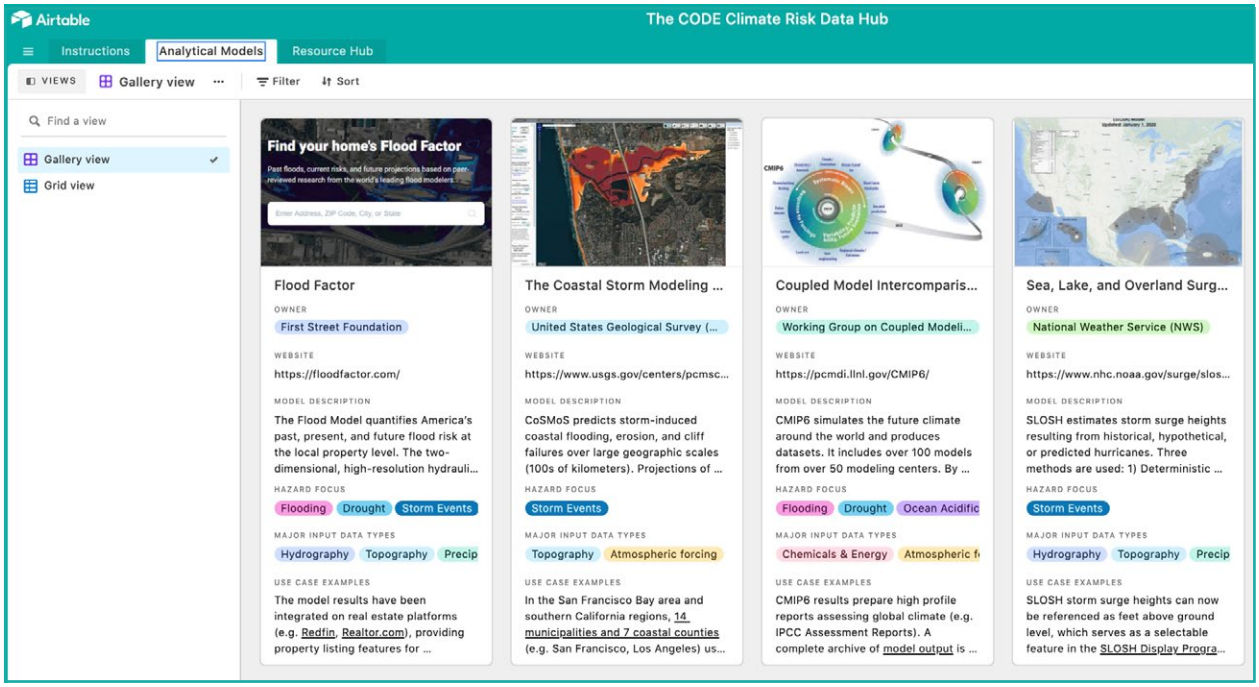
Why is this participatory approach so important? First, because it builds trust and ensures that communities will put data analyses to use, especially important in communities that have a history of distrust in government and other institutions. But equally important, co-production is needed to ensure that data will be truly reflective of what is happening on the ground in communities. Governments and other institutional representatives, including scientists and other academics, need community knowledge to ensure accurate data.

This sort of local knowledge can be invaluable during a climate emergency. In the wake of Hurricane Sandy, the community-led Occupy Sandy was often able to serve residents better than FEMA or the local police and fire departments in no small part because of their community roots and knowledge. This community driven approach has been successful in other countries as well. In the wake of a devastating earthquake in Nepal, Kathmandu Living Labs was able to quickly launch a mapping site to connect first responders, including volunteer organizations and the national army, to vital information.

Local knowledge and participation is vital not just while responding to climate hazards, but also while preparing for their risk. Involving local stakeholders can determine existing data gaps, understand data and technological needs, ease data access, and contribute to more accurate, useful risk assessments.

CLIMATE RISK DATA HUB

Based on the discussion during the Roundtable, CODE's team gathered examples of resources, organizations, and use cases around the globe that may be useful to climate scientists, community leaders, and others working in this field. We have compiled those resources into the ***CODE Climate Risk Data Hub***. This database complements the Roundtable Summary Report and describes and analyzes core characteristics of the resources we identified. CODE envisions this hub as a living resource and hope this inventory will continue to grow and provide the public with better resource access and insights for new projects. CODE welcomes suggestions for additions to the HUB via this form.



RECOMMENDATIONS

CODE's synthesis of findings in this report is based on Roundtable participants' discussions in 20 facilitated breakout sessions, as well as other input and research. The Roundtable was not designed to produce consensus or agreed-upon recommendations from the group of almost 100 participants as a whole. The following are CODE's recommendations based on the organization's assessment of major themes and their alignment with trends in climate science and Federal data programs and policy.

1. **Use partnerships to address data gaps and meet data needs.** Addressing the data needs identified in the Roundtable requires collaboration among the Federal government, state governments, private-sector companies, and nonprofit and academic partners. Relevant data from all sources should be made open whenever possible.

   The Federal government should work with private companies to encourage data sharing and ease cost burdens imposed on under-resourced communities. For example, data from utility and other public service providers should be made public, with proper privacy and security protections, regardless of whether the utility in question is managed by a private company (e.g. local power companies should make relevant data open, without cost to users). Recent work on the development of data collaboratives can provide some models for this kind of data sharing.

   Private cloud service providers can also work with researchers, local communities, and nonprofit organizations to provide cloud storage and analytical tools at reduced or no cost, and can work with agencies to develop programs like NOAA's Big Data Program - carried out with major cloud service providers - to expand public access to agency data on the cloud. They can also leverage their platforms to conduct and share analysis that can be used by multiple communities and other stakeholders.

   State governments should develop open source and open data policies, especially for climate-relevant data. These policies can help ensure that states have long-standing places to house data that will survive through political transition and leadership change.

2. **Apply open data policies and principles to climate and climate-relevant data.** Under the Foundations for Evidence-Based Policymaking Act, Federal agencies are now required to make their data resources open, accessible, and easily usable by the public. President Biden's Executive Order on climate action has underscored the need for more open, accurate, and useful data to address climate change in particular. All Federal agencies should prioritize climate and climate-relevant data in their data programs and make that data available using the best principles of open data. CODE has recently assessed Federal open data policies and their implications, along with similar policies on the use of open source software and hybrid cloud adoption, in a paper published by the IBM Center for the Business of Government.

   Several Roundtable participants pointed out that some important Federal datasets are now only available for a fee, which goes against the spirit of open data. Charging for this essential data makes it particularly difficult for under-resourced communities, nonprofit organizations, and other noncommercial data users to apply these data sources. Federal agencies should make these and other datasets available for free, and can expect that the economic benefit will outweigh the relatively minor loss of revenue.

However, simply opening data is not enough. The Federal government and other stakeholders also need to focus on making climate data accessible and usable. Previous efforts, like the Obama administration's Climate Data Initiative or PREP can be reinvigorated and expanded on. So can work already being done through efforts like the Amazon Sustainability Data Initiative, which is aligning data access and computing power to analyze climate's impact across domains.

3. **Standardize data through public-private standards development approaches.** To make data usable, it needs to be interoperable. Roundtable attendees pointed out that much of the most relevant data for climate risk assessment is not standardized or optimized for modern technologies like the cloud. The Federal government, private and nonprofit sectors, and community groups can work together to develop data standards using well-established public-private standards development models. Cloud service providers, in particular, should work to ensure that relevant climate data can be hosted and analyzed on the cloud.

   Data standards will ultimately increase the value of open climate data and enable more stakeholders to use the data for risk assessment and planning. Standardization can make the universe of climate data and tools more coherent and cohesive and less confusing and duplicative, and will encourage widespread use of certified, authoritative climate data in planning for the future across all sectors of the economy.

4. **Develop more "downscaled" datasets with Federal leadership and support.** There is a particular need for "downscaled" climate data in order to understand climate risk. Downscaling has been defined as "the process of obtaining location-specific climate information from global or regional models that provide data at a higher geographical resolution." The Federal government should work with local communities -- particularly under-resourced ones -- to understand data needs and take steps to appropriately downscale lower-resolution data to more local levels. The U.S. Department of Transportation's CMIP Climate Data Processing Tool, which processes "readily available downscaled climate projections at the local level into relevant statistics for transportation planners," could serve as a model for other Federal efforts to appropriately downscale data for local uses. The private sector has a role to play here as well. Data analysts and consulting firms can work with communities to identify and apply downscaled data. Cloud service providers can help disseminate this data by hosting it on their platforms and connecting potential users to it.

5. **Use existing and new funding mechanisms to support community-level data use.** Many communities will need funding and resources to develop the technical capacity to use Federal and other data sources. The Federal government can provide competitive funding to communities, especially those that are at risk and underserved, to incentivize climate action and help bolster its development. To encourage participation and engagement, the Federal government could provide free capacity building programs, but require communities to participate before accepting Federal funds for their risk assessment activities. Private companies can also support under-resourced communities by donating time, computing resources, or data analysis.

   Roundtable attendees pointed out that funding local projects and developing them with impacted communities can generate more buy-in and engagement than more traditional, top down approaches. Senator Cory Booker's (D-NJ) Climate Stewardship Act was cited as a potential vehicle to fund some of these community focused efforts.

The Federal government can also help by expanding existing Land-Grant and Sea-Grant Universities' extension programs to distribute climate information into communities and help them put it to use. One Roundtable attendee suggested developing new "Climate-Grant," or "Anthropocene" universities, to serve the same function.

6. **Create technical assistance and training programs to put Federal data to use.** The Federal government can provide guidance on existing tools and best practices for community practitioners, rather than having them start from scratch. Local planners can tailor emergency response trainings to align with the most likely local climate hazards like heat waves and flooding. Adding training components to state and regional climate risk assessments will ensure that communities have practitioners trained according to the local context.

   Several Roundtable participants proposed that the Federal government create a cadre of climate data "expert guides" – individuals with appropriate technical capacity who would be embedded into local communities to assist with climate risk assessment and related work. These guides would be able to make sense of the raw data and lead local communities through deliberative frameworks, like the Science of Teaching and Reading certification exam. They could also lead the development of the equivalent of a cooperative extension service to support climate risk management, in every county or other local region. These expert guides would ideally come from the communities they are sent to help, combining expertise with local knowledge. A program to provide expert guides could be managed and funded through the "Climate-Grant" universities mentioned in the previous recommendation.

7. **Apply climate data in the larger context of socioeconomic and other community factors.** New frameworks are necessary to integrate climate hazard data with data on social vulnerability, socioeconomic risk, the social determinants of health, and other factors. Models should include several types of vulnerability, including social vulnerability. Impacts should be analyzed in terms of socio-economic variables, with predictions centered around how people will be affected by infrastructure failures across populations. This sort of analysis could get as granular as assessing whether gas stations will run out of gas or grocery stores will run out of milk in vulnerable communities during a disaster.

   The Federal government should work closely with end users at the community level to identify and integrate different Federal data sources to produce more intersectional risk assessments that go beyond hazards. This effort could build on NOAA's Regional Integrated Sciences and Assessments (RISA) Program to develop a broader risk assessment program that highlights health-related as well as climate-related effects. The Federal government should also consider adding thresholds and metrics to their risk assessments to help communities better understand when to react to climate risks. For example, an assessment for Detroit, Michigan would flag temperature levels at which local leaders should consider activating cooling centers or take other action.

   Communities developing climate risk assessment models should also incorporate comprehensive infrastructure assessments in their analysis. The Federal government should work with state, tribal, and local governments as well as community organizations to embed climate data and information within ongoing efforts to deal with other pressing challenges that vulnerable communities are facing such as food insecurity and housing displacement. PREP is already showing how organizations from various sectors can work together to highlight the

intersections between climate data and a variety of social needs. These approaches can support programs like FEMA's BRIC and the U.S. Department of Housing and Urban Development's (HUD) Community Development Block Grant Disaster Recovery (CDBG-DR) program. At the same time, standard approaches can be combined with guidance and capacity building efforts directed at state agencies, which can then help local communities tap into the benefits provided by programs like BRIC and CDBG-DR.

8. **Engage citizens in data collection and use.** Federal agencies should work with state, tribal, and local governments as well as community organizations to develop and support citizen science projects that collect high resolution data. For example, NOAA's National Integrated Heat Health Information System has been funding a citizen science driven heat island mapping project for the past four years. This project is "a volunteer-based community science field campaign that builds upon local partnerships, engages residents in a scientific study to map and understand how heat is distributed in their communities, and produces high-quality outputs that have been used in city sustainability plans, public health practices, urban forestry, research projects, and other engagement activities."

   Citizen science projects can help produce higher-resolution data in otherwise inaccessible locations and increase community appreciation of the legitimacy of science and data. NOAA and other agencies can expand on the citizen science activities they already conduct. Integrating citizen science and other forms of local knowledge with other sources of data can lead to better data and more robust, informed risk assessments and planning processes. When it comes to applying the data, President Biden's proposed Civilian Climate Corps may provide a possible path to engage citizens to address technical capacity gaps at the local level.

9. **Develop communities of practice to understand, integrate, and apply data from different sources.** There is a need for better, structured ways to exchange methods and data among local government, community groups, state, tribal, and Federal governments, especially for programs designed to serve localities but administered by states using Federal resources. Roundtable participants suggested creating communities of practice, developed around particular climate issues or the needs of different regions, to share knowledge, data, best practices, and guidance for climate resilience planning.

   The Federal government could play a lead role in creating these communities of practice and contributing knowledge and expertise. It also has an important role to play in exposing local level practitioners to data and resource repositories, providing capacity building, and engaging local communities in planning and decision making. For example, *Roundtable* participants recommended a formal discovery process working with state, tribal, and local governments to identify data needs in these communities. The Federal government should provide subject matter experts on climate science and planning as well as funding to support local efforts.

10. **Develop regional, cloud-based climate data hubs.** The Roundtable identified the need for some form of data aggregation and distribution, as well as opportunities to make data available through analytic tools or with analytical outputs, to make it easier for under-resourced communities to use. Roundtable participants also recommended building these hubs at a regional level, which may be more relevant than national- or global-level data hubs and make it easier for communities to address climate change across states and cities that face similar

hazards. To this end, cloud technology providers should explore ways to develop regionally focused climate data and analytics hubs. These could be modeled on the success of NOAA's Big Data Program (BDP) which has increased access to NOAA climate data and opened the door to leveraging the cloud to conduct regionally focused climate analysis. Cloud-based hubs could ensure that communities can access appropriate data, analytical tools, and resources from neighbors facing similar challenges.

11. **Conduct return-on-investment (ROI) analyses of the benefits of climate risk reduction.** Many ideas from the Roundtable will involve Federal funding - funding for data, for technical capacity, and ultimately for improving infrastructure in at-risk communities. Several participants suggested that new kinds of economic analysis could help make the case for this spending. Specifically, they recommended doing ROI analyses to determine where and how this Federal funding could be expected to have a tangible pay-off.

    Some recent analysis has shown how Federal investments can lead to significant returns in traditionally under-resourced areas that are also vulnerable to climate hazards. A study by the World Resources Institute has shown that $15 billion in Federal climate investments would support more than 250,000 jobs in rural America. Analyses like these should become a matter of course, and climate risk assessments should include analysis of the benefits as well as the costs of spending in local communities.

CONCLUSION

The *Roundtable on Data for Climate Risk Assessment in Vulnerable Communities* emphasized the ongoing need for the Federal government to provide leadership, oversight, and guidance across the climate data value chain - from observation to assessment - in support of local communities. Federal leadership, in turn, will depend on better coordination and collaboration among Federal agencies and with non-Federal entities. This must include not only agencies and organizations that have traditionally provided climate data, but those that provide climate-relevant data of all kinds.

The Biden administration has declared that every Federal agency should now be considered a climate agency. They will all need to work together to tackle this unprecedented challenge. NOAA has already begun to move in this direction with the recent announcement of a new NOAA Climate Council, "which will leverage the agency's resources and expertise in support of the whole-of-government approach to addressing the climate crisis."

The Roundtable focused on several approaches to achieving the goal of better coordination and collaboration within and among Federal agencies as well as between Federal agencies and non-Federal stakeholders. Participants also discussed several current potential routes to better Federal coordination. These included:

- Continuing NOAA leadership as a coordinator of climate data and provider of climate data services. NOAA's role could be enhanced with new, dedicated, and sustained funding for climate data services including data collection, maintenance, interpretation, and engagement.
- Supporting the U.S. Global Change Research Program (USGCRP) in providing leadership, vision, and strategy around open climate data and bottom-up engagement. The USGCRP was recently tasked by the Biden administration with advancing science and informing decision making at the Federal, state, and local level around climate risk.
- Embedding detailees from NOAA, the White House Office of Science and Technology Policy (OSTP), or other expert organizations in each agency's leadership office to help organize activities and coordinate across organizations.
- Exploring establishing a National Climate Service akin to the National Weather Service that could include private, nonprofit, academic, and state and regional government resources. This idea was brought up by multiple Roundtable attendees and has been proposed in one form or another since the George W. Bush administration.

While NOAA, FEMA, and the USGCRP are likely to continue leading in the effort to fight and respond to climate change, they will need to coordinate with the rest of the Federal government as well as a whole host of non-Federal stakeholders to achieve the Biden administration's ambitious goals. The Roundtable made it clear that more work needs to be done to identify the highest impact paths forward and start down them. CODE is pleased to play a part in that effort and believes that additional stakeholder Roundtables and Workshops will help set us on the right path towards climate resilience.

ACKNOWLEDGMENTS

This paper was researched and written by CODE's Research and Communications Manager Matt Rumsey and Research Associate Temilola Afolabi, with support from the CODE team. It was designed by Amelia Pittman with input from the CODE team. The Roundtable that formed the basis for this report was organized with leadership from CODE Roundtables Program Manager Paul Kuhne, and the CODE Climate Risk Data Hub was designed by Data Analytics Fellow Sophie Hu. For more information about this paper or CODE's research, please contact Matt Rumsey at matthew@odenterprise.org or Temilola Afolabi at temilola@odenterprise.org.

CODE thanks The Amazon Sustainability Data Initiative and Amazon Web Services for their support of our work on this project and their extensive and valuable input into this document and Roundtable planning. CODE would also like to thank NOAA for co-hosting the Roundtable and for its collaboration, feedback, and guidance at all stages of this project.

NOAA's mission is to understand and predict our changing environment, from the deep sea to outer space, and to manage and conserve America's coastal and marine resources.CODE would especially like to thank NOAA staff in the Office of the Under Secretary of Commerce for Oceans and Atmosphere (NOAA Administrator), who provided close guidance during the development of the Roundtable and this report.

The Amazon Sustainability Data Initiative (ASDI) seeks to accelerate sustainability research and innovation by minimizing the cost and time required to acquire and analyze large sustainability datasets. ASDI supports innovators and researchers with the data, tools, and technical expertise they need to move sustainability to the next level.

Amazon Web Services provides a highly reliable, scalable, low-cost infrastructure platform in the cloud that powers hundreds of thousands of businesses in 190 countries around the world. With data center locations in the U.S., Europe, Singapore, and Japan, customers across all industries are taking advantage of our low cost, elastic, open and flexible, secure platform.

APPENDIX 1: LIST OF ACRONYMS

ACS American Community Survey

ASDI Amazon Sustainability Data Initiative

BCCA bias correction constructed analogs

BDP Big Data Program

BRIC Building Resilient Infrastructure and Communities

CDBG-DR Community Development Block Grant Disaster Recovery

CDC Centers for Disease Control and Prevention

CODE Center for Open Data Enterprise

FEMA Federal Emergency Management Agency

HHS U.S. Department of Health and Human Services

HUD U.S. Department of Housing and Urban Development

IPCC International Panel on Climate Change

LOCA Localized Constructed Analogs Statistical Downscaling

MACA Multivariate Adaptive Constructed Analogs

NEXRAD Next Generation Weather Radar

NOAA National Oceanic and Atmospheric Administration

OSTP Office of Science and Technology Policy

PREP Partnership for Resilience and Preparedness

RISA Regional Integrated Science Assessment

ROI Return-on-investment

SoVI The Hazards and Vulnerability Research Institute's Social Vulnerability Index

SVI CDC's Social Vulnerability Index

SDOH social determinants of health

TOP The Opportunity Project

USGCRP U.S. Global Change Research Program

APPENDIX 2: WEBINAR AGENDA

WEBINAR ON DATA FOR CLIMATE RISK ASSESSMENT IN VULNERABLE COMMUNITIES Wednesday, June 23, 202, 12:00 - 1:00 PM Eastern Time (ET)
Welcome to the Climate Risk Project Joel Gurin, President, Center for Open Data Enterprise (CODE)
Welcome to the Webinar Don Graves, Deputy Secretary of Commerce, U.S. Department of Commerce
NOAA Special Remarks Benjamin Friedman, Deputy Under Secretary for Operations, National Oceanic and Atmospheric Administration (NOAA)
Keynote Address: Better Data, Better Policy for Climate Risk Ko Barrett, Deputy Assistant Administrator, NOAA
An Overview of CODE Joel Gurin, President, CODE
Lightning Talk: Addressing Climate Risk at the Local Level Jennifer Jurado, Chief Resilience Officer, Broward County, Florida
Lightning Talk: Bringing an Equity Lens to Climate Risk at the Federal Level Krystal Laymon, Deputy Director of Climate Resilience, White House Council on Environmental Quality
Lightning Talk: Applying Climate Hazard Data Ed Kearns, Chief Data Officer, First Street Foundation
Special Address: Amazon Web Services Dave Levy, Vice President, Amazon Web Services
An Overview of Amazon's Sustainability Data Initiative Ana Pinheiro Privette, PhD, Lead, Amazon Sustainability Data Initiative
Moderated Q&A

APPENDIX 3: PARTICIPATING ORGANIZATIONS

Civil Society

American Society of Adaptation Professionals supports and connects professionals to better prepare for climate change. ASAP helps members strengthen their professional network, exchange best practices and practical advice, and accelerate innovation-all leading to a more equitable and effective climate adaptation practice.

Center for Open Data Enterprise's (CODE) mission is to maximize the value of open and shared data for the public good, by working with government agencies, businesses, nonprofits, and researchers who are both data providers and data users.

First Street Foundation is a nonprofit 501(c)(3) research and technology group based in Brooklyn, NY, whose mission is to define and communicate America's flood risk based on the highest standards of scientific investigation and analysis.

Government Accountability Project is the nation's leading whistleblower protection and advocacy organization. A non-partisan, public-interest group, Government Accountability Project litigates whistleblower cases, helps expose wrongdoing to the public, and actively promotes government and corporate accountability.

National Council on Citizenship (NCoC) is a congressionally chartered nonprofit dedicated to advancing civic life in America. NCoC was chartered by Congress in 1953 to harness the patriotic energy and civic involvement surrounding World War II.

Ocean Conservancy educates and empowers citizens to take action on behalf of the ocean. From the Arctic to the Gulf of Mexico to the halls of Congress, Ocean Conservancy brings people together to find solutions for our water planet.

Red Cross volunteers and staff work to deliver vital services – from providing relief and support to those in crisis, to helping you be prepared to respond in emergencies.

Shift7 works in partnership on complex, systemic problems, finding opportunities to scout and scale promising solutions and solution-makers, and to apply sustainable models for investing resources, talent, tech and capital, especially across under-resourced spaces.

SilverLining is a mission organization driving research and policy on understanding and responding to near-term climate risk. In 2020, SilverLining launched the Safe Climate Research Initiative, a research fund to advance critical efforts to study climate impacts and the effects of increasing the reflection of sunlight from the atmosphere.

The Union of Concerned Scientists mission is to use rigorous, independent science to solve our planet's most pressing problems. Joining with people across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

United Nations University is a global think tank and postgraduate teaching organisation headquartered in Japan. The mission of the UN University is to contribute to efforts to resolve the pressing global problems of human survival, development and welfare that are the concern of the United Nations, its Peoples and Member States.

The World Resources Institute's mission is to move human society to live in ways that protect Earth's environment and its capacity to provide for the needs and aspirations of current and future generations.

Federal Government

The U.S. Department of Commerce promotes job creation and economic growth by ensuring fair trade, providing the data necessary to support commerce and constitutional democracy, and fostering innovation by setting standards and conducting foundational research and development.

National Oceanic and Atmospheric Administration (NOAA) is an American scientific agency within the U.S. Department of Commerce that focuses on the conditions of the oceans, major waterways, and the atmosphere.

National Ocean Service (NOS) translates science, tools, and services into action to address threats to coastal areas such as climate change, population growth, port congestion, and contaminants in the environment—all working towards healthy coasts and healthy economies.

The National Marine Fisheries Service is responsible for the stewardship of the nation's ocean resources and their habitat. They provide vital services for the nation, all backed by sound science and an ecosystem-based approach to management.

The National Environmental Satellite, Data, and Information Service provides secure and timely access to global environmental data and information from satellites and other sources to promote and protect the Nation's security, environment, economy, and quality of life.

National Centers for Environmental Information are the Nation's leading authority for environmental data, and manage one of the largest archives of atmospheric, coastal, geophysical, and oceanic research in the world.

The National Weather Service (NWS) provides weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.

The Office of Oceanic and Atmospheric Research provides the research foundation for understanding the complex systems that support our planet. NOAA Research helps enable better forecasts, earlier warnings for natural disasters, and a greater understanding of the Earth.

The Office of Weather and Air Quality improves high-impact weather and air chemistry forecast information and products by funding, facilitating, and coordinating research, and working with the NWS to transition this research into useful weather applications, watches, and warnings.

The U.S. Department of Energy mission is to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.

Lawrence Berkeley National Laboratory is a multiprogram science lab in the national laboratory system supported by the U.S. Department of Energy through its Office of Science. It is managed by the University of California and is charged with conducting unclassified research across a wide range of scientific disciplines.

National Renewable Energy Laboratory (NREL) is transforming energy through research, development, commercialization, and deployment of renewable energy and energy efficiency technologies.

The Office of International Affairs has primary responsibility for addressing international energy issues that have a direct impact on research, development, utilization, supply, and conservation of energy affecting the United States.

The Office of Science is the lead federal agency supporting fundamental scientific research for energy and the Nation's largest supporter of basic research in the physical sciences.

Pacific Northwest National Laboratory (PNNL) is a leading center for scientific discovery in chemistry, data analytics, and Earth science, and for technological innovation in sustainable energy and national security.

The Federal Emergency Management Agency (FEMA) is helping people before, during and after disasters. Our core values and guiding principles help us achieve it.

National Aeronautics and Space Administration (NASA) is an independent agency of the U.S. federal government responsible for the civilian space program, as well as aeronautics and space research.

The United States Digital Service (USDS) aims to deliver better government services to the American people through technology and design. It deploys small, responsive groups of designers, engineers, product managers, and bureaucracy specialists to work with and empower civil servants.

The White House Office of Domestic Climate Policy coordinates the policy-making process with respect to domestic climate-policy issues, coordinates domestic climate-policy advice to the President, ensures that domestic climate-policy decisions and programs are consistent with the President's stated goals and that those goals are being effectively pursued, and monitors implementation of the President's domestic climate-policy agenda.

Private Sector

AIR Worldwide is a @Verisk business, pioneered the catastrophe modeling industry, creating the tools and technologies that changed how people think about risk management.

Amazon Web Services (AWS) provides a highly reliable, scalable, low-cost infrastructure platform in the cloud that powers hundreds of thousands of businesses in 190 countries around the world.

Azavea is a certified B Corporation that applies geographic data and technology to promote the emergence of vibrant and sustainable communities while advancing the state-of-the-art through research. Each of its projects, products and pro bono engagements showcases this commitment.

Cyrus One Data Centers enables the computing needs for the businesses that change the world through a network of more than 50 data centers around the globe.

Eagle Rock Analytics is committed to deliver true value to organizations by providing the highest-quality professional services to maximize their potential, develop new capabilities, and provide effective solutions to their businesses needs.

Esri is the global market leader in geographic information system (GIS) software, location intelligence, and mapping, helps customers unlock the full potential of data to improve operational and business results.

Fern Leaf Interactive builds software for understanding and visualizing the complex relationships between climate, the environment, and valued assets.

JPMorgan provides innovative financial solutions for consumers, small businesses, corporations, governments and institutions around the world. JPMorgan is a leading global financial services firm with operations servicing clients in more than 100 countries.

KatRisk LLC is a leading catastrophe modeling company that was founded in 2012 by one geek, one scientist, and one engineer. KatRisk's mission is to be a provider of comprehensive and cost effective catastrophe risk models resulting in exceptional value to clients.

MapBox is the location data platform for mobile and web applications. Location is the coordinate system for everything, and its decentralized network of sensors transforms live data into the pulse of our planet.

RMS Insurance Brokerage, LLC is a corporate insurance broker serving various personal and commercial lines, and is ranked among the nation's top 5% insurance brokerage firms. RMS Insurance is headquartered in New York, and has auxiliary offices in the Empire State and in Baltimore, MD.

S&P Global accelerates progress by delivering essential intelligence that unlocks opportunity and fosters growth. For 160 years, S&P's insights and data have helped countries, companies and investors make decisions with conviction.

UrbanFootprint develops the world's first urban intelligence platform, enabling those who build our world to design a better future

Willis Towers Watson is a leading global advisory, broking and solutions company that helps clients around the world turn risk into a path for growth. With roots dating to 1828, Willis Towers Watson has more than 45,000 employees serving more than 140 countries and markets.

Researchers and Academia

Carnegie Mellon University's Department of Civil and Environmental Engineering has established research strengths in a number of areas, including sustainable, intelligent infrastructure systems; water and air quality science and engineering; resilient engineering materials; and environmentally sustainable engineering practices.

Columbia Water Center at Columbia University's mission is to creatively tackle water challenges of a rapidly changing world where water and climate interact with food, energy, ecosystems and urbanization.

National Environmental Modeling and Analysis Center (NEMAC) is an applied research center at the University of North Carolina Asheville. NEMAC's research aims to help society understand the changing world and learn from the space between where science is made and where science is used.

North Carolina Institute for Climate Studies is an inter-institutional research institute of the University of North Carolina system, that facilitates climate-related research across the UNC system and its partner organizations.

Rutgers Institute of Earth, Ocean, and Atmospheric Sciences unites faculty, researchers, and graduate students studying Earth's interior, continents, oceans, atmosphere, and biosphere, their interactions through Earth history, and their effects on human civilization today.

Southern Climate Impacts Planning Program (SCIPP) is a climate hazards research program whose mission is to assist organizations with making decisions that build resilience by collaboratively producing research, tools, and knowledge that reduce weather and climate risks and impacts across the South Central U.S.

The University of Rhode Island Fisheries Program, begun in the late 1960s and administered by the Department of Fisheries, Animal and Veterinary Sciences (FAVS), is one of the oldest fisheries programs in the northeastern United States.

The University of Washington's Climate Impacts Group is widely recognized for scientific discovery, as an experienced creator of impartial & actionable science and as a catalyst for building regional climate resilience.

State and Local Government

Arizona Department of Transportation (ADOT) is responsible for planning, building and operating a complex highway system in addition to building and maintaining bridges and the Grand Canyon Airport.

The Broward County Natural Resources Planning and Management Division coordinates regional climate resiliency strategies focused on urban and natural systems and protects, restores and enhances the County's natural resources.

California Public Utilities Commission regulates privately owned electric, natural gas, telecommunications, water, railroad, rail transit, and passenger transportation companies, in addition to authorizing video franchises.

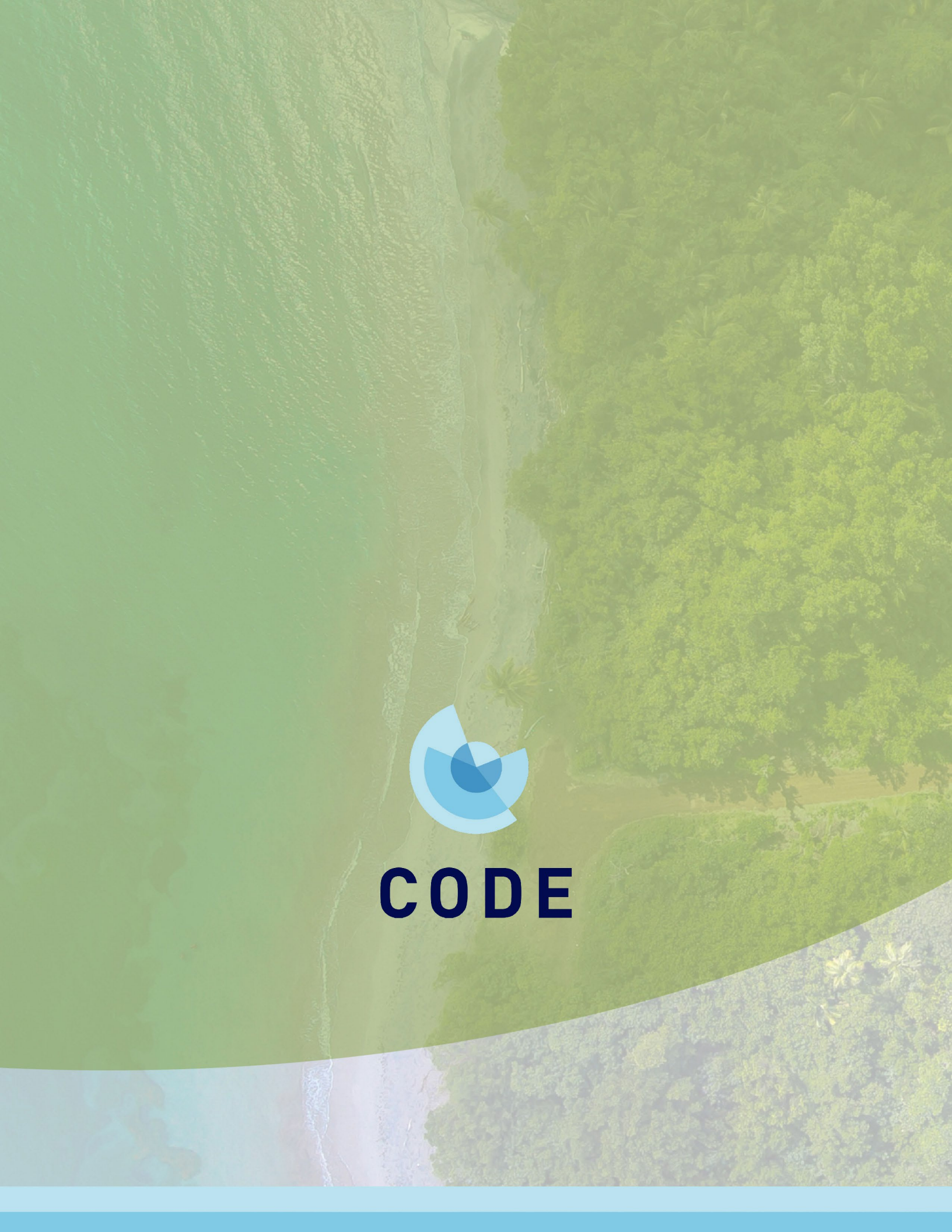
The City of Baltimore Business Process Improvement Office resides within the Administration division and uses data analytics and automation, user-centered design, and strategic pipeline partnerships to improve efficiency in each division at DGS.

Local Governments for Sustainability is a global network of more than 2500 local and regional governments committed to sustainable urban development. Active in 125+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development.

Midwest Climate Hub's mission is to develop science-based, region-specific information and technologies alongside USDA agencies and partners, and deliver these products to agricultural and natural resource managers that enable climate-informed decision-making.

Northern Plains Climate Hub serves Montana, Wyoming, Colorado, Nebraska, South Dakota, and North Dakota. The Hub delivers science-based knowledge, practical information, management & conservation strategies, and decision tools to farmers, ranchers, and forest landowners with the goal of helping them adapt to weather variability and changing climatic conditions.

Science for Climate Action Network (SCAN) is designed to foster evaluation and analysis of climate-related knowledge for applications. As its network builds and evolves, so will its work and goals.


CODE