GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy

THE GREAT AMERICAN ADAPTATION ROAD TRIP

Lessons learned about how hometowns across the United States are building their resilience to climate change

By Allie Goldstein & Kirsten Howard

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy

THE GREAT AMERICAN ADAPTATION ROAD TRIP

Lessons learned about how hometowns across the United States are building their resilience to climate change

By Allie Goldstein & Kirsten Howard

FOREWORD

Authors Allie Goldstein and Kirsten Howard took to the roads to experience adaptation first hand across the country. They met with farmers in Georgia, planners on Cape Cod, utility executives in Denver, volunteers in New Orleans, and a host of other Americans struggling to cope with the effects of climate change. And they came back with vivid and compelling tales of ingenuity, resilience, and daunting challenges as people face the changes climate change is bringing to our land, communities, wildlife, and people. They found some surprises along the way. For instance, out of the tragedy and destruction from Superstorm Sandy has come at least one unanticipated benefit—a boom on solar power that's cutting carbon emissions.

We both had a chance to suggest communities or individuals to visit, and wished we could join them given our own work at Georgetown and University of Michigan on adaptation. Fortunately, through their blogs, updates, and media coverage and now through this report, we can all travel with them vicariously, sharing in their discoveries and experiences as they speak with individuals on the front lines of a changing climate. This report brings to life what it really means to prepare for, survive, and thrive in a "new normal."

Vicki Arroyo, Executive Director, Georgetown Climate Center
Professor from Practice and Environmental Law Program Director, Georgetown Law

Rosina Bierbaum, Professor of Natural Resources and Environmental Policy, School of Natural Resources & Environment and School of Public Health, University of Michigan

TABLE OF CONTENTS

INTRODUCTION

A ROADMAP FOR RESILIENCE

When you think of examples of 'impacts of climate change' in the United States, you might picture New York City's flooded subway system after Hurricane Sandy or the scorched cornfields of Iowa and Nebraska during the 2012 drought or the dwindling glaciers in Glacier National Park in Montana. But conjuring up examples of 'adapting to climate change'—or taking action to minimize the harmful consequences of impacts such as rising temperatures and sea levels, increased frequency of droughts and floods, intensifying storms and forest fires, and changes in precipitation patterns—is more difficult. The day-to-day work of building local resilience rarely makes headlines. Even after studying climate change science and policy in graduate school at the University of Michigan, we had trouble picturing how communities in the United States were preparing for and dealing with climate change impacts.

Kirsten Howard and Allie Goldstein off-road in the badlands of South Dakota

So we decided to take a three-month road trip around the U.S. to answer the question: *What does climate change adaptation look like?* Our goal was to uncover and share stories of people using their wits and resources to build resilience. We were looking for tools, mechanisms, and processes through which the harmful consequences of climate change are minimized in communities—anything from a more efficient irrigation system, to a new municipal utility to manage stormwater, to an innovative financing mechanism for reducing forest fire risk, or even a set of cultural values that promotes smart coastal development. In May 2013, we began our adventure — the Great American Adaptation Road Trip — and captured stories from our trip on a blog. (http://www.adaptationstories.com).

Over 103 days, we traveled 17,358 miles in a clockwise route around the U.S., interviewing more than 150 people, from shellfish farmers on the Olympic Peninsula to city planners in Baltimore. Though the road trip ended in August 2013, we have continued to add to the blog as people across the country have contacted us to share their efforts to adapt to climate change impacts in their communities. To date, we've published 34 'adaptation stories' across 24 states. Our journalistic approach means that each story is a snapshot in time, illustrating what a community was struggling with at the moment we visited.

The incredible people and initiatives we encountered throughout our journey—and our visual storytelling approach—struck a chord, and our project received press coverage in local and national publications, including *The Atlantic*, *National Geographic*, *The Weather Channel*, *High Country News*, and *Grist*. Further validation of the need for these boots-to-ground stories came from the 2014 U.S. National Climate Assessment, which finds that, "adaptation planning is occurring in the public and private sectors and at all levels of government but few measures have been implemented," suggesting that these best practices are increasingly important to share as the need to move from plan to implementation becomes more urgent.

Indeed, local governments, private companies, non-profit organizations, and individuals face difficult financial, legal, political, and knowledge barriers when it comes to preparing for climate change impacts. A heart-wrenching refrain we heard again and again from the people we spoke with was, "We're waiting

for the next storm" (or forest fire, or flood)—since an extreme event is what it would take to mobilize the funding and public support needed to spur action. Moving beyond this reactive response toward a more proactive approach will save lives and livelihoods and allow communities to build the places they want to live rather than simply *rebuild* after disaster. But the question for many communities is: *how do we get there?*

This report explores six key lessons learned from the Great American Adaptation Road Trip about how communities across the country are preparing for coming changes:

- Communities have many reasons for building resilience, and the co-benefits of climate adaptation projects are often key to getting them implemented.
- The likelihood and magnitude of the climate impact itself affects the nature of the resilience-building actions that can be taken.
- Scaled-down climate science is essential for local planning and decision-making in many sectors.
- New relationships and new partnerships across local governments and with private and non-profit allies can leverage the key skills needed to adapt to a changing climate.
- Communities need new funding and financing models to enable the investment needed to adapt to climate change.
- Sometimes adaptation and mitigation goals will conflict; but often times communities can reduce emissions while preparing for impacts.

A rainstorm floods a coastal Delaware road

For each lesson, we include snippets of the stories from our road trip to illustrate the lesson learned from the real-world examples of action being taken by people and communities across the nation. And since our 'adaptation stories'—and most adaptation actions—would not exist without the strong proponents for community resilience we met across the nation, the 'faces of resilience' featured throughout the report highlight four community champions. We conclude with a brief epilogue on the power of storytelling and the elements of our 'adaptation stories' that were effective. Our hope is that this report will serve as a source of both inspiration and information for those committed to shifting from reaction to resilience.

—Allie Goldstein & Kirsten Howard

CHAPTER 1

THE MANY DRIVERS OF ACTION

Take-home lesson:

Many drivers motivate communities to pursue initiatives that enhance resilience to climate change impacts; projects that have multiple benefits are more likely to be implemented.

Implementation tip:

Identifying, quantifying, and communicating the multiple benefits of resilience-building projects can help to make the case for implementation. Knowing your audience is important: for instance, some audiences might be most interested in cost savings while others may be motivated by protection of endangered species.

As climate change impacts such as more intense coastal storms, hotter heat waves, bigger floods, and more extreme droughts emerge across the U.S., communities are responding and preparing in myriad ways. At the heart of most action is people's desire to protect and improve the place where they live, but this core motivation manifests itself differently in different settings. Some communities are driven to action by the 'wake-up call' of a hurricane or another disastrous event that exposes vulnerabilities. Some communities find that resiliency to climate impacts is yet another benefit of neighborhood initiatives such as tree planting or smart zoning that enhance quality of life. And some communities may not be thinking about climate change at all but nevertheless implement projects that help them weather the storm or the drought. **Understanding what motivates people to build resilience is key when it comes to designing incentives, determining what information people will use to make decisions, and communicating the need for a project.**

For some communities, witnessing a neighboring community's vulnerability is enough to spur action, and there are examples of projects that are implemented with specific climate projections in mind. For example, the new Spaulding Rehabilitation Hospital, located on the waterfront overlooking Boston Harbor in Massachusetts, is designed specifically to continue operating through intensifying coastal storms like Hurricane Sandy and withstand sea-level rise. Architects incorporated lessons learned from Hurricane Katrina by elevating the building to 2.5 feet above the 500-year flood elevation, which is more protective than the standard practice of elevating to the 100-year flood.[i] The building also hosts critical utilities on the roof rather than in the basement, generates power with a fuel-pump located in a flood-proof vault, and includes automatic unlocking windows to provide ventilation as well as a route out in a power outage.[1] Boston hospitals have always been at risk from storm flooding, but it was the city's climate scenarios—paired with the understanding that came from the tragedy at New Orleans' Memorial Hospital during Hurricane Katrina—that spurred the climate-smart design.

Though the designers of Spaulding Hospital made decisions directly in response to the site's vulnerability to sea-level rise and intensifying coastal storms, climate change is not always the primary driver of actions that increase resiliency. Storms, floods, heat, and drought are not new problems; people have been dealing with them for centuries. Climate change acts as a multiplier on top of existing threats, intensifying hazards and vulnerabilities and increasing the urgency for communities to prepare. As a result, **climate projections are often an added factor in the decision to raise a road, flood-proof a home, or widen a culvert that has likely been at risk for some time.**

i. The 100-year and 500-year flood elevations are the height of flood waters during flood events that have a 1 percent and 0.2 percent chance, respectively, of flooding any given year based upon historical flood data. These areas are known as the 100-year and 500-year floodplains (FEMA, *Flood Zone Definition/Description* (2014), http://www.fema.gov/floodplain-management/flood-zones).

Given the long list of competing priorities that most communities face, **climate adaptation projects that have clear, important co-benefits are easier to push for and more likely to be supported by local government officials and the public.** Benefits like immediate or mid-term budget savings, bolstered economic development, improved public health and safety, and enhanced water quality and availability, in addition to climate change preparedness, are often major factors that get projects implemented. In Ann Arbor, Michigan, for example, the city is investing in a bigger, healthier tree canopy because of the many benefits trees provide, including beautifying streets, absorbing air pollutants, and buffering against climate risks like flooding and heat.[2]

A dune restoration project protects beachfront homes in Galveston, Texas

"We don't do anything for just one reason anymore," Matthew Naud, the Environmental Coordinator for the city of Ann Arbor, said. "Oak trees are beautiful, and maple trees look nice in the fall, but they also store a quarter inch of rainwater and our stormwater infrastructure would have to be a lot larger without them."

In some cases, a project that enhances resilience is undertaken for another reason entirely—and increased climate preparedness itself is the co-benefit. For instance, a dune habitat restoration project on Bermuda Beach in Galveston, Texas provides natural storm protection for a subdivision that was flooded during Hurricane Ike in 2008.[3] The project was organized by Artist Boat, a non-profit organization working to restore coastal habitats while teaching students about the ecosystems through hands-on restoration and art projects. The project funders, the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department, were most interested in the fact that the project helped to achieve their mandate to protect endangered species by creating critical habitat for the Kemp's Ridley turtle. For Artist Boat, a major motivation for doing the project was to engage 300 inner city Houston students who otherwise might not have the chance to go to the beach or gain an understanding of local ecology. Protecting the subdivision against the rising seas and bigger coastal storms expected as climate change intensifies was also an important—but in this case, secondary—reason for implementing the restoration. Indeed, the current political priorities in some communities and states may lend themselves to *under*emphasizing climate adaptation benefits in order to gain backing for a project.

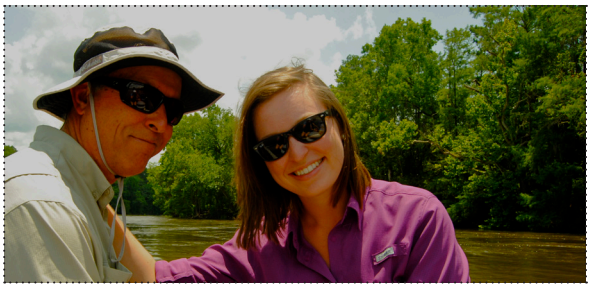
However, in other cases, the opposite may be true, and emphasizing how a particular project helps to prepare a community for climate change can be a way to unlock financial and political support. **As more federal and foundation funding streams target climate preparedness, communities may focus the lens of climate adaptation to accomplish infrastructure, conservation, and equity enhancement projects that have been stuck in the queue for a long time.**

FACES OF RESILIENCE: CASEY COX

"The whole point of the partnership is to introduce the farmer to the technology—it's available, it's here, you can have this—*and get* them *to want to adopt it."*

Hometown: Camilla, Georgia

Role: Co-owner of Longleaf Ridge Farm, alongside her father, and research assistant at Stripling Irrigation Research Park



Young Georgia corn and peanut farmer Casey Cox with her father and mentor

How she builds resilience: Casey has been at the forefront of piloting a GPS-based precision irrigation technology, called variable rate irrigation (VRI), that saves water and energy by adjusting the water application rate according to crop type and landscape. She works part-time at the Stripling Irrigation Research Park where the technology is being developed and is hoping to create a young farmers group to share new ideas about sustainability. Through the Flint River Basin Partnership, Casey is trying to get more Georgian farmers to adopt VRI systems that could save them money—and alleviate demand on their aquifer in the context of intensifying droughts.

Keys to her success: A love for the land and a deep understanding of ecology—plus plenty of Southern charm. As a woman in her early 20s, Casey is not what you might think of as the typical Georgian farmer, but she is the perfect ambassador to bring 21st-century technology to traditional corn and peanut growers in her area.

ADAPTATION STORY: GEORGIA FARMERS IRRIGATE SMARTER

Some farmers in southwest Georgia aren't convinced by climate change science or don't think it's a major threat to their crops—but they are still acutely aware of the vulnerability of their rain-fed aquifer, and early adopters are motivated to try new precision technologies that save water and energy.

This center pivot only waters where it needs to thanks to Variable Rate Irrigation

Camilla, Georgia is home to approximately 5,000 people as well as a burgeoning corn and peanut industry irrigated by a rain-fed, underground aquifer. Though the aquifer is recharged most years, a drought in 2012 and increasing demands from farmers wishing to irrigate their fields are two factors leading farmers and researchers to think more carefully about water use. A few individuals

are also considering the effect that predicted higher temperatures and more frequent, longer droughts may have on water availability and agricultural production in the future.

Calvin Perry, an agricultural engineer at the University of Georgia's Stripling Irrigation Research Park, has been working with a research team to create VRI technology—a water-saving system that uses GPS to vary the rate of water applied by center pivot irrigation to crops. Center pivot irrigation systems, common fixtures on large farms across the country, are large sprinkler systems used to water crops in a circular pattern, rotating on wheels around a pivot that marks the center of a field. Many fields in Southeast Georgia are peppered with small, indented areas where water collects. Traditional irrigation systems will simply water over these mini wetlands as if they were corn or peanuts, but VRI allows the farmer to program the water to shut off as it pivots over a puddled area or change the rate of application as it reaches a different crop type. Though still in a pilot phase, VRI has been shown to produce water savings on the scale of 15 percent.[4]

"There are going to be some years when the aquifer may not recharge," Perry said. "We better be realizing that, in general, we need to be more conservation-minded."

While Perry is thinking about the potential for VRI in a warmer, water-starved world, the 75 or so farmers who are piloting this new technology are not necessarily motivated by climate change. Glenn Cox predicts that any temperature changes will have marginal impacts on his 2,500-acre corn and peanut farm, and in order to justify the $6,000-$25,000 price tag of the VRI technology, he looks to the more tangible, immediate benefits of lower water costs and the long-term sustainability of the aquifer. He is concerned that added pressures on the aquifer from agriculture combined with the occasional, expected drought in southwest Georgia could greatly impact his farm in the future, so the less water he uses, the better off the Longleaf Ridge Pine farm, its employees, and his family will be.

"You can live with heat, you can live with cold, but you can't live without water," he said.

CHAPTER 2

KEEPING PACE WITH CLIMATE IMPACTS

Take-home lesson:

Minimizing vulnerability to climate risks means both iterative, long-term planning and emergency management, depending on the likelihood and intensity of the impact.

Implementation tip:

Identify the desired lifespan of vulnerable infrastructure and other resources, determine the tolerance for risk, and plan for climate impacts accordingly. For instance, people are probably risk averse towards expensive critical infrastructure but risk tolerant when it comes to a small retail building.

Some climate change impacts are gradual and will affect areas we can pinpoint with moderate certainty—sea-level rise, for instance, is generally projected over long time horizons and vulnerable places along the coast are usually identifiable. Other impacts are sudden, extreme, and often unexpected—hurricane intensity, for example, is expected to increase, and we know those storms will occur *somewhere* at *some time,* but exactly where and when is incredibly challenging to forecast beyond a few days. When doing an adaptation project in a particular place, **the risk—both the likelihood and the intensity of the climate impact—affects the perceived urgency of efforts to prepare, the scope of the options available, and the potential to be successful.**

Climate change impacts that are occurring gradually lend themselves to long-term planning and allow for thoughtful, iterative preparation processes. In this case, the best adaptation strategies can be revised over time as better information becomes available, as the effectiveness of tried efforts is monitored, and as new funding sources and other resources become available. For instance, North Carolina is expecting about three feet of sea-level rise along its coast, but the total amount could be greater depending on global ice melt and emissions. The state Coastal Resources Commission is experimenting with different strategies to protect coastal infrastructure, including dredging channels to divert sand and stacking rocks at key places along the coast. 'Living shoreline' projects that feature loosely stacked rocks that help grow oyster reefs and marsh grasses are providing evidence that 'soft' natural infrastructure can be more effective and more flexible than sea walls in certain areas, absorbing more wave energy and slowing erosion.

Oysters + rocks + marsh grass = living shoreline at Pine Knoll Shores in North Carolina

"Sea-level rise is not an emergency," said Tancred Miller, a Coastal and Ocean Policy Manager with North Carolina's Department of Environment and Natural Resources. "We have time to plan. We have time to talk about it. So let's talk about it."

However, **low-intensity climate impacts occurring over long time horizons can also cause local governments to lack a sense of urgency.** For example, in Louisville, Kentucky, the Metro Tree Advisory Commission has recommended that the city adopt a 'no net loss' policy for urban trees to provide cooling shade, since the city is projected to experience three months worth of 90-degree temperatures every year by 2100 (versus one month now). The policy would mean replacing any city trees that die or are cut down. However, Louisville's mayor said that the city needs to do further studies on tree numbers and species before they can adopt 'no net loss'. The Tree Commission

is frustrated by this decision; they say that since it takes decades to grow an urban canopy, the city should get started immediately in order to keep pace with rising temperatures.

On the other side of the coin are extreme events such as mega-forest fires and extreme storms that are occurring more frequently and intensely with climate change. These are low-probability events—for instance, extreme storm events are often characterized as having a 0.2 to 10 percent chance of occurring in a specific place in a given year. However the intensity, and therefore potential to cause damage, is very high and is increasing with climate change, making them high-consequence occurrences. **Because the exact location and timing of these extreme events is uncertain, and because the magnitude of the consequences is large, 'keeping pace' with these impacts often means enhancing emergency preparedness.**

The road trippers explore Grinnell Glacier in Glacier National Park, Montana before it melts

Perhaps the hardest thing about 'keeping pace' with the impacts of climate change is the fact that there are always competing demands for resources and time, so reducing vulnerability to climate risks often gets thrown on the back burner. It could be argued that no American city knows this better than Detroit, Michigan, which declared bankruptcy during the summer of 2013. But despite the fact that 40 percent of the streetlights in the city are out and 78,000 buildings are abandoned, a grassroots movement of Detroiters has formed a Climate Action Collaborative to push the city to consider climate change impacts such as urban heat and increased stormwater runoff in future planning.

"If you want to look at murder rates or darkened streets or slow fire response, those are all extremely important issues," said Guy Williams, the president of Detroiters Working for Environmental Justice (DWEJ), which is convening the Collaborative. "But I believe we need to work on more than one issue at once. If we wait until we resolve all these other issues before we start working on climate change, it's going to be way too late. On the scale of problems, climate change may be slow-moving, but we know it's big and powerful in the long-term."

Indeed, **for some of the United States' iconic landscapes, the momentum of climate change impacts is so powerful that 'keeping pace' simply means adjusting to a new reality.** Montana's Glacier National Park is losing its namesakes as temperatures rise. Of the 150 glaciers that speckled the Park at its founding in 1910, only 25 remain, and all glaciers are expected to be gone by 2030. Park managers know they cannot save the glaciers, so they are focusing instead on intervening where they can to conserve the species that can adapt to a future of less snowpack, more wet snow avalanches, and shifting species zones.

ADAPTATION STORY: CAPE COD PLANS FOR BOTH LONG-TERM SEA-LEVEL RISE AND SUDDEN STORMS

Residents and planners of Cape Cod, Massachusetts are dealing with the consequences of both long-term, slow-onset sea-level rise and higher-intensity coastal storms. Slowly, 'band-aid' solutions are being replaced with more flexible and durable ones that work with both types of climate impacts.

Residents of Brewster, Massachusetts and other nearby towns on the Cape Cod peninsula have come to expect their beaches to erode between two and three feet per year due to wave action and storms. But erosion has recently averaged 10 feet per year, and in February 2013, the vicious winter storm Nemo shaved 20 feet of beach off of the region's shores. The 45 beachside parking spaces at Paine's Creek beach in Brewster have been whittled down to six as the pavement literally washes into the ocean.

Like many places along the East Coast, Cape Cod is threatened by both the gradual effects of sea-level rise and the impacts of relatively low probability storm events. These two types of effects layer on top of each other: six feet of projected sea-level rise by the end of the century combined with more frequent storms means heightened storm surges, significant flooding, and increased erosion, the likes of which have not been experienced in the region in recent history.

Towns are finding that the 'hard' solutions they have used in the past, such as armoring the coast with stone revetments, are making erosion worse by disrupting natural sand processes that would otherwise build protective dunes. So, in addition to retreating from the encroaching waves and looking to relocate parking spaces further back from the shoreline, Brewster is trying to delay erosion and retain sand with low-cost, flexible strategies like fences and dune grasses.

In Provincetown, a town at the very tip of the Cape's arm that is experiencing similar climate change impacts as Brewster, the National Seashore Advisory Commission that runs the popular beachfront is also trying out some flexible solutions. They moved their parking lot back 125 feet in anticipation of sea-level rise and increased coastal flooding, and rebuilt the seaside bathhouse with hurricane clips that allow a crane to move the structure back, away from the ocean.

In the longer term, the Cape will have to incorporate storm and sea-level projections into planning for a much-needed sewer system on the peninsula. Currently, more than 90 percent of homes send their wastewater to aging septic tanks that are at high risk of saltwater intrusion as sea levels rise. The Cape Cod Commission, a regional planning body, is beginning to address those questions through a Regional Wastewater Management Plan[5] that assesses both gray and green wastewater infrastructure, as well as some more creative options—such as composting toilets or shellfish aquaculture—to reduce the nitrogen load. The Cape Cod Commission is explicitly considering sea-level rise projections in this process[6], recognizing that the 20-30 year planning horizons that most Cape Cod towns use may not be long enough if the water infrastructure built today is expected to last for half a century or more. For planners, this approach takes patience.

"I've learned that planning is not an instant gratification profession," said Ryan Bennett, a planner at the Cape Cod Commission. "It takes time, but eventually you see the results of your efforts."

CHAPTER 3

DOWNSCALING GLOBAL CLIMATE SCIENCE

Take-home lesson:

Climate science is more likely to be used when it is at the appropriate geographic and temporal scale for local decision-makers.

Implementation tip:

Consider partnering with a nearby college or university to fill information gaps about local climate impacts and answer questions about the best ways to respond and prepare.

A common barrier to building local climate preparedness is that scientific information about climate change, produced by researchers around the world and summarized by groups such as the Intergovernmental Panel on Climate Change, tends to span large geographic scales, typically global or continental, as well as long timeframes. Temperature and sea-level rise projections are often presented for the year 2100 and sometimes 2050 at the global and national levels, and **communities have difficulty interpreting how broad-scale information relates to their local risks.** Communities need ways to facilitate action at their local scale and on shorter planning horizons, or even briefer electoral timeframes.

To overcome this information gap, efforts to scale down the global climate science to the local decision-making scale are gaining popularity. The latest nationally coordinated effort to downscale the national and global climate data—the 2014 U.S. National Climate Assessment[7]—provides regional trends and projections. At an even finer scale, community organizations and experts are compiling local climate data, sometimes from longstanding sources of information such as tide gauges, weather stations, or farm records. Increasingly, academic researchers are employing complex statistical techniques that use local climate and geographic data together with existing global climate models, like those in the Intergovernmental Panel on Climate Change (IPCC) reports,[8] to project future scenarios at a high-resolution local scale. By partnering with academic institutions, local decision-makers can obtain downscaled climate data and get help aggregating the sometimes overwhelming amount of information that exists through maps and other useful data communication methods. When governments and organizations collect local climate data or develop a climate study together with a nearby university, the scientific product is much more usable than what would have been produced without input from the entities that ultimately need to make decisions based on the data.

Dr. Dave Burdick measures elevation to assess flood risk in Portsmouth, New Hampshire

Localized climate trends, models, and scenarios make the effects of climate change relevant to local contexts and facilitate action to prepare. For example, grant funding secured by the city of Portsmouth, New Hampshire was used to commission a study[9] by experts at the University of New Hampshire and the Rockingham County Regional Planning Commission, which uses nearby tide gauge data and local subsidence rates to show that sea levels have historically risen 0.7 inches per decade. The researchers ran the local data through low and high carbon emissions scenario models used by the IPCC to determine that the rate of sea-level rise is expected to accelerate in Portsmouth and total rise will likely reach 1 foot to 1.7 feet between 2010 and 2050. The study shows that the localized rate of relative sea-level rise in Portsmouth will be slightly slower than in Boston but faster than

in the Pacific Northwest due to differences in local subsidence rates, among other factors. This sea-level rise information was used by local planners to conduct a vulnerability assessment. A modified version of the vulnerability assessment is expected to be included as a chapter in Portsmouth's 2015 Master Plan[10] and the Public Works Department has recognized the need to use the new information to prioritize capital projects. **By partnering with local experts, including university researchers, local governments are getting creative about how to improve knowledge at the most relevant scale.**

Scaled-down spatial data can also be a useful tool for local planning and communication. For instance, the Adaptation Strategy for the Blackwater National Wildlife Refuge in Maryland, produced jointly by The Conservation Fund and the Audubon Society, used the Sea-level rise Affecting Marshes Model (SLAMM) to map the dramatic conversion of marsh habitat to open water over the coming decades with sea-level rise.[11] The color-coded maps also help to visualize a strategy: they show where marsh restoration may be ecologically and economically feasible, and where conservation easements could be used to protect areas for marshes to migrate inland. As more spatial datasets related to climate change become publically available and as more practitioners are trained in Geographic Information Systems (GIS) analysis, maps will be an increasingly important tool for not just understanding climate impacts, but also selecting adaptation strategies to pursue.

These grapes will make delicious wine thanks to the Napa Valley, California micro-climate

Localized climate information can be especially relevant for businesses whose bottom lines depend on climate futures. After two studies and a series of worrying headlines indicated that climate change could drastically decrease grape production in California, the Napa Valley Vintners (NVV) Association partnered with researchers at UC San Diego to better understand past temperature trends on a smaller scale that would more accurately capture their unique valley climate. Since growers plant on a 25-year timescale, if they make the wrong decisions about which variety of grapes to plant in anticipation of climate impacts they could face large financial losses. Researchers spent three years collecting data from the nearest weather stations and going door to door, sifting through old notebooks to uncover historical data about when vintners planted and harvested over past decades.[12]

"The very thing that makes premium wine grape growing happen is the very thing that often gets ignored [in climate studies]," Patsy McGaughy, the communications director at NVV, said, referring to the complex micro-climate of Napa Valley that can only be understood accurately with detailed local information.

Localized climate science serves several purposes. **In some cases, downscaled science is a motivator**; it helps educate communities and instigate coordination, planning efforts, and action where they did not previously exist. In Napa Valley, it wasn't until the initial studies were released highlighting the potential vulnerability of grapes that vintners got together to coordinate around the issue. **In other cases, localized science provides justification for new planning efforts** and discrete recommendations in plans. Local climate impacts laid out in the Hazard Mitigation and Climate Adaptation Action Plan for Lewes, Delaware give the plan credibility. By pointing to extreme precipitation estimates or local sea-level rise data, local officials may be more able to persuade the city council, residents, and other important decision-makers to support and fund recommended actions.

However, much more work is needed to make climate science truly salient to local level decision-making. In less populated places that lack resources and do not have an affiliate university or organization funding a climate study, localized data can be hard to come by. For example, in Paonia and Hotchkiss, Colorado, small towns dependent on fruit crops, little climate science exists, even about the climatic factors that can make or break the economy of the region: season length and late spring frosts. Dr. Ron Godin, an agronomist at the Colorado State University Agricultural Extension, has shown with rough calculations that the growing season is, on average, four weeks longer than it was three decades ago—which may explain why the late spring frosts have recently been hitting fruit buds at more critical growth stages. But Godin's estimate is based on limited data and is not well publicized to local farmers. Godin explained that more local research is needed that captures the intricate micro-climates within the North Fork Valley, because local farmers are skeptical about using science transferred from other places to make decisions about crop varieties or technology investments.

Allie eats a peach grown in Paonia, Colorado's special climate

Though there is a desire and need for higher resolution climate information, a perceived need for better scientific information can sometimes be used as a tactic to defer necessary action. **It is therefore important to recognize when decision-makers have enough scientific information to make a decision.** This may mean being clear beforehand about how the findings in a commissioned study will be used for planning purposes. Or, it may mean moving forward with 'low-regrets' actions—such as conserving more of Maryland's stunning coastal landscape.

"What's the worst that could happen?" asked Erik Meyers, Vice President of The Conservation Fund. "You protect all this great open space and it doesn't convert to marsh immediately. The science isn't perfect and the map isn't perfect, but we have enough information to move forward."

ADAPTATION STORY: OLYMPIC PENINSULA SHELLFISH FARMERS DOWNSCALE CLIMATE SCIENCE TO ADAPT TO OCEAN ACIDIFICATION

Oyster farmers in Washington State realized the need for better science and monitoring after ocean acidification contributed to a crash in oyster larva populations, and oyster farmers are now using new information to improve oyster growing conditions.

An oyster is shucked on the Hama Hama Oyster Company farm

In 2007, most of the larvae in oyster hatcheries across the Pacific Northwest died off before it could be sent to farms. For a while, no one could figure out why. Eventually, a scientific investigation by researchers at Oregon State University pointed to ocean acidification. Because oceans all over the world are absorbing much of the carbon dioxide we emit into the atmosphere, they are 30 percent more acidic today than they were before the Industrial Revolution. The hydrology off the coast in the Pacific Northwest makes it an acidification 'hotspot,' with waters even more acidic than the global average. So, in 2006, the especially acidic water siphoned into the Taylor Shellfish hatchery in Quilcene, Washington and prevented the oyster larvae from accessing the carbonate they need to build their shells, and they grew weak and eventually died. Oyster farms all along the coast were left without a source of oyster seed.

Prior to the 2006 die-off, oyster farms didn't really pay attention to water quality.

"In hindsight, it was kind of stupid of us. We had this multi-million dollar investment and we weren't even keeping track of what's going on in the water," said Bill Dewey, director of public policy and communications at Taylor Shellfish Company.

Once they recognized that ocean acidification was the problem—a problem that is only expected to get worse as the oceans continue to absorb more carbon dioxide—the oyster industry in Washington banded together to convince Congress to fund $500,000 worth of monitoring equipment so they could better understand the issue.[13] The State also created a Blue Ribbon Panel on Ocean Acidification, which Dewey participated in along with other representatives of the oyster industry and several local researchers, in order to make recommendations for action.

The Taylor Shellfish hatchery installed an automated system that uses the real-time pH monitors to mix acidic water coming into the hatchery with sodium carbonate, raising its pH from around 7.45 to 8.2, the 'normal' pH of ocean water. In addition to this short-term solution, the Blue Ribbon Panel convinced the Washington State Legislature to fund a $1.8 million Ocean Acidification Center at the University of Washington. The partnership between the Olympic Peninsula oyster industry and local researchers will be a long-term endeavor. Better understanding of the science of ocean acidification and how it affects shellfish is a vital first step for the industry that will hopefully form the basis for new farming innovations that buffer against the impacts of increasingly acidic oceans.

CHAPTER 4

NEW CLIMATE, NEW PARTNERSHIPS

Take-home lesson:

Resilience efforts that span multiple government departments or include non-governmental actors are often able to leverage resources and expertise and create wider buy-in for action.

Implementation tip:

Expand partnerships beyond the usual suspects. By working across sectors, communities will be stronger and more prepared for climate changes.

For local governments, the ability to prepare for the impacts of climate change is often limited by available resources and expertise. In some cases, local governments have the motivation to lead adaptation action but lack capacity and knowledge in areas like coordinating volunteers and implementing new technological tools. In other instances, non-profit groups or individual citizens may 'push' local government to act. By creating new partnerships across government departments as well as beyond government doors, city planners may be able to fill critical gaps in their own resources, accomplish ambitious goals, and more effectively address the cross-cutting nature of climate change impacts.

With good care, this little tree will cool the hot streets someday in Baltimore, Maryland

Partnerships across local government can help tackle the multiple facets of climate risk. In Baltimore, Maryland, the Planning Department is working with relevant city departments to help understand the city's climate risks and find integrated solutions. For example, as Baltimore's urban heat island[ii] intensifies with climate change, one goal of the Department of Recreation and Parks is to increase the urban tree canopy to reduce inner city temperatures by up to 9 degrees Fahrenheit. But tree planting is a long-term solution. In the shorter term, the city's Health Department is implementing the Code Red Program to open cooling centers on days that reach above 105 degrees Fahrenheit on the heat index. Coordinated by the Planning Department, staff across city agencies are working together to better understand the climate projections for the region so they can make sure residents have a safe place to go during heat waves in the near future, while also working to reduce the health risks long-term.[14]

Local governments are also partnering with non-governmental actors such as private companies, community groups, and non-profit organizations to enhance community resilience and tap into creative, outside-the-box solutions. For instance, San Francisco's Department of Emergency Management recently teamed up with web-based bed-and-breakfast company Airbnb to identify technological strategies that can help the city keep residents safe during disasters. The idea arose after one Airbnb user posted a room in their apartment for free during Hurricane Sandy in October 2012. The company then created the Airbnb Disaster Response program,[15] which allows hosts to automatically offer free housing to people displaced by extreme events. After taking note of this innovative shelter-sharing concept, the City of San Francisco is now working with Airbnb to see how the model could be used for other aspects of emergency management.

ii. The urban heat island effect refers to the fact that paved, built-up areas absorb more heat than surrounding vegetated areas, causing higher average annual temperatures in cities.

In some cases, **grassroots movements or individual citizens may provide local governments with a 'push' to move forward on a project that enhances resilience.** After Brad Lancaster discovered that he could capture precious stormwater for his sidewalk garden by cutting an indent in his street curb, he approached the city of Tucson, Arizona to create a $50 curb cut permit so that his neighbors could harvest rainwater too. The curb cuts also benefit the desert city: they divert rainwater that would otherwise be lost to runoff, reducing flooding (and therefore potholes) and watering the municipal trees which shade increasingly hot city sidewalks. Lancaster's neighbors now harvest two acre-feet of rainwater per year with curb cuts, contributing to luscious, canopied streetside gardens that provide much-needed shade as Tucson's summers heat up.[16]

FACES OF RESILIENCE: BRAD LANCASTER

"When we're harvesting our fruit, we're out here. We're getting to know more of our neighbors. So you actually feel like you're in a community, not just a housing development."

Hometown: Tucson, Arizona

Role: Rainwater harvester and community organizer

Brad Lancaster, master rainwater harvester in Tucson, Arizona

How he builds resilience: Brad quite literally wrote the books that teach others how to capture and use the precious rainwater that falls rarely in his hometown of Tucson and other arid communities. His home boasts a composting toilet, outdoor shower, and drinking water filtration system—all powered by rainwater and solar panels—and his grey-water-fed garden provides 10 to 20 percent of his diet. But Brad's bigger impact lies in working with his community to permit and install curb cuts that funnel water from the street into tree wells, cooling the curbside with canopy shade and harvesting, on average, one million gallons of water on each block every year. Brad helped his Dunbar Spring neighborhood obtain a Pima County Reinvestment grant to pay for the curb cuts and plant a community garden.

Keys to his success: Charisma and a belief that sharing resources and knowledge with his neighbors is fundamental to building resilience.

ADAPTATION STORY: NEW ORLEANS WORKS WITH VOLUNTEERS TO GIVE EVACUATION PLAN AN ARTIST'S TOUCH

A non-profit organization is helping a local government recruit and train volunteers to provide essential hurricane evacuation support and infuse existing emergency management strategies with new ideas.

New Orleans, Louisiana bus drivers pose at an EvacuSpot

Seventeen 'EvacuSpot' statues have replaced the nondescript evacuation signs that previously marked the meeting points to catch buses out of New Orleans, Louisiana in an emergency hurricane evacuation.

After the disastrous response to Hurricane Katrina in 2005, New Orleans shifted its emergency management approach from 'vertical evacuation' to City-Assisted Evacuation—meaning that rather than help people stay safe *in* the city, they will help people get safely *out*. When Hurricane Gustav hit in 2008, the city helped evacuate 18,000 people, but the process wasn't smooth, and many residents weren't sure where to catch the buses.

Evacuteer, a nonprofit organization founded in 2009 that partners with the city on emergency management, focused on making sure residents know where to go to evacuate and training volunteers—called 'evacuteers'—to help them get on public transportation. The organization, together with the Arts Council of New Orleans, held a contest for a public art design that could mark the 'EvacuSpots.' If there is a mandatory evacuation, people (and their pets) who have no other means to leave the city can meet at an EvacuSpot where a city bus will take them to the Union Passenger Terminal to catch a ride out of town.

"I think the cornerstone of resilience is finding ways to bring communities together at large. Public art sculptures do this," David Morris, the President of Evacuteer's Executive Leadership Committee, said. "It's a novel approach to emergency management."

Evacuteer signed an agreement with the New Orleans Office of Homeland Security and Emergency Preparedness to recruit, train, and manage volunteers to staff EvacuSpots, 311 call centers, and the Union Passenger Terminal. As part of the agreement, the city provides financial support for volunteer trainings—a sign that the City is placing great trust in a non-governmental organization to help them with very high stakes evacuation efforts.

Though (thankfully) a mandatory evacuation has not been called since the partnership was established, evacuteers did help with 311 calls during Hurricane Isaac in the fall of 2012. When the next storm hits, 500 evacuteers will be ready, and approximately 30,000 New Orleans residents will meet at the glistening statues to hail buses out of the city.

CHAPTER 5

ADAPTATION'S PRICE TAG

Take-home lesson:

A key challenge for funding adaptation efforts is finding ways to overcome upfront investment costs in order to save money in the long run. Creative financing mechanisms and savvy individuals can pave the way.

Implementation tip:

Payment for ecosystem services programs can help to overcome the barrier of upfront costs by distributing the costs of resilience-building projects among the people that benefit from them.

The World Bank has estimated that it will cost between $70 billion and $100 billion annually to adapt to a 3.6-degree-Fahrenheit warmer world by 2050.[17] However, these figures depend strongly on whether our adaptation efforts are proactive or reactive: The United Nations Development Programme estimates that every dollar spent on preparedness for disasters now can save up to seven in relief efforts later.[18] But what does this mean for a local city planner or natural resource manager trying to attach a price tag to a resilience-building project at the local level?

In some cases, the upfront cost to take proactive steps to adapt to climate change is low. In Tucson, Arizona, rainwater harvester Brad Lancaster experimented with curb cuts that funneled precious rainwater into his sidewalk garden and then worked with the city to create a $50 permit per block to allow others to cut their curbs, too.[iii] His neighbors now 'harvest' two acre-feet of water every year and are able to grow more trees to shade their block. In another example of affordable resilience, social media-based bed-and-breakfast company Airbnb created a Disaster Response program that lets hosts post their apartments or spare rooms for free during an extreme event such as a hurricane. In both of these instances, creative individuals thought of a way to build resilience without breaking the bank. However, many of the larger resilience actions that are required to effectively adapt communities to the impacts of climate change carry expensive price tags that are serious barriers to their implementation.

For the private and public sector alike, the sometimes hefty cost of adaptation projects are often considered in isolation, without considering the estimated costs of inaction or the many economic benefits of adaptation that are not always accounted for in traditional markets—benefits like improved water quality, habitat conservation, or storm protection. Often, though, the costs of inaction are starkly apparent after a disaster. For example, while the Federal Emergency Management Agency (FEMA) spent $441 million[19] on cleanup and compensation after the Cerro Grande mega-fire in the Santa Fe National Forest in 2000, the Santa Fe Watershed receives only $1.5 million per year in federal dollars for thinning trees—one of the main measures that could *prevent* the forest fires that are intensifying with climate change. Agencies such as the US Forest Service and the FEMA are beginning to make funding available for preparedness, but funds offered for proactive adaptation efforts are still dwarfed by reactive disaster relief money. Private sector companies and individuals can sometimes move more nimbly, but **the recognition that adopting a new technology or implementing another adaptation strategy will save money in the long run doesn't necessarily help overcome the hurdle of upfront costs.**

This is a common scenario in agriculture. Farmers are constantly weighing risk and reward when deciding

iii. Contractors charge $350-$400 per curb cut, or $160 to drill several curb holes. Custom Saw Cuts says that the rainwater-harvesting cuts now comprise up to 10% of their business, while Tucson Concrete Cutting and Coring says coring for rainwater-harvesting accounts for 1% of their work.

whether to invest in a new piece of equipment or seed variety, try out a new technology, irrigate a field or hold off. Fruit growers on the western slope of the Rockies in Colorado are certainly weighing the costs against the benefits in deciding on how to deal with late spring frosts. These frosts are becoming more of a problem because, as temperatures warm earlier in the spring, cherry and apple buds reach critical stages sooner in the season, and a frost that comes at the wrong moment can wipe out the entire crop. Fruit growers such as Glenn Austin of Austin Family Farms are taking the low-cost approach of lighting small brush fires under his trees when the temperatures drop. Others, however, are investing in expensive wind machines that circulate warmer air to the buds. The machines cost around $32,000 apiece, but according to Lee Bradley of Black Bridge Winery, if his new wind machine saves even one crop, it will make up the expense. To overcome the prohibitive cost, some farmers purchased used wind machines while others shifted to more frost resistant crop varieties.

Funded by stormwater utility revenue, this park in Ann Arbor, Michigan protects homes from flooding

At the municipal level, overcoming the problem of upfront costs can be equally challenging, since officials must justify spending taxpayer dollars. Even if adaptation projects have political support, there might not be room for them in the budget. **Some communities have been able to raise money for adaptation by rethinking the way residents pay for services like stormwater treatment.** In Ann Arbor, Michigan, the city now charges residents a stormwater utility fee based on the square footage of impervious[iv] surfaces on their property. Residential stormwater bills range from $13.68 to $71.82 per quarter, which is enough to raise over $5 million each year.[20] The city then reinvests this revenue in stormwater pipe maintenance, public flood protection projects, and an urban tree program. By spreading the cost across many residents, the upfront investment is more manageable for the city and residents directly benefit from the grey and green infrastructure enhancements.

Often, it takes committed, creative, and far-sighted individuals to make the case for spending money now to reduce climate risk in the long-term. In Norfolk, Virginia, Jim Redick and Latoya Vaughn of the city's Office of Emergency Management are chipping away at flood mitigation projects that consulting firm Fugro Atlantic estimated would cost a cumulative $1 billion to implement.[21] Vaughn, for instance, works directly with residents to apply for up to $30,000 in FEMA grant funding to raise their homes above the base flood elevation. Redick's leadership was instrumental in Norfolk's selection for the Rockefeller Foundation's RE.invest Initiative, which included in-kind engineering support, as well as its selection as a Rockefeller Resilient City, which will provide them with a citywide resilience officer. When adaptation funding is competitive, framing and persistence can go a long way.

iv. Impervious surface does not allow water to percolate. For instance, a cement sidewalk or building is impervious while a lawn or rain garden is pervious.

"The balance is between how many homes to elevate versus floodgate projects."

Jim Redick, a champion of smart floodplain management in Norfolk, Virginia

Hometown: Norfolk, Virginia

Role: Director of Emergency Preparedness and Response for Norfolk

How he builds resilience: Jim helps to convene the Flood Executive Group in Norfolk through which heads of various city departments meet regularly to deal with the persistent problem of flooding. His department follows sea-level rise science as well as storm events closely and holds public meetings to hear from residents. Jim also created a new position in his department for a direct liaison between residents who experience repetitive property losses from flooding and the FEMA, to help residents apply for pre- and post-disaster mitigation grants to flood- proof their homes. Because of his leadership in Norfolk, Jim was recently appointed to co-chair a statewide Panel on Recurring Coastal Flooding to make recommendations to the Commonwealth.

Keys to his success: Equal parts pragmatism, creativity, and humility.

ADAPTATION STORY: DENVER UTILITY INVESTS IN FOREST MANAGEMENT UPSTREAM

When Denver Water realized that providing clean water to its customers meant managing upstream forests they did not own, they came up with a unique partnership with the US Forest Service to treat forests at risk of fire. For a cost of just a few cents a month per customer, the payment-for-ecosystem-services project project will raise enough money to treat 38,000 acres around key reservoirs.

Denver Water protects the Dillon Reservoir from fire by managing forests

Denver Water's main business is providing freshwater to the 1.3 million people living in the city and its suburbs. But the private utility has recently found itself in the forest management business. When the 1996 Buffalo Creek Fire tore through 11,700 acres around their Strontia Spring Reservoir, Denver Water had to spend $3 million over several months mucking out the debris that rushed off the charred landscape into the water source. Then, in 2002, the Hayman Fire burned 138,000 acres, and Denver Water and Aurora Water together spent $25 million removing sediment from reservoirs.[22] A century of fire suppression has left Colorado's forests ripe for fire, and the increasing temperatures and dwindling snowmelt from climate change are only making things worse.

Expecting larger—and more expensive—fires in the future, Denver Water realized that it would be economically prudent to manage their watersheds for mega-fires rather than repeatedly cleaning up the mess after the fact. In 2010, they forged the Forests to Faucets partnership with the US Forest Service, with each entity committing $16.5 million over five years to treat 38,000 acres of Forest Service land surrounding key reservoirs and water sources.

Since Denver Water passes the cost of tree thinning off to ratepayers, the initiative is a large payment-for-ecosystem-servcies program. However, when spread across the utility's 1.3 million ratepayers, it's not very expensive: Households have seen their water bills go up 14 cents per month, or about $27 over the life of Forests to Faucets.

The $33 million in total is not enough to eliminate the forest fire risk outside of Denver, but it's a tangible start, and it has gotten Xcel, the major electric utility in the region, interested in a similar program. Also, importantly, the financing partnership between Denver Water and the Forest Service uses a prioritization tool that factors in fire risk, soil erosion risk, and proximity to key water sources to determine where money for forest treatment should flow first, and which acres will be treated.

"It's just drops in the bucket in the grand scheme. But we're prioritizing where to put those drops," said Claire Harper, a Partnership Coordinator for the Forest Service.

CHAPTER 6

OPPORTUNITIES FOR LOW-CARBON ADAPTATION

Take-home lesson:

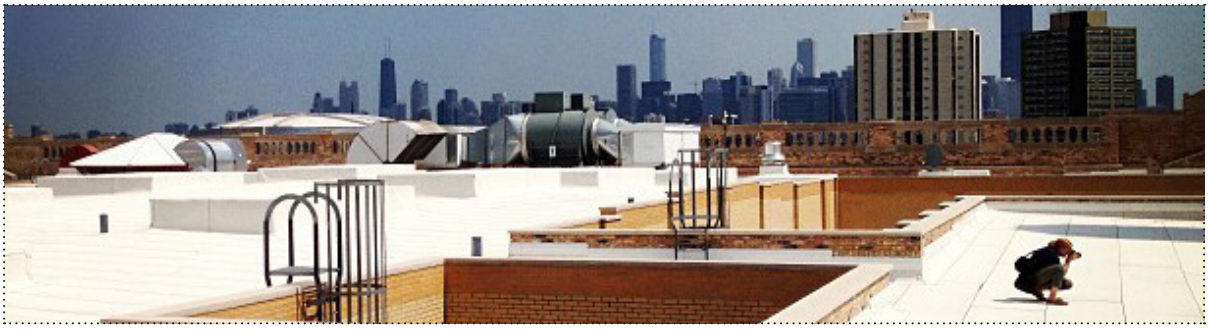
Sometimes greenhouse gas mitigation and climate adaptation goals will conflict; but often times communities can reduce emissions while preparing for impacts.

Implementation tip:

Financial incentives for buildings to install solar energy systems with backup battery power or green roofs can accomplish important resilience outcomes while also reducing greenhouse gas emissions.

With the 2014 National Climate Assessment detailing climate change impacts that are currently being felt in all 50 U.S. states, communities around the country are grappling with how to simultaneously adapt to these impacts and reduce their own greenhouse gas emissions. Doing so on a large scale will be key to making sure that efforts to adapt to climate change don't exacerbate the problem, and instead build towards communities that are less reliant on greenhouse gases—in itself a form of adaptation to a climate-changed world. Small-scale examples are beginning to show that this is possible.

At the community level, climate action plans now often include adaptation measures alongside greenhouse gas reduction goals. For some communities, the realized need to prepare for the impacts of climate change is part of what motivates a host of sustainability efforts. In Grand Rapids, Michigan, a series of floods in the 1980s exposed the need to separate the wastewater and stormwater systems. Under the leadership of Mike Lunn, the Director of the City's Environmental Services Department, Grand Rapid's wastewater treatment plant is now state-of-the-art. Its onsite rain gardens help divert 1.5 million gallons of untreated stormwater and prevent flooding, and its energy-efficient blowers transfer otherwise wasted energy from one building to another, earning the plant a one-time $39,000 energy rebate from Consumers Energy, the local utility. As reflected in the city's five-year sustainability plan, these efforts are about improving quality of life in Grand Rapids, so 'climate protection' translates into reduced energy demand, a safe water supply, and a quality built environment. The sustainability plan is tied to the city budget, putting some monetary muscle behind its targets, many of which increase resilience while also reducing emissions.



The bright white roof of Crane Technical High School in Chicago, Illinois

Many larger cities, such as Chicago, Boston, and New York, are coming out with climate action plans that include adaptation goals alongside emissions targets. For instance, Chicago's climate action plan calls for installing rooftop gardens on 6,000 buildings in the city, and an ordinance aimed at addressing the urban heat island effect requires non-garden roofs to reflect at least 72 percent of sunlight. Though the effectiveness of white-painted roofs need to be tested further, one study shows that building owners can save up to 40 percent on cooling costs from the increased reflectivity. On buildings like Crane

Technical High School, which serves low-income neighborhoods, the 'cool roof' reduces students' vulnerability to heat waves while also cutting the need for air conditioning and its associated emissions.

The private sector is also beginning to find ways to work on reducing emissions while preparing for climate impacts at the same time. Entergy, the major electrical utility in the Gulf of Mexico, plans to purchase carbon offsets from a wetlands restoration project west of New Orleans; they also financed the creation of the methodology that allows the project developer, Tierra Resources, to quantify and sell emissions reductions from the wetland. From Entergy's perspective, the investment serves two purposes. It helps the utility to reach its goal of reducing carbon dioxide levels to 20 percent below 2000 levels by 2020 by offsetting those emissions that cannot be reduced through efficiency, fuel-switching, or other means. But wetland restoration will also provide important storm protection to Entergy's assets, which include 15,800 miles of transmission lines and 40 generation facilities along the Gulf Coast.

That said, there are certainly instances of tension between the need to adapt to climate impacts on a local scale and the need to mobilize a global effort to avoid climate impacts by reducing carbon emissions. In many places, air conditioning use will increase as average temperatures rise—sometimes as an emergency response. After 13 people died in Baltimore due to heat-related causes in the scorching summer of 2012, the city stepped up its efforts to keep people safe for days when the heat index hovered above 105 degrees Fahrenheit, in part by opening air conditioned cooling centers for Baltimore's vulnerable populations of elderly, poor, and homeless residents. In cases such as this, where health and equity are concerned, the short-term need to keep residents safe must override emissions reductions goals. However, longer-term efforts to combat extreme heat in Baltimore by growing large shade trees may reduce the need for air conditioning over several decades, while sequestering some carbon, too.

ADAPTATION STORY: A POST-SANDY SOLAR BOOM BUILDS RESILIENCE WHILE CUTTING EMISSIONS

Hurricane Sandy left many small businesses on Long Island, New York devastated, but start-up solar company EmPower found a silver lining: The experience of losing power for days after the storm left some customers more interested in back-up batteries for their solar systems.

A decade ago, David Schieren left his high-paying job on Wall Street to found EmPower Solar, a solar panel installation company on Long Island, New York. Some thought he was crazy to leave a stable career for the uncertainty of a start-up, but Schieren believes strongly that renewable energy will dramatically improve people's standard of living.

"Because it's cheaper energy, it's cleaner energy," he explained. "We have one of the dirtiest power plants on Long Island here, just a few miles north."

On October 29, 2012—his birthday—Schieren hunkered down with a pizza during Hurricane Sandy as EmPower's offices on Long Island's south shore filled with three feet of water. But the six weeks after the storm passed were the hardest of all. EmPower operated out of employees' homes as the company sent technicians out to shut down solar systems that were corroded with salt water, creating a risky condition for electrical fires.

An EmPower Solar truck zooms by solar-paneled roofs on Long Island in New York

As the months passed, something unexpected started to happen: business roared back. Still shuddering after the storm of a century, more Long Islanders started to request solar systems that include backup batteries, which allow the power to stay on even if the grid is down. The batteries can cost just as much, or more, than the solar panels themselves, so Schieren estimated that only about five percent of the several hundred solar systems the company would install in 2013 included backup batteries. But that's still a significant increase from pre-storm sales, when almost no one was interested in the batteries. A week with the lights off had opened people's eyes to solar energy's potential role in enhancing resilience. Reduction of greenhouse gas emissions and other pollutants is a welcome side effect.

"Now, I walk around and I go to social settings, and people say, you may not be *that* crazy after all," Schieren joked. "At the end of the day, what we're doing is becoming part of the essential infrastructure. We're building power plants, that's what we do."

CHAPTER 7

THE POWER OF A STORY

Stories are magnetic. They draw people in and bring them together. They can impart knowledge and inspire action. And yet they have been underutilized in climate change communication, despite much research indicating that they could be helpful. When we came up with the idea for the Great American Adaptation Road Trip, we wanted to explore the hypothesis that stories about climate resilience could reach audiences that scientific climate reports and city adaptation plans were not reaching. After three months on the road, we think we gathered enough qualitative evidence to indicate that this is true, based not only on the wide reach of our stories but also on the many community members we met who are, in fact, using storytelling techniques to get their messages out.

Our 'adaptation stories' are composed of a few simple elements. Each story focuses on a specific climate impact and specific responses—such as a technology or a public process or a management plan—that in some way builds resilience to the climate impact. The adaptation story is grounded in place, because if there's one theory we confirmed pretty quickly, it's that *people care about the places they live* and regardless of whether they are concerned about the global problem of climate change, they are often very invested in improving and protecting their own backyard. An adaptation story is illustrated with striking visuals or multimedia. It includes an accessible, thoughtful depiction of available climate science, directly from a scientist, if possible. Most importantly, it is peopled with characters who, through quotes, tell much of the story in their own words, humanizing these serious challenges and the corresponding solutions.

Storytelling is an act of documentation, but it is also one of envisioning. Stories are a way to make sense of and learn from the past, but they are also a powerful way to chart the future—to imagine what a neighborhood or a city or a farm *could* look like and then build that vision. That is why we think stories are an ideal format to communicate how people and places are using their wits and resources to build resilience to the impacts of climate change—because climate change is inherently about looking at the past we have built while imagining the future we need.

Mike Hayman gets trees in the ground in Louisville, Kentucky

Many of the most driven, effective people we met on the trip were natural storytellers. Mike Hayman, a self-taught arborist in Louisville, Kentucky, can tell you the individual stories of dozens of the trees he helped plant in his neighborhood. The leadership committee members of Evacuteer, a New Orleans-based nonprofit that is using art to aid city-assisted evacuation, tell their personal horror stories from Hurricane Katrina to establish the 'never again' sentiment that propels their emergency management work. Dan Hansen of DuPont Pioneer, an international seed company, uses demonstration plots to tell the history of corn leading up to new, highly drought-resistant varieties.

People on the front lines of climate change use stories as guiding rudders, as a way to connect with others and share ideas. Julia Kumari Drapkin, a journalist who founded a media project called iSeeChange that connects citizen observers with climate scientists, found that stories are also a way to get important scientific information into the right hands. As she began collecting stories from citizens, she recognized that they are noticing changes occurring, but may not have access to information about why, and what it means for the future.

"As we started doing these question-and-answer stories, we found more often than not, citizens are seeing the same things that scientists are seeing. The difference is they're not writing papers about it—citizens are making decisions," Drapkin said.

"In the other world, there's this word called 'adaptation.' That word doesn't exist in the Gullah language. There's this word called 'resiliency.' Doesn't exist in the Gullah language. We call it living."

Master storyteller Queen Quet shows us an oyster shell recycling program near St. Helena Island, South Carolina

Hometown: St. Helena Island, South Carolina

Role: Elected head of state and Chieftess of the Gullah/Geechee Nation

How she builds resilience: Queen Quet advocates internationally for the rights and interests of the Gullah/Geechee Peepol, a recognized cultural and linguistic minority in the United States that arose over 400 years ago during times of slavery in the low country of South Carolina. She sees protecting their culture and heritage as integral to adapting to climate changes like sea-level rise and intensifying hurricanes, because the Gullah/Geechee are inherently resilient people. They have overcome slavery and weathered hurricanes before. They never build on the water, but rather they *go to* the water. Today, Queen Quet is helping organize an oyster shell recycling program to rebuild St. Helena Island's oyster reefs and enhance coastal protection. And in the interest of preserving the Gullah/Geechee way of life, she successfully helped establish a Cultural District Overlay on the island that prohibits large development like golf courses and resort hotels from taking over the land that holds their history.

Keys to her success: A commanding, dramatic presence, a gift for storytelling, and an unwavering commitment to protecting the culture and heritage of her people.

ENDNOTES

1. Spaulding Rehabilitation Hospital Unveils Its State-of-the-Art New Hospital to the Public (April 25, 2013); http://www.spauldingrehab.org/about/news-events/Spaulding-Hospital-Unveils.
2. Michigan Department of Community Health, Expanding Urban Tree Canopy as a Community Health Climate Adaptation Strategy (2014); http://www.michigan.gov/documents/mdch/Final_January_2014_HIA_446372_7.pdf.
3. Bermuda Beach, Dune Recovery Projects (2012); http://bermuda-beach.org/site/our-2012-success-story/.
4. Stripling Irrigation Research Park, Agricultural Water Conservation http://striplingpark.org/agricultural-water-conservation/.
5. Cape Cod Commission, Regional Wastewater Management Plan: Overview (January 2013); http://www.capecodcommission.org/resources/RWMP/RWMP_overview.pdf.
6. Cape Cod Commission, Regional Wastewater Management Plan: Sea-level Rise and Its Implications (December 2012); http://www.capecodcommission.org/resources/RWMP/RWMP_slr.pdf.
7. U.S. Global Change Research Program, National Climate Assessment (2014); http://nca2014.globalchange.gov/.
8. Intergovernmental Panel on Climate Change, Assessment Reports; https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml.
9. Portsmouth, New Hampshire, Coastal Resilience Initiative, Climate Change Vulnerability Assessment and Adaptation Plan (2013); http://www.planportsmouth.com/cri/.
10. Portsmouth, New Hampshire, 2015 Master Plan information; http://www.planportsmouth.com/masterplan/index.html.
11. The Conservation Fund, Places We Work: Blackwater National Wildlife Refuge http://www.conservationfund.org/projects/blackwater-national-wildlife-refuge/.
12. Napa Valley Vintners, Napa Vintners Release Findings of Climate Study (2011); http://napavintners.com/press/press_release_detail.asp?ID_News=3221202.
13. National Oceanic and Atmospheric Administration, Pacific oysters gain from IOOS Data (2011); http://www.noaa.gov/features/01_economic/pacificoysters.html.
14. Baltimore Office of Sustainability, The Disaster Preparedness and Planning Project (DP3) (2013); http://www.baltimoresustainability.org/disaster-preparedness-and-planning-project.
15. Airbnb, Disaster Response Program; https://www.airbnb.com/disaster-response.
16. Harvesting Rainwater, Curb cuts for streets runoff harvesting; http://www.harvestingrainwater.com/rainwater-harvesting-inforesources/companies-implementing-water-harvesting-systemscomponents-2/curb-cuts-for-street-runoff-harvesting/#Arizona.
17. World Bank, Economics of Adaptation to Climate Change: Synthesis Report (2011); http://www.worldbank.org/en/news/feature/2011/06/06/economics-adaptation-climate-change.
18. United Nations Development Programme, Act Now, Save Later campaign; http://www.undp.org/content/undp/en/home/ourwork/get_involved/ActNow/.
19. Global Institute of Sustainable Forestry and Yale University School of Forestry & Environmental Studies, Assessing the Environmental, Social, and Economic Impacts of Wildfire (2003); http://environment.yale.edu/gisf/files/pdfs/wildfire_report.pdf.
20. Michigan Green Communities Case Study: Ann Arbor Stormwater Utility (undated); http://www.mml.org/green/pdf/MGC_A2_StormwaterUtility_Case.pdf.
21. Fugro Atlantic, Preliminary City-wide Coastal Flooding Mitigation Concept Evaluation and Master Plan Development (2012); http://www.norfolk.gov/DocumentCenter/View/7614; Battleground Dispatches: Norfolk Readies for Future Storms, Sea-level rise; PBS News Hour (Dec. 6 2012); http://www.pbs.org/newshour/bb/politics-july-dec12-norfolk_12-06/.
22. American Planning Association, Case Study: Hayman Fire: Hayman, Colorado (undated); https://www.planning.org/research/postdisaster/casestudies/haymanfire.htm.

ACKNOWLEDGEMENT

The Great American Adaptation Road Trip was made possible with support from the University of Michigan's School of Natural Resources and Environment as well as countless generous friends, family, and strangers. Contact the road-trippers Allie and Kirsten at adaptationstories@gmail.com or www.adaptationstories.com.

To mitigate the climate impact of our trip, we purchased 10.34 metric tons (23,000 lbs) of carbon offsets from TerraPass. Using a carbon calculator, we estimated our emissions from driving and the energy in the homes and hotels we stayed in along the way. These offsets were sourced from carbon reduction projects in the United States.

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy

The nonpartisan Georgetown Climate Center seeks to advance effective climate, energy, and transportation policies in the United States — policies that reduce greenhouse gas emissions, save energy, and help communities adapt to climate change.

For additional information, please visit **www.GeorgetownClimate.org** or **www.AdaptationClearinghouse.org**.

GEORGETOWN LAW

Georgetown Climate Center
600 New Jersey Ave., NW, Washington, DC 20001 | www.GeorgetownClimate.org