

Risk Nexus

What can be learned from the
Columbia and Charleston floods 2015?



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Post event review capability (PERC) report on the October 2015 floods
in South Carolina

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Cover: Damage was widespread after intense rainfall caused major flooding in the Carolinas in early October 2015. The worst damage occurred in South Carolina, where 22 counties were declared federal disaster areas. The photo shows homes in Andrews, South Carolina.

Foreword



Mike Foley
CEO of Zurich North America

Once the rains stopped after the October 2015 floods in South Carolina, news crews captured the devastation. Reporters talked to residents who said they lost everything. Nineteen people lost their lives. The floods caused an estimated USD 12 billion in total losses with approximately USD 2 billion in insured and other funded losses. As we approach the one year anniversary of the floods, some residents are still trying to rebuild, and the sad reality is South Carolina could experience this type of extreme event again.

Similar flood events are happening all over the world and increasing in frequency. Since 1990, there's been a five percent increase in the number of storms in the U.S. causing at least USD 1 billion in damage, according to the National Oceanic and Atmospheric Administration.

These devastating floods, like all disasters, test our resilience and readiness to deal with similar situations in the future. Zurich Insurance Group started our global flood resilience program in 2013 and has invested more than USD 50 million in community resilience. To date, the program has directly helped 125,000 people in flood-prone communities around the world through research, community-based programs, and risk expertise. We focus on floods because they impact more people globally than any other natural hazard, affecting 250 million people each year. And resilience makes economic sense. Studies show every dollar spent on pre-event mitigation saves five dollars in future losses.

As part of our program, we set up the Zurich flood resilience alliance, whose members include organizations that share a common vision of enhancing communities' well-being by making them more resilient to floods. Together with other members of our alliance, we have developed a flood resilience measurement framework. The framework forms the basis for the assessment used in this report called Post-Event Review Capability (PERC). The PERC takes a consistent, analytical approach to uncovering the root causes of a disaster. This report is part of a series of PERCs conducted by Zurich and its research collaborators across the globe. It is the first time the PERC assessment has been used to examine floods in the U.S.

We would like to thank ISET-International and Aon for working with Zurich on this report and all the individuals in South Carolina who shared their personal experiences. The lessons learned from this and other PERCs can help create resilient communities in the U.S. and around the world.

As you'll read in the report, there are specific recommendations we can act on now. When we do so, we can save lives, reduce losses and build more resilient communities.

Best,


Mike Foley
CEO of Zurich North America

Executive summary

In October 2015, South Carolina experienced days of torrential rains and severe flooding. The floods were a major disaster. Total losses have been estimated at USD 12 billion, comparable to the economic impact of Hurricane Hugo in 1989.¹ Despite the serious nature of the event, it was hardly singular in terms of its severity and impact.

¹'SC floods damage: \$12 billion, economists say.' Roddie Burns, The State, December 1, 2015.
www.thestate.com/news/local/article47471060.html

A study published by ISET-International, a non-profit organization committed to building resilience, and Zurich Insurance Group, the global insurer takes a detailed look at the South Carolina floods. The study focuses not only on the impacts of the floods in the Columbia and Charleston metropolitan areas, but provides insights and lessons to better equip us to deal with these types of events in future. Based on interviews with households affected by the floods and people helping in risk-reduction and response and recovery at the city, county, state and federal levels, the study identifies key findings. It provides recommendations for enhancing flood resilience. The lessons and recommendations can be applied not only to Columbia and Charleston, but to many other communities exposed to flood risk.

Build back better

Initiatives like the Resilient America Roundtable, 100 Resilient Cities, and other such programs are encouraging useful discussions on the topic of 'resilience.' In the face of uncertainty, resilience means finding ways to mitigate, adapt, and build on experiences and insights we have gained from past events. It means going beyond the physical and financial aspects that affect our decisions, and putting humans, society and nature at the heart of initiatives to increase resilience.

It is very important that in the aftermath of a disaster, recovery efforts should be carried out in ways designed to enhance resilience and provide rewards for those who do it. This might mean setting aside retention areas that can take up flood water, giving more space to nature, and improving how we approach hazards.

One particular entry point for discussions on resilience is how the Federal Emergency Management Agency (FEMA) approaches resilience; notably, FEMA's 'deferred maintenance' policy. FEMA generally does not cover losses caused by 'deferred maintenance' (problems that existed before a flood), leaving vulnerable households living in sub-standard housing, and people in mobile homes unable to secure enough funding for recovery. Policy modifications are needed to better support these households to make a resilient recovery that will put them at less, not more risk, when the next flood occurs.

Address misconceptions about flood risk

Insurers, policymakers and others can help to clear up a misunderstanding about how often a particular event might occur. Some people wrongly believe that a rainfall or flood considered a '1,000-year' event may reoccur only after 999 years have passed. But the statistically-attributed frequency of a particular flood gives no indication when it might occur next. Trends in temperature, precipitation, and sea level suggest that such events will not only continue to occur, but may even intensify and increase in frequency.

"Initiatives like the Resilient America Roundtable, 100 Resilient Cities, and other such programs are encouraging useful discussions on the topic of 'resilience.' In the face of uncertainty, resilience means finding ways to mitigate, adapt, and build on experiences and insights we have gained from past events."

Increase personal awareness and responsibility

The influx of migrants to Charleston, as in many places in the world, is creating new vulnerabilities. Many new arrivals don't understand the city's history and the flood risk that goes with living in particular neighborhoods. Communities can take the initiative to help people understand their risk and learn local adaptation strategies. New households need to acknowledge they have a responsibility and role in reducing their risk, and be empowered and encouraged to take action.

Let people take the initiative

People affected by events are not only 'victims'; many have the capacity to help themselves and others, a fact that should not be underestimated. For example, North Charleston set up a 'transfer shelter' for evacuees. Along with food and clothing, these shelters provided people with resources to call family and friends to organize their own places to stay. Longer-term shelters were set up for people with no alternatives. Using transfer shelters greatly reduced the need for overnight accommodations.

Address problems related to dams

Dams need to be regularly assessed for flood risk to downstream communities. High-risk dams need to be regulated, and dam owners educated about how to maintain and operate them. The small lakes and dams that dot the South

Carolina landscape created substantial risk and their failures contributed to the October flood event impacts. Yet the potential flooding that dam failures could cause are not well understood or communicated. Downstream residents are often unaware of the risks. Addressing this issue will take commitment to funding the needed inspections and regulations, and adjusting policy to clarify who is responsible for dams and the risks they pose. Both these actions may face opposition, but both are preferable to continued catastrophic dam failures.

Review the damage assessment process

People affected by the floods in Columbia and Charleston were frustrated by the Federal Emergency Management Agency (FEMA) damage assessment process. Hiring inspectors locally, who are experienced in damage assessment or home construction, would help. Ideally, inspectors would conduct more comprehensive assessments, looking at a home in its entirety, not just as a sum of its parts. This could reduce the number of cases in which loss of moveable and non-critical possessions pushes homes into the 'substantially damaged' category, adding conditions to the recovery.

Make buyouts strategic

Using federal disaster recovery funds to buy out high-risk properties and convert the land to open space is one of the few mechanisms by which local and state

governments can reduce flood risk, while providing financial relief for property owners who have limited options. But funding for property buyouts is limited and generally falls far short of demand. If buy-outs are aimed at increasing resilience, for example by linking them to existing parks and greenways, ongoing maintenance can be less complicated and obtaining local matching funds for purchases may be easier.

Review insurance penetration and accessibility

Ideally, the U.S. National Flood Insurance Program (NFIP) would play a big part in flood risk management. The NFIP is usually the only flood insurance option available to property owners; private insurance generally does not cover flood losses with the exception of car insurance. However, even many living within the 100-year floodplain choose not to purchase insurance if they are not required to, primarily due to a lack of risk awareness, perceived risk, and cost. These barriers are exacerbated by FEMA's processes and rules; the narrow conditions under which NFIP pays out makes it unappealing to many homeowners outside the floodplain. Making NFIP more flexible would help to increase insurance penetration. Currently, in South Carolina only about 72 percent of those who should purchase flood insurance have it. Yet, flood damage outside the 100-year floodplain now accounts for 30 to 47 percent of all flood-related losses.



“Dams need to be regularly assessed for flood risk to downstream communities. High-risk dams need to be regulated, and dam owners educated about how to maintain and operate them.”

Introduction

In early October 2015, the Carolinas experienced historic rainfall, resulting in flooding and flash flooding, dam failures, bridge and road closures, and damage to thousands of structures. The worst damage was concentrated in South Carolina, where 22 counties were declared federal disaster areas.

In this study, we apply the post-event review capability (PERC) methodology² to analyze why the floods had the impacts they did and became a disaster in two major places: Columbia and Charleston. These case studies show how the same storm can unfold very differently across locations.

While the floods also heavily affected rural areas in Georgetown and Sumter counties, we focus on the flooding and flood impacts in the Columbia and Charleston metropolitan areas because both are expected to grow dramatically in the coming decades. This population growth, in combination with increasing risk of disaster, will exacerbate exposure, underscoring the need for serious decisions related to future developments and policy.

We also explore the successes and challenges of disaster risk reduction, response and recovery efforts and identify ways to build resilience to future floods. This is becoming increasingly important in the face of environmental change, urbanization, and development.

While these floods provide lessons for Columbia and the Charleston areas, we believe that these lessons can also be applied to a variety of contexts within and outside of South Carolina. Policymakers, disaster risk management practitioners – including non-profits, government, and volunteer groups – and homeowners are among those we believe will be receptive to our findings.

The floods in South Carolina were remarkable for the tragedy and damage they caused, including at least 19 deaths. Total losses were estimated at USD 12 billion, comparable to the economic impact of Hurricane Hugo in 1989.³ Although this was a major disaster, it is hardly singular in terms of either its severity, or its consequences. It is likely that events of even greater magnitude will strike with similar and possibly greater intensity and frequency in the future. The social and economic costs of these floods and other disasters must be kept in mind in any discussions about the feasibility of disaster risk reduction and resilience building.



²The information presented in this report was collected via interviews with individuals from key governmental agencies and departments, faith-based groups, non-profits, for-profits, and academic institutions involved in disaster risk management; interviews with flood-impacted households; and review of secondary literature such as newspaper articles, reports, and peer-review papers. For more information on the PERC methodology, please see: www.zurich.com/_/media/dbe/corporate/docs/corporate-responsibility/the-perc-manual.pdf

³SC floods damage: \$12 billion, economists say.' Roddie Burns, The State, December 1, 2015. www.thestate.com/news/local/article47471060.html

Section 1

One storm, two floods

Over the Atlantic and southwest of Bermuda, Hurricane Joaquin became a tropical depression. It underwent rapid intensification, becoming a major hurricane. Though it never made landfall in the U.S., it interacted with a large low pressure system that had formed over the southeastern states, which led to record-breaking rainfall. Rainfall began on Thursday, October 1 and continued through Tuesday, October 6. The greatest volumes of rain fell Saturday evening, October 3 into Sunday, October 4. Flooding followed in many parts of South Carolina as a result.

Throughout the state, residential property, public infrastructure and farmland flooded. Over 540 roads and bridges were closed, including a 74-mile stretch of Interstate 95. There were at least 75 dam failures. Road repairs alone were estimated to cost USD 137 million. Businesses suffered four or even six weeks' major disruption.⁴

Storm total rainfalls in various locations across South Carolina

Charleston Downtown	16.02"
Charleston Airport, North Charleston	17.29"
Columbia Metro Airport	11.44"
Georgetown	23.88"
Gills Creek	21.49"
John's Island	18.79"
Mount Pleasant	26.88"
Sumter	20.77"

Source: National Weather Service

Storm damage by county for Columbia and Charleston metro area counties.



Total damages



Total number of structures damaged

Richland County	USD 3.2 billion	21,212
Lexington County	USD 2.1 billion	18,114
Dorchester County	USD 1.9 billion	14,977
Berkeley County	USD 1.4 billion	15,137
Charleston County	USD 507.5 million	3,667

⁴For information about bridges and roads, see: 'South Carolina to Pay \$114M Share of \$1.2B Flood Damage Costs.' Jeffrey Collins, Claims Journal, December 4, 2015. www.claimsjournal.com/news/southeast/2015/12/04/267428.htm.

For information about dam failures, see: 'South Carolina's 1,000 year flood,' Brett H. Bayne, Jessica C. Tyndall, Claims Management, December 2015. theclm.claimsmanagement.epubxp.com/i/612300-dec-2015

For information about business disruptions, see: 'New forecast calls for growth in South Carolina economy in 2016.' John McDermott, Post and Courier, December 1, 2015. www.postandcourier.com/article/20151201/PC05/151209955/new-forecast-calls-for-growth-in-south-carolina-economy-in-2016

Source: CoreLogic, available in 'Insurance Journal,' October 28, 2015. www.insurancejournal.com/news/southeast/2015/10/28/386339.htm

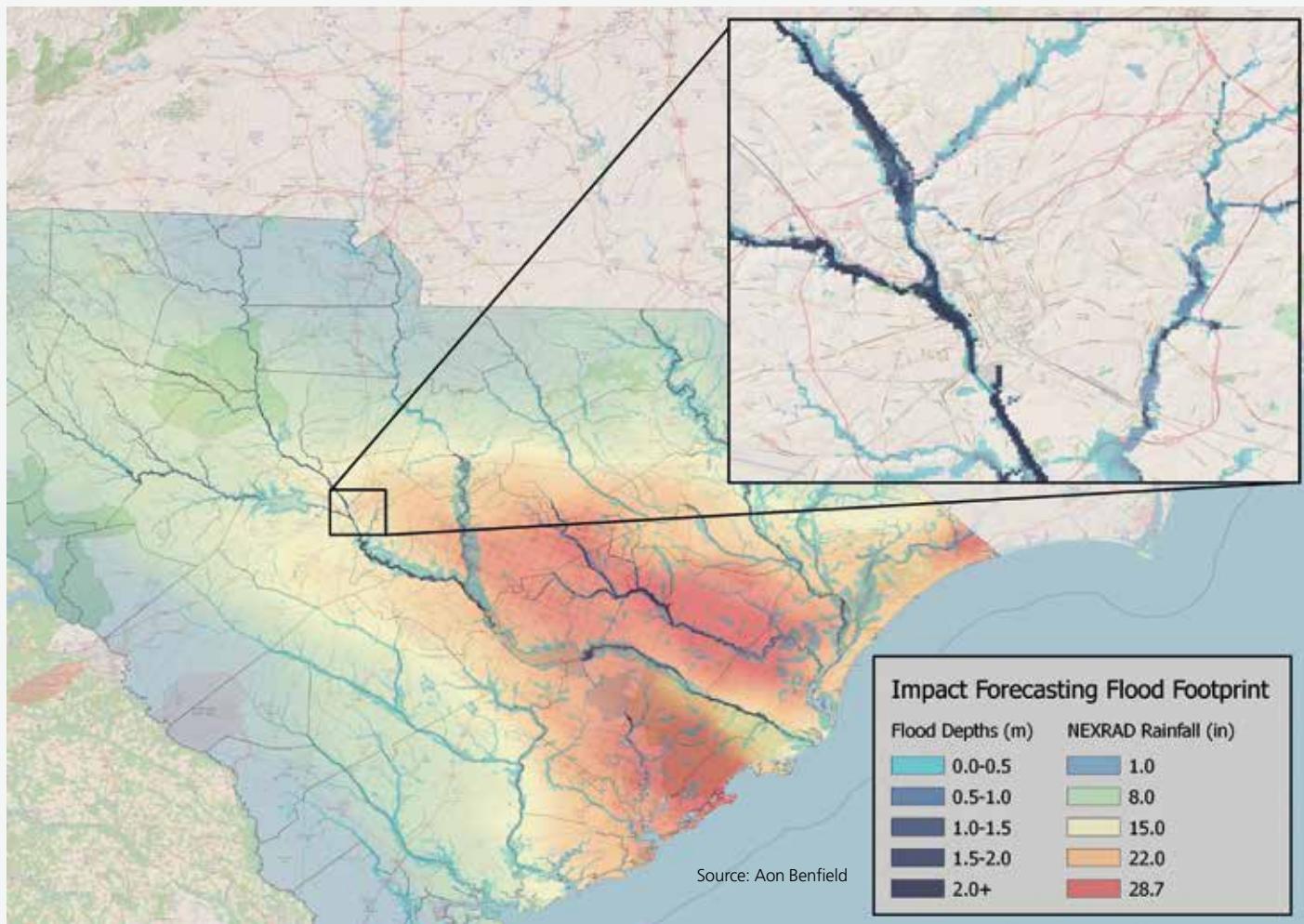
Columbia is located inland, at the break between the southern piedmont and the coastal plain. The city is built on gentle to moderately steep slopes with numerous, branching streams. Columbia floods regularly in some areas, but the city as a whole has not experienced severe floods for many years. Intense rainfall led to flash flooding Saturday night, October 3, and into Sunday morning. Flooding was exacerbated in many areas by dam failures and emergency dam releases.

Lacking experience with flash flooding and faced with unexpected conditions, the impacts were major and response was, of necessity, ad hoc.

Charleston commonly floods. Charleston lies within an estuary in the middle of South Carolina's coastline where the Ashley and Cooper Rivers meet. Topography is flat and drainage has always been an issue. Documented sea level rise – a foot in the past century – is exacerbating drainage issues.

The October 2015 floods were caused by intense rainfall that overwhelmed the natural drainage, but flooding was augmented by extremely high tides. Because much of the flooding occurred in places that regularly flood, response was targeted and effective. A second round of flooding followed several days later as flood peaks from the inland rains reached river mouths.

South Carolina flood footprint



A history of South Carolina flood events

1893: Sea Islands Hurricane, August 27

Southern coast and midlands of South Carolina, with wind speeds of 96-120 mph and a 16-30 foot storm surge: 2,000 deaths and USD 10 million in damages.

1908: August 26-30

Intense rainfall leading to the most extensive flooding in South Carolina history. All the major rivers of the state rose from 9 to 22 feet above flood stage, affecting over 80 percent of the state.

1940: Southeast Hurricane, August 11-19

Rainfall totals of 7 to 12 inches across southern and northwestern South Carolina: greater than 100-year flooding on the Broad River. Approximately 35 people lost their lives; death tolls were lessened by warnings and evacuations. Damage was estimated to be USD 10 million.

1959: Hurricane Gracie, September

Six-foot storm surge, intense winds of up to 140 mph, and 6 to 8 inches of rainfall on the coast: seven deaths and USD 20 million in damage. Charleston recorded the highest tide since 1940 – 9.5 feet above mean low water.

1989: Hurricane Hugo, September 22

The sixth costliest hurricane in U.S. history, Hugo made landfall in South Carolina with surface winds of 140 mph, gusts above 160 mph, and a storm surge of over 20 feet. Damages exceeded USD 6 billion, 50,000 to 70,000 people were left homeless, and 35 people were killed.

1990: Tropical Depression Klaus and Tropical Storm Marco, October

Major flooding across central South Carolina caused the failure of 17 earthen dams, damage to 81 additional dams, and resulted in 5 deaths. Rainfall totals were some of the highest recorded in 100 years, including one unofficial report of nearly 17 inches in the town of Rembert. 13 counties were declared federal disaster areas, with total damage around USD 22 million.

2015: October

10 to 27 inches of rain over three days, resulting in dam breaks, 19 deaths, and total losses estimated at USD 12 billion, comparable to the economic impact of Hurricane Hugo.

1903: The Great Pacolet Flood, June 6

The greatest loss of life in South Carolina from river flooding since 1900. Heavy rainfall on saturated soils: at least 65 deaths and USD 125 million in damage in 2013 dollars.

1928: August 15-17

Over 10 inches of rain within 2 days caused flooding throughout the entire state.

1945: September 17-23

Hurricane-related flooding on the coastal plain and central piedmont: one death and USD 6-7 million in damages.

1973: September 14

Major flash flooding in the Santee and Saluda River Basins resulted in total damage of USD 4-6 million.

1995: Tropical Storm Jerry, August 25-29

Eight to 20 inches of rain fell on the northwestern piedmont area in 8 hours, leading to severe flooding on the Saluda, Edisto, Broad, and Congaree Rivers. Dam breaks led to flooding, affecting roadways and washing out bridges. There were three deaths, and damage totaled USD 10 million (1995 USD).

1999: Hurricane Floyd, September 16

15 to 20 inches of rain fell along the coast, triggering widespread flooding.

— Both Charleston and Columbia affected

— Columbia (or upstream areas) primarily affected

— Charleston (or coastal areas) primarily affected

The policy context

The policy landscape for managing disasters in the U.S. differs significantly from state-to-state. In South Carolina, the policy landscape also differs by county and municipality because the state is a 'home rule' state. Municipalities and counties may create their own laws and policies, provided they follow the state and federal constitutions. Such decentralization allows municipalities and counties substantial autonomy in how they govern themselves. Making matters more complicated, the Columbia and Charleston metropolitan areas cross several counties. Policy decisions require cross-jurisdictional collaboration in both areas.

Cities and counties rely on the state to distribute federal funds for disaster mitigation, response and recovery, to administer the National Flood Insurance Program (NFIP), and to provide state-level services, resources and advice when needed. The state has some regulatory authority, but its ability to regulate is constrained by limited resources due to relatively low taxation.

The federal government provides some regulation; aids in response and recovery, primarily through the Federal Emergency Management Agency (FEMA); provides financial resources, technical support and capacity building; and creates incentives for risk reduction.

Navigating the different scales of regulation and ensuring that they regulate in ways that complement each other and reflect local needs is a challenge. Programs such as the 'Silver Jackets' (a group that brings together different agencies to learn from each other and use their knowledge to reduce flood risks) have been developed to help with collaboration and communication in disaster risk management.

There are other non-profit, civil society, and private organizations involved in disaster management. In particular, South Carolina has a state chapter and multiple county chapters of voluntary organizations active in disasters (VOADs) that are heavily involved in both response and recovery.

There are five categories of federal disaster recovery funding



Individual Assistance program

FEMA grants up to USD 33,000 per household to cover temporary housing, repairs, and to replace assets. The Small Business Administration (SBA) also provides low interest loans.



National Flood Insurance Program (NFIP)

NFIP provides payouts to homeowners and businesses that purchase policies. Payouts are capped at USD 250,000 (dwelling coverage) plus USD 100,000 for damage to personal property. Commercial entities can receive up to USD 500,000.



Public assistance

FEMA provides aid to state or local governments to rebuild damaged infrastructure. Public assistance pays for 75 percent of project costs. Approved projects generally only consider building back, not building more resiliently.



Community Development Block Grant Disaster Recovery program (CDBG-DR)

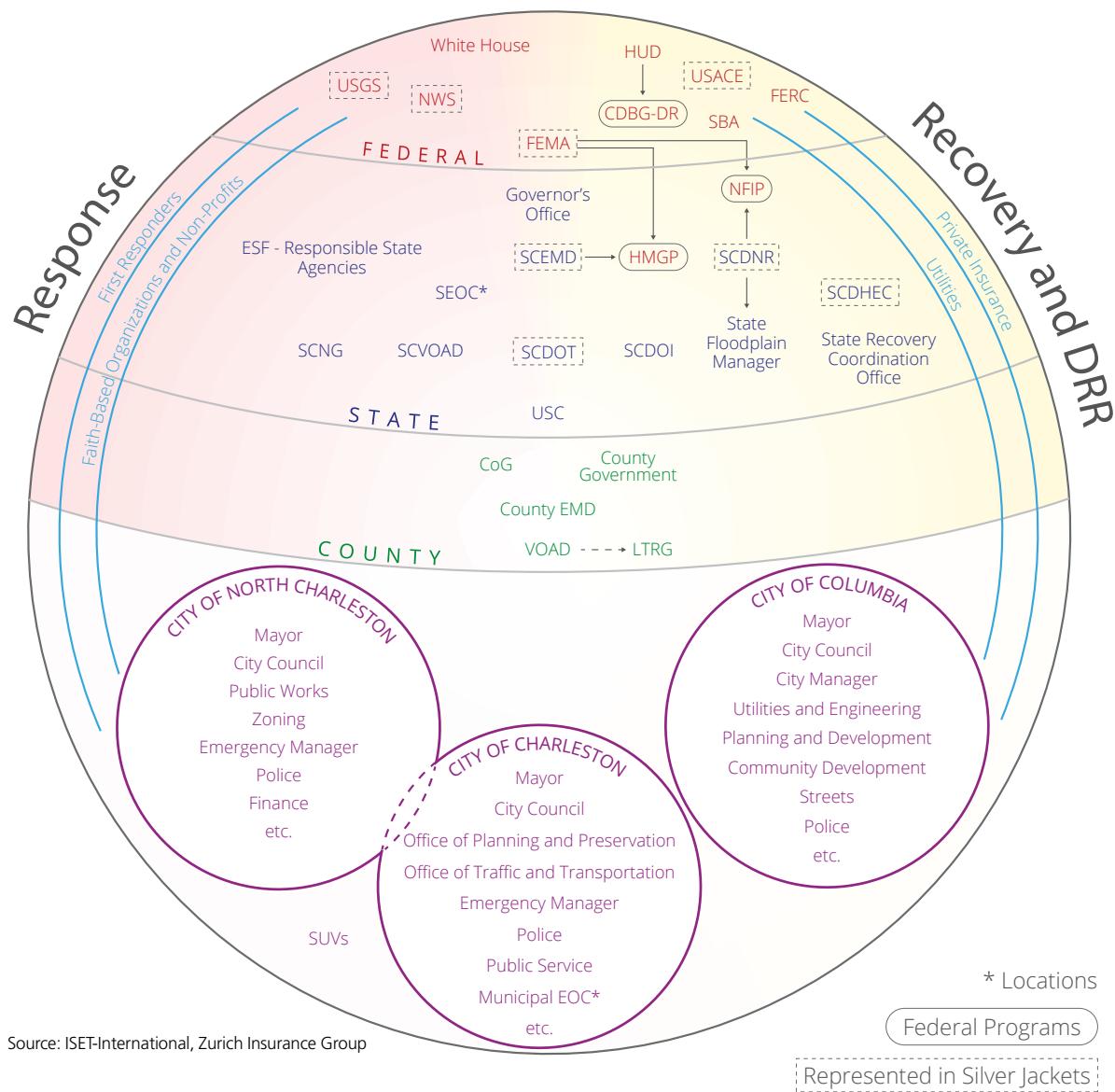
The U.S. Department of Housing and Urban Development (HUD) allocates grants to cities, counties and states to support recovery from presidentially declared disasters, especially in low-income areas.



Hazard Mitigation Grant Program (HMGP)

FEMA awards grants to reduce the potential for future disasters. Funding is limited to 15 percent of the total disaster grant by FEMA.

The disaster management system in South Carolina



Section 2

Flooding in Columbia

Columbia is the capital and largest city in South Carolina. It lies within Richland and Lexington Counties. Columbia is prone to earthquakes, winter storms and ice storms, tropical cyclones, tornadoes, and droughts. While major flooding has been rare in recent decades, Columbia does have a long history of flooding caused by tropical cyclones.

The city is located at the confluence of the Broad and Saluda Rivers; the rivers combine to form the Congaree River that flows south and east through Columbia and onto the coastal plain. The Saluda is controlled by the Saluda Dam that forms Lake Murray. The dam is located about 10 miles west of downtown Columbia and operated for flood control and power generation. Multiple small watersheds, such as Gills Creek, flow into the Broad, Saluda and Congaree rivers. Columbia's landscape is dotted with small, dammed ponds originally designed for agricultural use. Many are now located in heavily developed areas.

The heaviest rain in Columbia occurred from late Saturday night October 3 through early morning October 4. The Gills Creek watershed received the most rainfall at 21.49 inches. Gills Creek crested at 19.6 feet on October 4; the previous record was 8.66 ft. Failure of several small dams in the watershed contributed to the flooding and flood impacts.

The National Oceanic and Atmospheric Administration (NOAA) identified this as a 1,000-year rainfall event. However, the event did not lead to 1,000-year flooding at any gaged locations, although records were set at 17 locations. Most U.S. Geological Survey (USGS) gauges documented peak flows within the 10-year flood range, with a few gauges indicating 25- and 50-year flood events. Within Gills Creek, flows were reconstructed as a 1-in-500 year event.⁵

Vulnerability in the built environment

Columbia was originally a trade center as it was the furthest inland point for river navigation. This, along with agriculture, led to development along rivers. At the end of the Civil War in the late 1860s, freed slaves settled onto vacant lands, many of which were marginal and flood-prone. In the early 1900s, dams were built on creeks and rivers for water storage and power generation. These settlement and development patterns have shaped vulnerability in Columbia.

Today, elevated social vulnerability⁶ is found in the southern portion of Richland County, in Columbia around the urban core, in parts of the Gills Creek watershed, and in West Columbia. These are primarily lower-income groups, students, and renters. Many are on fixed incomes and/or lack the resource base to quickly rebuild homes, find new rental space or replace possessions. They rely heavily on federal and state safety nets and on their social networks during disasters.

The suburbs to the northeast, northwest, and southeast of the city have lower social vulnerability and can more easily recover. Lakefront property in these areas is particularly high value. Though these lakes come with increased flood risk, many of the property owners have the resources to recover quickly.

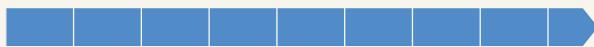
The Gills Creek Watershed in the southwest corner of Columbia includes both mixed-income and higher-end housing. There are about 100 lakes formed by damming small creeks.

Flood records

Gills Creek crested at 19.6 feet on October 4



The previous record was 8.66 feet



⁵USGS does not calculate above a 1-in-500 year event as there is insufficient data to characterize events rarer than 1-in-500 year events.

⁶Social vulnerability refers to the inability of individuals to withstand the impacts of shocks and stresses, and it reduces the ability of individuals to prepare for, adapt to, respond to, and recover from hazards. Critical factors that influence social vulnerability include: (1) access to resources (liquid assets, knowledge, information), (2) access to decision-makers, (3) cultural and legal norms, (4) access to critical infrastructural services (electricity, water, transportation, communications, shelter), and (5) individual strength (as determined by age, health).



“FEMA floodplain maps should help inform people about the risks they may face. However, very few people check the maps, particularly those outside of the designated floodplain.”

The larger lakes are owned and operated by homeowners' associations; almost all of them are not regulated by the state. Some homeowners' associations actively maintain their dams and operate spillways, but others do not. Neighborhoods and businesses downstream have no say over upstream dam management.

Risk perception

Flood risk awareness in Columbia is low. FEMA floodplain maps should help inform people about the risks they face. However, very few people check the maps, particularly those outside of the designated floodplain. Indeed, many homeowners consider the designation of the 100-year floodplain as a penalty that should be avoided if possible, rather than useful information about risk.

In addition, downstream residents are largely unaware of the substantial risk posed by small lakes and dams, particularly those in urban areas.⁷ This is partly because the risks of potential dam failures are often not evaluated. There have been attempts to increase risk awareness; for example, dam managers for major dams, such as the Saluda dam, annually mail information to homeowners in the floodways about flood risk.

Level of preparedness

At the city and county levels, preparedness initiatives in Columbia primarily focus on earthquake and hurricane risk; Columbia does not have a flood emergency plan. Since Hurricane Hugo in 1989, emergency responses have been mobilized primarily for ice storms.

⁷For more on flood plain maps in Richland County, S.C., which includes Columbia, see: 'Floodplain mapping and local hazards,' available at: www.rcgov.us/Government/Departments/Planning/FloodplainManagement/Mapping.aspx



Box 1: Preventing development in a floodplain – the Green Diamond case

In 1999 developers purchased 4,500 acres of Congaree river floodplain near downtown Columbia. The land lies at the bottom of the Gills Creek watershed. The developers planned to build an entire community there with houses, shopping complexes, golf courses, and hotels.

In the early 2000s, floodplain maps for Richland County were updated. New maps determined that 70 percent of the property was within a floodplain and restricted development. The developers sued Richland County, claiming that the county, by adopting the federal flood lines, unfairly restricted their use of the property.

The case went to the South Carolina Supreme Court. In August of 2015, the court unanimously ruled in favor of Richland County, noting the county is not the “involuntary guarantor of the property owner’s gamble that he could develop the land as he wished despite the existing regulatory structure.”

Immediately post-flood in October, the property resembled a lake. The flooding was a combination of rainfall, inflow from surrounding creeks, and possible failure of one of the earthen levees on the land. Even so, FEMA has proposed loosening some of the controls over development.⁸

At a state level, the focus has been on building networks and capacity. Government agencies like the EMD (Emergency Management Division) run regular multi-departmental exercises as part of the state’s preparedness training. Recent exercises with federal participants have helped develop strong partnerships with federal agencies and an understanding of federal processes, which is critical for responding to and recovering from a federally-declared disaster.

Efforts to reduce disaster risk

Households may reduce the financial risk of floods through insurance. The National Flood Insurance Program (NFIP) is usually the only flood insurance

option available to property owners; private insurance generally does not cover flood losses or damage, with the exception of car insurance. Flood insurance is mandatory for households that meet the following criteria:

- They have a federally-backed mortgage
- They are located in the 100-year floodplain
- They live in an NFIP participating community

In non-NFIP participating communities, lending institutions must consider the risks of making loans on properties within the flood hazard area. In South Carolina, about 72 percent (August 2015 estimate) of those who should purchase flood insurance are enrolled in the NFIP.

The majority of NFIP policies in South Carolina are held in coastal areas. Only about 1,700 households in Richland County and 2,400 households in Lexington County carry flood insurance.⁹ Many within the 100-year floodplain choose not to purchase insurance if they are not required to, primarily due to a combination of risk awareness, perceived risk, and cost. Yet nationally, flood damage outside the 100-year floodplain now accounts for 30 to 47 percent of all flood-related losses.¹⁰

There have been efforts to limit further development on floodplains. Box 1 provides an example of where risk considerations prevented flood-prone land developments.

⁸The State of South Carolina in the Supreme Court, Columbia Venture, LLC, Appellant, v. Richland County, Respondent. Appellate Case No. 2013-001067

⁹Source: Aon Benfield

¹⁰Source: *ibid*

Section 3

The event

Impact and response

The South Carolina Emergency Management Division (SCEMD) began making preparations as Hurricane Joaquin approached the coast of South Carolina. By September 30, it was clear Joaquin would not make landfall, but the National Weather Service (NWS) issued a hazardous weather alert for extremely heavy rain. In response, SCEMD began to mobilize the State Emergency Operations Center (SEOC). At 2 a.m. Saturday October 3, it revised the forecast to a warning, indicating flash flooding was imminent.

The advance notice gave SCEMD ample time to prepare. The state and FEMA agreed to bypass the rapid damage assessments and declare a presidential disaster¹¹ if warranted. This would speed up FEMA's mobilization of staff and resources. SCEMD held daily conference calls with first responders and helped county emergency management divisions mobilize resources.

The Department of Health and Environment Control (DHEC) told lakeside homeowners associations to begin dam releases to drop lake levels. Some associations complied. Others did not know what to do, could not unlock the spillways, or could not find the person in charge.

Though emergency officials were on alert, most residents were not. Rain was light at first, leading people to let down their guard. The most intense rains fell between Saturday night and early Sunday morning. Many people were surprised to wake up to major flooding.

Nine lives were lost in Columbia during the floods, with five caused by individuals drowning in submerged vehicles and four in traffic accidents in conditions made worse by floods.

Dam releases and dam failures made flooding worse. On Friday October 2, the Saluda dam began early flood releases. Spillway gates were opened on Sunday for the first time since 1969. This caused homes downstream in the floodway to flood. At least three regulated dams in Lexington County, 16 regulated dams in Richland County, and multiple smaller unregulated dams were damaged, releasing floodwaters that inundated many homes. In some areas, water backed up against infrastructure such as railroad embankments and exacerbated flooding.

Official emergency management groups organized search and rescue, evacuation, and shelters, but many evacuations were only ordered after dams were already breached. Emergency personnel were stretched thin and could not reach some places that needed help. Some communities organized their own rescue operations. In the Gills Creek watershed, for example, people used boats to rescue neighbors. Social media supported these efforts.

Rumors of dam failures spread, causing panic and leading people to take unnecessary risks. Warnings sent to phones were less effective than they might have been; recipients did not always understand the warnings and some were uncertain whether the warnings applied to them.

In many cases, critical infrastructure failed. Flood flows in the Congaree River just below the confluence of the Saluda and Broad caused the Columbia Canal to breach and on the night of October 5 affected the Columbia water treatment plant's intake. Multiple roads and bridges carrying water and sewage lines were also damaged. Overall, the water supply for 375,000 customers was disrupted. The water treatment facility lacked an emergency plan to handle for a full breach. Attempts to build an emergency dam were unsuccessful and caused a second breach. Successful emergency measures included installing pumps that drew water from the Broad River and from the water treatment facilities in neighboring Cayce and West Columbia. All wastewater utilities in the area were affected; sewage systems were overwhelmed and treatment plants difficult to access. Millions of gallons of sewage were spilled; no communities were evacuated, but ecosystem and human health may have suffered from the effects.



¹¹Under U.S. law, the state governor must request that the U.S. president declare a major disaster or emergency. This activates federal programs to provide relief and assist recovery.

Early recovery

A national disaster was declared late Monday, October 5 for all but 8 counties in the state. FEMA mobilized 1,600 of its staff to assess damage, work with officials and help coordinate early recovery. The state worked with counties to dispatch floodplain managers to assess damages and provided information. These included an online session to explain to people how to do FEMA's substantial damage assessments and explain to them what requirements needed to be met if assessed damages exceeded 51 percent of property value.¹²

Volunteers from non-profit agencies and spontaneous unaffiliated volunteers (SUVs) assisted in cleaning up homes. Formal groups, worried about liability, tried to train SUVs on safety and best practices. But it was challenging to provide SUVs with the full training, protective gear, and coordination needed. Meanwhile, 'hawks' – predatory service providers – began arriving in communities trying to push homeowners into making costly repairs. The state set up a hotline to report price gouging and unscrupulous contractors. For the SC Safe Home hurricane risk mitigation program, the state also mandated that contractors go through Department of Insurance (DOI) certification before providing services.

Long-term recovery

Long-term recovery typically begins about six months after an event and can take over a decade. It is often left to locals and households. Interviewees expressed frustration that the Long Term Recovery Group's (LTRG) case management system was still not operational five months post-disaster; however, this timeframe is not unusual. Voluntary organizations active in disasters (VOADs) focused on identifying households below the poverty line with elderly or disabled residents who were awarded less than USD 3,000 by FEMA. The VOADs worked to make these people's homes functionally livable by December.

Following any disaster, prioritizing limited recovery spending is challenging. South Carolina is using the Social Vulnerability Index® (SoVI®) to identify the most vulnerable communities. It is expected to help prioritize areas for recovery, with more detailed case assessments of individual homes and households determining what funds should be distributed and what types of contracts should be awarded. But, as it is applied at the census tract level (1,000 homes), it can neither identify smaller areas where vulnerability and impact overlap,

nor identify individual homes that are having trouble accessing recovery funding and face going into heavy debt. The State is wrestling with what recovery is needed for the communities that are prioritized.

The state is also facing challenges around dam recovery and regulation. Dams are often regulated based on the risk assessed when the dam was constructed; subsequent development in downstream areas or development that changes hydrology are not taken into account. The debate over whether some dams should be rebuilt is fraught with issues of land tenure, dam inspection, dam ownership, dam regulation, compliance, and also individual rights and lifestyles, sometimes spanning generations. Lakefront property owners want to keep the lakes, but are not sure that they have the money to rebuild the dams in compliance with new regulations. The question of who should pay for rebuilding is also contentious, especially where private dams support public roads (see Box 2).

Counties are working to decide how best to spend limited recovery funds. Buying out high-risk properties and converting the land to open space is one of the few mechanisms through which local and state governments can reduce existing flood risk, while providing financial relief for property owners whose options are limited. Though substantial funds are available to cover damage to critical infrastructure, funding for property buyouts is limited and falls short of demand.

Wealthier households were more easily able to get contractors to rebuild their homes. Many of these residents believe they will be safe once recovery is completed and dams have been repaired.

Middle- and low-income households face difficulties. Many homes remain

"Though emergency officials were on alert, most residents were not. Rain was light at first, leading people to let down their guard. Many people were surprised to wake up to major flooding."

¹²According to FEMA, substantial damage is: "damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred. Work on structures that are determined to be substantially damaged is considered to be substantial improvement, regardless of the actual repair work performed."

gutted months after the event. Some people continue to live illegally in homes that have been condemned; others have decided to sell their homes at a financial loss and walk away. The decision of whether to rebuild or leave is largely based on finances. Those without the NFIP applied for Individual Assistance, but out of 80,000 applicants, only about 30,000 were eligible. FEMA does not generally cover losses caused by 'deferred maintenance' (issues that existed before the event). As a result, some of the most vulnerable households living in sub-standard housing have received insufficient recovery funding. While SBA loans offer an alternative source

of recovery funding, discrepancies in timing, homeowners often need to make decisions on loans before they have clarity on their reconstruction needs (see Box 3). Homeowners are also facing difficulties finding licensed contractors willing to work for the rates that FEMA outlines.

Households in middle-class communities that sustained extensive damage have come together to navigate the recovery landscape amid concerns that safety nets will not benefit them. They fear their families will have to go into debt to rebuild their homes to comply with FEMA regulations. Communities have

also come together to pursue litigation against upstream dam owners over dam failures.

Renters are also facing challenges. Most renters do not have a NFIP renter's insurance policy, and funds from Individual Assistance can only be used to replace lost belongings, pay a few months' rent, or to move. Rental property in Columbia is in short supply. Renters with bad credit struggle to find a place to live. Interviewees reported that some landlords have not returned security deposits, claiming that units affected by floods are habitable, even if they are not.



Box 2: Who's responsible for the Arcadia Wood Lake dam?¹³

The Arcadia Wood Lake dam was built in 1937 and topped with a single lane road to the home of T. D. Taylor. In 1948, Mr. Taylor sold the Right of Way of the dam to the South Carolina Department of Transportation (SCDOT). SCDOT widened the dam and built a two-lane road across.

Following her husband's death in 1960, Mrs. Taylor sold the home and moved to a property just below the dam. For unknown reasons, the dam remained in her possession. She tried to transfer ownership to the homeowners' association or to SCDOT but the judge would not allow the transfer. In 1991, Mrs. Taylor attempted a second lawsuit, which resolved that, though Mrs. Taylor owns the dam, she cannot control the water level behind the dam. Similarly, Mrs. Taylor and the homeowners' association have no control over traffic crossing the road on the dam. Over the years, road traffic has increased beyond the dam's structural capacity. Because SCDOT did not build the dam, it maintains that it cannot set a load limit, though in recent years residents have partially succeeded in getting truck restriction signs installed.

DHEC regulations state that the owner of a dam is someone who owns, controls, operates, and maintains the dam. If one entity has full control over these dam elements and functions, they have the ability and should have the responsibility to maintain that dam. So who is ultimately responsible?

The water operations infrastructure, the dam itself, and the road across the dam are all under different jurisdictions. The dam owner benefits from neither the lake nor the road, but cannot control the use of either.

Box 3: A middle class household's challenges with accessing recovery

The Smiths live in a tri-level home built in 1955 in the South Beltline neighborhood in Gills Creek Watershed. The neighborhood is prone to flooding, particularly the houses along the creek. Nonetheless, many of the owners who have paid off their mortgages have chosen not to retain flood insurance as it's expensive.

The lowest level of the Smith's house is a tenth of a foot above Base Flood Elevation (BFE, the water level during a 100-year flood). During the October 2015 flood, the first and second floors flooded while the third did not. Four months post-flood, their lowest level is gutted and the main floor stripped to the studs from the floor to waist height.

Richland County determined that damage to the Smiths' home exceeds 51 percent of its value. To rebuild, the Smiths have been told they must elevate the lowest portion of the living space two feet above BFE. Their lowest level is slightly above the BFE. If the Smiths didn't need to elevate, they could complete their repairs fairly quickly and inexpensively; all that is needed is new insulation, drywall, baseboard and flooring. The kitchen stove, washer and drier, though they were submerged, still work. The house is structurally sound. It's unclear why this home has been designated 'substantially damaged.' Though the Smiths have yet to receive a quote, elevating the home is likely to be cost-prohibitive. Tri-levels, similar to any home built on a slab, can't be simply jacked up and a higher foundation inserted underneath.

The Smiths describe the recovery process as 'oppressive from every direction.' Ideally, they would be bought out at pre-flood value. However, they have had no indication of whether a buy-out is probable. They have been offered an USD 81,000 SBA loan to cover repairs and personal losses, but have to make a decision about the loan soon, well before there will be buyout information available. If they take the loan now, they will be required to buy flood insurance on a damaged property that they are unable to live in; because of pre-existing conditions, the insurance wouldn't pay out if there were another flood and the house was not yet repaired.

The Smiths continue to talk with different agencies, hoping to find a solution.

¹³Rosanna Winters Lomas, 'Homeowners suffer from dam controversy,' Columbia Star, November 1, 2013: www.thecolumbiastar.com/news/2013-11-01/Front_Page/Homeowners_suffer_from_dam_controversy.html

"Many homes remain gutted months after the event. Some people continue to live illegally in homes that have been condemned; others have decided to sell their homes at a financial loss and walk away."



Section 4

Resilience in Columbia

The findings here follow the '5C' analysis for measuring resilience. This approach is used to evaluate existing 'capitals' (resources) and how people access, use, and manage them, so as to determine where resilience can be built.¹⁴

Physical capital

Dams are subject to complex policy considerations. The state government has not allocated enough funding to inspect the thousands of regulated dams in the state, let alone track and review unregulated structures. Even if it did have the resources, the question of who should be responsible for what is not always clear, particularly in cases where older dams are reclassified from 'low' to 'high' risk; not the fault of the dam owner, and often in cases where private dams support public infrastructure.

Contention over whether failed dams should be rebuilt. Many people see the floods as a rare event. However, the dam failures in the 2015 floods clearly indicate that dams can pose a major risk. People are growing increasingly aware of such risk, but addressing it is complicated. Discussions on whether, and how to rebuild the dams are highly contentious.

Critical assets are often at risk.

Critical infrastructure located in the floodway sometimes failed – and did not fail safely – for example, millions of gallons of sewage spilling left many people without drinking water. The water treatment facility's connection to facilities in neighboring cities was critical for continued supply of water in Columbia.

Financial capital

NFIP penetration in areas that do not regularly flood is low. Households in the 100-year floodplain often choose not to carry flood insurance unless required by a mortgage lender. Those outside the 100-year floodplain, even if affected by floods, are unlikely to buy flood insurance unless it's inexpensive or they're required to.

Accessing recovery funds is challenging. Due to deferred maintenance, those requiring Individual Assistance often do not receive as much as they need. Even homeowners with flood insurance struggle because of rigid damage assessment procedures. Complying with FEMA mandates in reconstruction can be prohibitively expensive for homeowners. Such recovery challenges may lead people to build back to the original, vulnerable state – or worse.

Human capital

The public, by and large, fails to take early warnings seriously. The general public failed to grasp the implications of, or did not believe, the warnings sent by the NWS. The government and first responders, however, acted on early warnings and were able to substantially mitigate what could have been a much larger disaster.

Lack of risk perception is a widespread, chronic issue. People tend to misinterpret the likelihood of an event occurring, thinking that a '1,000-year event' means 'rainfall we won't get again for 1,000 years.' This hampers people's understanding of risk and hinders the potential for resilient recovery. For example, it is possible to have '100 year' floods in two successive years – such as 1928 and 1929 – the statistical frequency of a particular flood event is no indication as to when it might occur next.

Flexibility played a critical role in response. When a water treatment plant unexpectedly failed, staff at the facility were able to improvise solutions. In another example, people used boats to rescue others and opened their homes to neighbors and strangers, thus filling gaps in the official emergency response.

¹⁴To learn more about our flood resilience framework, see www.zurich.com/en/corporate-responsibility/flood-resilience/measuring-flood-resilience

"Communities and the city responded well despite having no plan for flooding; pre-existing networks and relationships were critical to this success."

Social capital

Coordination during response was very successful. Communities and the city responded well despite having no plan for flooding; pre-existing networks and relationships were critical to this success. In particular, SCEMD's scenario training established strong relationships between state and federal agencies.

Those most affected had to wait months for support in recovery efforts. People affected by floods may often wait for months before case management is operational and their remaining needs can be systemically addressed.

Safety nets are lacking. Many lower- and middle-class households are likely to go heavily into debt as they try to recover from the floods, regardless of whether they have insurance or not. Those faced with deciding whether to rebuild or walk away may have to wait one or two years before knowing whether a buy-out is even an option.

Volunteers can prove to be an important source of labor, but coordinating them is challenging. The number of spontaneous unaffiliated volunteers (SUVs) increase with every disaster; but there are few effective ways to make best use of them. Non-profit organizations are working on ways to develop systems to bring together, train and deploy SUVs.

Natural capital

Places that have resisted building in floodplains have largely avoided the impact of floods. Had the Green Diamond project (page 17) gone ahead, the extent of the flooding in the area could have had both social and economic consequences. However, even though buyout programs offer a way to phase out risk-prone developments in floodplains, only limited funding is available for these programs.



Section 5

Flooding in Charleston

Charleston and North Charleston are located in the Charleston/Berkeley/Dorchester tri-county area. The Charleston metro area is a flat, estuarine delta. In this area, natural hazards like earthquakes and hurricanes pose the greatest concerns; however, heavy rains and extreme high tides are increasingly causing nuisance flooding.

Drainage and flooding have been issues since the city was founded in 1670. The sea's level has risen about a foot between 1921 and 1999, further exacerbating flooding. The sea is expected to rise an additional 1.5 to 2.5 feet over the next 50 years. Planning is underway to address this.

The October 2015 storm brought about 16 inches of rainfall. Coastal flooding, especially in downtown Charleston, was made worse by onshore wind and high tides. Tides greater than 7.0 feet cause problems. In the 2015 floods, on October 3, tides peaked at 8.29 feet. Equally problematic, low tides remained unusually high for weeks, severely curtailing drainage.

Vulnerability in an increasingly urbanized environment

The tri-county, with its protected port, river access and fertile soils, has a long history of settlement. The Civil War and a series of hurricanes led to the collapse of the rice industry; poverty was widespread. In the 1920s, severe drought and a crash in cotton prices devastated the economy. Poor farmers and seasonal laborers moved to urban areas. Since the 1950s the area's population has surged. There has been significant development in flood-prone areas. Development along the shoreline exploded when the U.S. National Flood Insurance Program (NFIP) was introduced. The development boom, however, bypassed the most

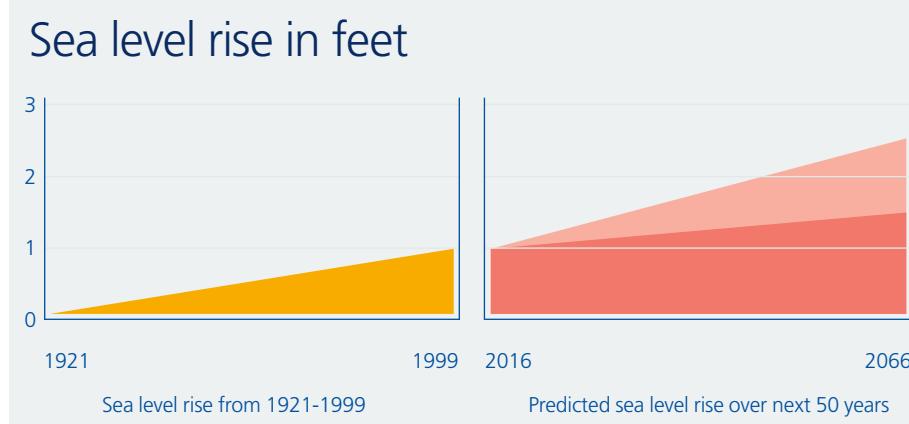
marginalized groups of people, who tend to be concentrated in the urban core.

High in-migration and subsequent development is exacerbating flood risk. Gentrification, rising rents, and rising insurance premiums have displaced poorer communities. Many will likely move to North Charleston, an area of high social vulnerability. This displacement is also changing known patterns of vulnerability. Adding to problems, Charleston's drainage system has become less and less effective, largely because it is not much higher than sea level. Construction on floodplains and barrier islands and filling in wetlands is further exacerbating drainage problems.

Risk perception

Long-time residents of the tri-county area know their flood risk. People have adapted; houses have been raised, and assets that could be damaged are portable. During major events, people know to evacuate.

Flooding is a greater issue for people who have recently moved to the area. They often do not know what action is needed to save assets, or when to take measures to increase safety. There are also few incentives to help people understand flood risk when deciding where and how to live. Realtors want to sell, insurance agents want to receive





their commissions, and communities want to grow and thrive. Realtors lack any incentive to inform clients that insurance coverage can be capped well below the full value of the house, or that coverage will be expensive.

Level of preparedness

Charleston, Berkeley and Dorchester counties coordinate action and share resources and capacities. Emergency managers from the cities within the tri-county frequently work together. The voluntary organization active in disasters (VOAD) is closely involved in these efforts. Charleston and North Charleston have a strong culture of emergency preparedness and response;

Charleston has its own emergency operations center (EOC), and both cities have emergency managers tasked with building networks to address disasters. Hospitals and school systems are a part of the EOC, and the utilities, medical and transportation sectors can be involved as needed. As there aren't enough local shelters in a major event, the city evacuates residents. A major challenge here is that only the governor can order mandatory evacuations, making it difficult to carry out localized evacuations for smaller events.

At the household level, preparedness varies according to demographics and income. In general, lower income people are less well prepared for disasters. They often have less insurance coverage, fewer assets, and may lack the means to leave

their homes. Transient populations including seasonal workers, and students, are often unaware of local risks and are among the hardest to reach and educate through public outreach efforts.

Efforts to reduce disaster risk

In recent years, Charleston has been proactive in reducing flood risk and increasing public safety and service as a means to build resilience. The Charleston Resilience Network was recently established to bring together diverse stakeholders to streamline disaster risk management and resilience planning and develop strategies for coastal hazard identification, mitigation, and information communication (see Box 4).

Box 4: The Charleston Resilience Network (CRN)

The CRN brings together public and private sector organizations that have a shared interest in building resilience. It works to ensure critical infrastructure and socio-economic continuity are resilient to disasters and chronic hazards. The CRN aims to foster a unified strategy, educate stakeholders, and enhance long-term planning decisions. The CRN was set up to improve coordination between groups working on resilience-related challenges.

It has made it easier to provide streamlined information, and introduce a common language and shared goals for resilience planning. The network also provides access to data resources that municipalities can use to apply for Hazard Mitigation Grants. CRN continues to build relationships among regional stakeholders and is identifying organizational capacities to deliver analysis, products and services.





For years, Charleston County has had one of the highest NFIP Community Rating System (CRS) scores east of the Mississippi. However, the effectiveness of the CRS is increasingly being questioned. The CRS aims to provide incentives to communities to pursue comprehensive mitigation strategies. But there is concern that the score is not a true measure of better floodplain management. Instead, critics assert that the CRS's priority lies in providing incentives to reduce insurance costs rather than reducing disaster risk. Communities achieve higher scores if they implement as many small-scale activities as possible, as opposed to adopting policy changes that could significantly reduce disaster risk and vulnerability.

Accordingly, Charleston is proactive in its efforts to reduce risk. The city has spent USD 240 million on drainage projects and plans to spend more in the next 20 years. New drainage systems are being installed on the peninsula in areas where nuisance flooding is high. The first of these systems is now operational and has proved highly successful. The city is also requiring that new developments construct drainage capable of handling a 100-year storm event for 24 hours.

The Upper Peninsula Initiative (UPI) aims to ensure that development on the upper eastern side of the peninsula is urban, open to pedestrians, and avoids suburban sprawl. One 'eco-district' has already been formed; it is using incentives to increase resilience (height and density bonuses, adopting best practice for storm water management, using green spaces, green roofs, and LEED certification). The city is also developing projects to increase social cohesion.

There has been, and continues to be strong political support at the city-level for disaster risk reduction and resilience initiatives. However, obtaining support at other levels of government has been challenging. The recent floods have helped to take discussions forward and increase support for the work that cities are doing.

Charleston wants to pursue a multi-hazard approach. But there are challenges involved in integrating multiple, diverse hazards into one plan. For example, measures taken to reduce flood risk can exacerbate the impact of earthquakes, and earthquakes could destroy structures designed to mitigate sea level rise.

"There are few incentives to help people understand flood risk when deciding where and how to live. Realtors want to sell, insurance agents want to receive their commissions, and communities want to grow and thrive."

Section 6

The event

Impact and response

Alerted by Hurricane Joaquin off the coast, and acting on forecasts for over 10 inches of rain, the emergency operations centers (EOCs) began mobilizing three days before the floods began. They spoke with school officials and major employers; schools were closed and city staff advised to stay home on Friday. The mayor held a press conference to alert people to the danger.

Rains began in Charleston on Thursday, October 1 and by evening the tri-county and state had activated their EOCs. In the area, rainfall totals for the five-day event ranged from 15 to 25 inches. Forecasters correctly predicted the rainfall, but people were surprised by the actual intensity and the impact. Onshore winds, high tides and extreme runoff exacerbated the flooding and prevented floodwaters from receding. Tides remained high for nearly three weeks. Several days after the rainfall event, Charleston suffered a second bout of flooding caused by the upstream rainfall in Columbia days earlier.

The floods hit North Charleston worse than Charleston; and the water took longer to recede. Over 500 homes in North Charleston were flooded, and over 80 percent of those sustained major damage. Among the homes flooded were many that were not (according to flood maps) in the floodplain. In Charleston, fewer property losses occurred (about 60 homes flooded), but many of the damaged homes were repeated losses – ‘repetitive loss’ properties.¹⁵ Here, flooding and damages occurred in areas where flood risk was well established.

Emergency crews focused on places likely to flood. In Charleston, they went door-to-door in flood-prone areas, recommending that people evacuate. North Charleston set up a transfer shelter for evacuees, providing food, clothing, and an opportunity to call family or friends to organize places to stay. Longer-term shelters were set up for people unable to organize their own shelter. These ‘transfer shelters’ greatly reduced the need for overnight

accommodation. Setting up longer-term shelters was difficult, as they are required to have wind-bearing walls – a critical feature for hurricane shelter, but not relevant in case of floods. North Charleston saw a large influx of volunteers from businesses, faith-based groups, and non-profit organizations. Coordinating volunteers was challenging; communication was difficult, and there was a lack of clarity as to who would coordinate the volunteer reception center.

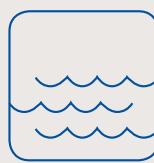
Charleston’s critical infrastructure was not seriously affected by the floods. Power was intentionally shut down in some flooded areas and there were sporadic, short-term power outages elsewhere. Drinking water and communications systems were not compromised. There were sewage spills, but the most significant would probably have been averted if a new pipe that was under construction had been put into operation. As expected, however, much of the drainage system was overwhelmed, including the new Church Creek Drainage in West Ashley



Forecasts for over 10 inches of rain



Actual rainfall totals ranged from 15-25 inches



Tides remained high for nearly three weeks



Over 500 homes in North Charleston were flooded



Transfer shelters set up for evacuees

¹⁵Repetitive loss properties are insurable buildings that have received NFIP payments of more than \$1,000 two or more times in a 10-year period.

that was completed in 2010 and designed for a 25-year event. The main interstate highway, I-95, was shut down due to the flooding, something emergency personnel had not foreseen. Major road closure bulletins were regularly disseminated; secondary road closures were not communicated in an effective and timely manner.

Early recovery

Charleston and North Charleston carried out rapid assessments in the flood's immediate aftermath. North Charleston trained 50 to 60 employees in damage assessment. These focused on 86 homes that required immediate help. FEMA personnel went door to door in Charleston, checking on households in flooded neighborhoods. The city government made sure that FEMA and the city police force were in close communication, identifying households needing assistance.

Disaster recovery centers were set up in the worst-affected areas in both cities. The centers serve as one-stop shops for information and support on recovery, putting representatives from FEMA, SBA, SCEMD and other relevant agencies in touch with people to explain disaster assistance programs and help them apply for aid.

Businesses worked to reopen soon after the floods, allowing people to get back to work relatively quickly, which helped limit the economic impact.

Long-term recovery and efforts to build resilience

The Council of Government (CoG) is a regional governing and coordinating body; in the aftermath of the floods it helps to lead recovery efforts. The CoG's priorities include getting FEMA recovery grants and working to reduce risk, as well as forming a tri-county coalition of recovery and social service organizations, the Long Term Recovery Group (LTRG), to coordinate recovery. The area has had a voluntary organization active in disasters (VOAD) before, but the 2015 floods marked the first time a LTRG had been formed. While the LTRG's exact role is still being discussed, in addition to case management and addressing unmet needs, it may also include providing information on building codes and reconstruction and helping foster public, private, and volunteer recovery partnerships.

The LTRG, the CoG and local organizations are exploring alternative funding sources to help households with unmet needs. Most homeowners in Charleston have been accessing recovery funding through NFIP and SBA loans, but payouts have, by and large, not been enough. Contractor services in Charleston are expensive. Insurance penetration in North Charleston is lower than in coastal Charleston. Many of those affected did not have flood insurance, partly because they were not in designated floodplain areas. Fewer than 30 percent of Individual Assistance applicants have been approved because of deferred maintenance problems, and because damage from rain through the roof does not qualify as 'flooded'.

The county is advocating that existing hurricane grants for upgrading homes be extended to more hazards. Currently, mitigation grants for hurricane improvements in coastal areas provide a grant-match for homes; this has been widely taken up across the tri-county area. The CoG is trying to create a 'rainy-day' fund to purchase materials for volunteers who want to help with recovery. This initiative would be supported by a provision in South Carolina that a licensed contractor can obtain the needed building permits and oversee volunteers doing the work.

Those in 'repetitive loss' houses are hoping for buy-outs. Those who have now been flooded four times thought the city could engineer them out of their risk. They are now coming to the realization that this is not possible. The city can apply for grants through the Hazard Mitigation Grant Program for buy-outs, but it is unlikely that enough funding will be available to buy out all homeowners who would like to sell.

At the city level, the floods have increased public support for resilience and actions to reduce risk, addressing both rainfall and tide-related flooding. There are discussions underway on strengthening critical infrastructure, based on a growing awareness of the risks of relying on a single drinking water plant and a single sewage treatment plant. Discussions also are continuing on other issues: ways to modify roads so they can stay open during a 100-year event; how to keep public transportation running during floods; and how to improve information on road closures.

"Several days after the rainfall event, Charleston suffered a second bout of flooding caused by the upstream rainfall in Columbia days earlier."

Given the rise in sea level, the federal government has made suggestions that Charleston should retreat from the coast. But local communities don't consider retreat an option. Charleston's sea-level rise strategy was made public soon after the floods. It outlines initiatives the city will take over the next three years to address tidal flooding. This strategy and county and CoG hazard mitigation plans are expected to make use of FEMA funding to support mitigation efforts. In the tri-county area, other cities and towns are following suit and developing their own sea-level rise strategies.

The city is introducing policy changes to enhance storm water drainage and ensure developers take the hydrology of the entire watershed into account when constructing new drainage systems. New development is now required to have capacity to store runoff from a 100-year event for 24 hours. However, post-flood findings indicate that these recent changes may not be enough. In West Ashley, for example, it was found that the basin requires 96 hours to recover from a 100-year event, not 24 hours.

"Businesses worked to reopen soon after the floods, allowing people to get back to work relatively quickly, which helped limit the economic impact."



Section 7

Resilience in Charleston

The findings here follow the '5C' analysis for measuring resilience. This approach is used to evaluate existing 'capitals' (resources) and how people access, use, and manage them, so as to determine where resilience can be built.¹⁶

Physical capital

Drinking water and wastewater treatment systems have little redundancy and flexibility. The cities within the tri-county area share utilities; there is only one drinking water plant and one sewage treatment plant. Failure of either during a disaster could require evacuation of the metro area for a period of days to weeks.

Development strategies are very forward-looking. Charleston is changing building requirements to better manage storm water, creating regulations for integrated basin management, and working to encourage green infrastructure. However, most of these changes apply only to new developments. There is also concern that these strategies may not be enough; for example, requiring drainage in new developments to hold 100-year floods for 24 hours is insufficient, as some basins take up to 96 hours for recovery.

Financial capital

FEMA's deferred maintenance policy is inhibiting resilience. Denying assistance to homeowners with deferred maintenance makes it hard for people with low incomes to get badly-needed funds to recover after floods and improve their homes. Without adequate funding, households are likely to build back worse.

Updating floodplain maps may have major socio-economic consequences. If lower income people are required to get flood insurance, they may be priced out of their homes. It is unclear where they would go. Such displacement can increase vulnerability, and is likely to change known patterns of vulnerability in the tri-county area.

Human capital

Risk awareness is currently high in Charleston, but this may change as new people move into the area. Many of the new arrivals will come from different risk contexts. In addition, long-term residents are being, and will continue to be, pushed to relocate due to rising costs and gentrification. Maintaining risk awareness among newcomers is challenging. Communicating with vulnerable groups will require new strategies and involve targeted approaches.

There is poor understanding of what the government (from federal on down to local) and private insurers will cover in recovery. After the floods, many people were surprised to learn that FEMA and insurance (federal and private) don't cover all recovery costs and needs. Despite efforts by LTRGs and other organizations to help households address unmet needs, many households are left with costs or gaps they must fill themselves.

¹⁶To learn more about our flood resilience framework, see www.zurich.com/en/corporate-responsibility/flood-resilience/measuring-flood-resilience

Weather forecasts have limitations, particularly in terms of predicting impacts. Most residents received warnings and acted on them, reducing the scale of the disaster. But predicting the impacts is hard, especially given changes to land use and in the risk landscape.

Existing emergency response protocols do not always support appropriate action. The tri-county area is able to handle small-scale, localized flooding, and is prepared to handle larger-scale disasters such as hurricanes where the main response is early evacuation. Events like the October 2015 floods, which required localized evacuations, present a challenge; currently, only the governor can mandate evacuations. Local emergency personnel need the authority to mandate targeted evacuations if needed.

Incentives-based programs can help change behaviors. Programs such as the Upper Peninsula Initiative (UPI) and the Community Rating System (CRS) let people choose how they want to adapt and reduce disaster risk, and reward them for taking such decisions. But the current CRS structure may provide more incentives to communities to undertake a number of different activities to reduce insurance cost, rather than encouraging them to take measures that could reduce risk across the board.

Social capital

Cross-jurisdictional networks are important for managing disaster risk and building resilience. City and county communications during the emergency response phase worked very well. Gaps in the process have been identified and officials are working to build the necessary relationships to ensure that similar gaps do not occur in the future. Without existing networks and entities to encourage communications across various groups, 20 different governments in the area would have been issuing their own information.

The transfer housing system was a success. It gave citizens a place to recover from the initial trauma and resources to make use of their own networks and resources to organize their own long-term shelter. It also allowed emergency services to prioritize those who needed the most support.

There is a lot of energy within cities in the tri-county area to build resilience. Cities have brought together multiple participants and organizations and are beginning the process of integrating resilience and disaster risk reduction initiatives across sectors and scales.

Natural capital

Development is taking precedence over preserving open spaces and wetlands. Economic growth is a priority for most places; accordingly, resilience initiatives will only be adopted if they enhance or do not curb economic growth. Filling in wetlands, tidal creeks, and riverine creeks is exacerbating drainage issues and flood risk.





“Gaps in the communications process have been identified and officials are working to build the necessary relationships to ensure that similar gaps do not occur in the future.”

Section 8

Recommendations

Risk reduction

Maintain risk awareness. Lack of risk awareness was a major problem in Columbia. As more people move to Charleston and other cities in the tri-county area, educating people about risks is likely to become a bigger challenge. We need to foster a cultural shift so that people seek out information about the risks related to them, and where government agencies make that information readily available.

Plan for changes in the risk landscape.

Infrastructure and planned development will alter the risk landscape. Future floods will bring new surprises as water flows into different places, affecting different communities and infrastructure. Planning for this uncertainty should include:

- Placing major assets (critical infrastructure, houses) outside of known floodways and flood-prone areas.
- Keeping floodways natural.
- Incorporating safe-failure elements in design to avoid impacts that can spread and prove catastrophic. For example, dams should be regularly assessed for flood risk to downstream and surrounding communities.

- Building redundancy into infrastructure so key services are not compromised by the failure of individual elements. For example, having more than one way to access clean water.
- Using a multi-hazard approach where possible to ensure that increased resilience to one hazard doesn't undermine resilience to another hazard.

Increase insurance penetration and accessibility. Local governments should work with both federal and private insurance providers to increase flood insurance penetration in their jurisdictions. Flood risk information needs to reach everyone, and not only those that live in the 100-year floodplain and have federally-backed mortgages. But increasing insurance coverage alone is not enough. FEMA processes and rules, and the constraints on NFIP payouts make it unappealing to many homeowners. These processes and rules need to be made more flexible to increase insurance penetration.

Favor incentives to reduce risk over regulations. Incentives can be as effective at changing behaviors as regulation, and can be extended to several aspects of reducing disaster risk. For example, in the tri-county area, maintaining open spaces can be encouraged through height and density bonuses. Rewarding efforts to increase

resilience through insurance and tax credits can increase the likelihood that households and communities will take action to reduce disaster risk. But incentives programs should be assessed regularly to ensure they truly reduce risk. The CRS especially might do well to shift its priorities. Its efforts to achieve resilience would be better served by providing cities and counties with significant benefits if they spend on strategic buy-outs and retire flood-prone properties.

Make buyouts strategic. The funds available for buy-outs are small relative to the number of owners who hope to be bought out. Buy-outs must be conducted to maximize the effect they have on reducing flood risk. If buy-outs are linked to existing parks and greenways, ongoing maintenance will be less complicated and obtaining local matching funds may be easier.

Use green infrastructure to reduce flood risk. Parks and greenways can add value to land. They offer aesthetic and recreational benefits and act as flood buffers for households and communities. There are also opportunities to introduce solutions that reduce flood risk while supporting development. Porous pavements and 'green' roofs, for example, can help reduce nuisance flooding around developments and improve water quality.

"We need to foster a cultural shift so that people seek out information about the risks related to them, and where government agencies make that information readily available."

Response

Make early warnings more relevant and easier to act on. Warnings must be accurate, focused, relevant, and tailored to the local context. Information should be the kind that people can act on, or at least it should convey that conditions are dangerous and require sound judgment. It's impossible to predict extreme events with absolute accuracy. The public needs to know how to react to the information provided, but people must also understand that there will always be uncertainties and be prepared to respond to the unknown.

Generate localized situation and verifiable information. Information of local conditions (e.g. geo-located weather conditions, road closures, and water depths) can be crowd-sourced and help with responding to rapidly changing conditions. Ideally this system would be built on apps and websites people already use in daily life and not just during disasters.

Develop disaster response in ways that allow people to make use of their resources and networks. All too often after disasters, those affected are seen as victims in need of help. This means they may lose the opportunity to take the initiative to help themselves, and places an unnecessary burden on responders to 'rescue' people who may not need it. Instead of seeing merely victims, we can see people as able to use resources and capacities, and try to help them to make best use of those assets. North Charleston with its 'transfer housing' did exactly that, proving it can be done successfully.



"The role of disaster recovery centers should be expanded to provide household-level information that people need to support their own recovery."

Recovery

Plan for recovery. Imagining what long-term recovery should look like and coordinating it poses a major challenge, not only in South Carolina, but globally. Governments and non-profit organizations involved in recovery need to plan well in advance of disasters. This could include maintaining and strengthening relationships formed in previous disasters, keeping track of what was learned from prior events, and sharing these lessons with others that face similar risks.

Provide better recovery information. Prior to disasters, residents need to understand what the Federal Emergency Management Agency (FEMA), The Small Business Administration (SBA) and private insurers will cover through the recovery phase. They need greater support to understand their options. The role of disaster recovery centers should be expanded to provide household-level information that people need to support their own recovery. This could be modeled on existing programs elsewhere, such as the UK's National Flood Forum,¹⁷ which advises people how to best get help and provides unbiased information and quotes on repairs/reinstatement after flood losses.

Create a more integrated, context-based damage assessment system.

People affected by floods in Columbia and Charleston were frustrated by FEMA's damage assessment process. They felt it did not fairly or accurately assess damages. The damage assessment process needs to be revised; inspectors should be hired locally, have damage assessment or home construction/maintenance experience, and should conduct more comprehensive assessments that look at the home as a whole and not just as a sum of separate parts. This would reduce the number of cases in which loss of moveable and non-critical possessions pushes homes into the 'substantially damaged' category.

Use volunteers for recovery.

Volunteers want to help in any way they can after disasters, particularly those events that get high media play. Volunteer labor can help to reduce the cost of reconstruction and repairs. Volunteer hours are often used by cities and counties to create a soft match for FEMA funding, but this requires knowledge of FEMA's documentation and what activities and hours FEMA will accept, and having a system in place that can operate across multiple organizations. This system needs to be put in place in advance of, or immediately following a disaster in order to claim on thousands of donated volunteer hours.



"Volunteers want to help in any way they can after disasters, particularly those events that get high media play. Volunteer labor can help to reduce the cost of reconstruction and repairs."

¹⁷The UK's National Flood Forum (www.nationalfloodforum.org.uk/) is a national charity dedicated to supporting and representing communities and individuals at risk of flooding.

Conclusions

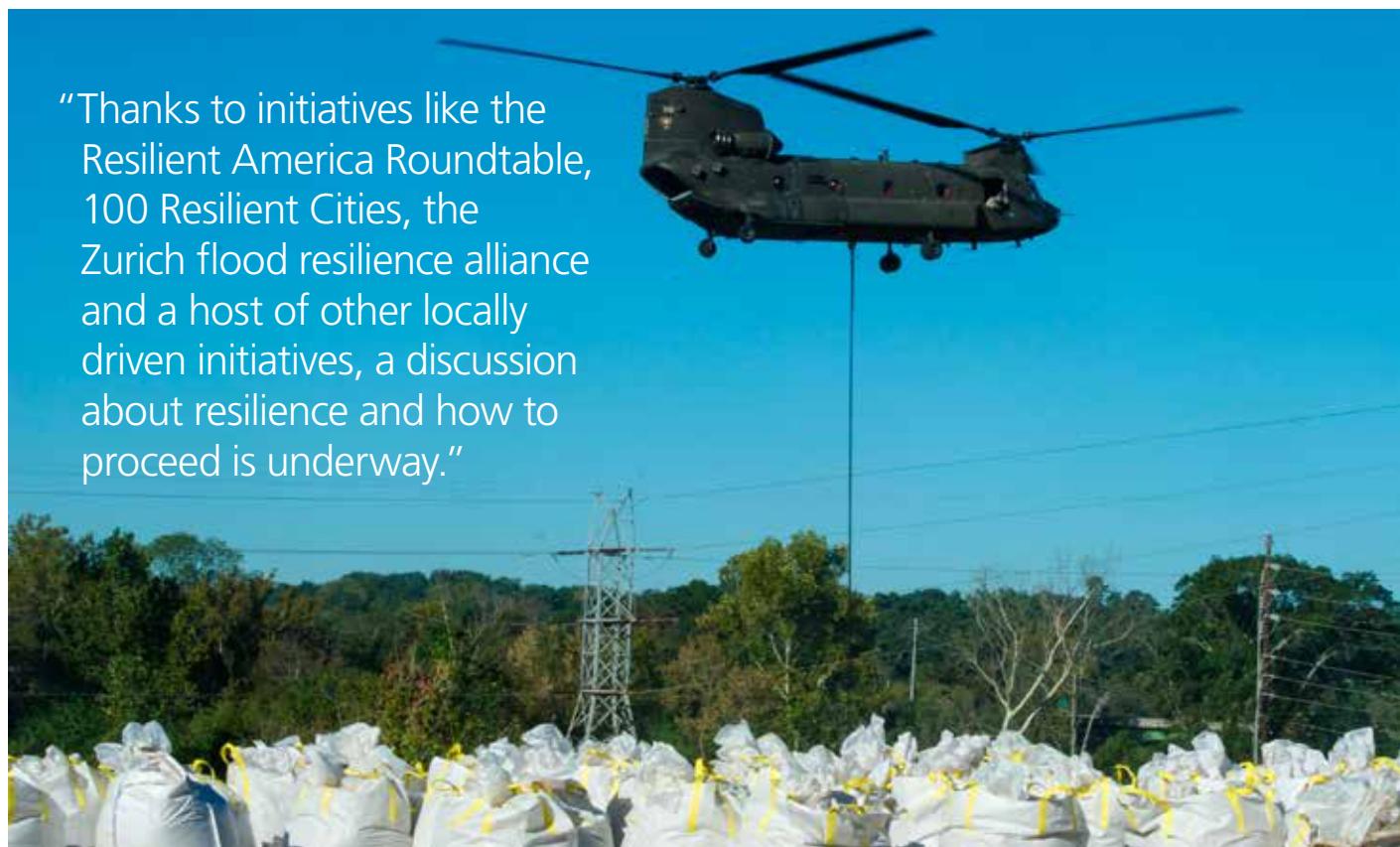
The floods in Columbia and Charleston were extreme, but trends in temperature, precipitation, and sea level suggest such events will continue and may even intensify and increase. Just months after the South Carolina floods, Houston, Texas faced its second '100-year-plus flood' in 12 months. News articles about the floods bear headlines such as: 'Stop building neighborhoods that cause other neighborhoods to flood',¹⁸ 'Extremely High Risk Dams a Concern Amid Historic Houston Floods',¹⁹ and 'Houston flood damage: chronic, expensive, and avoidable'.²⁰ All of these articles recount very similar narratives to those in South Carolina. These events should be a call to action, pushing cities to rethink risks and how

they continue to modify their risk landscape, regardless of whether or not they have faced floods in recent years. These events should also push the nation as a whole to rethink what it means to recover from a disaster and how to leverage the recovery phase as an opportunity to build resilience.

Thanks to initiatives like the Resilient America Roundtable, 100 Resilient Cities, the Zurich Flood Resilience Alliance and a host of other locally driven initiatives, a discussion about resilience and how to proceed is underway. The contention is around what it actually means to build resilience. Is it mitigation? Is it adaptation? In many places, mitigation is a more comfortable approach; in particular, there is an expectation that protection structures

will effectively and indefinitely protect people from extreme events. However, as cities, counties and states move forward with structural mitigation, they need to understand that structures can fail – globally, we regularly see extreme events overwhelm design standards.

Therefore, risk perceptions, local knowledge and capacities on how to handle disasters should be maintained, local governments should incentivize best building practices and 'soft' mitigation actions such as leaving room for water, and recovery mechanisms should be strengthened. In the face of uncertainty, building resilience requires a combination of mitigation, adaptation, and building on lessons learned from past events.



"Thanks to initiatives like the Resilient America Roundtable, 100 Resilient Cities, the Zurich flood resilience alliance and a host of other locally driven initiatives, a discussion about resilience and how to proceed is underway."

¹⁸Jay Blazek Crossley, 'Stop building neighborhoods that make other neighborhoods flood.' Houston Chronicle, April 27, 2016: www.houstonchronicle.com/local/gray-matters/article/Stop-building-neighborhoods-that-cause-other-7377091.php

¹⁹Steve Borrello, 'Extremely High Risk' Dams a Concern Amid Historic Houston Floods,' ABC News, April 20, 2016: www.abcnews.go.com/US/extremely-high-risk-dams-concern-amid-historic-houston/story?id=38553007

²⁰Robert Ferris, 'Houston flood damage: chronic, expensive, and avoidable.' CNBC, April 20, 2016: www.cnbc.com/2016/04/20/houston-flood-damage-chronic-expensive-and-avoidable.html

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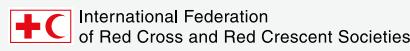
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About the Zurich flood resilience alliance

An increase in severe flooding around the world has focused greater attention on finding practical ways to address flood risk management. In response, Zurich Insurance Group launched a global flood resilience programme in 2013. The programme aims to advance knowledge, develop robust expertise and design strategies that can be implemented to help communities in developed and developing countries strengthen their resilience to flood risk.

To achieve these objectives, Zurich has entered into a multi-year alliance with the International Federation of Red Cross and Red Crescent Societies, the International Institute for Applied Systems Analysis (IIASA), the Wharton Business School's Risk Management and Decision Processes Center (Wharton) and the international development non-governmental organization Practical Action. The alliance builds on the complementary strengths of these institutions. It brings an interdisciplinary approach to flood research, community-based programmes and risk expertise with the aim of creating a comprehensive framework that will help to promote community flood resilience. It seeks to improve the public dialogue around flood resilience, while measuring the success of our efforts and demonstrating the benefits of pre-event risk reduction, as opposed to post-event disaster relief.



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