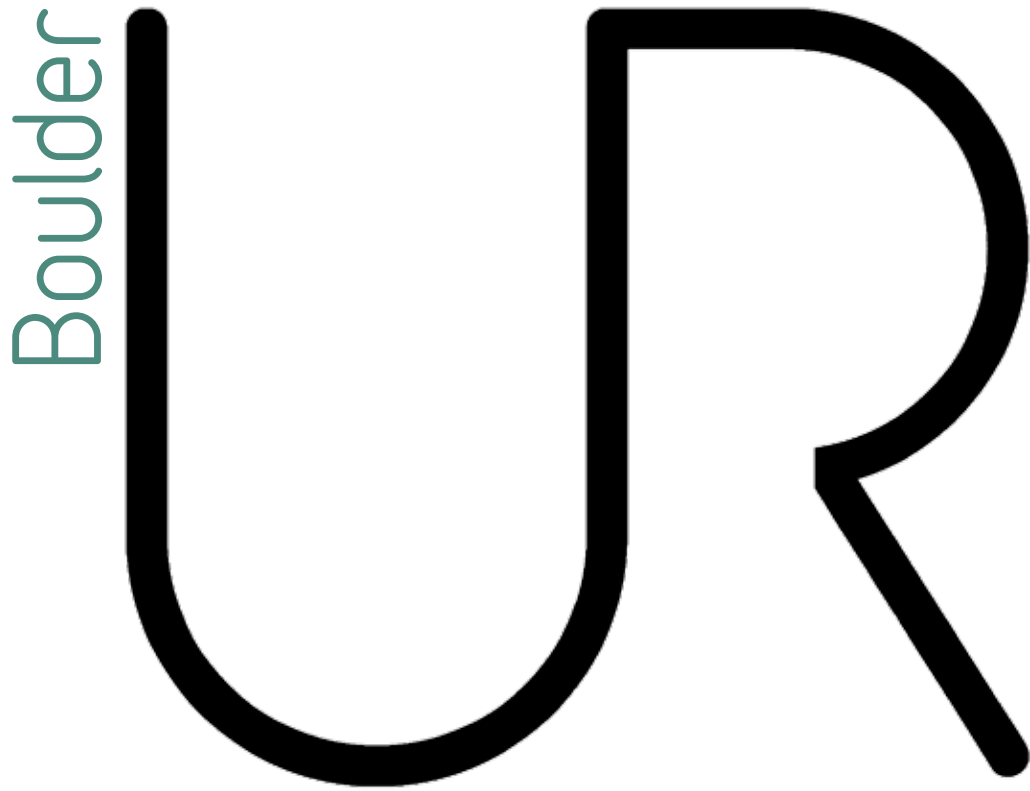




Understanding Risk

Building Boulder's Resilience

Proceedings from UR Boulder

This publication is made up of a series of submissions from Session Leaders of the Understanding Risk and Finance. These submission were compiled by the Global Facility for Disaster Reduction and Recovery (GFDRR). The content and findings of this publication do not reflect the view of GFDRR and the World Bank Group.

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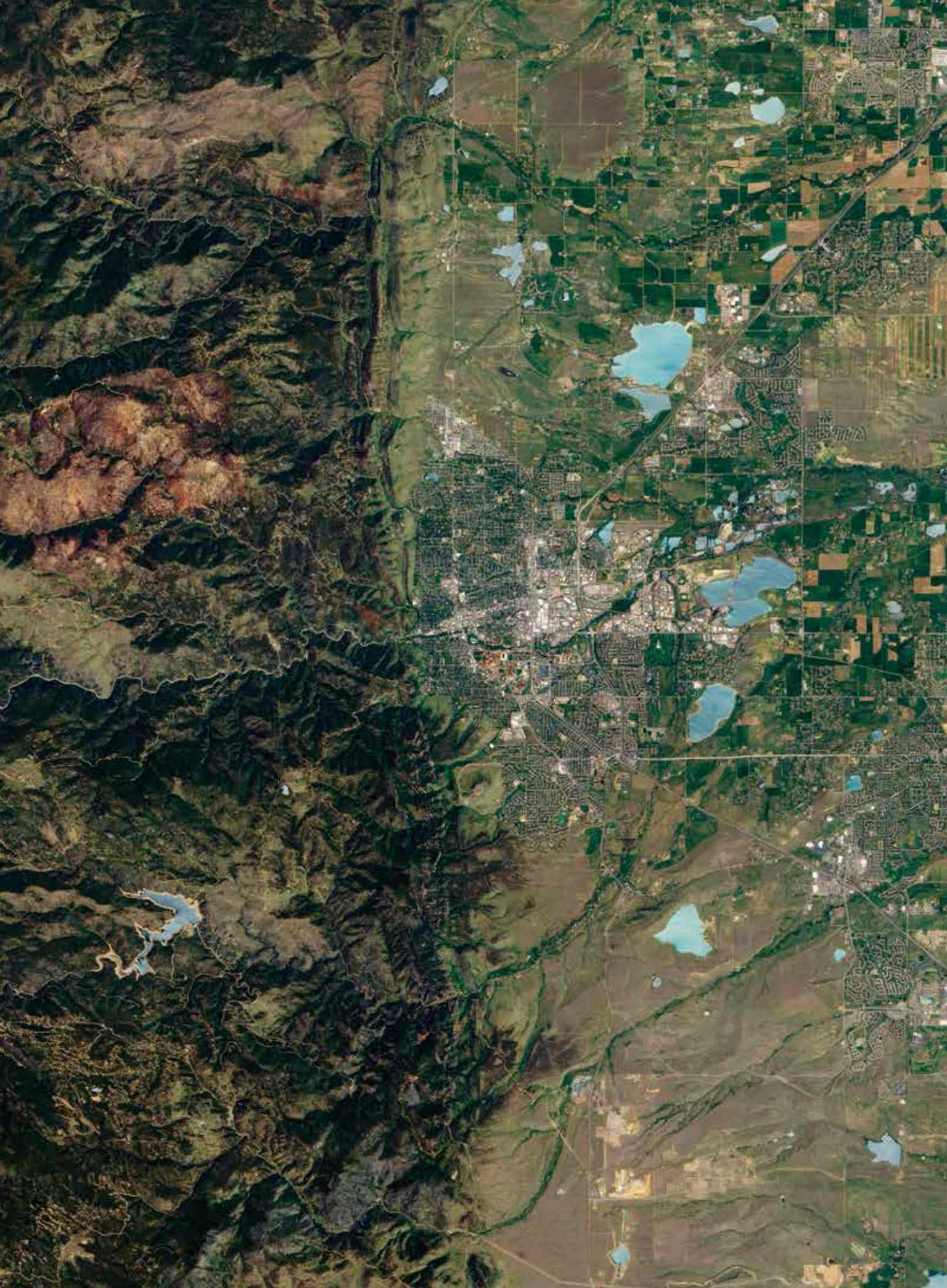
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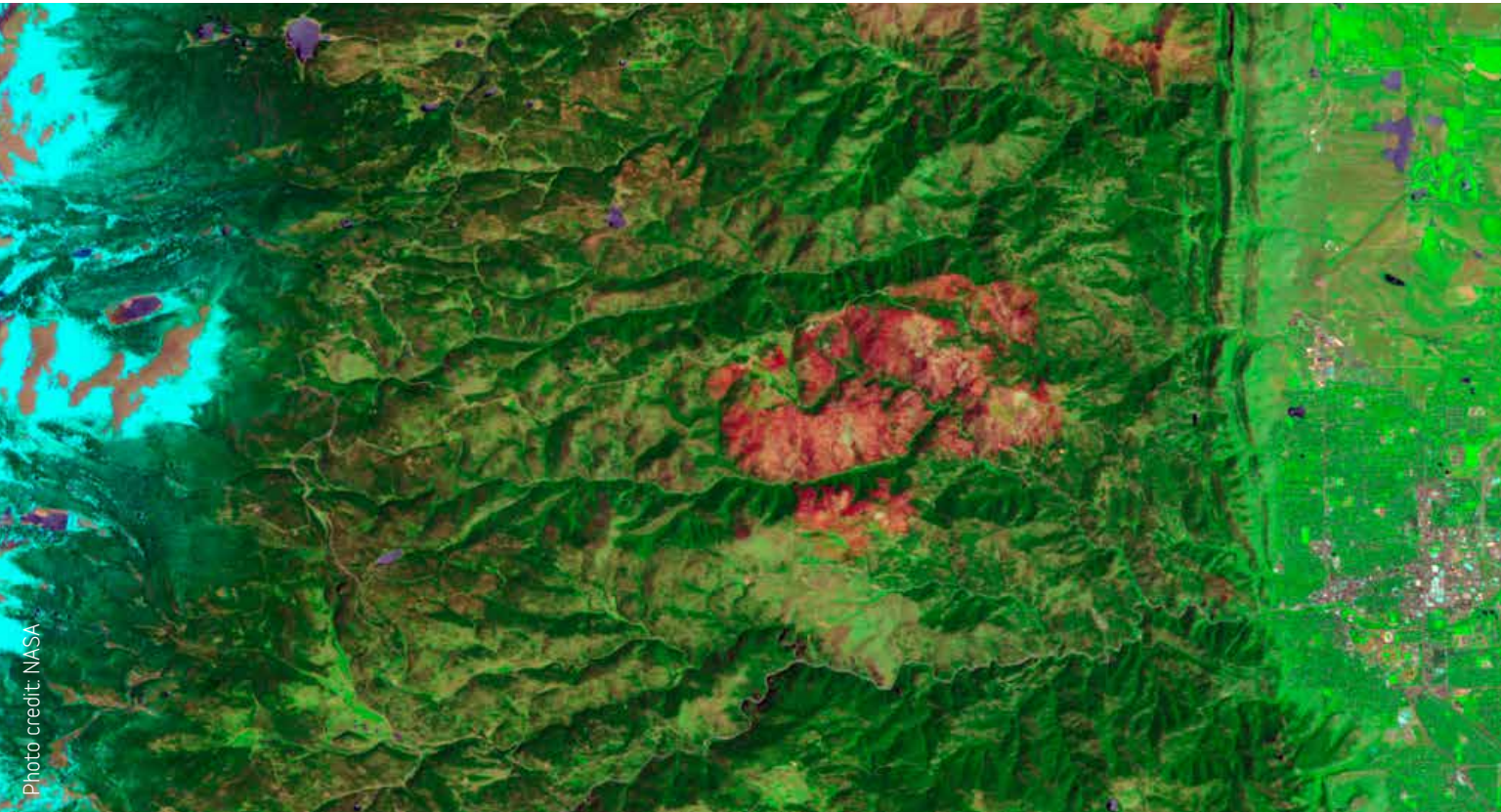
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Satellite image of Boulder, Colorado reflecting the burn scar from the Fourmile Canyon Fire. Photo credit: NASA





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Acknowledgments



ABOUT

UR Boulder was a 2 day event in October 2015 that convened over 120 experts, practitioners, and community members to discuss challenges we face in building resilience to climate change and natural hazards in the region. Events included 12 thematic sessions on topics ranging from food security to citizen science, keynote presentations and Ignite Talks from some of Colorado's leading thinkers on these issues, and a TechChallenge that awarded over \$20,000 to local tech innovators working on resilience.

Thanks to all of the incredible individuals and organizations who made UR Boulder a success.

First off, we would like to thank the UR Boulder partners: the City of Boulder, the University of Colorado Boulder, the World Bank's Global Facility for Disaster Reduction and Recovery, Ushahidi, BoCo Strong, and Lynker Technologies.

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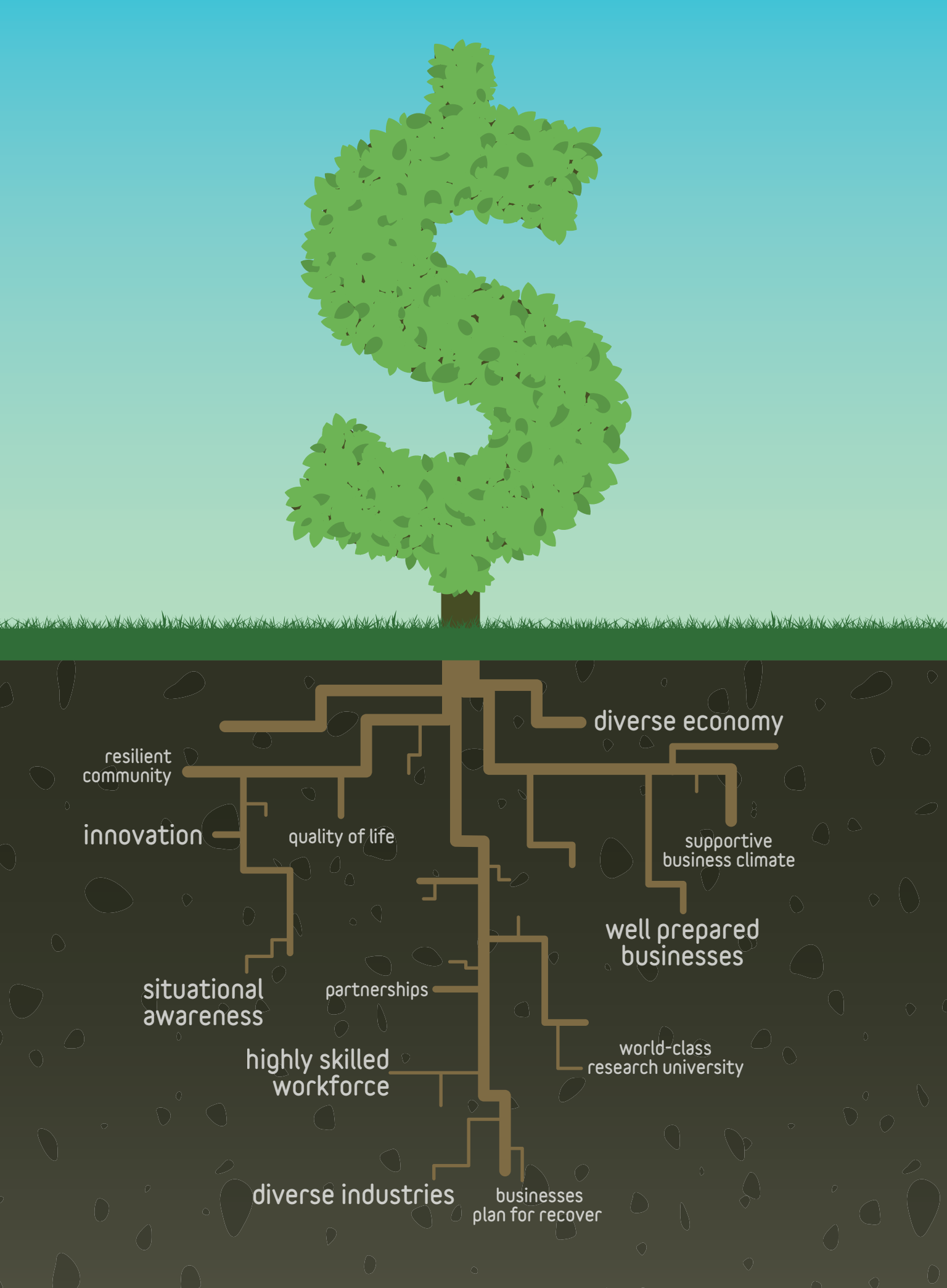
Special thanks to other contributors and supporters including: Katie Boseo, Lawrence Bujja, Maria Fernanda Enriquez, Katya Hafich, Karen MacClune, Stephanie Morris, Leysia Palen, Lisa Packard, Alanna Simpson, Yeng Vue, Mountain Grass, and Sanitas Brewing Company.

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Thanks!

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Graeme Aggett | Simone Balog | Tiernan Doyle | Greg Guibert
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Boulder's Economic Resilience

Jennifer Pinsonneault, City of Boulder

It is well known that communities with strong, diverse economies and well prepared businesses preceding a natural disaster are better equipped to recover more quickly. While the city of Boulder has a diverse economy and is committed to building resilience, more needs to be done to help area businesses plan for and recover from disasters.

Background

As Boulder has a healthy economy anchored by a world-class research university, federal laboratories and broad mix of businesses in diverse industries. Known as a center for innovation and startup activity, the city has a supportive business climate and offers a quality of life that attracts a well-educated, highly skilled workforce.

Though the area's strong and diverse economy helps buffer the effects of shocks and long-term stresses, major flooding in September 2013 affected businesses throughout the Boulder area, damaging buildings, equipment and inventory. In the city of Boulder, more than 100 businesses had significant physical damage ranging from severely flooded basements to building collapse. Road closures, power outages, residential flooding and other impacts affected many

more businesses, contributing to disruption of economic activity and lost revenue. More than two years later, some businesses have not fully recovered from the impact of the flooding.

Responding to the flooding provided lessons about economic resilience and what is needed to help businesses help plan for and recover from a natural disaster.

Responding to an Unprecedented Event

The size and scope of the September 2013 flooding was unprecedented. Boulder received more than 16 inches of rain over an 8-day period, including an all-time single-day record of 9 inches, causing 25- to 100-year flooding along all of Boulder's drainage ways. The flooding caused loss of life and widespread damage; Boulder County (including the City of Boulder) was designated a Federal Disaster Area.

A number of public agencies and private organizations responded to the flooding and provided assistance to affected businesses. The Boulder Office of Emergency Management, in partnership with the City of Boulder and Boulder County, activated its Emergency Operations Center (EOC) to support the initial response

to the disaster by developing situational awareness, coordinating communication and identifying resources.

The City of Boulder, Boulder Chamber/Boulder Economic Council, the Boulder Small Business Development Center (SBDC) and other business support organizations responded to inquiries and reached out to the business community to identify needs and provide information about available resources. Local officials worked with state and federal agencies to establish a Disaster Recovery Center and provide information about grants and funding available for businesses.

The Boulder SBDC provided direct assistance to businesses including extensive help with applications for grants and loans through the federal Community Development Block Grant Disaster Recovery (CDBG-DR) program.

These efforts were well coordinated, reflecting strong public/private partnerships in place before the flood. Collaborative relationships between the city, county, university, business support and other non-profit organizations helped stretch resources and reduce unnecessary duplication of effort.

Understanding and Responding to Business Needs

In evaluating the response to and recovery from the 2013 Flood, a number of areas for improvement were identified for helping businesses plan for and deal with natural disasters and other disruptions.

accurate. Ongoing communication with businesses can make it easier to determine what programs and resources are most effective and where improvements are needed.

More than half of Boulder's workforce lives outside the city and transportation, communication and broadband systems are key considerations in a disaster. Many businesses were impacted when

more specialized needs like lab or office space. Although many of the businesses impacted by the flood were able to eventually find resources, many of those who applied for financial assistance reported the process was confusing, frustrating and took longer than expected. Some businesses, especially those that were small and somewhat fragile before the flood, did not qualify

More than half of Boulder's workforce lives outside the city and transportation, communication and broadband systems are key considerations in a disaster.

Communication and outreach

— After the flood, the city's economic development staff and local business support organizations reached out to businesses, especially those located in areas known to be flooded, to help assess damage and provide information on available assistance. Easy access to comprehensive lists with emergency contact information would enable organizations to increase the number of individual businesses directly contacted after the flood.

Although some businesses called the city or local business organizations for information and assistance, many did not know what resources were available or where to find help. In some cases, businesses shared incorrect information with other businesses. Capturing information from businesses looking for assistance would have made assessing economic damage more timely and

employees couldn't get to work due to road damage and closures after the flood. Having systems in place to support remote access allowed some employees to work from home, benefitting both employees and businesses.

Disaster assistance for businesses

— Many of the resources available after the flood focused on residents rather than businesses. Information and applications for loans and grants for businesses affected by the flood were not immediately available. Program eligibility and requirements presented challenges for both businesses and the organizations providing assistance with the application process.

The flood impacted different industries and businesses in different ways. Some needed financial assistance to cover building or equipment damage or lost revenue. Others had

for disaster recovery funding and went out of business after the disaster.

The experience of assisting businesses after the flood has made local government and business organizations more aware of business needs and the federal disaster assistance application process. Having this information will help identify opportunities for expanding available resources, managing expectations and making the process easier for businesses in the event of future disasters.

While every disaster or major disruption is different, many aspects of the response and recovery process are similar. Having a plan for opening a Business Recovery Center and creating a business information hotline and website that can be adapted to reflect situation-specific details would enable the city and its partners to provide more timely information and assistance to businesses.

Risk assessment and disaster planning

— Many businesses did not have a formal continuity of operations plan in place before the flood. This is common, especially for small businesses without staff available to develop plans. While the time to develop an emergency plan is before it is needed, it is difficult to motivate people to do so when they do not perceive a need or threat.

Disaster response plans should include contingencies for damage to infrastructure, i.e., a “1984 Plan” that identifies options when current levels of technology in networks and infrastructure are not available. Disaster planning should also include a training and practice component. This will help to ensure that everyone in an organization is familiar with the plan, knows what to do in an emergency situation and has the opportunity to identify areas that need to be updated or improved.

Encouraging businesses to take time to better understand risk and develop emergency preparedness and continuity of operations plans may help increase the community's economic resilience. Boulder County has a diverse economy and businesses will be affected differently in a disaster. In addition to promoting disaster planning, it will be important to provide information and a variety of tools that will make the process easier and more convenient for smaller businesses with limited resources.

Need for increased coordination

— Boulder is a highly partnered community and the city, county, university and business organizations routinely collaborate on projects. Although these entities reached out to partners to coordinate efforts during and after the flood, there were gaps in the information and assistance provided to businesses. Working together to improve coordination and develop a more formal program for sharing information about available resources such as temporary lab and office space for displaced businesses may enable partner organizations to improve their effectiveness and avoid unnecessary duplication of programs and services.

Conclusion

By leveraging the experience and lessons learned from the flood to better understand where the local business community is vulnerable and how to improve disaster planning and response, the city and its partners are working to develop new tools and processes to improve communication and coordination between public and private partners. network underlying a climate service; each entity provides an important contribution. No one single organization can deliver all of the elements needed to support a climate service's successful results. As the field of climate information services grows, there is much that we can learn from each other in order to create and promote

sustainable information systems rooted in evidence-based best practices. By collaborating with the network of climate service stakeholders, we can cocreate solutions that build climate resilience.

Session Contributors

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Re-view Flood Risk in Boulder

Leah Sprain, University of Colorado

Introduction

The Re-view Flood Risk in Boulder session focused on how individual homeowners understand flood risk, including how they interpret and use information from flood maps and engineering models to inform decision-making. We explored these themes through a novel approach: we played a game.

In this game, small groups work together to make a series of choices related to flood risk. Led by a facilitator, they begin by buying a home, which requires considering location (e.g., inside the 100 year floodplain or outside the 500 year floodplain) and building design (e.g., basements vs. crawlspaces). Then the group must decide whether to purchase insurance, do mitigation, or take no additional action. The group rolls a die that

to decide whether to buy a new house, purchase insurance, or use mitigation strategies.

This game is part of ongoing research at University of Colorado Boulder on critical infrastructure and community resilience funded by the National Science Foundation. The flood data and repair outcomes are based on the engineering models developed by our team. Playing the game at Understanding Risk Boulder simultaneously: (1) helped the research team understand the decision space for homeowners managing flood risk, which can inform designing engineering models that better fit user needs; (2) educated players about flood risk by having them work with scenarios based on actual data; and (3) explored interdependencies

of models for residential buildings have been developed thus far. The first utilizes empirical data from the 2013 Boulder floods based on FEMA inspections of 6,000 damaged residential properties. The FEMA dataset was supported by Boulder County assessor's data, which contain property values, foundation types, and floor areas. These data were supplemented by responses to a survey conducted by the City of Boulder immediately after the flood. Further, in areas where data from different sources did not agree, social media (e.g., tweets and their photo attachments) collected during the flood were used to evaluate the extent of damage at a particular location and converge the datasets. After converging the datasets, statistical methods were used to predict the costs of flood damage

The Re-view Flood Risk in Boulder session focused on how individual homeowners understand flood risk, including how they interpret and use information from flood maps and engineering models to inform decision-making.

represents flood risk, determining whether a flood occurs and, if so, the damage. The groups have to then pay for repairs, which depend on the flood levels and their prior choices. As the game continues, groups work with flood maps, information handouts based on engineering models, and experts

between the built, social, and information infrastructures from the perspective of citizens.

Boulder Flood Damage Models

Our game foregrounds engineering models for flood damage to residential buildings. Two types

as a function of flood intensity parameters (water depth, source type - e.g. sewage vs. rainwater, etc.), and building or foundation characteristics (presence of basement or other types of foundation, building area, etc.). The result is a family of models for homes with finished and unfinished basements, crawlspaces, and

split level foundation conditions that can be used to predict flood damage if urban flood extents are known. This model was used to produce two information handouts used during the game that are also included here as figures: Expected FEMA Reimbursement for Buildings with Basements and Expected FEMA Reimbursement for Buildings with Crawlspaces.

The team also developed a novel assembly-based model. The assembly-based model uses site-specific information about the residential housing stock, including typical component quantities, material quality, geographical location, and other structural characteristics within a building. Local rates for construction materials, equipment, and labor are used to estimate the total replacement costs for these building items. This model was used to produce two informational handouts used during the game and included here as figures: Homeowner Out of Pocket Costs for Buildings with Basements and Homeowner Out of Pocket Costs for Buildings with Crawlspaces.

Although the models are based on the Boulder data, they are applicable to other U.S. places with similar building typologies. In addition, the agreement of the novel assembly-based model with the empirical data suggests that similar approaches could be utilized to develop flood models in other regions where the building typology is different.

Fostering Community Resilience through Participatory Games

Rather than simply present these models in conventional presentations, we elected to play a game because we believe that participatory processes can uniquely contribute to community resilience. Participatory processes like games provide sites for self-determination about the future. In our case, the game helped participants think about flood risk in Boulder and how they might approach future decisions for their own homes. Rather than presenting technical information like engineering models and flood maps as providing clear, obvious, prescriptive information about how to act, the game helped create the conditions for participants to consider this information—to think slowly about what figures and flood maps might both reveal and conceal—then then play out different scenarios. Working in groups, players tend to encounter different perspectives and diversity of thought. This pushes players to both articulate their reasoning but also fosters experimentation with different approaches.

The group discussions during our game provided our research team valuable insights into how people actually use (or don't use) information. But the process also provides a space for helping build community capacity that contributes to community resilience. In small ways, players are able to be open and explore

different possibilities—including considering novel approaches and reconsidering their values. They get new information about floods—even changing how they answer objective questions about flood risk before and after the game. In turn, game play can help build the type of trust and social capital that contribute to a community's ability to adapt and transform. For these reasons we think that participatory processes like our game provide one way of fostering more resilient communities.

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Participatory processes like games provide sites for self-determination about the future. In our case, the game helped participants think about flood risk in Boulder and how they might approach future decisions for their own homes.



UR Boulder Tech Challenge

Shadrock Roberts, Director of Resilience Programs, Ushahidi

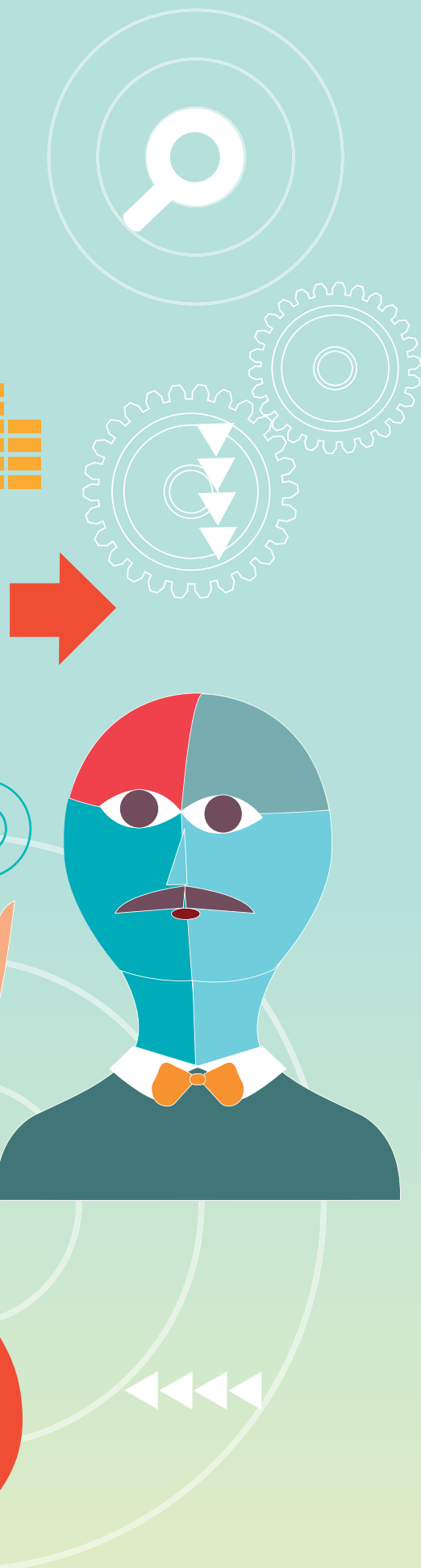
Why Open-Source and Open-Data are Vital for Understanding Risk and Improving Resilience

Understanding risk and improving resilience begin with investigation, research, and data collection that is all part of the discovery process leading to solutions. While this can be achieved with pencil and paper, new technologies are increasingly seen as part of the process. Terms such as “big data” and “social media” are often liberally employed to suggest that technical advances can illuminate this process as never before. However, behind the ever evolving technological landscape are people: individuals and communities who are at risk but who also have untapped resilience capacity.

The target population from whom we seek to gather real-time data, the analyst that struggles to extract knowledge from the data, the decision makers who choose to use or ignore what the data say, and the stakeholders with whom the data and decisions are shared – or kept hidden from – are all actors in the socio-technical systems we employ to understand and respond to issues of resilience and

risk. These systems, in which the social and the technological are closely tied together, can be used to improve resilience. In some cases, technology is a tool that allows or facilitates a response. The citizen group Boulder Flood Relief leveraged a variety of Internet communications technologies such as social media and collaborative web applications to share information and connect volunteers with homeowners in need during the 2013 Colorado floods. In other cases technology can be the response. The Global Facility for Disaster Reduction and Recovery has ensured that open and publicly accessible data for disaster reduction is available online via tools such as OpenStreetMap (<http://www.openstreetmap.org>) by building capacity and long-term ownership of open data and mapping projects that are tailored to meet specific needs and goals of stakeholders.

However, technology can also exclude those who may not have equal access to it, and technology’s potential to foster greater participation and equity among stakeholders depends on how it is employed. Many efforts to introduce technology for resilience focus on improving the technology



itself: faster data collection, better data management, improving the accuracy of algorithms to extract meaning from data, etc. However, ensuring that appropriate technology is developed requires more than just improving technological efficiencies. Unfortunately, many organizations that occupy themselves with risk and resilience – from small city governments to large international donors – still silo and lock technology in proprietary formats or within systems that are not easily accessed by those they seek to help. Coordination and collaboration remain difficult.

New modes of technology development and data sharing are needed if we are to give all voices an opportunity to be heard. The open-source software development model and open-data movement offer a new path. Open-source software is software whose source code is freely available for modification or enhancement by anyone. Similarly, open-data can be freely used, modified, and shared by anyone for any purpose. Using open technology can improve transparency by allowing everyone to access the data and methods upon which decisions are being made. This approach can also release hidden social and commercial value: technology and data are key resources for commercial activities and making them freely available can help drive the creation of innovative businesses and services that deliver social and commercial value.

For these reasons, the open-source software company Ushahidi (<https://www.ushahidi.com>), together with the Rockefeller Foundation's 100 Resilient Cities, chose to pursue open-source and open-data solutions for resilience in Boulder, Colorado. The UR Boulder Innovation Competition was an open call for ideas about how technology could help build resilience, and provided twenty thousand dollars in seed funding for the winning entry chosen by a panel of expert judges. The competition goal was to help area technologists, coders, and analysts fill technology gaps within local organizations.

Examples from the UR Boulder Innovation Competition

The UR Boulder Innovation Competition acted as a convening point both for stakeholders to showcase their innovative ideas about employing open technology and also to discuss what they saw as the most important resilience challenges in their city. The event was more than just software development: it fostered exchange about risks and resilience as a starting point.

The process for judging the winners took place in two stages, both of which allowed for public dialogue about technology and resilience. Entries were gathered through an online system and judged by a panel. The 5 finalists were published via an open, online forum (<https://www.loomio.org/g/wPg3yCBK/ur-boulder-tech->

challenge) that allowed for public voting and lively debate about how the proposed idea might, or might not, solve a given challenge. The event generated strong interest throughout Boulder's technology communities, while also drawing in others who were interested to see computer programmers and analysts explain how their innovation might succeed.

Finalists were then given an opportunity to pitch their ideas to an expert panel in front of a live audience at UR Boulder. Time was allotted for questions from the panel and from the audience. This extended engagement with a variety of different stakeholders allowed applicants to refine their ideas and discover approaches or challenges they hadn't considered. All of the applicants expressed how meaningful the opportunity was for iterating on their initial idea. Each of the ideas presented offered an opportunity to learn how local residents understand risk and want to improve resilience. They include:

- **TrendsOnline** won the competition and will create an open version of the Trends indicators report that will make visible the most pressing needs in Boulder by identifying chronic stresses and connecting organizations and people to take collective action.
- **Rocky Mountain Rescue Group (RMRG) App** proposed to reduce the time necessary for mountain rescues by replacing a legacy system of digital and voice pagers with

a streamlined app to improve coordination and deployment.

- The **Survivor-Centric Case Management System** sought to build an open-source portal to improve city and county case management by empowering participation of survivors, improving coordination among response entities, and allowing for real-time tracking of cases and automatic grant matching with survivors.
- **Resiliency Education App** suggested filling the gaps in resiliency education by serving as a platform to pair ‘mentors’ that have expertise in resilience and community members that have an interest in learning about these issues from fellow citizens/organizations.
- **Urban-Climate Adaptation** Tool proposed to collate and manage publicly accessible data to support storm-water management decisions and allow urban planners to evaluate how different deployments of green infrastructure could improve the city’s resilience.

The Challenge of Open Technology

While there are relatively few challenges in hosting an event like the UR Boulder Innovation Competition, there are challenges in getting organizations to consider open-source tools and open-data. Historically, most organizations have proprietary databases at the core of their technological infrastructure.

These, and the technology that surround them, are not built for collaboration. Because this digital infrastructure represents the institutional reality of the informational landscape, organizations are generally very nervous about opening them up. The process of change is a slow one, but it begins by showing the value of openness: not just in technological terms, but also in what it can do for truly engaging community and fostering greater participation to meet the resilience challenges of the future.

Conclusion & Recommendations

As UR Boulder has shown, technological development can be a convening point for diverse stakeholders and make strides towards greater inclusivity. The UR Boulder Innovation Competition produced a valuable community resource for relatively little investment; it also promoted a wide range of ideas about how to improve resilience which may continue to evolve by way of private sector funding, other grant programs, or as a voluntary project. Hosting a similar event is relatively easy: the single most important action is partnering with local communities. Talk with universities or community colleges; reach out to area technologists, government employees, and volunteer groups. Also reach out to private sector companies who may have an interest in supporting open technology financially. Greater inclusivity will ensure a

greater diversity of ideas and help you discover things about your community you may not have known.

Even without an innovation competition, you can begin to use technology to promote inclusiveness. Whenever possible, your organization should build or procure open source technology. Connect with technologists or community groups in your area to help test and improve your technology. Ensure your organization publishes open data—data that can be freely used, re-used and redistributed. This means that data must be:

- **Technically Open:** Many organizational datasets are published in formats that can only be read by proprietary software (and sometimes hardware, like obsolete magnetic tape backup drives). The data must be released in ways that allow any device or software can read it.
- **Legally Open:** be licensed in such a way that they may be used and shared widely.

By doing this you take the first step towards including a wider audience in understanding risk and resilience.



Thresholds and Tipping Points: Looking Beyond the Obvious

Marcus Moench, Institute for Social and Environmental Research International (ISET)

The question of thresholds and tipping points in relation to Boulder's resilience is a critical one both in terms of the risks the city faces and the opportunities it has to address them. Most discussions on tipping points focus on the potential for major system failures in relation to the history of large-scale disaster. In Boulder's case, fires and flood have played a prominent role in our history and are the focus of most attention.

Prior to the September 2013 floods, the public primarily associated flood risk with summer flash floods due to stalled thunder storms, or spring flooding due to high runoff or rain on snow events. This perception was based on the history of floods in the canyon itself and in neighboring areas, particularly the Big Thompson Canyon flood in the 1970s. Very few people would have projected that widespread flooding in the smaller streams and drainages that cross Boulder due to a late-summer, multi-day rain event would pose a major flood risk – yet this is exactly what happened in 2013.

The flood highlighted the limited capacity of government alone to provide protection. Yet it was not an isolated event. It came after several years of devastating fires that affected large areas within Boulder County and other locations across the state. These fires, and a growing awareness of the impact of other stress factors such as pest invasions (bark beetles), drought, and high levels of human settlement in forest areas, had already begun to catalyze change. The surficial impact was probably similar to that of the flood – a wider awareness of fire risk. The deeper awareness, particularly in the mountains, related to the recognition that community relationships and communication were central to resilience. Catalyzed by the fires, the mountain communities formed the Intermountain Alliance (IMA), a network of radio operators and relationships to help in fire awareness and response. Formation of the IMA reflected a fundamental recognition that the mountain communities needed to stand on their own – that they couldn't respond to large-

scale events purely as individuals, through existing volunteer organizations, or by relying on the government.

Was the creation of the Intermountain Alliance a tipping point? Its existence and the set of relationships developed in response to multiple fire events proved crucial when the floods occurred. Such relationships served, in many ways, as the backbone for emergent organization and response to the unanticipated nature of the floods. This could, as a result, be seen as a tipping point in social resilience through the development of networked relationships. The social resilience that growing sets of networked relationships provides is directly relevant to a wide range of anticipatable disaster risks. It provides a basis for self-organization and response not just to floods and fires but also conceptually to risks from economic fluctuations, the long-term stresses of an ageing population, civil unrest, and potentially many health related issues.

However, networks in and of themselves do not build resilience. James Newcomb from the Rocky Mountain Institute focused his presentation on power systems, and highlighted that in the U.S., power systems could collapse catastrophically as a consequence of direct sabotage, exposure to extreme solar events, or other factors. This could result in outages for many areas that extend into months or even years. While a few areas have pursued programs to build resilient power systems through, for example, greater reliance on distributed generation, local solar, and off-grid or micro-grid approaches, most regions have not done so.

power supply system, as a result, represents a threshold that would cause cascading failures of the higher-level systems that contribute to resilience. While neighborhood-based resilience could help hugely in the first few days following such a failure, given the of dependency in most rural and urban areas on imported food, fuel and other basic necessities, the capacity of neighborhood level actors to manage the disruption would be rapidly exceeded.

The core point being made here is that resilience at one level and in one set of systems depends heavily on resilience at other levels and in other sets of systems. When disruptive thresholds are

interactions across system types or scales. The ability of Boulder to spring back from the floods of 2013, for example, depended heavily on the relationships and experiences accumulated during the previous fires – a very different form of disaster. It also depended on the fact that, in most areas, the power system remained fully functional.

Networks are now growing in Boulder that support social learning in ways that contribute to resilience. BoCo Strong, for example, is a countywide resilience network that grew out of the 2013 floods with the goal of building a culture of resilience across the county. It has as

Resilience at one level and in one set of systems depends heavily on resilience at other levels and in other sets of systems. When disruptive thresholds are reached in critical foundation systems, these can cause tipping points in higher level systems even if these other systems are resilient to direct disruption.

Even if the probability of catastrophic grid failure is low, the consequences are likely to be extremely high. Networked, community-based resilience programs such as those emerging in the Boulder areas would have limited functionality if power supplies and associated communications and transport systems fail. Reliable power supplies are an essential foundation for communications and transport, which themselves are the foundation for emergency response, water supply, health care, markets, etc.. Failure of the

reached in critical foundation systems, these can cause tipping points in higher level systems even if these other systems are resilient to direct disruption.

A second point that is implicit in the above discussion is the importance of learning and the sets of relationships or networks that can facilitate it on a long-term basis. The first-order impacts from a disruptive event and the most obvious factors that enable response are often less relevant to resilience than elements that are less obvious and involve

members other organizations, such as the Inter-Mountain Alliance, county, city and town government representatives, city and county emergency management, and numerous non-profits. The activities of BoCo Strong focus primarily on efforts to build neighborhood resilience to events such as the floods and fires and to link the neighborhood level to higher-level organizations, such as the cities. While the content of BoCo Strong's work doesn't directly address issues in critical systems such as power supplies, it does provide

a framework for continuous learning. In many ways, the existence of learning networks such as BoCo Strong could represent a “tipping point” or threshold toward wider resilience.

Most people think of tipping points and thresholds in relation to system failure, the catastrophic forms of collapse that create disaster. There are, however, more positive thresholds and tipping points. These have to do with the gradual evolution of networks and relationships that support social learning and contribute to resilience. The extended history of fires and floods in Boulder was sufficient to catalyze first action at a local level (the creation of the IMA) and then countywide efforts through BoCo Strong. These provide a framework for action and learning that, while they don’t currently address “over the horizon” questions such as power supply or other, less immediately obvious issues, ultimately could. The creation and growth of social learning networks, as a result, represents a significant tipping point in the growth of understanding and action on resilience.

Bruce Goldstein closed the session with a presentation on how learning networks can be intentionally built to support transformative resilience. Bruce described how learning networks combine multi-stakeholder collaboration in place-based communities with community-spanning interaction and exchange across sites and scales. Learning networks are inter-organizational voluntary collaboratives that support innovation and social learning to promote systemic change. Learning networks are often attempted in situations where existing institutional arrangements cannot address looming challenges, and change is thwarted by a combination of lack of capacity and a powerful status quo.

Bruce described a range of learning networks that he is examining, all of which address social-ecological challenges, such as ecological fire restoration, city resilience, regenerative agriculture, and restoring indigenous resource management regimes (see www.brugo.org). Bruce focused on how disasters can provide a window of opportunity for network building, learning, and transformation. Some of the key tools and approaches

for designing and facilitating a network include creating a shared understanding of what motivates actors at different levels, developing new types of language that communicate that understanding, engaging staff as “netweavers” to act as translators between groups and across scales, using poly-vocal storytelling to construct shared social visions across communities, and clearly communicating the incentives for participation such that all the network players see the value their participation in the network brings for them. Using these approaches, learning networks can enhance resilience by nurturing the capacity to transform knowledge and practice, transform relationships between the people involved, and transform institutions.

Session Contributors

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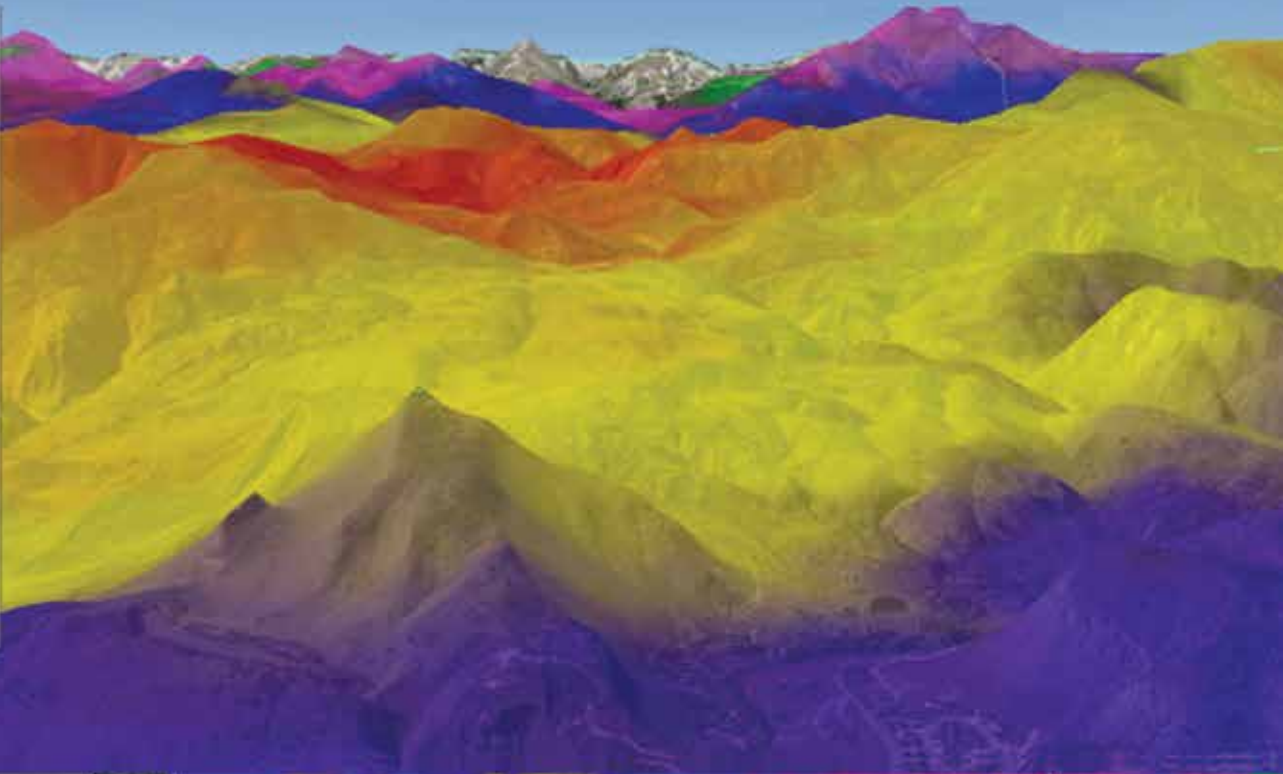
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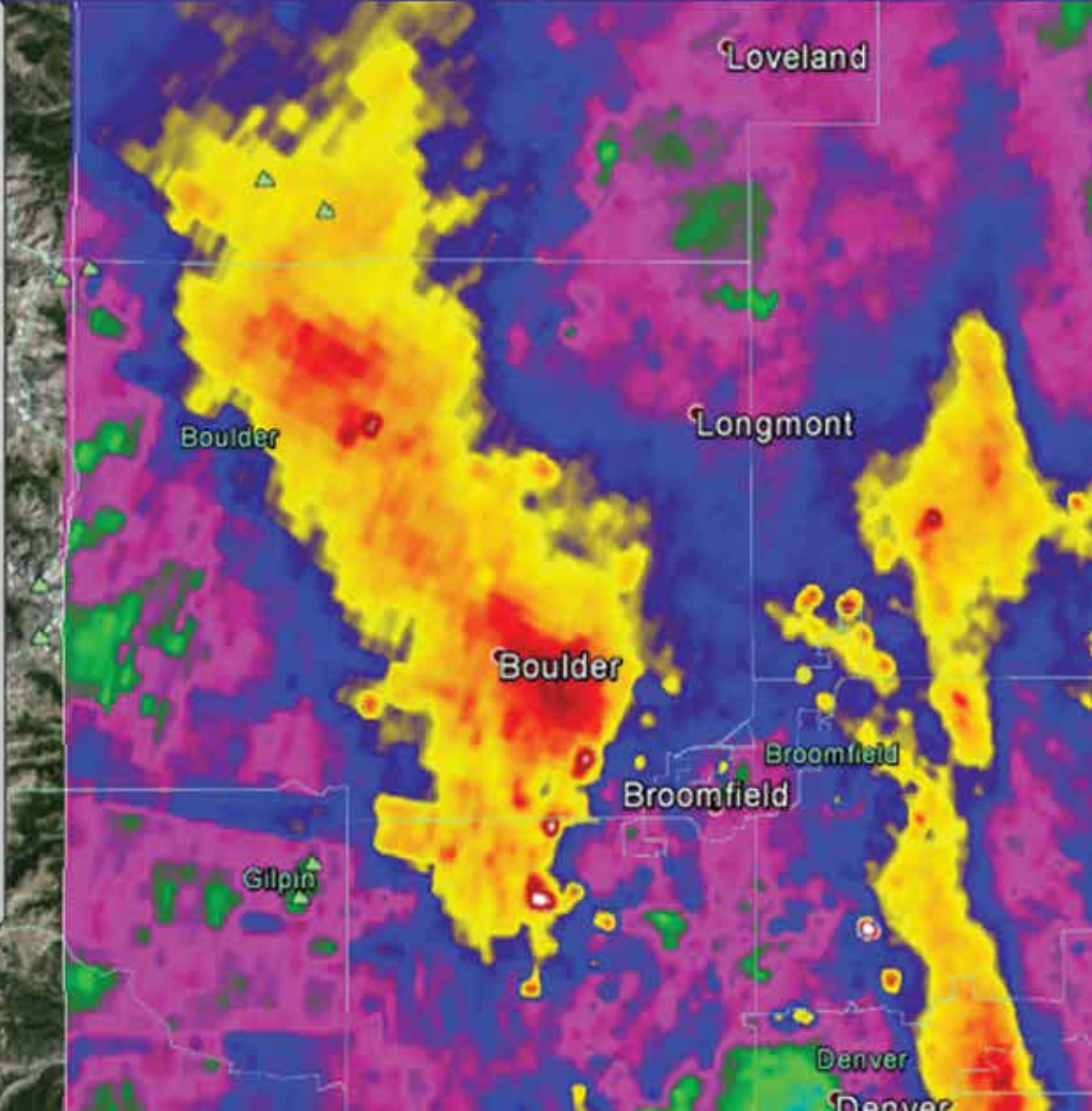
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The 2013 flood visualized using the Weather and Climate Toolkit. Above image shows one of the heaviest precipitation areas occurred up-canyon from Boulder near Lyons. Below image depicts the locations with the most extreme precipitation totals. Photo credit: NOAA Clear Creek Image Landsat

A 50% Chance of an Effective Forecast

Julie Demuth, National Center for Atmospheric Research (NCAR)

On a daily basis, we're surrounded by a dizzying array of risk communications, ranging from warning labels on numerous products we pick up to messages about health, terrorism, technology, and more. Weather forecasts, although not traditionally thought of as risk communication, are among the slew of risk messages that are ubiquitously conveyed and, ostensibly, regularly accessed and used. Weather forecasts—especially those for high-impact weather threats, such as hurricanes, tornadoes, winter storms, and flooding—convey what is known about the possibility of a weather threat that may cause harm to people. Such risk communication information is readily and increasingly available and utilized by end-users ranging from members of the public, government officials (e.g., emergency managers, departments of transportation, school superintendents), and media (including broadcast meteorologists) to private businesses and many others. Increasingly, there are efforts to understand these myriad consumers of weather risk information, including how they access, interpret, and use it in their decision-making. Yet, what weather risk information people get

and use is inherently tied to what information is (and is not) known and communicated.

The “A 50% Chance of an Effective Forecast” session focused on the weather risk context of riverine flooding and flash flooding, but turned the risk communication lens onto the originators of weather risk information, that is, atmospheric scientists who research the hydro-meteorological system and who operationally forecast the weather. The goal of the session was to discuss what is and is not known about riverine flood and flash flood hydrometeorology and forecasting. It discussed our current capabilities and limitations associated with characterizing flood risk exposure (whether, when, where, and how flooding can happen) through observing, understanding, and forecasting the atmosphere. It also discussed needed future directions for providing more effective weather risk information to enhance the resilience of cities such as Boulder and beyond.

The session included presentations from three atmospheric science experts. Dr. Russ Schumacher—an Assistant Professor in the Department of Atmospheric Science at Colorado State

University—spoke about his research efforts to understand the atmospheric conditions and processes that produce extreme amounts of precipitation. Dr. Kelly Mahoney—a research scientist at the National Oceanic and Atmospheric Administration (NOAA) Earth Systems Research Laboratory and with the University of Colorado Cooperative Institute for Research in Environmental Sciences—spoke about her research to numerically model the hydrological response of extreme precipitation. Daniel Nietfeld—the Science and Operations Officer at the NOAA National Weather Service forecast office in Omaha, Nebraska—spoke about how, operationally, he diagnoses and predicts flood threats and issues forecasts (including watches, warnings, and advisories) to the public. The ideas summarized below are rooted in the expertise that Russ, Kelly, and Daniel provided to seed the session conversation.

Background and Key Concepts

Tremendous advances have been made in the atmospheric sciences over the last several decades due to improved observations

and technology (instrumentation and computing power), which in turn have enabled improved understanding and forecasting of atmospheric processes. Still, quantitative precipitation forecasts, that is, forecasts of how much rain will fall where and when, are extremely difficult and often lack skill. The amount of precipitation that falls in an area is a product of the average rainfall rate and the duration of rain (i.e., precipitation amount = rainfall rate * time). Or, as Russ simply noted, “the most rain falls where it rains the hardest for the longest”. Predicting this, however, requires understanding the complex interplay of what causes precipitation to occur, how and why precipitation intensity varies spatially within a storm, storm motion (direction and speed), and the formation and dissipation of storm cells. In other words, the simple equation for precipitation amount is deceptively complicated in practice.

Research on understanding precipitation conditions and processes has informed the development of numerical models, which are essential aids to operational forecasters. Two types of numerical models are used in forecasting riverine and flash flooding: models that predict the weather only, and models that couple the atmosphere with the land-surface to predict the hydrologic response (e.g., streamflow) based on weather predictions. These models are sophisticated computer programs that predict the future

state of the atmosphere using observations (e.g., of temperature, pressure, winds) and by solving physical equations of motion. Hydrologic models—which have detailed physical representations of topography, land characteristics (e.g., soil type, vegetation), and stream channels—then predict how the modeled precipitation is distributed (e.g., moisture absorption, runoff, flooding) when it interfaces with the ground, including surface-level hydrology.

Uncertainty is inherent to numerically modeled precipitation forecasts. The sources and reasons for forecast uncertainty are myriad. Among them are the quality and density of observations (including lack of observations, e.g., for parameters such as soil moisture) that serve as model input; model parameterizations (which are representations of physical processes); and model resolution and computational power. Although modeled precipitation forecasts are improving, “simple” model errors such as precipitation amount or location have huge implications for the actual outcome of whether flooding occurs, when, and where. For instance, although numerical weather models were “good” at forecasting that a large amount of rain would fall over the Front Range of Colorado in September 2013, the amounts of rain were drastically underestimated and the exact locations were in error (Figure 1).

Thus, the role of the operational human forecaster is essential

for issuing skillful, timely flood forecasts, especially for spatially localized, rapid-onset risks such as flash flooding. NWS forecasters utilize numerically modeled precipitation forecasts, which they combine with their event-specific assessment of the atmospheric environment, observations (e.g., radar, rain gages, and reports from media, spotters, public), and their local expertise to evaluate flood risk and issue forecast products. In doing so, they parse the precipitation amount equation discussed above, paying particular attention first to the rainfall rate and second to its duration, all the while evaluating whether the hydrological basin can drain the amount of water coming into it without being overwhelmed (Figure 2). Practically, though, precipitation intensity can vary substantially over an area (Figure 3), which can present major flash flood risk assessment and communication challenges.

Challenges and Conclusions

Several challenges for detecting and effectively communicating flash flood risks were highlighted during the session presentations and discussions.

Significant advances are being made in the atmospheric sciences in observing, understanding, and modeling meteorology and hydrology. Still, there is a tension between precision (spatial and temporal) and accuracy for flash flood forecasting. For a small area (point or small drainage basin),

Figure 1. Precipitation forecasts from several numerical models, issued the evening of September 10, 2013, and valid for September 11-12, 2013. From Gochis et al. (2015) (Fig 13) and courtesy of Russ Schumacher.

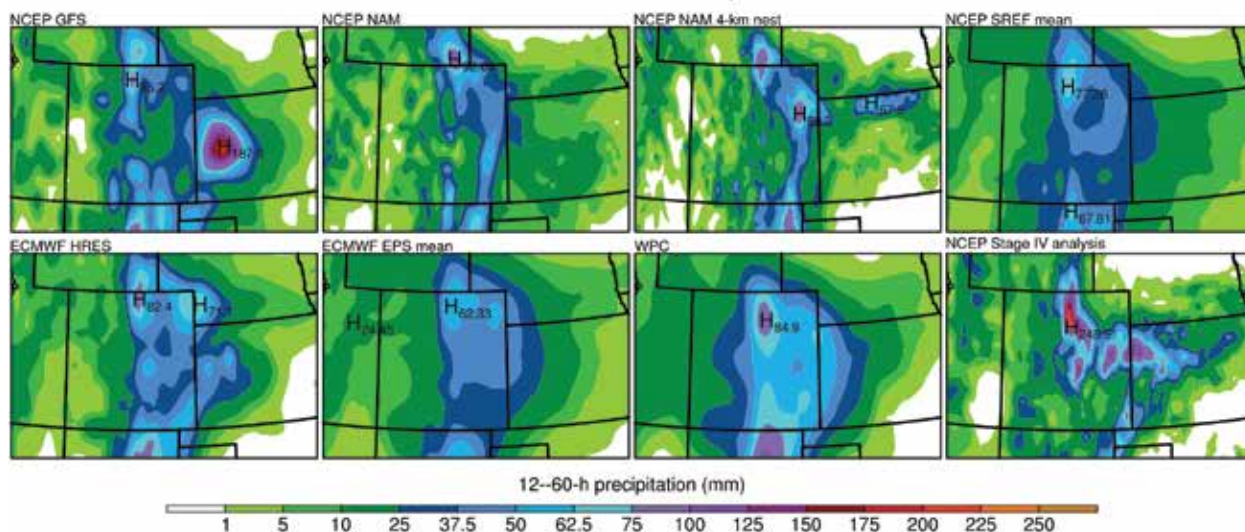


Figure 2. Example of the (a) operational forecasting area of NWS Omaha illustrating their observations of (b) Doppler radar and (c) social media reports during a flash flood event. Courtesy of Daniel Nietfeld.



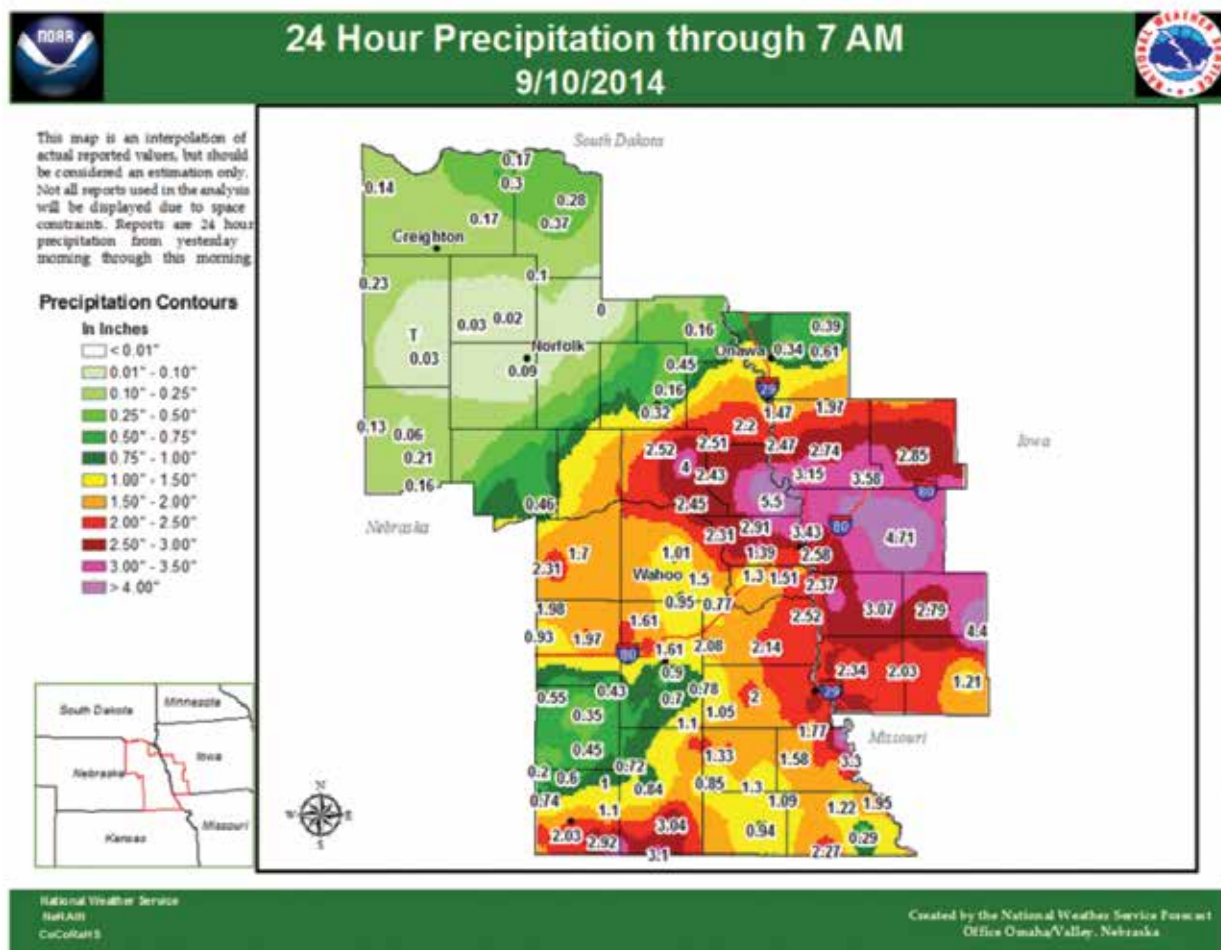
accurately predicting where a flood-causing rain event will occur is currently beyond our scientific capabilities. These challenges are exacerbated at longer-lead times, but they exist at very short lead-times as well, including as the rainfall event is occurring.

This uncertainty poses challenges in communicating the impending or ongoing flash flood risk to end users in all roles—from emergency managers to members of the public—who are assessing their risk and making protective response decisions. This challenge

is exacerbated for extreme events, such as the September 2013 Front Range flooding. By definition, the probabilistic occurrence of such events is minimal (for example, 1%, 0.2%, or 0.1% chance of occurring in any given year). Such low probability events tend to not be well predicted because they're not well known or understood by researchers or practitioners. Relatedly, those affected by low probability events likely have no direct experiential reference, and thus may not be able to imagine the extent of the event and its impact, nor how to prepare for and respond to it.

Despite these challenges, there are "knowns" (known knowns and known unknowns) of flood and flash flood threats, and this event-specific information can be useful for risk assessment and responses, including information-seeking responses as well as protective behavioral responses. In addition, forecasters and emergency

Figure 3. Observed 24-hour rainfall totals over Eastern Nebraska and Western Iowa from the flash flood event illustrated in Figure 2. Courtesy of Daniel Nietfeld.



response personnel generally recommend that members of the public attend to forecast information, be situationally aware and attend to environmental cues, and to have detailed family communication and response plans. For additional information about flash flood risks from the perspectives of warning and response professionals and the public, see Morss et al. (2015) and Lazrus et al. (2016), respectively.

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There are “knowns” (known knowns and known unknowns) of flood and flash flood threats, and this event-specific information can be useful for risk assessment and responses, including information-seeking responses as well as protective behavioral responses.



Neena Sasaki, 5, carries some of the family belongings from her home that was destroyed after the devastating earthquake and tsunami on March 15, 2011 in Rikuzentakata, Miyagi province, Japan. Photo credit: Paula Bronstein/Thinkstock.com

Resilience in Disaster Preparedness: Global Lessons

Ken MacClune, Institute for Social and Environmental Research International (ISET)

Historically disaster preparedness has focused on mitigation to reduce impacts from hazard events. However, for mitigation to be successful the nature of the hazard needs to be well understood. Increasingly, global change processes such as urbanization and climate change are altering how hazards emerge and behave, making traditional mitigation efforts increasingly difficult. In the face of these changes the concept of resilience—which systemically assesses impacts and identifies opportunities to enhance the capacity to adapt, respond, recover from and leverage the opportunity that shocks and stresses bring—has emerged as an area of focus. Much of this work has been pioneered overseas, from which there are key lessons to be learned. This session provides resilience lessons learned by three international researchers in the research, action research and development fields.

Background

Scientists have for decades used historical data, geology and social science to reconstruct historic hazards and their frequency. These

reconstructions can then be used to inform infrastructure design elements and land-use planning, information campaigns, policies and laws to reduce risk. But the combined forces of urbanization, which alters how the landscape absorbs a hazard generating event, and climate change, which alters the frequency and nature of the hazard, have increased the level of uncertainty. To address this uncertainty, planners and disaster risk reduction specialists have begun to work on improving resilience to disasters.

Though there are a number of definitions of resilience, in the end the point of resilience work is to understand the dependencies of people on key systems that provide them the services they need to survive, and to identify opportunities to increase the flexibility, adaptability, accessibility and transformability of these systems such that they continue to provide needed services in times of stress or shock. These systems range from the most basic—water, food, shelter—to higher order services such as energy, communication, and transportation that provide access to livelihoods and improved well-being.

Building community resilience

Communities are composed of built, social, natural and environmental elements that influence one another in complex ways. Within this complexity, community resilience is the capacity for successful adaptation in the face of stresses and adversity. However, there are limits to successful adaptation—in particular, urbanization and climate change are already pushing us beyond business as usual, and this will only increase. If communities are to meet future challenges and remain resilient, they will need to better leverage the support they derive from resources to meet the challenges posed by new or intensified stresses.

There are four primary resources communities can link to build their resilience:

- 1. Information:** Information is only valuable if it is usable, and to be usable information needs to be tailored to local conditions, trusted, and timely. Information also needs to flow out from communities in ways that support resilience. Communities, particularly the

Figure 1. Economic resilience—the rule of relative need vs. the rule of relative advantage. (Race and Recovery in Post-Katrina New Orleans cooperproject.org)



vulnerable, need to feel heard and understood.

2. Economics: Livelihood stability and equitable distribution of assets is critical to resilience. This comes into play in particular during mobilization of support during and after stresses and adversity. All too often, support goes first to those with connection and power; yet where we want it to go to best support resilience is to those with greatest need. Efforts to level this playing field through policy, cultural normalization, and enforcement are required.

3. Community competency: Both community competency and perceived community competency are critical to resilience. Communities must be able to engage with higher levels and influence resource streams coming into their communities. However, how communities are portrayed is equally critical to how they are

perceived and engaged. All too often, communities are blamed for their condition, or media narratives lead responders to focus on law-breakers rather than saving lives. Building resilience requires building the image of the community, both from the inside and out, as a place where resilience is possible.

4. Social capital: Social capital enhances resilience when it is positive; when groups within communities are working together, when communities are working with one another, and when communities are working effectively with groups and organizations at higher levels (e.g. city, regional or national organizations and governments). Social capital that is exclusive or disconnected, however, will erode resilience. When sub-networks aren't connected to other networks, or when communities close themselves

off from outside engagement, resilience is reduced.

Building community resilience means working with these four resources. First, we must identify the intended outcome of our engagement. Resilience efforts must take a systems approach, not focus on individual actions or elements that may build resilience in one area but strengthening inequitable business-as-usual models or lead to unintentional, maladaptive transformation. Second, we need to be persistent. Vulnerability and lack of resilience is rarely accidental; it is rooted in inequitable policy and cultural norms and will take time and consistent effort to change. Third, we must be cognizant that, for many problems, transformation is needed and we must be intentional, not unintentional, about what sort of transformation we achieve.

A Framework for Building Community Resilience

The second presentation focused on the framework used by ISET-International to engage and work with cities in South and Southeast Asia to build resilience, with examples from India and Vietnam. This approach and the example case studies illustrate what community resilience building can look like in practice.

ISET-International works from the assumption that there is no single set of climate adaptation “experts”. All the players involved

in an issue — local residents, local, regional and national stakeholders, and external “experts” brought in to support the work — need to enter into the work with an expectation of collaboration and a perspective of “share and learn”. This prevents those involved from talking over potential solutions.

Collaboration of this type requires that you identify a common framework and language for the work at hand. ISET-International uses a relatively simple framework that supports a systems-based understanding of vulnerability coupled with planning and implementation through a shared learning dialogue engagement process (Figure 2). This framework divides the world into four main elements: systems, the physical landscape people live in and the services they rely on; agents, the people and organizations active in the physical landscape; institutions, the legal and social norms that constitute the “rules of the game” governing how people can and

cannot act and the services and systems they can access; and exposure, the risk and hazards that could affect systems, agents and institutions.

This general way of exploring resilience from a systems perspective was used in the Rockefeller Asian Cities Climate Change Resilience Network (ACCCRN) to understand and build resilience in ten cities in South and Southeast Asia, as described in the case studies below.

Case Study: Gorakhpur

Gorakhpur is one of the ACCCRN cities in India. It is a rapidly urbanizing city of about 700,000. Gorakhpur experiences regular flooding and water logging, exacerbated by poor or non-existent drainage. Flooding impacts livelihoods directly and causes secondary health issues. The Gorakhpur Environmental Action Group (GEAG), working in the Mahewa Ward in Gorakhpur,

realized that before they could work with the community to build a drainage system to mitigate water logging and flooding, they first needed to build the social institutions needed to construct, value, and maintain a drainage system. Thus, though the problem looked to be one of insufficient infrastructure, the solution needed to involve people, organizations, cultural norms, and infrastructure, which collectively could then reduce exposure.

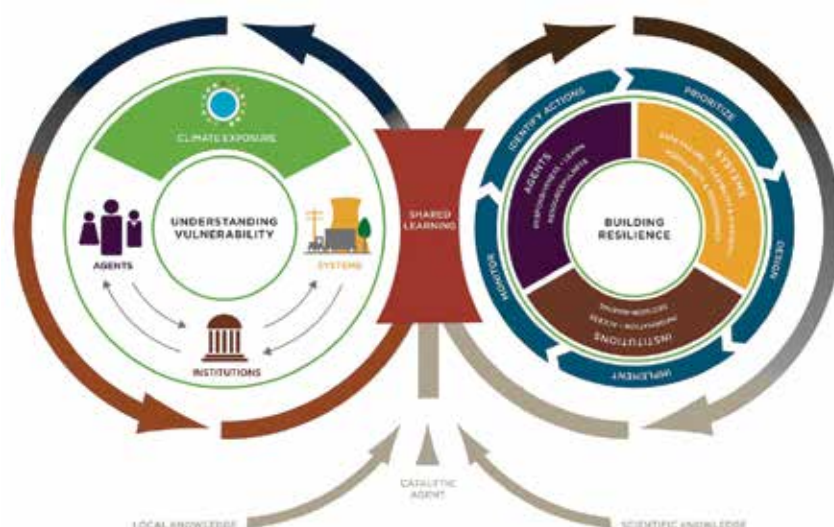
The project, structured this way, was highly successful. Mahewa Ward residents cleaned and renovated the drainage and paving of several streets in their ward. Using this as proof of concept, and supported by GEAG on how best to advocate on their own behalf, they then embarrassed the government into completing the rest of the ward.

Case Study: Da Nang

Da Nang is the third largest city in Vietnam. Located on the coast about midway between Hanoi and Ho Chi Minh City, Da Nang is rapidly urbanizing, and increasingly growth is occurring in highly vulnerable areas. Housing and businesses are both at risk of typhoon-induced flooding and wind damage.

The Women’s Union Housing project focused on building resilience in the housing sector for poor, woman-headed households. The project worked with architects to design housing that could deal with winds, storm surge. Houses were designed collaboratively with

Figure 2. The Climate Resilience Framework (ISET-International; <http://i-s-e-t.org/resources/working-papers/resilience-into-practice.html>)



residents to meet cultural and practical needs. They were also designed to address typhoon risk by including a hardened refuge within each home into which residents could retreat during a storm and improved construction elements such as how roofs were attached to walls. Additionally, the layout of neighborhoods and streets was modified to break up winds rather than channel them. These design and construction elements were coupled with a skills building program for homeowners to increase their livelihoods options, and with low-interest loans to allow them to renovate their homes.

The project was tested in 2013 by Typhoon Nari. None of the 244 beneficial homes were damaged

“This is the excellent foppery of the world, that when we are sick in fortune, often the surfeit of our own behaviour, we make guilty of our disasters the sun, the moon and the stars...” King Lear, Act 1, Scene 2.

Though we’ve known for centuries that we create risk through the places that we choose to inhabit and the ways we build in those areas, nonetheless, on average humanities’ risk is increasing over time, and increasing exponentially. This is primarily because, as population increases, people move into increasingly more hazard-prone lands. And, though we assume we’re getting smarter in what we build, there isn’t much data to support that assumption.

earthquake risk is not constant in time. Exposure changes every time someone moves into a new city, or even just commutes. Vulnerability is also changing, with changing construction practices, deterioration, and vulnerability in a broader social sense is even more dynamic. So riskscape are extremely dynamic.

If we are to effectively manage post-disaster riskscape, we must:

1. Reframe post-disaster recovery in terms of risk and resilience. This should focus in particular on “reformatory recovery”, as opposed to “restorative recovery”. The aim of reconstruction has usually been to restore to the previous state. Any improvement from this previous state is

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in the typhoon, though Da Nang suffered a direct hit, thousands of homes lost their roofs, and storm damages city-wide exceeded 41 million USD. (<http://i-s-e-t.org/resources/working-papers/lessons-typhoon-nari.html>)

Building Resilience in Post-Disaster Settings

The third session in the panel focused on the ways in which humanity creates our own disasters and tries place blame elsewhere.

The “riskscape” that we live in are a collection of risk features across a geography, including multiple hazards, drivers of vulnerability, etc. Like landscape elements, these too have specific characteristics such as intensity, frequency of occurrence, etc. And like landscapes, “riskscape” are dynamic. They’re constantly changing in time.

If we define risk as some combination of hazard, exposure and vulnerability, then we recognize that none of these are fixed in time: hazards are changing due to climate change, even

usually focused solely on the physical infrastructure (build back better). Reformatory recovery, by comparison, is a process through which new dynamics for resilience are created, often through government and social reform.

2. Define “acceptable risk”. One of the obstacles for risk reduction in post-earthquake Haiti was that while everyone agreed that risk should be reduced, no one knew what it should be reduced to. In the absence of properly understood standards for ‘acceptable risk’, agencies tended to either avoid action

altogether, ignore using risk as a criterion, or to significantly over-design their interventions. However, defining “acceptable risk” requires that you address the ethical (what is morally acceptable?), practical (what is possible given limited resources?), and cultural (what is appropriate?) issues involved. Therefore it should result from an open and realistic debate involving civil society and communities who will have to live with the risk.

3. Control risk in uncontrollable settings. This is particularly challenging because many decisions that determine risk are made at the household level. For example, in Haiti where people are deciding to build homes, the types of homes they build, etc. is constructing new risks. In places such as Haiti, these decisions are then realized through processes that occur mostly outside any regulatory environment. One of the few

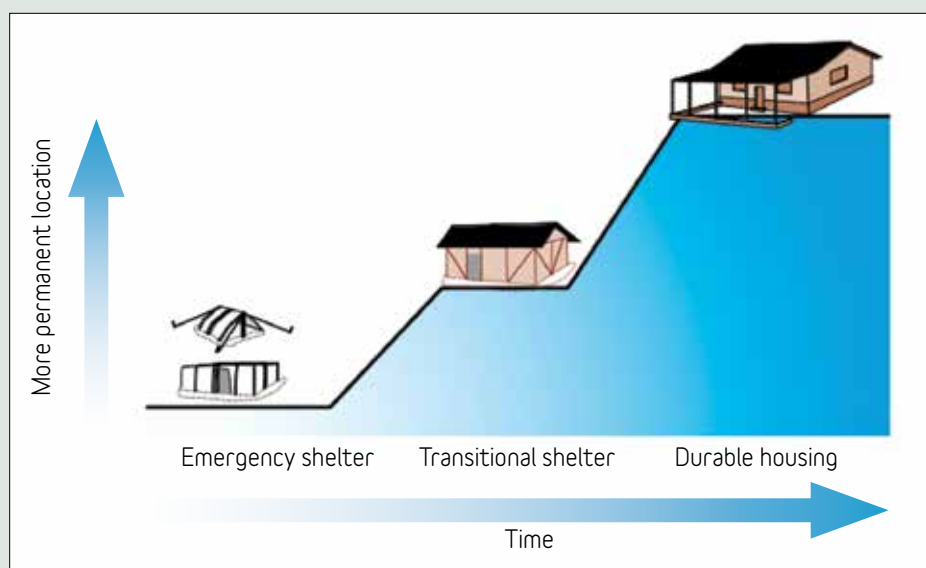
ways to address this is to to promote self-compliance to safe practice and to provide the information households need to make rational decisions about their own risk.

4. Address the structural causes of vulnerability. Focusing so intently on “building back better” that we ignore the systems that are creating vulnerability will leave communities less resilient than they began. If we want to talk

Building for “Acceptable Risk” in Post-earthquake Haiti

A “transitional-shelter” solution was heavily promoted early on in the wake of the Haiti earthquake. The “T-shelter” approach was framed as a disaster risk management initiative, securing the population against the impending hurricane season. This also set the standard for T-shelter design, a structure able to withstand three Category 3 hurricanes, and costing as much as US\$10,000 including design, materials, labor, shipping (plywood was imported), warehousing, etc. (Haiti Shelter Cluster, April 20, 2010, Transitional Shelter Parameters).

From a risk management perspective the T-shelter standards should have arisen from a proper discussion of “acceptable risk,” and properly weighing other potential “transitional solutions”. An engineer who participated in the T-shelter working-group meetings explained that the working group went straight to “design”, without explaining clearly the “design assumptions” or “acceptable risk”. In fact the high-level standards proposed led to very expensive shelters, while other options for shelters meeting “acceptable risk” criteria were not discussed.



about resilience, than we have to recognize that the systems that create and perpetuate extreme vulnerability are extremely resilient.

Thought we've broken down the management of post-disaster riskscapes into four steps, they aren't simple. While these long-term changes cannot realistically be fully addressed during the reconstruction process, "reformative reconstruction" should promote these debates and begin these reforms. This will involve addressing the root causes of vulnerability, rather than only its symptoms.

Conclusion

There is a huge opportunity for reforming disaster preparedness and recovery by viewing it through a resilience lens, but to be successful we need to understand why people make the decisions they do so that we can identify

entry points for realistic action. To accomplish this, Disaster Risk Reduction needs to be recast not as a cost but as a value. Reducing risk may cost more upfront, but not only does it reduce future damages, but as people stop dreading the next disaster it also enables them to relax and make long-term investments.

We also need to better leverage technology to identify gaps and opportunities. In Japan, mapping where people ran when they received tsunami warnings has identified communication and education gaps; people ran to the tsunami walls because they felt they wouldn't be breached.

We need to do a better job of asking what people want and need rather than showing up and assuming we know what's best. This was successfully done in one community in Haiti post-earthquake. Residents identified that their primary needs were "we can't charge our phones" and

"what do we do with our kids". Aid organizations were able to hear this and respond by setting up a community center so school could restart and a tiny solar power system to recharge phones. This type of response supports residents to be more pro-active about their own recovery, in this case by freeing up their time and enabling communication.

Finally, you have to make sure when you assemble a "community group" that you don't just recreate the pre-existing power dynamics. You need to be aware that most "disasters" that require extensive, long-term outside support occur where power dynamics promote inequality and vulnerability.

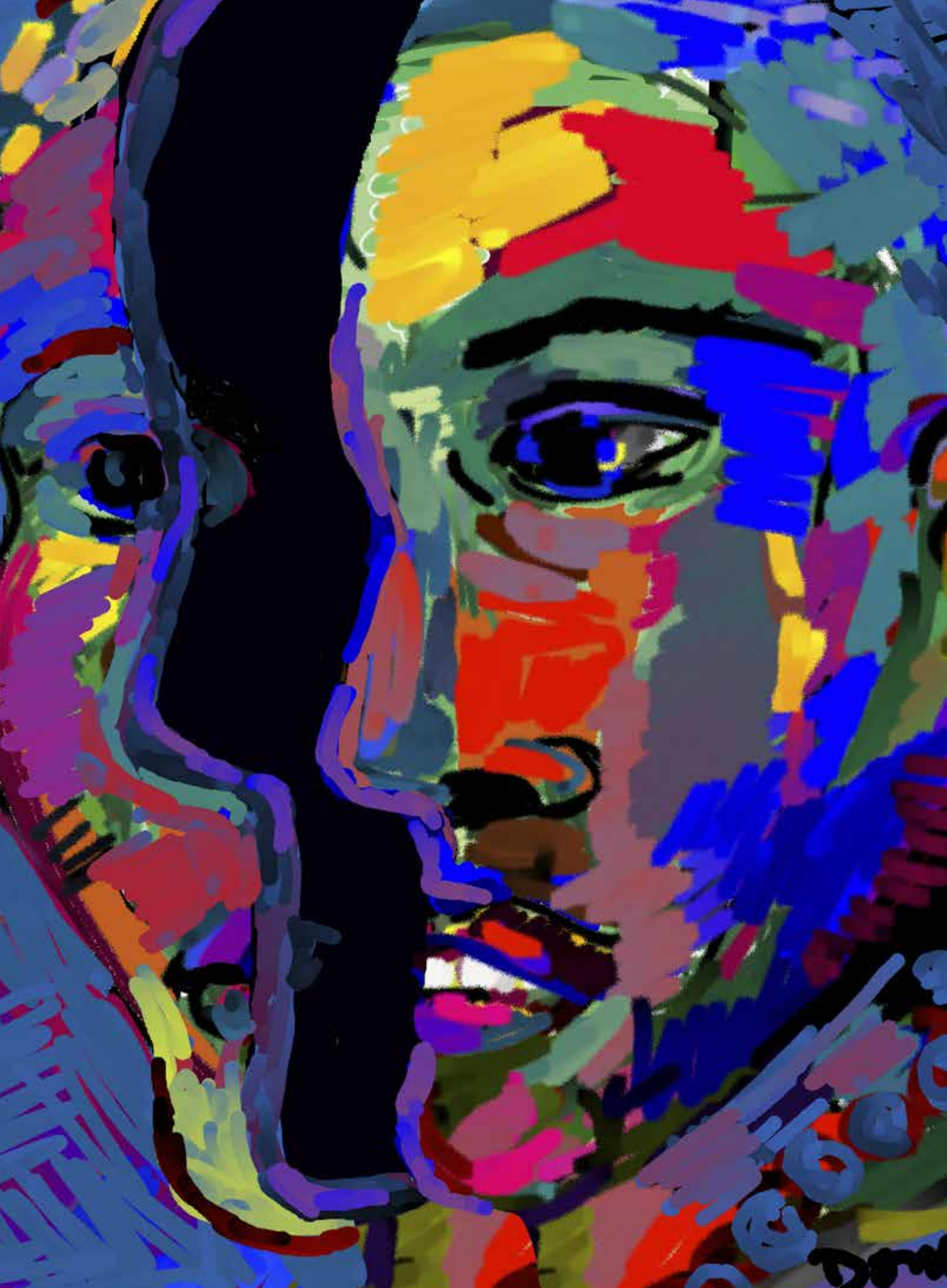
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At the Edge: Looking Beyond Trauma and Resilience for Emerging Perspectives in Disaster Mental Health

Heather Cook, Healing Among Chaos

Introduction

Disasters are complex. The human psyche is complex. The combination, an individual's experience of a disaster, is particularly complex, personal, collective and nuanced.

Psychological well-being in the disaster world is often described with two key words: trauma and resilience. This session explored both of these concepts, discussing the sociological, psychological and neurobiological factors that influence these juxtaposed concepts, reviewing current interventions in the field of disaster mental health, and exploring emerging perspectives that expand the concept of mental health beyond disaster survivors to understanding the human experience of uncertainty

Disaster Mental Health Background & Concepts

There is no well-articulated definition of risk when it

comes to mental health and disasters. Typically, risk is seen as a combination of threats, vulnerability, impact and the capacity to mitigate impact. Research has identified factors at the community and individual levels that are likely to place an individual at risk of long-term stress reactions. These include an individual's previous mental health history, prior experiences they've overcome, social connection, trauma history, socioeconomic status, ego structure, and sense of purpose. The role of disaster mental health as the field currently stands, is to help individuals and communities strengthen their capacity to manage stress following disasters.

Disaster mental health is not primarily about clinical or therapeutic interventions, although that is a part. Rather, it includes all the considerations of how to assist in alleviating suffering following a disaster event. The goal is to reduce stress by attending to basic needs, being present with a person, providing connection to resources, and

encouraging the use of existing coping skills. If necessary, referrals to professional mental health services are provided; however, the vast majority of disaster survivors will not need these. A sense of safety, connection to others and sense of hope is, for most individuals, sufficient to support them through the stress of a disaster.

One of the most common reactions in disasters is bereavement — of the loss of life, property, hope for the future — at both the individual and community levels. This often results in increases in community substance use and abuse following disasters.

Another common reaction is trauma. According to the panel experts, on average no more than 20% of disaster survivors will be traumatized, though research statistics indicate this is dependent on the disaster event itself. Trauma is different from a normal stress reaction. Stress is an unavoidable and necessary part of life, especially following a disaster; the body and mind are

activated to survive the initial threat, and remain activated to get through the days, weeks and even months following. Trauma is currently conceptualized as an extreme stress involving a sense of overwhelm and helplessness. It is often associated with death or severe bodily injury.

The psychology field is increasingly recognizing that trauma is more strongly influenced by individual perception of an event, not always the event itself. Over the past decade, a deeper understanding of the nervous systems and the stress response is influencing approaches to trauma informed care. However, while there is a clear need for trauma informed care, there is also a great need to support the idea that people are capable of dealing with and moving through disaster. Indeed, there can be positive aspects to disaster. When people are knocked off of their norm, they are forced to be resourceful, to make changes in their lives, and to reassess their values. Resilience, the capacity to find a way through, adapt to, and recover from difficulties is a fundamental part of every person. Being impacted, traumatized, and showing resilience are not mutually exclusive.

The public health and programmatic elements of disaster mental health increasingly gaining importance. More and more public health departments and emergency management offices around the country are including disaster mental health in their official plans, and the mental

health community is training their members to respond appropriately following disasters.

Challenges

While disaster mental health is being recognized more and more as a necessary component in disaster response and recovery, the field still faces challenges.

Primary among these is the issue of competing needs. For those in the mental health field, mental health during disaster is a clear need and their primary focus. Yet, for the broader disaster response community, in the overall context of planning for, responding to and recovering from disaster, mental health is just one of many competing needs. Consequently, integrating disaster mental health in disaster response, and in particular funding disaster mental health efforts, remains a challenge.

Second, attending to mental health in general in the United States is mixed. In some regions there is still a strong negative stigma to discussing or seeking help for mental health issues at the individual, community, and/or organizational level. If there are negative perceptions of mental health in place prior to disaster, engaging communities following a disaster is extremely challenging. Increasingly, mental health is being viewed as an integral part of health; nonetheless, negative stigmas remain, often among more vulnerable populations, and mental health funding remains limited across the board.

Third, attending to mental health needs, both in the United States and internationally, requires an understanding of culture, diversity and the collective history of the people impacted by disaster. Mental health interventions must be tailored to the affected population, and the availability of mental health assistance must be presented in ways that are culturally acceptable if it is to be utilized. For example, interventions need to be tailored differently for refugees or asylum-seekers living in the US who have experience extreme stress prior, and in areas where mental health support carries a negative stigma, services need to be framed in a way that culturally normalizes seeking aid.

Recommendations

The value of connection in mitigating disaster stress, trauma and other mental health challenges cannot be underestimated, especially in the recovery phase. To be resilient, people need to be connected to their community, to resources, and to their neighbors and family. One powerful way to foster or enhance this connection is to engage communities in disaster recovery planning and response. Collective action allows people to feel more connected and engaged, and therefore builds resilience in and of itself. It is when people are left alone to address their own recovery, or cast solidly in the victim role, needing post-disaster care, that is the basis of most mental health problems. This was experienced in Colorado during

the 2013 floods with regard to disaster mental health. If the local community is to be supported as the best resource for people in the community, community representatives should be actively involved in the disaster response and recovery phases to provide feedback and knowledge that is meaningful to those that would access services.

A core aspect to supporting independent community action is communication. Communication following a disaster is key and has direct impact on people's mental well-being. It is important to have an honest, direct information officer that people trust. Information itself has the ability to provide direction so that proper actions can be taken, increasing control and building a sense of empowerment.

As mentioned above, the interventions that allow for healing are not strictly professional, therapeutic approaches. Peer support is increasingly being used in communities to connect people, provide safety and stability, and attend to basic needs, thus reducing stress. Peer support does not need to be clinical; it can be as simple as providing the support, guidance and company an individual needs to make it possible for them to fill out the papers required for FEMA or other assistance, a task which if done alone can be overwhelming to many disaster survivors.

When professional support is called for, all staff member with direct client contact should be trauma informed to best support individuals. Even interactions with caseworkers can be an opportunity if people are trained to assess their clients' level of traumatic stress.

Every community has a different set of resources available to them, and they often need to prioritize where to put funding. Often, trying to acquire funding specifically for mental health needs for a potential disaster is lower on the list than more immediate needs. Consequently, immediately post-disaster, there should be active mental health advocacy, particularly as part of grant proposals. The decision as to where mental health program funding should be invested post-disaster can be complicated. Community mental health centers, first responder resiliency programs, school-based programming, providing funds for individual therapy, and group-based interventions are all proven valuable routes for utilizing funds.

Ideally, however, we would not leave disaster mental health to be funded post-disaster. When responding to disaster mental health needs, the community and grassroots approach is absolutely necessary, and much of this will occur post-disaster. But, disaster mental health should also be included from the top-down well in advance, including preparedness, planning and in the incident command system.

Conclusion

Disasters often create a heightened sense and focused awareness of the human experience. In the time following a disaster it can seem that we are at an edge. Disasters, large and small, natural and man-made, will continue to occur. Some argue, especially with regard to the impacts of climate change and world terror events, that disasters are happening more often and at a larger scale. In a very fundamental way, disaster mental health addresses the human experience of a collective event.

In the face of disasters, we need to understand risks and try to prevent, mitigate and respond to human suffering, both through current means and innovative approaches. At the same time, there is a need for healing of the collective psyche. Our capacity to be with the unknown, to deal with uncertainty, and to effect this collective healing may very well be the key to our resilience.

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Risk of Absence: The Importance of Social Capital and Community Engagement for Risk Reduction and Disaster Response

Tiernan Doyle, BoCo Strong

Communities are complex; difficult to define; and often indecipherable to outside observers. Informal roles and responsibilities within communities are crafted out of need, intangible norms, and social behaviors and hierarchies that are not readily intelligible to those outside of the 'community' boundary. This can be especially problematic during a disaster, as resource delivery and recovery processes are delayed by a lack of local connections; cultural conflicts; and unstated or divergent goals that create friction between responders and members of the public. For both response organizations and community members, communicating about risks and needs requires a process of translation that must often be carried out under extreme or acutely stressful circumstances. This is made more difficult when compounded by differences in environment, language, culture, jurisdictional idiosyncracies, and social expectations. As such, it can be beyond the capacity of

many organizations to engage directly with community members. However, effective interaction with local leaders, skill sets and social networks, will allow relief organizations, responders, and local institutions to provide better service delivery, match resources to needs, effectively communicate risks, and build better, more resilient relief and recovery processes that increase collective community capacity.

Case Studies

Boulder County has experienced several natural disasters over the last five years, including wildfire, drought, and widespread flooding. While affecting the natural environment, they have also impacted residents situated along a wide spectrum of social situations, geographical contexts, and jurisdictional regions. These cultural, topographical, and political diversities have resulted in a densely complex fabric of recovery that remains in process

two years after the most recent event in 2013. Crucial to the rebuilding of each city, town, and unincorporated area in the county has been the ability of each community to participate in directing their own recovery process according to local strengths and needs.

Rich Lopez, former Lefthand Fire District chair and board chair of the Community Foundation Serving Boulder County, has been instrumental in facilitating assistance for the Fourmile and Lefthand Canyon areas, which were impacted by both major wildfire and flooding in the past five years. Close to the city of Boulder, Fourmile and Lefthand canyons are part of unincorporated Boulder County and have had few government representatives to advocate for them during recovery processes. After the 2010 Fourmile Fire burned 6,181 acres and destroyed 162 homes in Fourmile Canyon, neighbors organized a benefit

concert with all proceeds going to affected community members. This strategy was particularly effective for the community members at that time since it allowed them to create an event that showcased local skills and drew on existing musical and artistic traditions.

In addition to identifying and creating recovery processes appropriate to and supportive of cultural context, the community also relied on residents such as Rich Lopez to create bridges to outside resources necessary for recovery. After the 2013 flood, his ties to the Community Foundation Serving Boulder County were especially beneficial in bringing in outside resources and reducing

County in the years following the Fourmile Fire. Staff has been cut, and there have been several leadership changes. This situation underwent a transformation during the flood of 2013, when dedicated attention to community connections and consistent communication with neighborhood and local leaders made the organization one of the most influential partners in the ongoing recovery.

Recognizing the success that they have had with the 2013 response, the Red Cross is now piloting a community-centered approach to volunteering in Boulder County. Joan Cernich and her team have been instrumental in recognizing

The Red Cross' new strategy in Boulder County hints that there are ways to institutionalize community engagement that can be adapted for a variety of organizations. One method for quickly increasing community-based response and engagement is the inclusion and use of emergent citizen groups. Meghan Dunn's research traces the rhetoric around emergent citizen groups from the 1980s into the present as social activism changed the discourse around community disaster response and recovery. Looking at the effects of Occupy Sandy in New York during the devastating superstorm Sandy underscores that citizen relief opens a particular space for

Looking at the effects of Occupy Sandy in New York during the devastating superstorm Sandy underscores that citizen relief opens a particular space for innovative response.

the transactional discord that often arose during discussions with government representatives. Through the efforts of Mr. Lopez and other community advocates, the Fourmile and Lefthand areas were able to obtain and disperse financial resources to residents in the area more effectively than other parts of unincorporated Boulder County.

Though crucial to recovery after disasters, response organizations can have difficulty in identifying and reacting to the needs of communities that are different from their established model. The Red Cross experienced an ebb and flow relationship with Boulder

the importance of volunteering in place, and in establishing local connections and resources before disaster hits. Key benefits of this approach include having people trained and ready in diverse geographical areas and the ability to harness on the ground skill sets to help the broader community. This new model has made the Red Cross a key player in local resilience and disaster preparedness efforts across the county. Using a bottom up approach to volunteer and resource deployment, the Red Cross' flexibility in adapting to local context has succeeded in creating a successful model for working in Boulder County.

innovative response. Emergent groups are able to repurpose existing tools and create new methods to implement hyper-local response that is flexible and adaptive to the contexts at hand. Without preexisting structures or bureaucracies, emergent groups are able to meet the needs of the moment and quickly acquire and shed resources as necessary.

Giving place to emergent citizen groups for risk communication and disaster response also opens the door to better interaction with vulnerable populations such as non-English speakers, the elderly, and disabled. These communities are disproportionately affected

by disasters and often struggle during the subsequent recovery without sufficient resource access or representation in policy decisions. Interaction with vulnerable populations can be difficult; requiring both trust and specialized messaging that communicates both risks and resources in vernaculars targeted to diverse groups with divergent needs. If local leaders and culture are not respected, response efforts can place an extra burden on populations that are already at a disadvantage in terms of information and resource access.

Likewise, if existing skill sets and knowledge of community members are not utilized, the overall capacity for response and recovery also decreases. Nnenia Campbell's research into the impact of disaster on elderly populations in Boulder County shows that pre-disaster engagement of these groups increases health and happiness while also building the overall social strength through the exploration and use of specialized local information and knowledge that would otherwise go to waste. Identifying members of elderly populations that have the time, energy, and skills to facilitate the transfer of information between interior and exterior audiences would allow better resource delivery and communication in both blue sky and disaster periods.

Challenges

Gaining traction and trust with community members can be a difficult process for risk

communicators and emergency response organizations, but it is vital to creating effectively collaborative working models and information exchange. Without data from community members it is hard to target where gaps in relationships will negatively impact risk communication, emergency response, and recovery.

During an emergency, many organizations struggle to find the capacity to successfully target vulnerable populations or effectively identify and prioritize needs from the community. Building a culture of community engagement with two way information flow pre-disaster will have far reaching benefits during an event.

Additionally, engaging local community members through their interests and passions helps immensely in volunteer retention, reducing friction and increasing capacity for risk communication and disaster response. Without committed engagement or recognition of the context and culture of a community, it is difficult to retain local volunteers and connections as community members become disinterested or feel disenfranchised.

Moving Forward

As natural disasters continue to increase in size and frequency, it is important to build response and recovery capacity in communities. This can be done by creating and supporting community engagement programs within

response organizations; identifying and working with local leaders and cultural brokers before disaster strikes; developing communication strategies for and building trust with vulnerable populations; and making contact or networking with other response organizations in the area in order to deliver coordinated, collaborative services. Reciprocally, communities can build their own capacity by strengthening internal social capital within neighborhoods and external ties to local nonprofits and government representatives.

Closing the gap between risk communicators, disaster responders and community members will create multiple benefits — preexisting skill sets emerge, vulnerable populations participate in their recovery, and nontraditional partners step forward to serve in ways that create a rich and vital tapestry of response that is not reliant on any one resource stream, but empowers collaborative, productive partnerships for future recovery and resilience.

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