

THESIS

THE ROLE OF HUMAN DIMENSIONS OF NATURAL RESOURCES
AND RISK COMMUNICATION
IN MITIGATION EFFORTS DURING FLOOD RECOVERY:
A LYONS, COLORADO CASE STUDY

Submitted by

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ABSTRACT

THE ROLE OF HUMAN DIMENSIONS OF NATURAL RESOURCES AND RISK COMMUNICATION IN MITIGATION EFFORTS DURING FLOOD RECOVERY: A LYONS, COLORADO CASE STUDY

In December 2015 during the 21st conference of the Parties to the United Nations Framework Convention on Climate Change, virtually all the nations agreed on the existence of anthropogenic climate change, the need for a decrease in carbon emissions, and a responsibility to help mitigate its effects (Watt, 2015). It is widely accepted that climate change is a global phenomenon caused by humans that impacts people and will continue to do so (Vitousek, 1997). Until recently, research efforts have focused primarily on identifying human causes of climate change and affecting behaviors that aid in prevention of this phenomenon.

There is a need for research into the impacts of climate change, a systemic problem caused by people, affecting people, and which must be solved by people. Due to the interdisciplinary nature of the problem and the connection to natural systems, climate change stands to be the largest challenge for human dimensions of natural resources (HDNR) professionals to date.

The purpose of this paper is to examine the flood recovery efforts in Lyons, Colorado, considering the implications of climate change and the increase of extreme weather events like the floods in 2013. In the face of uncertainty, HDNR is well positioned to address the social aspect of climate change and inform strategies for both mitigation and response.

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Chapter 1: Problem Statement and Research Question

Scientists predict more frequent occurrences of extreme weather events in unexpected locations due to climate change (IPCC, 2013). The effects are present already and more attention on climate change mitigation and management is needed. The September 2013 floods on the Front Range of Colorado were unprecedented in scope and scale, and may be attributed to climate change-related weather patterns. The recovery efforts of the Front Range involved communities working together to incorporate mitigation and develop a master plan for the watershed. However, community leaders are facing challenges with communication and organization. The lessons from this study will inform town leaders on the methods for the current recovery effort as well as provide a framework for other communities attempting to incorporate mitigation with recovery efforts and increase resiliency in the face of climate change and extreme weather events.

For this study, I was interested in the role of social capital to encourage participation in mitigation efforts related to the recovery from the Front Range floods of September 2013, as well as potential factors that led to development in the floodplain. Chapter 2 is an explanation of the focus of this study, the Front Range Floods in September 2013, and how this event is related to climate change and Human Dimensions of Natural Resources (HDNR). In Chapter 3, visual interpretation through ArcGIS is used to identify the land use and land cover changes that have occurred in Lyons, Colorado. In Chapter 4, qualitative interviews and analysis are used to identify drivers of development in the floodplain as well as methods for community leaders to encourage mitigation in recovery efforts. Chapter 5 is a summary of conclusions and recommendations for Lyons and other towns faced with increased risk of extreme weather events

due to climate change. The overall question guiding this research is: *How can HDNR improve resiliency in recovery efforts from extreme weather events caused by global warming?*

Chapter 2: The Role of Human Dimensions of Natural Resources in Addressing Climate Change

2013 Front Range Floods

In September 2013, the Front Range of Colorado experienced flood events that were unprecedented in size and scope. A disruption in normal climate patterns forced a storm to stall, causing monsoon-like rains. Six rivers and their tributaries in 14 counties were affected. Areas within the epicenter of the storm received 600% of the average rainfall for September. The probability of this storm was between 1/100th% and 1/1000th% (National Climatic Data Center, 2013). As demonstrated in Figure 1, the causes of the storms can be connected to a change affecting the jet stream, which caused the stall (Climate.gov, 2013). The rise in intensity and frequency of storms like this one might be attributed to climate change. The amount of rain, combined with the geography of the region and population density lead to a catastrophic event (National Climatic Data Center, 2013).

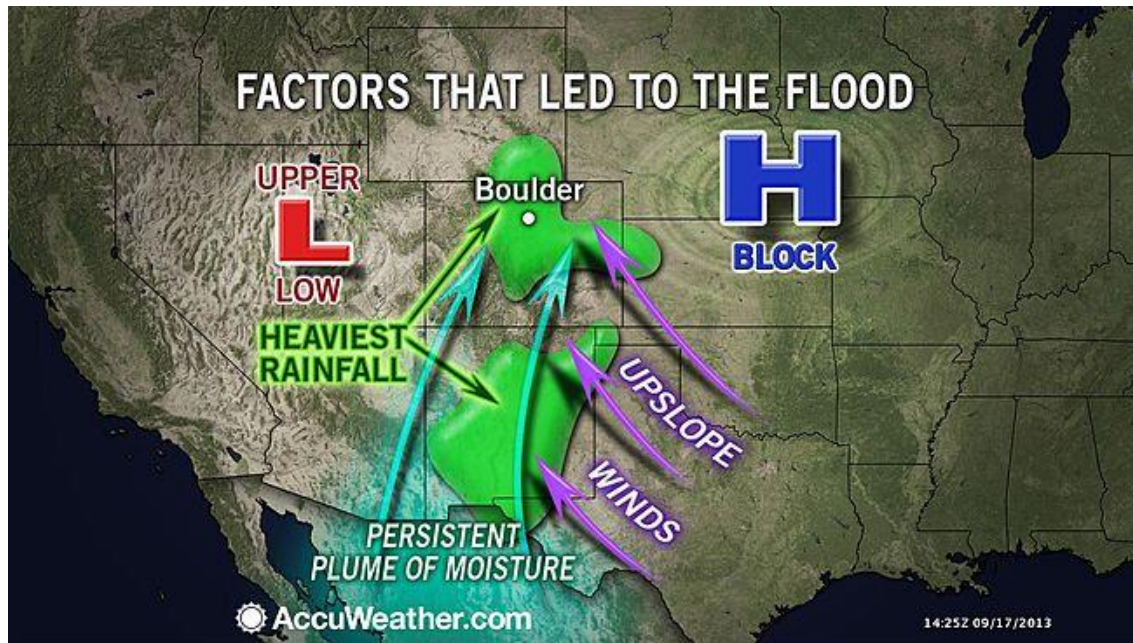


Figure 1. Factors that led to the flood. Reprinted from Why Was the September 2013 Colorado Flooding So Bad? AccuWeather. by A. Sonowski, 2013, Retrieved June 27, 2014, from <http://www.accuweather.com/en/weather-news/colorado-flooding-why-so-bad/17861732>. Copyright [2016] by AccuWeather, Inc. Map credit AccuWeather.

In the wake of the 2013 floods in the Front Range, social capital continues to play a role in recovery efforts. Although government aid is generally available for immediate rescue and relief efforts, communities and individuals are increasingly responsible for the ensuing long-term recovery. In the 2013 floods, many people who were counting on insurance money to recover lost property received as little as half of the compensation amount they expected. The communities who have been successful in recovering quickly from the floods worked on a grassroots level to organize and mobilize recovery efforts. The model from the community response to these flood events can serve to help other communities prepare for or respond to extreme weather events.

Lyons, Colorado

Lyons, Colorado, was greatly affected by the September 2013 floods. The town was isolated by flooded rivers and its population was evacuated. Many residents were out of their homes for weeks or months, with several residents remaining out of their homes for over a year, and some lost their homes entirely and have not returned. The current population of Lyons is over 2,000, an increase of greater than 21% since the year 2000 (State Demography).

The town is located within Boulder County, in the Saint Vrain Watershed, and is 1.5 square miles. This area was originally occupied by the Shoshone and Pawnee American Indian Tribes with record of Cheyenne, Crow, Ute, and Arapahoe migrating through. The first white settlers arrived in 1861 for the sandstone quarries and “health resorts.” The railroad came through in 1884, connecting the town to trade markets for sandstone and gold. While farming and ranching are still present, the primary industry in town is CEMEX concrete. Lyons is a bedroom community for Boulder and is branching out into tourism as the “double gateway to the Rockies,” due to their dual highways that provide access to Rocky Mountain National Park (*Lyons and Surrounding Area Double Gateway to the Rockies the Town Below the Cliff the Quarry Town, 1977*).

Global Climate Change

Climate change is a complex issue riddled with controversy and uncertainties. In its fifth report, the Intergovernmental Panel on Climate Change (IPCC) stated that the climate is warming, and that it is due to human actions releasing greenhouse gasses. According to the IPCC (2013), human-caused climate change has contributed to unprecedented warming of the planet since the industrial revolution due to increased carbon emissions. The atmosphere has warmed,

amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased (IPCC, 2013). Climate change results in changes in the global water cycle, changes in climate extremes, and increased incidence and intensity of extreme weather events (IPCC, 2013). If the status quo is uninterrupted, continued emissions of greenhouse gasses will cause further warming and changes in all components in the climate system (IPCC, 2013).

In Figure 2, the graph on the top shows evidence of global warming trends. The top graph is a graphic representation of the increase in observed globally averaged surface temperature since 1850. The bottom image in Figure 2 is a graphic representation of observed change in surface temperature between 1901 and 2012 (IPCC, 2013, p. 11). Figure 3 (IPCC, 2013, p. 12) represents the increase in anthropogenic (human caused) emissions since 1750, which is generally accepted as the beginning of the industrial revolution. These two figures are evidence that the climate is warming and that it is due to human emissions since the industrial era.

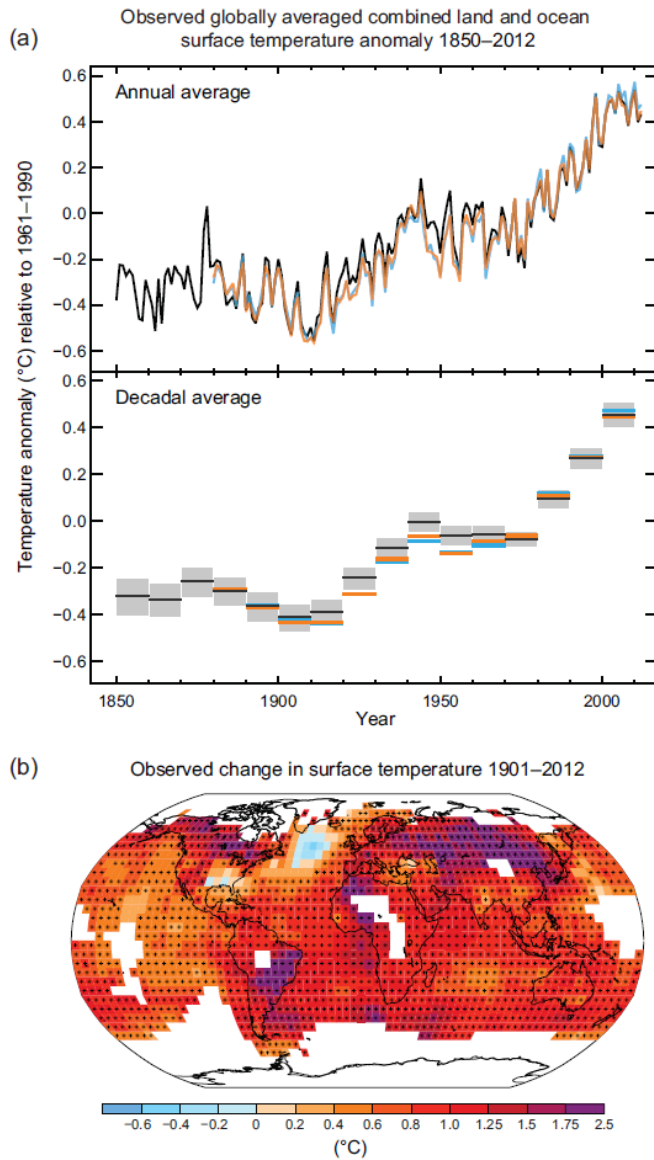


Figure 2. Global warming trends. Reprinted from IPCC, 2013: *Summary for Policymakers*. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 5), T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)] (2013). Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press. Copyright 2013 by the Intergovernmental Panel in Climate Change. Image credit IPCC.

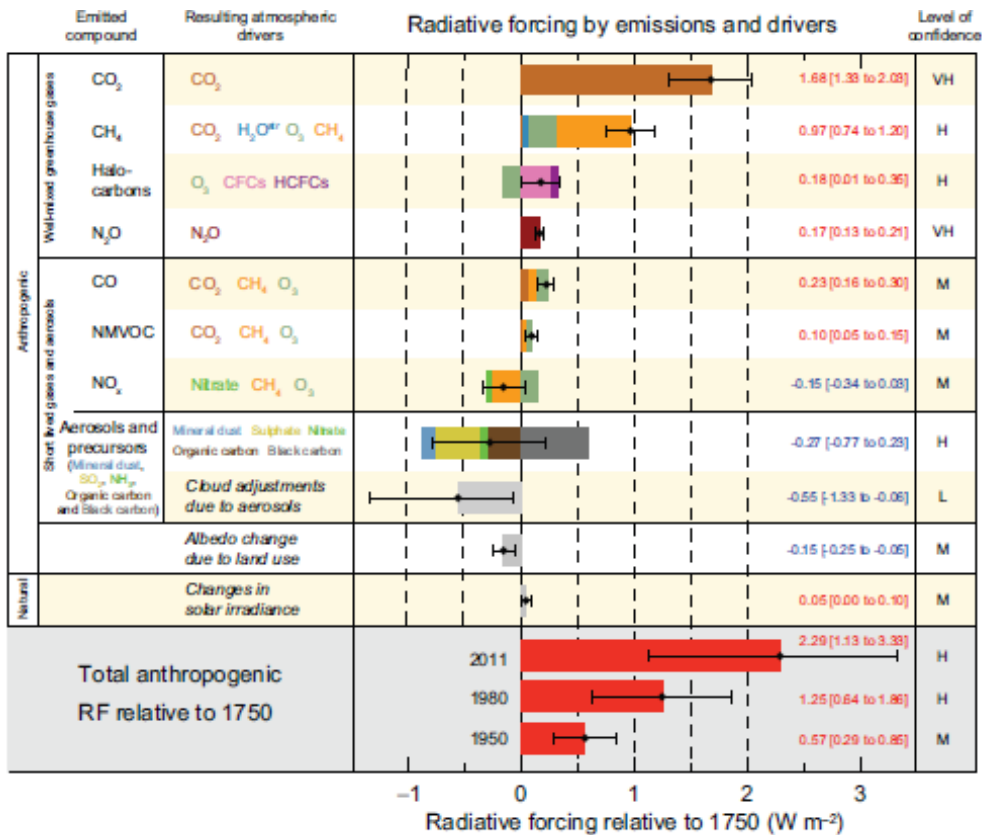


Figure SPM.5 | Radiative forcing estimates in 2011 relative to 1750 and aggregated uncertainties for the main drivers of climate change. Values are global average radiative forcing (RF^a), partitioned according to the emitted compounds or processes that result in a combination of drivers. The best estimates of the net radiative forcing are shown as black diamonds with corresponding uncertainty intervals; the numerical values are provided on the right of the figure, together with the confidence level in the net forcing (VH – very high, H – high, M – medium, L – low, VL – very low). Albedo forcing due to black carbon on snow and ice is included in the black carbon aerosol bar. Small forcings due to contrails (0.05 W m⁻², including contrail induced cirrus), and HFCS, PFCs and SF₆ (total 0.03 W m⁻²) are not shown. Concentration-based RFs for gases can be obtained by summing the like-coloured bars. Volcanic forcing is not included as its episodic nature makes it difficult to compare to other forcing mechanisms. Total anthropogenic radiative forcing is provided for three different years relative to 1750. For further technical details, including uncertainty ranges associated with individual components and processes, see the Technical Summary Supplementary Material. (8.5; Figures 8.14–8.18; Figures TS.6 and TS.7)

Figure 3: Radiative forcing of emissions relative to 1750. Reprinted from IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (p. 14), T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.) (2013). Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press. Copyright 2013 by the Intergovernmental Panel on Climate Change. Image credit IPCC.

According to the IPCC, it is likely that extreme weather, such as heat waves, heavy precipitation events, droughts, intense tropical cyclone activity, and high sea level, will continue to increase throughout the 21st century (IPCC, 2012). For this paper, I have focused on increased intensity and incidence of extreme weather events as an effect of climate change.

Human Dimensions of Climate Change

There is scientific consensus that the climate is changing, although it is difficult to predict exactly what the changes will look like. Humans have built societies and made decisions based on a constant climate; we depend on the moderating influences of atmosphere and climate to protect life (Dietz & Rosa, 2002). Therefore, changes in climate will affect people on many scales. Existing theories on the human dimensions of climate change can inform future research (Dietz & Rosa, 2002). This section will provide an overview of prior research in several related fields, informing the broad scope of HDNR from the individual to the societal level.

Psychology and Climate Change

The role of psychology in climate change discussion is to improve understanding of the function of individual and interpersonal behavior in relation to the environment (Stern, 1992, p. 272). Environmental psychology, as a subfield, focuses on individual interactions with the local environment, which aggregate on a global scale. While the IPCC has identified the distal cause of climate change to be increased anthropogenic emissions of greenhouse gasses, psychological research has identified proximate causes. According to Stern (1992), these causes result from driving forces, including population growth, economic growth, technological change, political-economic institutions, values, and attitudes. The roles of these forces are difficult to determine because they are studied by a wide range of disciplines and because the forces operate in combination and interaction. When materialist values are strong, higher income may lead to

more environmental degradation than when other values predominate (Stern, 1992). However, a shift to “post-materialist” values may do little to halt that environmental degradation if economic conditions, government policies, and technological limitations make it difficult to convert attitudes into action (Stern, 1992). Therefore, it is important to understand both individual actions and driving forces to affect change on an individual level and, to understand these interconnections, relevant disciplines must listen to each other (Stern, 1992). Human dimensions of natural resources is suited as the field to facilitate this collaboration.

The human actions that drive climate change are actions of not only individuals, but also firms, communities, governments, and international organizations. Psychologists, in collaboration with researchers from other social science disciplines, can contribute by considering the outside factors that influence individual behavior, and also how individuals can affect change in organizations and governments. The primary areas of psychological research that are relevant to these endeavors are environmental attitudes, individual behaviors directly affecting the global environment, and individual behaviors affecting collective action. An understanding of these areas will inform ways to affect changes in behavior (Stern, 1992).

Some psychologists advocate for the development of a “super ordinate or meta-discipline of psychology—global-community psychology—defined as a set of premises, methods, and practices for psychology based on multicultural, multidisciplinary, multisector, and multinational foundations that are global in interest, scope, relevance, and applicability” (Marsella, 1998, p. 1282). This is the study of the individual as a member of a global community. The term “global” is meant to dissolve boundaries and emphasize connectedness. This movement seeks to overcome predisposed biases and create a truly global, interdisciplinary effort to revolutionize psychology in response to climate change. While conventional psychology is useful for

understanding, and affecting individual behavior as it relates to climate change, global-community psychology is perhaps a catalyst for collaboration.

Sociology and Climate Change

The field of sociology can help to draw connections between proximate and distal driving forces by connecting the actions of the individual to societal pressures. Using empirical scientific evidence to move past the constructivist perspective that climate change is only happening if we think it is, Dietz and Rosa (2002) advocate for adoption of an evolutionary and normative theory to inform action toward solutions for climate change. The new evolutionary theory they have advanced is concerned with how individuals make certain decisions and how that process can inform normative theory, which focuses on what should be done. Norms, which are expectations of how one should behave and how others should behave in a social group, have been referred to as one of the most powerful tools for human dimensions professionals (Manfredo, 2008).

American economist Elinor Ostrom (1999) presented the evolution of social norms as a response to American ecologist Garrett Hardin's (1968) "tragedy of the commons." The tragedy of the commons is an economic theory about how individuals deplete a common resource, acting independently and rationally in their own self-interests, despite knowledge of the long-term negative consequences for the group. Hardin's focus was on population growth and consumption of natural resources, and it can be applied to climate change if atmosphere is considered to be a common-pool resource (CPR). This idea has been debated and studied extensively in many social science fields. Ostrom's (1999) research suggests that CPRs are moderated by the groups who depend on them using evolved norms. Users of CPRs include the following people: free-riders (individuals who take advantage of the system – taking more than their share and offering nothing in return), those willing to initiate reciprocal cooperation in the hopes that others will

return their trust, those unwilling to cooperate unless they can be guaranteed they won't be exploited, and altruists (Ostrom, 1999). According to Ostrom:

“When the users of a resource design their own rules (Design Principle 3) that are enforced by local users or accountable to them (Design Principle 4) using graduated sanctions (Design Principle 5) that define who has rights to withdraw from the resource (Design Principle 1) and that effectively assign costs proportionate to benefits (Design Principle 2), collective action and monitoring problems are solved in a reinforcing manner” (Agrawal, 1999 as cited by Ostrom, 2000, p. 151).

Norms can be applied on local and global scales to manage common-pool atmospheric resources. The evolution of norms may be aided by the development of social capital.

Social Capital

Social capital, a sociological concept, has been shown to play a role in enhancing collective actions in a context of disaster recovery (Nakagawa and Shaw, 2004). Development of social capital can increase resilience in the face of climate change. Nakagawa and Shaw (2004) from the United Nations Center for Regional Development define social capital as “the function of mutual trust, social networks of both individuals and groups, and social norms such as obligation and willingness toward mutually beneficial collective action” (p. 10). Social capital is the idea of investing in social connections to increase resilience through cooperation. When facing new challenges brought on by climate change, social capital can increase resiliency through cooperation and grassroots organizing.

Political scientist Robert Putnam (1995) writes about the loss of social capital in the United States over the last two or three decades, attributing the trend to one or more of the following causes: movement of women to the labor force, mobility, demographic

transformations, and the technological transformation of leisure. Transformations in culture and society are making it more difficult for communities to build social capital. The same trends leading to globalization and climate change (i.e., industrialization and modernization) also are contributing to the loss of social capital. Strategies to build social capital and mitigate the effects of climate change on society go together.

Nakagawa and Shaw's (2004) research on social capital in relation to disaster recovery can be applied to the social response to climate change. According to the IPCC (2013), climate change will lead to increased occurrences of extreme weather events such as drought, floods, and storms. "Natural events [sic] occur within various processes of nature, however these events become disasters when they affect human lives and livelihoods" (Nakagawa and Shaw, 2001, p.6). According to Nakagawa and Shaw (2004) the three actions for social capital—recognize, preserve/conserve, and invest—will lead to mutually beneficial collective actions within communities. Furthermore, Shaw and Sinha (2003) proposed that risk management frameworks be applied at community, local, state, and central levels. It is the responsibility of the community and its leaders to increase their social capital to manage risk in the post-disaster recovery process.

In addition to improving resilience in the face of climate change, social capital has actual economic value (Knack & Keefer, 2013). Interpersonal trust is important in facilitating economic activity in place of formal substitutes. Therefore, building social capital can be seen as an investment in a community. The benefits of social capital for the focal actor are the following: improvement in the quality, relevance, and timeliness of information; influence, control and power; and solidarity. "For the broader aggregate, the positive externalities associated with a collective actor's internal solidarity include civic engagement at the societal level and

organizational citizenship behavior at the organizational level” (Knack & Keefer, 2013).

However, social capital also carries risks of reinforcing existing power structures and wasted time and effort. In general, the risks of social capital can be mitigated or exacerbated by social and economic structure (Adler & Kwon, 2002). Social capital is valuable when applied thoughtfully with a culturally and politically holistic perspective.

Social Ecological Systems Science

Natural disasters occur when a disruption occurs in the ecosystem on which people depend. Folke et al. (2005), stress the importance of assessing and actively managing resilience, i.e. the ability of a system to absorb recurrent natural and human impacts, and to continue to regenerate without degrading or flipping to less desirable states. Resilience can be managed by recognizing the innate connection to ecological systems and managing the relationship socially and technologically.

A social-ecological system (SES) is an ecological system intricately linked with and affected by one or more human social systems. An ecological system can be defined loosely as an interdependent system of life (Aderies et al., 2004). Humans have been using and abusing ecosystems throughout history and adapting to the changing conditions created; often those responses involve stricter control through domestication and simplification to reduce uncertainty (Folke et al., 2005). These changes may be gradual or sudden, and sudden changes tend to pose challenges for adaptation. The relatively sudden changes of climate change, combined with the large human population and degraded ecosystems, pose a global challenge to adaptation.

Climate change is happening globally and on many levels. Psychology studies individual behavior, and the relationships between individuals and their social and environmental surroundings. Sociology tends to focus more on social groups or, in the case of environmental

sociology, broader societal forces. The study of social-ecological systems takes a broader and more integrated view, highlighting the connections and interdependence between people and ecosystems. This broad view provides another perspective on why studying climate change is so important. Simply put, humans depend on ecosystems. The same processes identified by Putnam (1995) as degrading social capital also have severed the connection people feel with the ecosystems that sustain them. Robustness, defined as “the maintenance of some desired system characteristics despite fluctuations in the behavior of its component parts or its environment” (Carlson and Doyle, 2002, p. 8), focuses on the costs and benefits of systems that can cope with abrupt change. By focusing on the robustness of both social and ecological systems, as well as their interactions, methods to increase resilience in the face of climate change can be identified.

Wildland-Urban Interface

As human populations continue to grow and people move further into wild lands, there is more opportunity for conflict between humans and natural resources. “The wildland-urban interface (WUI) is the area where houses meet or intermingle with undeveloped wildland vegetation” (Stein et al. 2014. p. 11). The WUI is a focal area for human-environment conflicts, such as destruction of homes by wildfire, habitat fragmentation, introduction of exotic species, and biodiversity decline. The trend toward and extent of the WUI highlights needs for ecological principles in land-use planning as well as sprawl-limiting policies (Stein et al, 2014). Human dimensions of natural resources can help people to understand and manage the risk of building and living in the WUI. While this term is generally applied to the risk of wildfire, it is also appropriate for risks associated with building in the floodplain. The risk of fire in the forest is like the risk of floods in the floodplain in that they are both rare enough to be ignored by people interested in building in risky areas for perceived benefits.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) was created in 1968 to protect a vulnerable population. Prior to the 1950s, flood insurance was included in homeowner's insurance. As flood insurance ceased to be profitable, companies dropped it from their policies. Unfortunately, many of the people living in the floodplain were vulnerable, such as the elderly who had already paid off their mortgages and could not afford to move, and others with lower incomes. NFIP was provided by the federal government in exchange for floodplain management ordinances on local and regional levels, as well as mitigation on individual levels, to reduce flood risk in special flood hazard areas. It was meant to be self-sustaining, borrowing from the treasury when necessary and returning with interest. However, with increased flood events due to climate change and repetitive loss properties, NFIP is costing the taxpayers (Holladay and Schwartz, 2010).

It is possible this program is subsidizing the cost of living in the floodplain. The NFIP is currently under appeal to become self-sustaining and remove dependence on taxpayers. There is pressure to change the language from "100 year" and "500 year" to reflect the probability of a flood event any given year (Holladay and Schwartz, 2010). The justification for this is that once a flood event occurs, people are lulled into a false sense of security thinking they are safe for a set number of years. With the changes in the climate, it may not even be possible to predict the probability of natural disasters such as floods. As populations increase and unpredictable weather patterns emerge, people will come into conflict with natural resources more often. It is important to clearly communicate risk so that people can make informed decisions and incorporate mitigation to decrease their vulnerability.

Local Regulations

The Town of Lyons adopted Ordinance 912, regulating building permits in the floodplain in February of 2013. Prior to the adoption of this ordinance, there was no regulation regarding building in the floodplain. In fact, in the 1960's the buildings of the town of Nolan were relocated into what is now known as the confluence neighborhood in Lyons, CO (*Lyons and Surrounding Area Double Gateway to the Rockies the Town Below the Cliff the Quarry Town*, 1977). The confluence neighborhood was created by redirection of the Saint Vrain River and infill to create buildable land, much of which is currently in the FEMA delineated floodplain. The lack of regulation and the purposeful relocation of buildings in the flood plain increased both the risk of damage to buildings from major flood events and tolerance of that risk by homeowners, as this action was directed and initiated by community leaders at that time.

Conclusion

There is an urging across disciplines for an interdisciplinary approach to climate change. As naturalist John Muir (1911) said: "When we try to pick out anything by itself, we find it hitched to everything else in the universe" (p. 110). This description of socio-ecological systems also applies to the fields of research and social constructs of this modern world. Because the world is a global system, climate change has the potential to serve as a great equalizer, crossing borders and forcing cooperation throughout social structures.

There is scientific evidence that anthropogenic climate change is happening. The changes may be swift or gradual, mild or extreme. Humans are tied closely to their ecological surroundings and dependent on a hospitable climate. While efforts in the mitigation of climate change are certainly worthwhile, there appears to be a need for a shift toward adaptive management. As suggested by Albert Einstein, "we cannot solve our problems with the same

thinking we used to create them;” perhaps it is time for an “axial revolution” in education and capacity building to confront the challenges of climate change (O’Brien et al., 2013, p. 49). As population increases, along with the rate of disasters due to climate change, traditional disaster relief methods will be taxed. There is a gap in research regarding community response to natural disasters resulting from global environmental change (Stern 1992). Further research is necessary in this field and will continue to gain attention as more of the population realizes the need for a response to climate change.

Depending on the effects of climate change, there will be need for reform at many levels of society. It is my position that the development of social capital within and among communities is one reasonable way to respond to climate change. Although climate change is a global issue, many of the effects will be local. Any community can be empowered to take the climate change response into their own hands by developing social capital. If communities have their own safety nets, disasters can be mitigated by swift local response. In this case, the community of Lyons can plan their recovery in a way to mitigate future risk of the effects of climate change.

Chapter 3

Investigation of New Structures in the Floodplain in Lyons, Colorado

Between 1999 and 2011

Introduction

Population growth in the Front Range of Colorado is driving development further out of the city centers in the plains and into the foothills, where development is often geographically limited to river valleys and canyons. After the flood in Big Thompson Canyon in 1976, Boulder County began to implement development and building restrictions in the floodplain. However, not all locations and communities were subject to this regulation. The Town of Lyons did not restrict development and building in the floodplain until 2013. This chapter investigates the conversion of open space into structures prior to the 2013 regulation.

The purpose of this chapter is to investigate new structures build in the Town of Lyons between 1999 and 2011, and to identify possible drivers of that development. As development pressures increase, structures are built in vulnerable locations. Additionally, this research will inform subsequent chapters in this paper. As we continue to realize the impacts of climate change in increasing incidence and intensity of storms, there is an intensification of vulnerability for structures.

Physical Impact of Flooding on Lyons, Colorado

Rapid runoff from the steep, impervious terrain of the mountains, combined with ground saturation and overland flow in urban areas led to flooding along a stretch of the Front Range in 2013 stretching nearly 200 miles from north to south (Scott, 2013). The town of Lyons is located in a canyon at the confluence of the upper and lower Saint Vrain Rivers. Development and growth is geographically and topographically limited to the valley floor, which creates

vulnerability to flood events. Figure 4 shows the peak inundation through Boulder County resulting from the September 2013 floods. The floods turned Lyons into an island, causing residents to evacuate and leaving many without utilities for months. The scouring in canyons surrounding Lyons after the 2013 flood in Figure 5 demonstrates the damage and erosion caused by the flood event to the canyons and valley floors.

The flooding caused tremendous damage to infrastructure and changed the landscape through erosion, sediment transport, and deposition. The rain event was concluded to be a 1,000-year event, having a one in 1,000 chance of happening each year. However, the flood event is harder to classify because a flood occurring today will have much different effects than one 100 years ago (Scott, 2013).

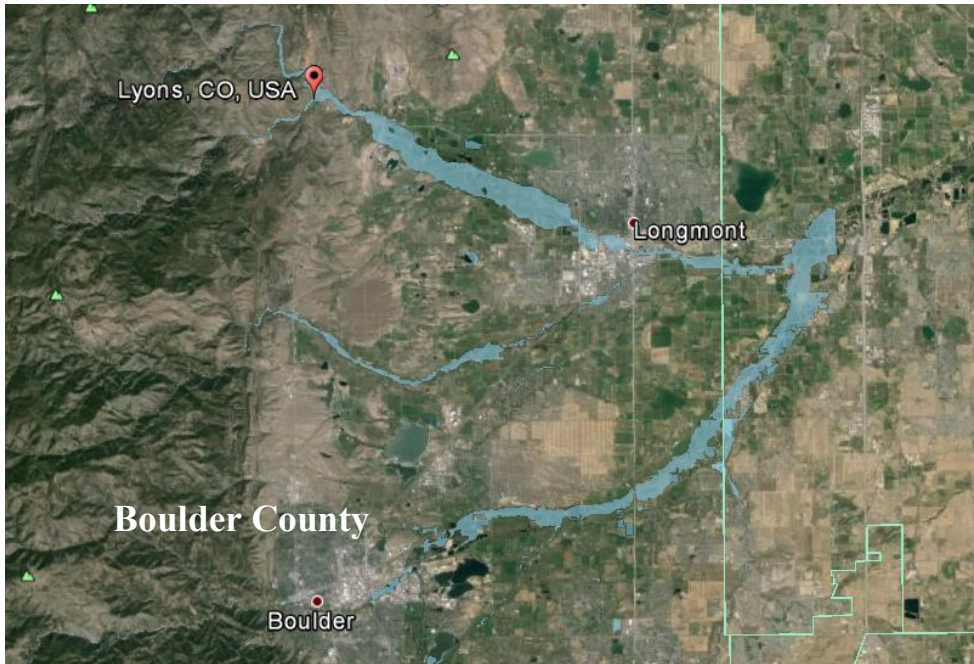


Figure 4. Flood inundation in Boulder County. Map reprinted from *GoogleEarth* by Google Inc (2009) Retrieved from <https://www.google.com/earth/>. Copyright (2014) by Google. and shapefile reprinted from *Boulder County geographical information system (GIS) downloadable data*. Retrieved February 2014 from <http://gis.bouldercounty.opendata.arcgis.com/>. Copyright 2014 by Boulder County, CO. Image credit Google Earth and Boulder County GIS.

NASA Earth Observatory
September 16, 2010

NASA Earth Observatory
September 16, 2013



Figure 5. Scouring in canyons surrounding Lyons after the 2013 flood event. Map reprinted from *NASA Earth Observatory* by J. Allen and R. Simmon, using EO-1 ALI data provided courtesy of the NASA EO-1 Team. Retrieved from

<http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=82174>. Copyright (2014) by

NASA. Image credit NASA Earth Observatory.

Research Question

Although this flood was rare, there was a similar flash flood event to the north in the Big Thompson Canyon in 1976. In response to the damage caused by that flood, Boulder County implemented development and building restrictions in the floodplain (Simons et al., 1978). However, municipalities within the county can establish their own building and development regulations. The Town of Lyons did not adopt Ordinance No. 912, regulating construction in the floodplain, until February 2013. Lyons, perhaps in response to strong development pressure and demand for housing, increased its population 21% between 2000 and 2010, primarily through new construction. The purpose of this study was to identify the land use and land cover change in the floodplain in Lyons between 1999 and 2011, specifically the conversion of open space into

development or similar structures, and the implications of this development for damage in the 2013 flood.

Methods and Data

For this study, I used visual interpretation with ArcGIS (Lillesand, Kiefer and Chipman, 2008). Two aerial photographs were used to compare land cover. The aerial photograph from 1999 is a digital orthophoto quadrangle (DOQ) aerial photograph from USGS Earth Explorer. The aerial photograph from 2011 is a National Agriculture Imagery Program (NAIP) aerial photograph. In addition, the following Environmental Systems Research Institute (ESRI) shapefiles from Boulder County Geographic Information Systems (GIS) were used: 1) Flood 2013 flood inundated preliminary, 2) Federal Emergency Management Agency (FEMA) floodplain, and 3) municipalities and parcels.

ArcGIS drawing tools were used to outline and create a vector overlay of the land cover of the two air photos, using GoogleEarth and ground-truthing to confirm land cover type. The land cover was classified into the following categories: residential, municipal, transportation, commercial, and open space. In addition, each classification was applied to the following flood zones: FEMA 100, FEMA 500 and actual inundation. For this study, agricultural land was classified as open space, with agricultural structures classified as residential. Dirt roads and parking lots were classified as open space if there were no permanent structures. Major roads were included in transportation, while neighborhood roads were included in residential.

To analyze the land cover change in Lyons, numeric codes were created for each shapefile classification within ArcGIS. The overlay functionality union in ArcGIS was used to compare the two land-cover maps. The two air photos were compared, along with the vector

overlays, in ArcGIS to measure the change of land cover between the 1999 photo and the 2011 photo.

Additionally, Boulder County shapefiles showing land price were overlaid on the 2011 air photo so that land price could be compared between the floodplain and surrounding areas.

Figure 10 demonstrates the results of this overlay.

Results

The Boulder County shapefiles were laid over on the two separate air photos to determine actual inundation from the 2013 flood compared with the FEMA 100 and 500 floodplains. This marked the study area (see Figures 6 and 7 below). Figure 8 contains the 1999 air photo with the land cover categories applied in a vector overlay. Figure 9 contains the 2011 air photo with the land over categories applied in a vector overlay. Vector overlay of categories of land use allows quantification of land use by type, which allows for comparison.

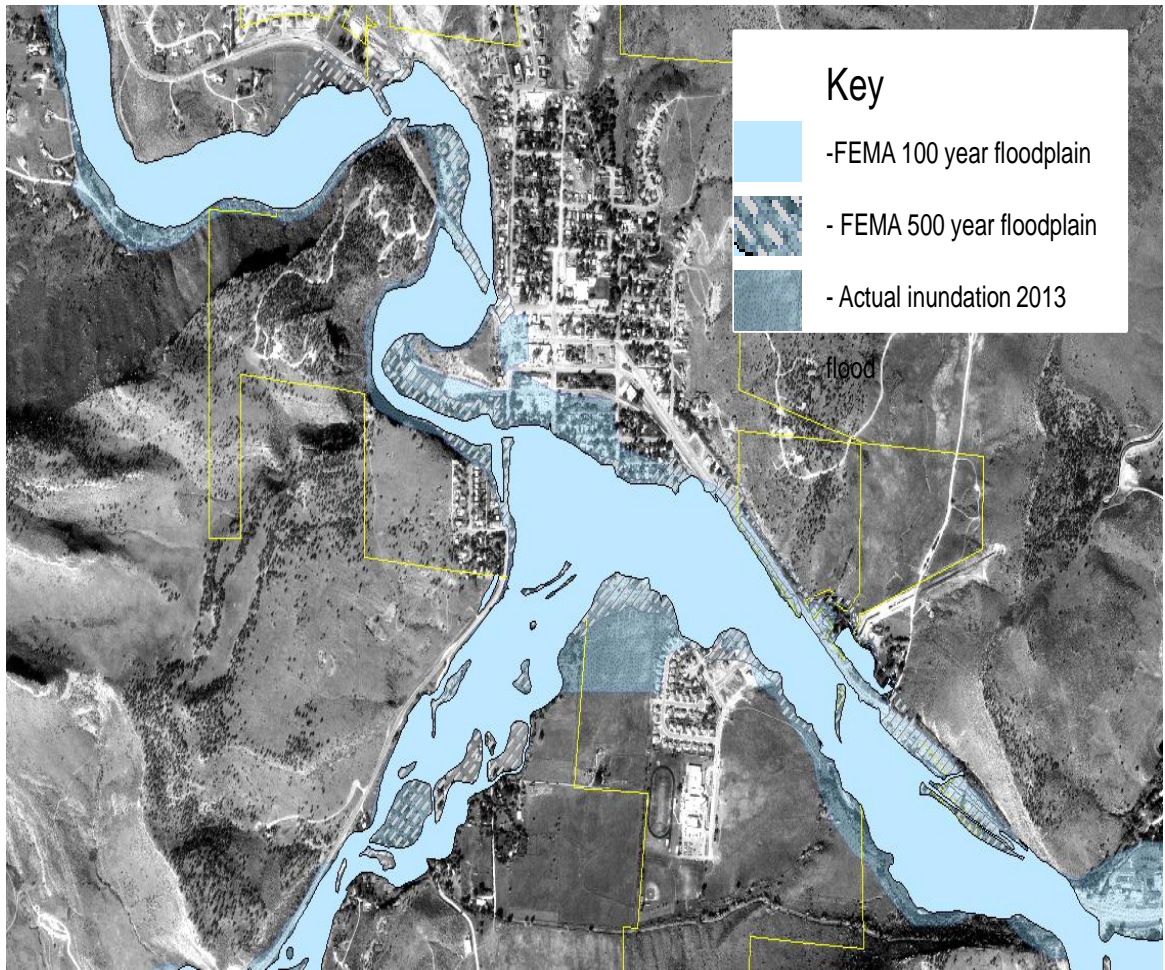


Figure 6. 1999 air photo with FEMA 100, FEMA 500 and 2013 inundation; DOQ October 4, 1999 air photo with Boulder County shapefiles overlaid. Reprinted from *USGS Earth Explorer*. Retrieved March 5, 2014 from <https://earthexplorer.usgs.gov/>. and from *Boulder County Geographic Information Systems*. Retrieved March 5, 2014 from <http://gis.bouldercounty.opendata.arcgis.com/datasets?keyword=floodplain&geometry=-107.526%2C39.77%2C-103.146%2C40.401>. Image Credit USGS Earth Explorer and Boulder County GIS.

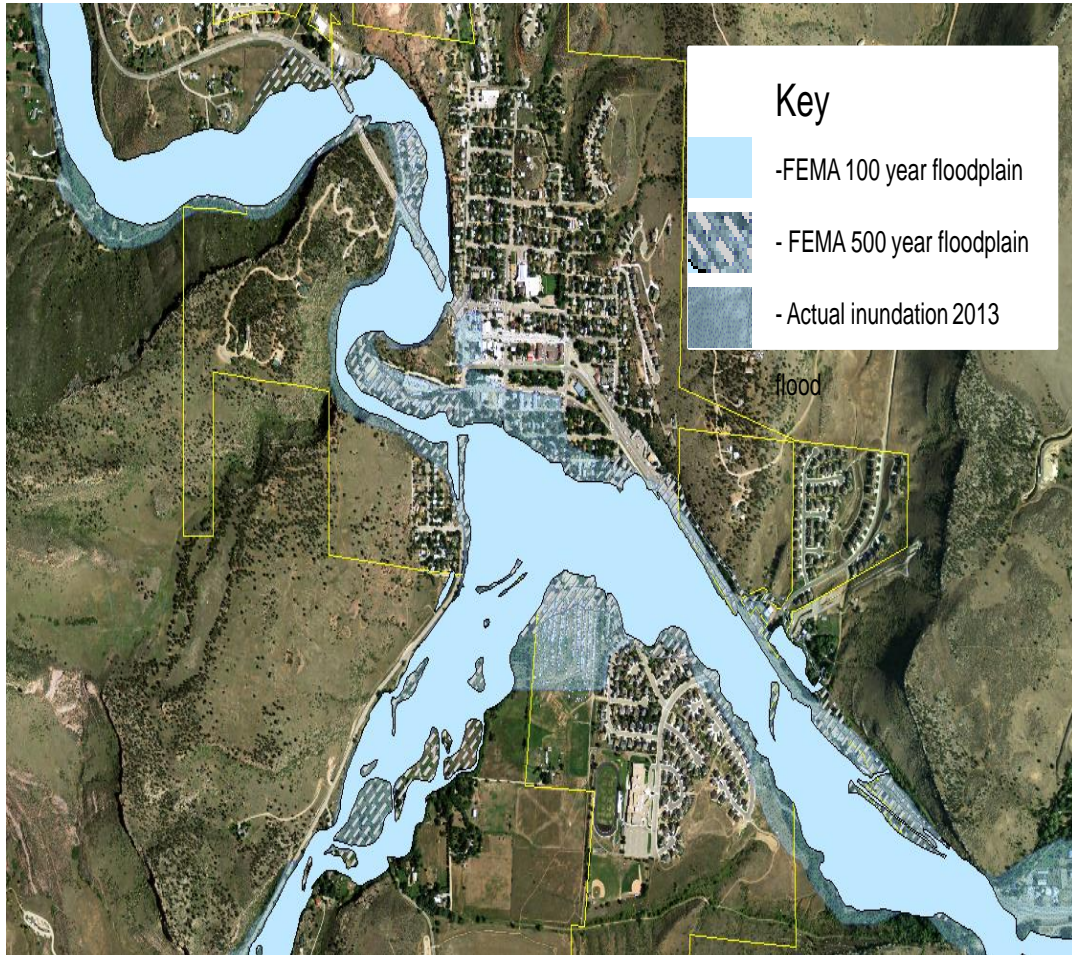


Figure 7. 2011 air photo with FEMA 100, FEMA 500 and 2013 inundation; NAIP July 30, 2011 air photo with Boulder County shapefiles overlaid. Reprinted from *USGS Earth Explorer*. Retrieved March 5, 2014 from <https://earthexplorer.usgs.gov/>. and from *Boulder County Geographic Information Systems*. Retrieved March 5, 2014 from <http://gis.bouldercounty.opendata.arcgis.com/datasets?keyword=floodplain&geometry=-107.526%2C39.77%2C-103.146%2C40.401>. Image credit USGS Earth Explorer and Boulder county GIS.

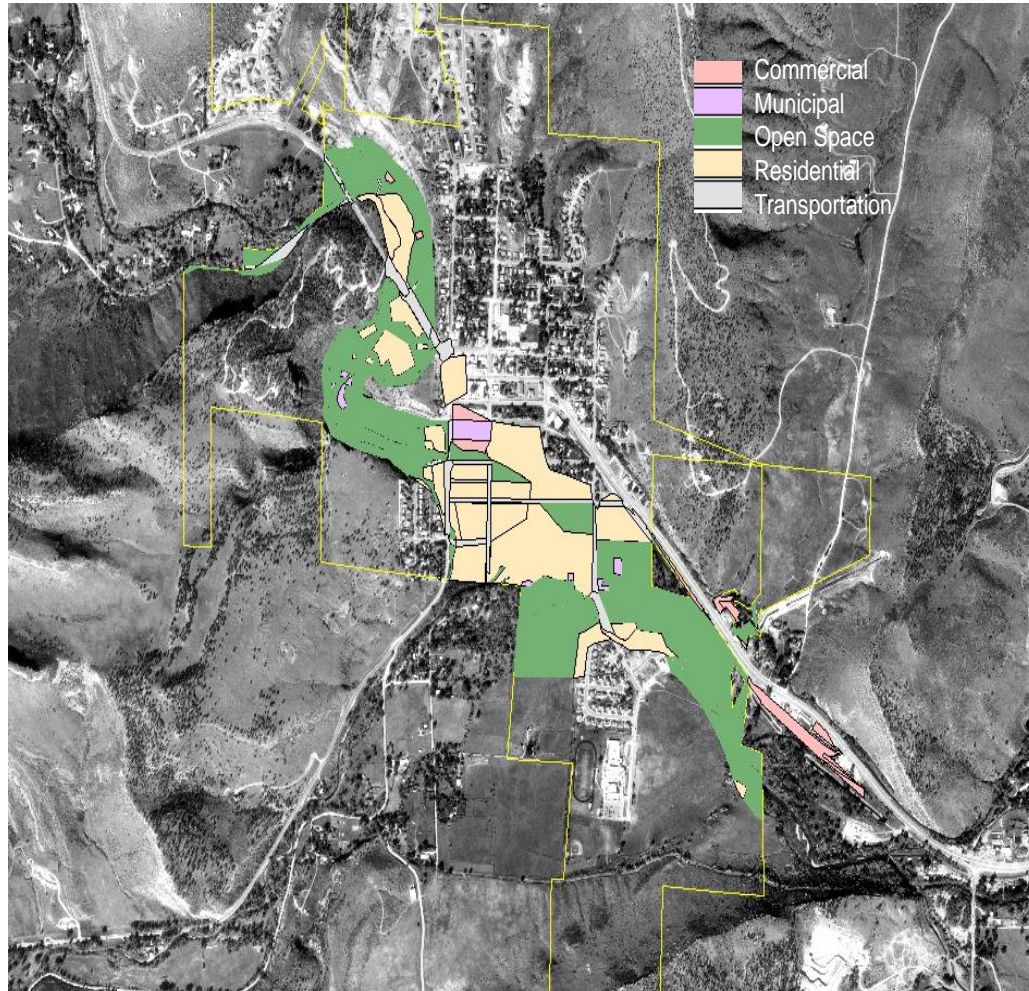


Figure 8. 1999 land cover and land use; DOQ October 4, 1999 with Boulder County Shapefiles and ground cover vector overlay. Reprinted from *USGS Earth Explorer*. Retrieved March 5, 2014 from <https://earthexplorer.usgs.gov/>. and from *Boulder County Geographic Information Systems*. Retrieved March 5, 2014 from <http://gis.bouldercounty.opendata.arcgis.com/datasets?keyword=floodplain&geometry=-107.526%2C39.77%2C-103.146%2C40.401>. Image Credit USGS Earth Explorer and Boulder County GIS.

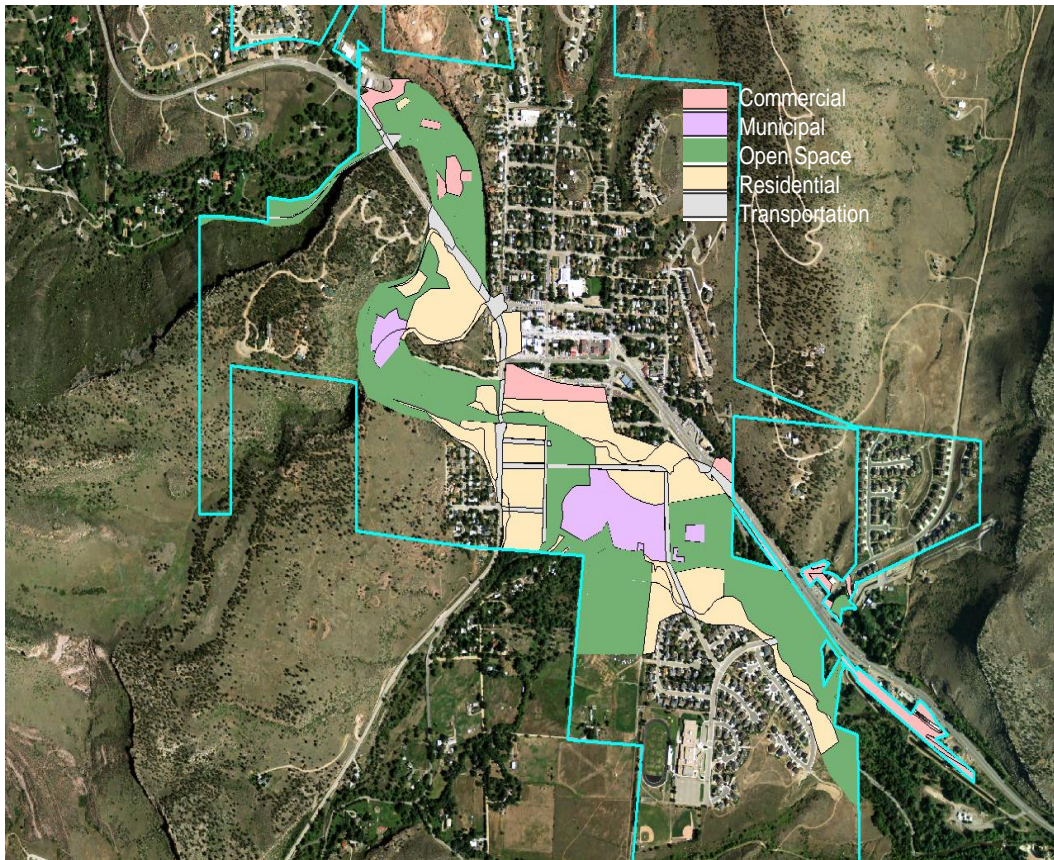


Figure 9. 2011 land cover and land use; NAIP July 30, 2011 Air Photo with Boulder County shapefiles and ground cover vector overlay. Reprinted from *USGS Earth Explorer*. Retrieved March 5, 2014 from <https://earthexplorer.usgs.gov/>. and from *Boulder County Geographic Information Systems*. Retrieved March 5, 2014 from <http://gis.bouldercounty.opendata.arcgis.com/datasets?keyword=floodplain&geometry=-107.526%2C39.77%2C-103.146%2C40.401>. Image credit USGS Earth Explorer and Boulder County GIS.

Table 1 and 2 summarize the land change in the FEMA delineated 100- and 500-year floodplain between 1999 and 2011. Table 1 shows conversion from open space to other types of land use. Table 2 shows conversion of other land uses to open space. The change in land cover type was recorded in square meters and converted into acres for simplicity. Of the 80.2 acres in

the FEMA delineated 100- and 500-year floodplain in 1999, 28.3 acres were open space.

Between 1999 and 2011, 16.1 acres of that open space were converted into residential, commercial, or municipal use. During that same time, 3.7 acres were converted from other land uses to open space, resulting a net loss of open space during that time of 12.4 acres. Of that 12.4 acres, 7.9 acres was within the FEMA-delineated 100-year floodplain.

Table 1

Land Use Change from Open Space in FEMA 100 and FEMA 500 Floodplain between 1999 and 2011

Land Use Type 1999	Land Use Type 2011	Area (acres) in FEMA100 floodplain	Area (acres) in the FEMA500 floodplain	Total Area (acres) in FEMA100 and FEMA500 floodplains	Δ in Area from Open Space to Development from 1999 to 2011 (acres)
Open Space	Residential	7.9	3.6	11.5	11.5
Open Space	Municipal	1.8	0	1.8	1.8
Open Space	Transportation	0.4	0.1	0.5	0.5
Open Space	Commercial	0.6	1.7	2.3	2.3
Open Space	Open Space	5	7.2	12.2	0
TOTAL					16.1

Table 2

Land Use Change to Open Space in FEMA 100 and FEMA 500 Floodplain between 1999 and 2011

Land Use Type 1999	Land Use Type 2011	Area (acres) in FEMA100 floodplain	Area (acres) in the FEMA500 floodplain	Total Area (acres) in FEMA100 and FEMA500 floodplains	Δ in Area from Open Space to Development from 1999 to 2011 (acres)
Residential	Open Space	0.1	1.3	1.4	-1.4
Municipal	Open Space	0.3	0	0.3	-0.3
Transportation	Open Space	1.3	0.5	1.8	-1.8
Commercial	Open Space	0.2	0	0.2	-0.2
TOTAL					-3.7

According to Figure 10, the lot price of land in the floodplain is less expensive than other locations. Each color represents a price range for land. In the floodplain, there are 69 white lots (\$0–\$137,000), 26 blue lots (\$137,000–355,500), one green lot (\$355,500–\$554,900), and one yellow lot (554,900–1,065,000). There were two exceptions of more expensive lots within the floodplain: the green lot included a public park and the yellow lot included part of the old city center commercial area.

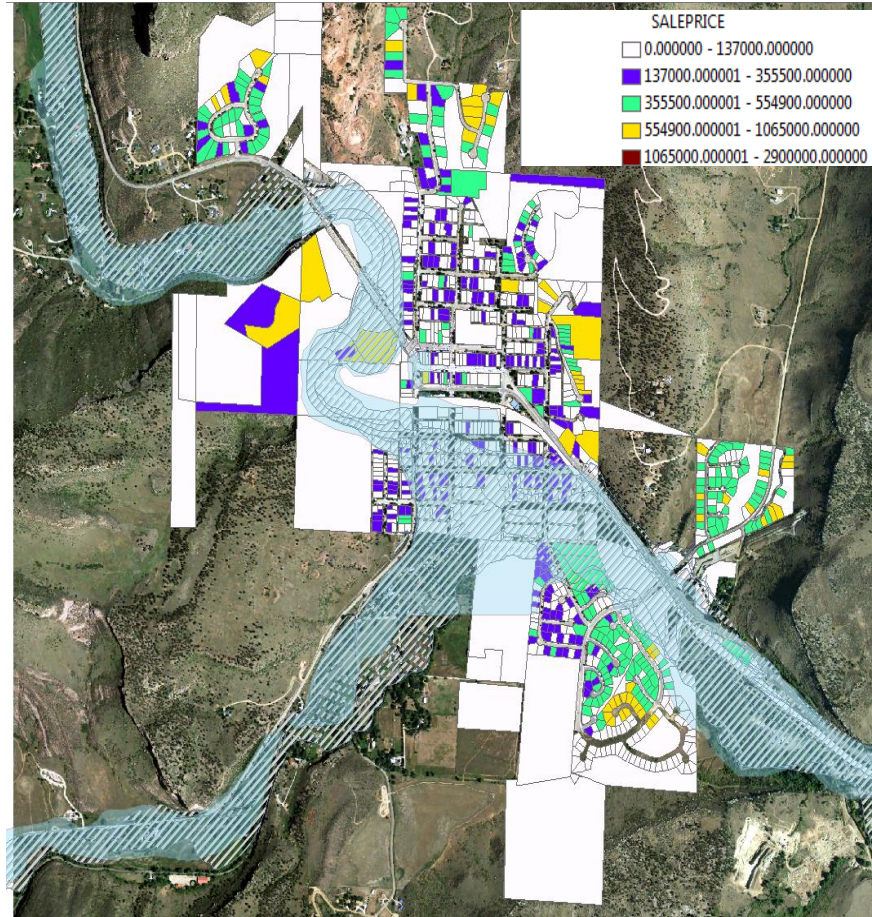


Figure 10. Lot prices in Lyons 2012; parcel sale price with floodplain overlay. Reprinted from *USGS Earth Explorer*. Retrieved March 5, 2014 from <https://earthexplorer.usgs.gov/>. and from *Boulder County Geographic Information Systems*. Retrieved March 5, 2014 from <http://gis.bouldercounty.opendata.arcgis.com/datasets?keyword=floodplain&geometry=-107.526%2C39.77%2C-103.146%2C40.401>. Image credit USGS Earth Explorer and Boulder County GIS.

Discussion

The purpose of this research was to identify the land use/land cover changes in the flood plains and areas of inundation within the town of Lyons, specifically conversion of open space into development. In addition, this research applies land use / land cover change theory to

speculate as to the drivers of the land change in the floodplain, which may inform policy regarding building in floodplains.

The town of Lyons is 960 acres, 80.2 of which is in the FEMA delineated 100- and 500-year floodplain. More than one-third of the land in the floodplain is residential and less than a third is open space. Between 1999 and 2011, 16.1 acres of open space were converted to structures, the largest portion (11.5 acres) to residential. What allows people to build structures in the floodplain despite the inherent risk? Population growth is high, topography limits the development options, and property values are high thereby making less expensive, albeit riskier, property options more desirable, such as plots in a floodplain. Additionally, there are federal policies incentivizing building in the floodplain, or at least making it seem more acceptable. What everyone failed to consider was the potential destruction if a major flood event were to occur, events that have become more frequent around the globe due to climate change

Recreation and changing values around nature in addition to Lyons's proximity to Rocky Mountain National Park may have impacted development. With the connections built by globalization, people can live further from work, and impacts can be far-reaching. Lyons is becoming a bedroom community for Boulder, which accounts for part of the increase in population. As attitudes change and more people have free time for recreation, Lyons has opportunities for growth as the double gateway to the Rockies. Since 1999, Lyons has undergone revitalization to recruit residents and tourists alike. This has led to development along the river to encourage recreation. As Lyons becomes better known for recreation opportunities, and the Front Range in general expands, more people are looking to move to places such as Lyons. Due to its location and size, building opportunities are limited and more people build in the floodplain

There was substantial amount of development in the floodplain in Lyons even after Boulder County adopted floodplain restrictions following the Big Thompson Canyon flood in 1976. The proximate drivers of the conversion of open space into buildings may be financial and demographic in nature. As population increases and more people move to Lyons as a bedroom community for Boulder, there is pressure to develop Lyons to meet the needs of the influx of residents. The topography of the canyon limits buildable land to flat areas around the rivers. Additionally, as demonstrated in Figure 10, land prices in the floodplain have been historically lower than surrounding properties. It is important to understand what is driving the land change in the floodplain in Lyons so that managers can incorporate mitigation into rebuilding efforts and hopefully prevent new permanent structures in the floodplain.

If zoning allows for building in the floodplain and land is available to purchase, development will continue in the floodplain. Ordinance 912, regulating building in the floodplain was not adopted by the Town of Lyons until February 2013. This will require new buildings are constructed out of the floodplain, but there are older structures remaining in the floodplain that are at risk for flooding. In addition to local policies and pressures, regional and federal policies and pressures may influence peoples' choices regarding building in the floodplain. Additionally, as mentioned in Chapter 2 of this paper, federal programs such as the National Flood Insurance Program (NFIP) may, in effect, subsidize the risk of building in the floodplain.

Conclusion

Policies from decades ago may not work today, given climate change and the anticipated increase in the frequency of extreme weather events. Community leaders and planners should revisit their policies and ethics allowing development in the floodplains. Development pressure increases as Colorado's population continues to grow. Land use planners need to have the

fortitude and wisdom to balance land use decisions with real risks of climate change. Regulations preventing construction in the floodplain are a step in the right direction, but more needs to be done to retrofit existing structures in the floodplain and increase resilience in the face of floods.

Limitations and Opportunities for Further Research

This study included a small area and was large scale, which does not allow for generalization or protection from error. In addition to scale, error was present in the digitizing of the photographs, as well as the projection into the coordinate system and conversion from three dimensions to two. These factors combined led to eight meters of error. This study could be replicated to other areas and regions easily following the methods of visual interpretation explained by Lillisand et al. (2008). This study was meant to look at a small area and inform further research. This research informed the next chapter of this thesis, in which follow up will include qualitative interviews, observations, and content analysis to gain a better understanding of the flood recovery efforts in Lyons. In the next chapter, remarks about flood recovery efforts made by Lyons residents displaced by the floods and community leaders is reported. Specifically considered are perceptions of risk of living and rebuilding in the floodplain, the role of social capital, and risk communication in encouraging mitigation efforts within the recovery to increase resilience to future flood events.

Chapter 4:
The Role of Risk Communication in the Inclusion of Mitigation
In Flood Recovery Efforts

Literature review and research question

In the face of extreme weather caused by climate change, it is not reasonable or wise to attempt to solve new problems with old solutions. Extensive literature exists on the causes and potential effects of climate change and while the exact consequences of climate change cannot be predicted, strategic plans to mitigate risk before and after natural disasters can be developed. Climate change is a global challenge, and in that challenge, lays an opportunity for people and communities to grow stronger. As these disasters increase in frequency and severity, communities must come together and empower each other to find solutions. This research fills a gap in literature regarding community solutions for climate change and the incorporation of risk communication. This research will inform communication strategies for communities recovering from natural disasters.

As people make decisions regarding rebuilding their homes, it is important to consider mitigation and resilience in the likelihood of future flood events. For people to work toward mitigating future risk, they must understand the risk of recurring flood events. Research shows that social capital can help in communicating risk and responding to risk (Mileti, 2012). Research exists on the value of social capital in reducing vulnerability as well as methods of risk communication. This chapter will apply a theoretical framework from risk communication literature to the flood recovery efforts in Lyons.

Risk Communication

Extensive literature exists on the topic of risk communication from several different disciplines. Mileti's 2012 meta-analysis stemming from a workshop on public response to alerts and warnings, summarizes findings from the social science world regarding risk communication and public response to alerts and warnings during public disasters. According to Mileti (2012), two types of behavior apply to public warnings and risk communication: public behavior and warning provider behavior. Public behavior in response to warnings is variable, but also predictable and malleable—meaning community leaders can influence public behavior with effective risk communication. Warning providers are individuals in a leadership role communicating with the public. Warning provider behavior is predictable and well researched and best practices have been established based on observations and past experiences. People operate based on their objective realities, or what they think is real, which is formed in part by interacting with others. Warnings tell people they are not safe and, consequently, they “mill” around, or interact with others to get more or confirm information with others. This “milling” intervenes between receipt of a warning and protective action-taking, which results in public protective action-taking delay. The result is a response gap.

Mileti (2012) presents the following theoretical framework for decreasing the public response gap: message filter, message content, message delivery, message style, information management, and monitor and re-warn. Message filter describes audience factors that influence how people process the warnings. Message content describes what is said in the warnings, including the timing, location, and explanation of warning as well as who is delivering messages. Message delivery relates to the number and type of channels as well as the frequency of communication. Message style relates to how the message is stated. Information management

includes the follow-up to initial communication. Monitor and re-warn is the monitoring of public response and adjustment of communication efforts based on public response. These are the six key areas for warning providers to focus on when framing warnings. Warning providers must identify the audience they are messaging and craft an appropriate message for each subset of their audience. Warning messages must be clear, concise, and accurate and should be delivered often through several methods. Additionally, it is important for warning providers to monitor public response, insure the accuracy of warnings, and correct misinformation. Figure 11 is a visual adaptation of Mileti's (2012) risk communication framework.

Risk Communication Framework

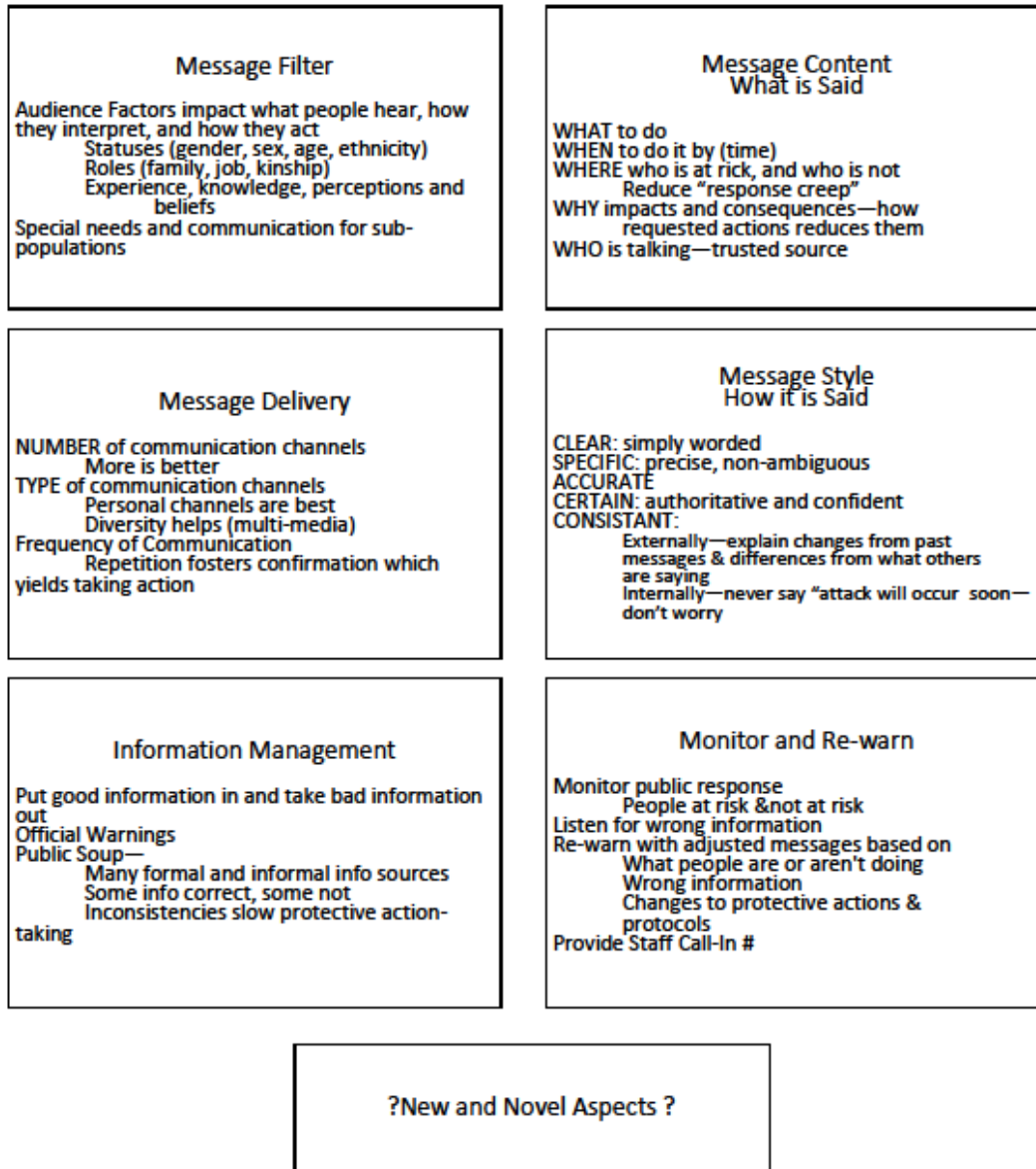


Figure 11. Visual adaptation of Mileti's (2012) risk communication framework. Adapted from Public Disaster Warnings: Highlights of repetitive findings from the social science research record. Workshop on Public Response to Alerts & Warnings via Social Media Research Council of the National Academies. By D. Mileti, 2012, Irvine, CA.

Research Question

The Mileti Risk Communication Framework was applied to both form the questions and interpret the results from interviews with Lyons residents to identify areas in which warning providers were successful and areas in which they could improve. Additionally, this research sought novel aspects of risk communication in the efforts in Lyons. The research questions are: *Were community leaders effectively communicating the risk of future flood events to residents considering rebuilding efforts in the floodplain? How did, or can, community leaders use existing risk communication frameworks to encourage land-owner participation in mitigation related to recovery from floods? Was implementing risk communication a good way to discourage rebuilding in the floodplain to reduce vulnerability in future flood events?* The findings may inform future communication efforts.

Methodology/Research Design

The approach for this research was a case study, which included immersion in the setting and the worldviews of both researchers and participants (Marshall & Rossman, 2011), looking at society and culture, and the focusing of inquiry on groups or organizations. The purpose of a case study is to gain an understanding of a specific, unique, bounded system (Stake, 2005). While the outcome of the research may inform decisions, generalizability is not the goal. Lyons is a fairly small case, rich with data for research questions. Interviews were used to triangulate experiential knowledge and understand the constructed perspectives of the case study. Responses of each interview were compared to understand perspectives of participants, and to construct a holistic interpretation of the situation. The case was clearly bounded by the geographic and municipal boundaries of the town of Lyons. The phenomenon studied was the flood recovery

effort Lyons. I am interested in the risk communication efforts of town leaders and how those efforts affect community member actions toward mitigation efforts.

The decision to study Lyons, Colorado was based on the recommendation of individuals close to and with an important role in the issue.

Interviews. Participants were selected using opportunistic sampling through contacts made at community meetings. The interviews were prepared according to the guidelines of Rubin and Rubin (2012), which entailed an interview guide with open-ended questions, based on Mileti's (2012) risk communication framework (see Appendices 1 and 2). The questions sought detail, depth, vividness, nuance, and richness, and included a face sheet (see Appendix 3) and post interview guide (see Appendix 4) to keep track of the social characteristics of the interviewees and surrounding details (Rubin & Rubin, 2012).

For the interviews, I established myself as a researcher and clearly introduced my topic and prepared an introduction on what to disclose regarding my research at the top of my interview guide (Weiss, 1994). I started with broad questions asking how the interviewee was affected by the flooding and his or her efforts toward recovery. I followed up with questions regarding awareness of and participation in community mitigation efforts, and concluded with questions about risk and actions to mitigate that risk. For community leaders, I focused on questions about communication methods to warn community members of risk; for community members, the focus was on perceived risk and reception of risk communication from community leaders. The interview guides are attached as Appendices 1 and 2. Demographic information and situational details are recorded on a face sheet (Appendix 3). I worked to develop trust (Rubin and Rubin, 2012, p. 79) with respondents by informing them of their right to stop the interview at

any time. Additionally, I volunteered for community efforts to support individual homeowners' efforts to recover and rebuild following the 2013 flood.

Interview subjects were assigned a code to protect privacy, and represented by a colored dot on the map of Lyons floodplains. Table 3 displays the interview subjects, their demographics, role in the community and reference code. Figure 12 displays where each community member's home is located within the confluence neighborhood and within the FEMA delineated 100 year and 500 year floodplains.

Table 3

Interview Subject Descriptions and Reference Codes

Reference Code	Title	Relevant Social Characteristics
CM1	Community Member 1	Caucasian female, mid-70s, retired, homeowner, home inundated by floodwater, home is now 40 feet from riverbank, lost 6 feet of property when river bank was washed away by floodwaters, repair underway, currently displaced from home
CM 2	Community Member 2	Caucasian female, early 50s, homeowner, home inundated by floodwater on the first floor, repair underway, currently displaced from home
CM3	Community Member 3	Caucasian couple in late 70s, homeowners, home inundated by floodwater, repair complete, currently living in home
CM4	Community Member 4	Caucasian male, mid 40s, renter, first floor of home inundated by floodwater, currently living in home
CM5	Community Member 5	Caucasian female, mid 30s, homeowner, home inundated by floodwater, repair underway, currently displaced from home
CM6	Community Member 6	Caucasian female, late 50s, homeowner, home inundated by floodwater, currently renting another house in the neighborhood that was not inundated
	Clean-Up and Construction Coordinator	Caucasian male, late 40s, town employee, home not inundated by floodwater
	Economic Development and Community Relations manager	Caucasian female, late 40s, town leader, employee, home not inundated by floodwater
	Deputy Town Clerk and Town Administrator	Caucasian female, late 40s, town leader, employee, home not inundated by floodwater
	Stream Team Recovery Task Force Leader	Caucasian male, early 50s, town leader, volunteer, home not inundated by floodwater
	Watershed Masterplan Consultant	Caucasian male early 50s, consultant for Colorado Water Conservation Board, home not inundated by floodwater.

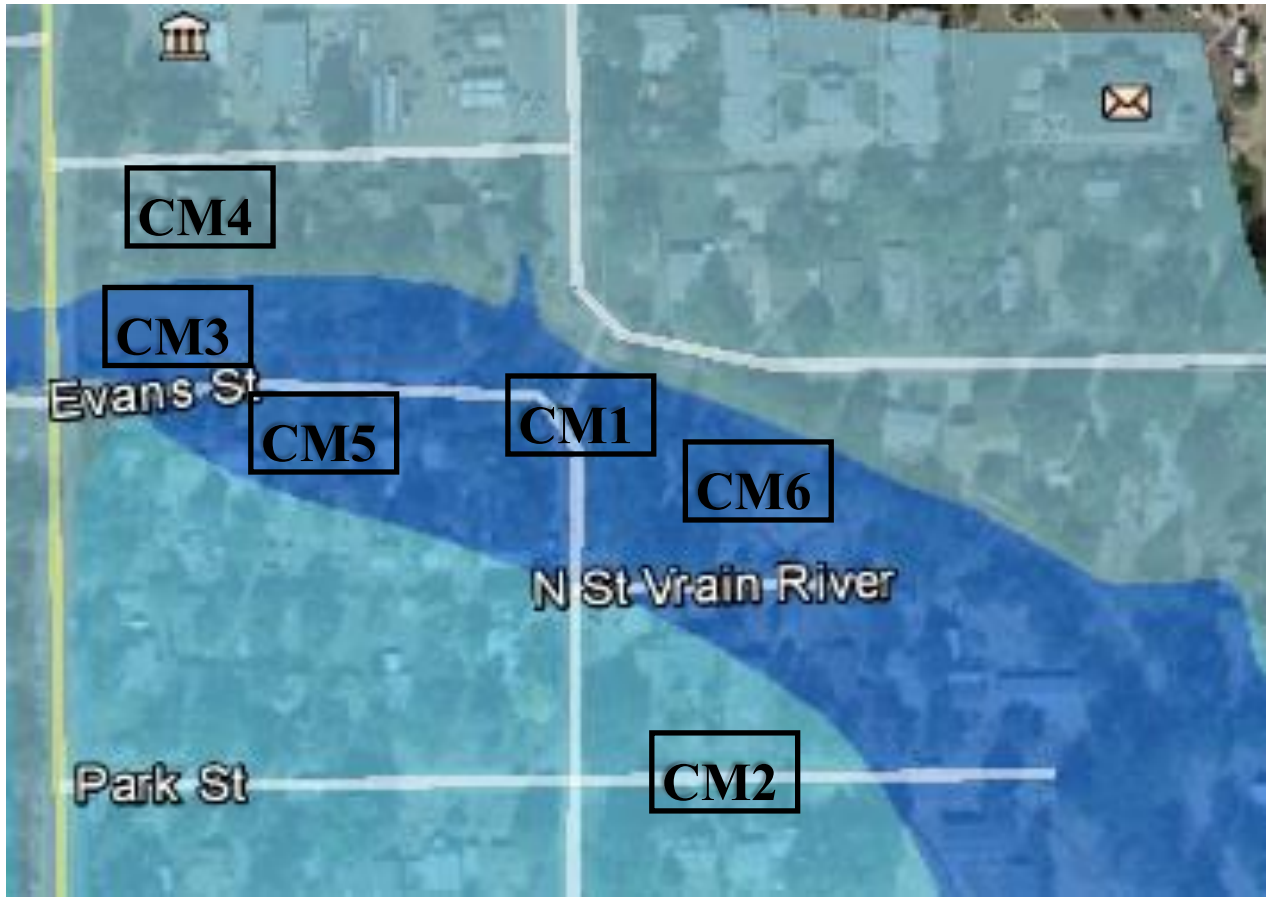


Figure 12. Community member interview subjects' location within floodplain in the confluence neighborhood

Sampling. Opportunistic sampling commonly is used and consists of taking a sample of people available at the time of the study who meet specified criteria (Marshall and Rossman, 2011). For this study, the criteria for community members was people whose homes had been inundated by the floods and who were currently undergoing the process of rebuilding. The criteria for community leaders was town employees or volunteers in a leadership role in flood recovery efforts. Cases were selected based on relevance to the research questions, and for feasibility and access. Leaders of the town of Lyons were interviewed first, followed by snowball

sampling of residents whose homes were identified as being in the flood zone as shown on a map created with ArcGIS (Appendix 5) (Biernacki and Waldorf, 1981).

The focus was on one neighborhood within Lyons, identified as “The Hole” or the confluence, which was hardest hit by the floods in this area. This neighborhood consisted of several blocks of homes, many of which were initially built in the early 1900s in the now-abandoned mining town of Holden, but moved to their current location in the 1960s.

Data analysis. I was reflexive in my analysis and adapted my methods as necessary during and following each interview. I was interested in the narratives from a naturalistic epistemology, which meant I gained knowledge through observation and recognized that reality was subjective; but in the end, I attempted to find a best practice from a more critical perspective (Rubin and Rubin, 2012). To be reflexive, I referred to prior research to confirm meanings and themes. I designed questions to incorporate what I learned to dig deeper into what I wanted to know. I wanted to use what I learned to inform my questions, without making assumptions.

Interviews were recorded, transcribed, and coded according to the guidelines for constructing grounded theory developed by Charmaz (2012). Coding in grounding theory requires two phases: initial and focused coding. Initial coding consists of studying fragments of data for their analytical import. Focused coding consists of selecting the most useful initial codes and comparing them against the rest of the data (Charmaz, 2012). Once the interviews were transcribed, I read through them and completed initial coding, looking for common and repeated themes throughout the interviews. Initial codes were informed by Mileti’s (2012) risk communication framework. After initial coding (Marshall and Rossman, 2011), I applied the risk communication framework from the literature review (Appendix 6) as codes to develop memos. The categories on the framework were used to develop a coding system and write memos,

allowing identification of areas that were strong and those that were missing from the communication efforts.

Findings

By applying the risk communication framework to the results from the community interviews, areas of strength and opportunities for town managers to improve each area of the framework were identified.

Message Filter

Each respondent had filters - factors that impacted what they heard, how they interpreted the message, and how they reacted. Several message filters were identified as barriers for risk communication in respondents: emotion, perceived threat of future flooding events, frustration and perceived alienation, economic status, age, and experience and/or knowledge. Each of the quotes below is demonstrative of one of the message filters expressed by respondents.

Emotion was a message filter for both community leaders and community members rebuilding after the flood. According to the economic development and community relations manager: “It’s difficult for people who are victims. They have themselves to focus on after their world is turned upside down. They must focus on them. We have to deal with every single person who thinks they are the worst off, which is hard because everyone who was affected has their own set of issues and problems.”

The Lyons clean-up and construction coordinator reminded me several times to “be gentle” with the displaced community members as their emotions were still raw and they were going through a grieving process for their homes and belongings. While attending a confluence meeting, those raw emotions were observed. Many people still were struggling with what to do

about the rebuilding process. It was difficult for the people who were still emotionally raw to listen to any overall risk communication message.

Perceived threat of future flooding events was a filter for many community members. As a certified flood plain manager, the Lyons' Economic development and community relations manager said there was a 1% chance each year of another flood similar the one that occurred in September 2013. They said each homeowner reacts differently to this information.

“Some people get it and some people don't due to circumstances, point of view, or perspective. They do not understand the process and they are fighting, kicking and screaming, and feel like they are getting punished or singled out or even victimized again. You can't always change that perception. It would be great if we could talk to each person, however that person has to be receptive and willing to hear it. That is part of town government period. It is always the case.” – economic development and community relations manager

“The Biggert-Waters Act said we cannot afford to subsidize flood insurance as a society.” The Town of Lyons did not take a hard line on this topic, they waited for the federal ruling. The NFIP is currently under appeal and revision. Town officials encouraged residents to mitigate beyond current recommendations to protect themselves from changes in legislature. This message was difficult to deliver because even town employees did not understand the risk until after this flood event. – clean-up and construction coordinator

These displaced residents were mostly unaware of the risk of their property flooding. Even though they all were in the FEMA delineated floodplain, they were either unaware of the risk, or unwilling to accept it. Respondent CM1 stated simply: “I've been here since '78. I've had the water crest the banks twice and been within a foot of my house, but I didn't understand the severity of it. We didn't think about this when we moved in... Yeah, this was my little piece of paradise. I actually rented this house for a year and then talked to the owner about buying it from him and this was it. This was my spot and this was where I was going to be.”

Respondent CM2 was unaware of the flood risk until closing on her house, at which point it did not seem like an obstacle to pay for flood insurance. “No, I found out at closing I needed

flood insurance and at the time it was \$20 a month. That was 29 years ago... I was in my 20s and it wasn't a big deal.”

Respondent CM3 was not required to purchase flood insurance and did not anticipate a risk of flooding on their property, stating that they were unaware they were in the floodplain when they moved in 40 years ago.

Respondent CM4 was a tenant in a home and specifically asked his landlord about flood risk. The tenant was told it hadn't been an issue in the 13 years the landlord owned the house. The tenant was not affected by the floods, but the basement area used by the landlord was completely flooded.

When asked if she anticipated the risk of her home flooding, CM5 stated: “Well, we live on the river, so yes.” But she decided to accept the risk because her home had been in her family for a long time.

When asked if she anticipated the risk of her house flooding, CM6 responded: “We moved in 1981. Yes, we knew we lived on the creek. We accepted that there might be a flood any time. I mean, you could have a flood any time. Initially we were rated in a 500-year floodplain, which means you have a 5% chance every year of having a substantial flood. In the 32 years before we had the flood, we never had more than one situation where the water came up into the yard. I think we were lulled into a somewhat false sense of security.” This response is an example of the confusion that exists around the current terminology of the FEMA-delineated floodplain. The idea of a 500-year flood is hard for people to conceptualize and easy to ignore.

Residents generally were aware of the risk associated with the floodplain, but they lived there because they either did not see the risk as considerable, inherited the property, or could not afford to live elsewhere. The economic development and community relations manager admitted

that even she did not fully appreciate the flood risk in Lyons. The town did not have an ordinance on building in the floodplain until 2012, and then only in reaction to FEMA threatening probation. People were drawn to the character of Lyons and the beauty of the river, two factors that took precedence over flood risk.

Frustration and perceived alienation from the town created a filter for CM5. “It would be nice to get anything. A knock on the door, a phone call, or anything at all. They made no effort whatsoever... They don’t want us to rebuild here, they would rather us leave. So, they’re not giving any information. That’s the way we all feel.” This person had received building permits from the town and was aware of the mitigation measures necessary for her property. Although this person was receiving information from the town and participating in the process, when asked about communication efforts from town leaders, she denied any outreach from the town. Her frustration and perceived alienation from the town was a filter.

Economic status was a filter for CM2, who stated: “Lyons is expensive! If your house gets destroyed and the buyout tops out at \$250,000 you cannot afford to buy another house. Boom! You’re out, and they want every single person to come back.”

Age was a filter for CM3, who was part of an elderly couple who did not feel comfortable participating in the community efforts because they could not hear very well and had a hard time understanding what was being said. The respondent said: “When we talked to the FEMA people, it’s hard to understand them.” The process for recovery is complicated and if there are preexisting barriers to understanding, people may be discouraged to the point of not receiving the message at all. The elderly couple expressed frustration with the process, which was alleviated to an extent when they were assigned a contact trained to work with senior citizens. In addition, the elderly couple mentioned that it would be physically and financially impossible for them to

incorporate expensive mitigation measures due to the condition of their home. Fortunately for these people, they also had family members in town helping them with the process.

Experience and knowledge were a barrier for CM6, as she stated, “I don’t know anything about (the permits).” Fortunately, she had a friend who is an architect helping her with the process. Respondent CM6 understood the residual risk of rebuilding in the floodplain and was raising her house on stilts to mitigate that risk. Although Lyons is a small town, with the confluence being an even smaller subset, status and experience have impact on what people hear, how they interpret, and how they acted in this situation. According to the Economic development and community relations manager, some people understood the process and were participating willingly, while others resisted because they had the perception of being singled out. Most of the people interviewed had positive feedback regarding the efforts of the town, while G4 had the perception that the town had not contacted her at all even though she clearly was receiving town resources.

A wealth disparity was also salient. The displaced residents in the confluence were aware that many of the wealthier residents of Lyons were back in their homes within a few weeks after the flooding and were not dealing with the same personal challenges that they were, which led to some resentment in “The Hole” neighborhood toward the rest of Lyons. This resentment may make it difficult for the town leaders to get through to begrudged displaced residents.

Town officials acknowledged these audience factors and have worked toward addressing the special needs and communication for sub-populations. They attempted to reach out personally to each displaced resident to identify needs and offer information. The approach to handle each case individually is time consuming, but allows the message to be adjusted for different audience factors.

“As to the effect filters have on what individuals hear and interpret from what is actually said “The overall picture is protecting the river, protecting our homes. We live in this beautiful place and it comes with responsibility. Yes it’s only 1% chance, but it’s going to flood again. It’s not just responsibility to yourself. That’s the bigger message. We have tried to share, but it’s not always received because people are so into their own personal recovery because it’s still so fresh and so painful. So very real... we try to balance that message of you should do this and we know how sensitive and fragile you are too. It’s not just you, it’s all of you. Everyone hears a different message no matter how many times you say the same thing. So that’s a challenge from our point of view. Not just the time and energy spent, but the way the message is received. How many ways are there to share it so that it gets home without offending someone or angering them? Instead we want them to absorb it in a way to apply it.” – economic development and community relations manager

While each respondent had their own unique combination of filters, the following message filters were represented among respondents: economic status, age, experience and knowledge, perceived threat of future flood events and frustration or perceived alienation. It is important for town leaders to be aware of existing message filters throughout the community so they can develop messaging to break through these filters, or barriers to deliver their message. The economic development and community relations manager demonstrates that town leaders are aware of existing message filters, but are struggling to break through the barriers they cause. The message the economic development and community relations manager is using to attempt to break through the message filters is that the town cares about each member, although this message is not getting through to everyone.

Message content: *What is said and who says it*

There were mixed responses from community members as to what the message content from town leaders was. Some community members expressed that they trusted their town leaders and understood the information they provided, while others distrusted town leaders and the information they provided. As stated by town leaders below, it was difficult for town leaders to

form a message because there were many unknowns. Their main message was to tell the community that they cared and update community members as information became available.

“There is no push from the town. There are the programs available, these are the rules. What do you want to do? Not here are individuals that ask, ‘would it be crazy to build back there?’ Of course! But those are conversations that happen at the coffee shop or dining room table [and not officially from town leaders to displaced citizens rebuilding homes in the floodplain].” The town clean-up and construction coordinator is explaining the difficult position town leaders are in wanting to make residents feel welcome and comfortable, while also discouraging people from rebuilding in the floodplain.

When asked if she trusted the town leaders and the information they were providing, CM2 said, “Absolutely, they only know what they know.”

“FEMA came in and did some revamping and looking at the waterways and what happened. As a result of that flood way, there was some hesitation initially about letting any of us remain in our places and rebuild. And then FEMA stepped in and said with certain guidelines, yeah you can do it. But the whole process, in the flood way, every step I do, I have to get permits and have to submit plans. The town will look at it, and they will accept or reject it. They will look at it again and again and again. Finally the approval.” – CM1

According to CM5: “They (town officials) don’t want us to rebuild in here; they would rather us leave. So, they are not giving any information. That’s the way we all feel.”

According to CM4: “There was FEMA and the town, and constant meetings at the Life Bridge Church once it got organized, several times a week. Then it divided out into communities and became more and more organized as they realized the scope of the damage. It’s still up in the air in the confluence area. They are making decisions about what to do—to take the buyout or not.”

The main message is that ‘FEMA requires that you build your house out of the flood plain and floodway. In the flood plain it is much easier because the flood plain is further away from the river and not as dangerous and you can elevate a minimum of one foot above. You can do more based on your insurance premiums...FEMA is not going to keep paying people to rebuild their homes in the flood way or plain. What they are saying instead is spend money to elevate and reduce our payouts to you, otherwise it will not keep coming. Something has to improve. That is not the case with us. This is our first major flood in 40 years. Nothing like this has happened in any of our careers or lifetimes,

so it's all new. So if you thought you had an idea of what it is like to live in the floodplain; no one had any idea. Our event gained national attention. - economic development and community relations manager

The clean-up and construction coordinator highlighted the differences between Lyons and Boulder stating, "Lyons was a complacent community", whereas Boulder prohibits building in the floodplain. Lyons has been slow to establish clear regulations regarding building in the floodplain. Ordinance 920 [Town of Lyons municipal code concerning flood damage prevention] was not created until 2012 after urging from FEMA and NFIP. The ordinance lists qualifications for building in the floodplain. If one person in the town does not follow the rules, everyone can lose their insurance. According to the Lyons clean-up and construction coordinator, the town officials put a great deal of effort into finding the correct answers to community members' questions. The official message from the town was to provide options and let homeowners decide what to do with their property. However, town officials encouraged homeowners to exceed the current requirements so that they still would conform when the regulations likely change with new data in coming years.

Message content was challenging in this case because information was coming from different sources and often was perceived as confusing or contradictory. In addition, town officials limited their communication to mostly describing options, but not making choices for displaced residents and risk being viewed as the bad guys.

The displaced residents who were listening and participating in the meetings about recovery trusted the town officials, often more than they trusted other entities such as federal agencies offering information, as stated by CM3 above. Town officials had a very important role to digest the information coming from all the different sources and provide options to displaced residents. Additionally, town officials had to answer to the rest of the town regarding the

decisions that were made to direct town resources to the confluence neighborhood, as explained by the economic development and community relations manager above. Up until then they had been providing information as it was available to them without a unifying message.

FEMA designated who was at risk, but the information was not available to provide clear instructions on what to do, when to do it, and the impacts and consequences, as explained in comments by community members above. There was a clear delineation of choices for homeowners to decide what they wanted to do with their property. However, the town officials were not strong with the overall message of the necessity of mitigation for the good of the town. Respondents were clear on the rules and regulations around rebuilding, but there was not a clear message pushing for mitigation and preparation for future flood events.

Message Delivery

There were mixed assessments from town leaders and community members on the quality of message delivery. Some community members shared that there were many avenues for message delivery, while some respondents expressed that information was not readily available.

According to the Lyons clean-up and construction coordinator, information regarding mitigation was available and delivered when homeowners applied for building permits through the town. He stated: "I think when you go get a permit for your house. I can't imagine you couldn't learn about all of this. You are going to learn about this. There is not a car going around saying, 'Attention! New flood regulations!' It's more like, how could you not learn about it and study it? How could you not go to these meetings?" That is to say resources were available and he expected people to seek answers and understand.

According to the economic development and community relations manager and the deputy town clerk, emails went out to everyone in town so that everyone was informed about

what the town was giving and receiving in grants and money. She said it was much more difficult to convey in a public setting what needed to happen to rebuild on individual private property. Such information needed to be conveyed in one-on-one meetings about each person's specific situation, which is very time-consuming.

According to CM1: "The word-of-mouth communication with the neighbors down here has been super; the town has done an excellent job on their emailing to the residents on different things." When asked if there was any way he wasn't contacted that he would have liked to have been, he stated: "I can't say there was... The rest of the community was proactive. I was proactive."

Both CM2 and CM6 expressed that they did not have computers, which made it difficult to access information remotely while evacuated, but they were still able to get the information through meetings and phone calls. Respondent CM6 stated: "Occasionally I came to the house and found printed information stuck to the door. That was a great way to get a hold of me as a non-computer person."

Lyons town officials did a thorough job with message delivery. Between emails, Facebook pages, door-to-door visits, fliers, mailings, phone calls, surveys, open-forum meetings, scheduling meetings, and seeing walk-ins they exhausted all possible avenues for communication. When a few residents voiced concerns that they were missing information because they did not have computers, town officials reacted quickly and found a solution with phone calls and mailings. Town officials kept in constant communication with displaced residents about the recovery process and continually asked for feedback about the process. Respondents expressed frustration with dealing with large federal agencies such as FEMA and NFIP, but felt the message was easier to understand once town officials oversaw delivery.

Residents generally knew who to contact for specific needs. However, the clean-up and construction coordinator may have identified a gap in message delivery stating that he expected people to find out on their own the information regarding permitting. It would be helpful to disseminate this information in the avenues available and identified by respondents.

Message style: How it is said

There was consensus among respondents that the message style of the town leaders was preferable to that of FEMA and other government organizations.

According to CM2: “You have to understand that with FEMA and NFIP, if you ask the same question of 10 different people, you get 10 different answers... The messages from the federal government were confusing, but once it came from the town, it was clearer.”

CM6 mentioned frustration and confusion at the beginning of the recovery process regarding what was going to happen in the confluence: “The confluence was always to be determined, to be determined. Always last on the list; it was always TBD (to be determined). We don’t know when you’re going to be back. We don’t know when city services will be back.” The message was clear, but the town did not have the answers that people were looking for.

The message style was dictated by available information. At first it was unclear, ambiguous, inaccurate, uncertain, and inconsistent, but as information became available and town officials become more confident in the situation, the message style improved. Town officials put much time and effort understanding the information that was available and delivering it to displaced residents. They were very careful to confidently state what they did and did not know. The messages were as clear and specific as they could be according to community leaders. They remained as consistent as possible and clearly explained changes.

Information Management

Information management is especially difficult in this situation. While there are several avenues for dissemination of information, it is difficult for town leaders to monitor how that information is being perceived and misinformation that may be spreading. The consensus was that town leaders did the best they could with the limited staff available.

The economic development and community relations manager expressed the difficulty they are having managing information and the desire for an additional staff person. When asked how they were managing information, they stated, “Our website, E-blast and face book and I am not that strong with that overall message. That's where I have all my flow charts that I have been creating my letters my message. I can get PSA's from FEMA. But I need me staff to do that. It is not as strong as it could be as soon as I have somewhere in here we are going to blast them with info.”

The watershed masterplan consultant had been hired by the Colorado Water Conservation Board to help with a regional plan for the flood recovery efforts. When asked about the biggest challenge in the recovery efforts, they stated “I still think the biggest challenge is communicating and getting the proper message out to the people who need to hear it. And during this flood there were a lot of different messages, all circulating out there. Whether it was part of the work what size event or what happened or what people are going to do in the future, or where the rivers are going to go later. That kind of thing. So, a lot of it was hearsay. So being able to develop a messaging strategy that really works. I think has to be done on a local level and community by community.”

Respondent CM2 decided to implement flood mitigation when she discovered that her neighbor across the street was saving \$2,000 per year on flood insurance after incorporating

mitigation. Respondent CM2 was an example of the possible benefits of what Mileti called “public soup,” which is the idea that community members seek out each other to confirm and understand warnings and messages from community leaders.

Another example of public soup came from respondent CM3: “I don’t hear too good. It’s too many people and I cannot hear well. We went to two or three (meetings). Our neighbor and other family members keeps us informed; our daughter-in-law goes to all (of the meetings) and lets us know what’s going on. Everyone keeps us informed. Maybe some bad information.” This comment showed that some people might not receive information if they only depended on official warnings. It would be wise for the town to monitor the public soup to be sure the information circulating is accurate.

According to CM2, messages were often confusing and conflicting: “Depending on who they sent, they gave you a different story. That took a long time to shake out.”

Information management can be easier in a small community, however, Lyons town leaders expressed that there wasn’t enough staff to monitor all the information. During community meetings, they sought understanding among attendees and made sure the information was interpreted correctly, but they couldn’t monitor what happened to the information out in the community. Aside from hiring additional staff, the town leaders seem to be doing all they can to manage information. They would ask those in attendance to report back to other community members, but only after officials were sure the message would be delivered correctly. When officials came across misinformation, they attempted to find the source and correct it immediately. The people interviewed for this study had correct information that matched the messages from town officials.

Monitor and Re-Warn

Like information management, consensus was that the town leaders did the best they could with limited resources.

The communication efforts evolved as more information became available, as explained by CM4: “It progressed. I think there was a continuous progression as they found out new info. How badly was each piece of infrastructure damaged? They had to assess it. They took logical steps. There was FEMA and the town, and constant meetings at the Life Bridge Church once it got organized, several times a week. Then it divided out into committees. It became more organized as they realized the scope of the damage. It’s still up in the air in the confluence area. They are making decisions as to what to do. To take the buy-out or not.”

The Lyons clean-up and construction coordinator expressed concern that the Facebook pages were “full of rumors,” but people could walk into town hall to seek clarification.

According to the economic development and community relations manager, “The community floodplain management program is important to the entire town because mortgage companies will not lend money to people who have homes in the floodplain without flood insurance. If the town not participate as a community, individuals could not have flood insurance. It would be damaging to the entire town if FEMA placed the town on probation for not managing the floodplain. I responded to a confluence email blast to open a line of communication, answer questions, listen for wrong information, and re-warn with adjusted messages. These resources are currently focused on the nuts and bolts of permitting and other recovery questions, but I would like to develop and present a unified message about the importance of mitigation and send it out to the entire town. I would like the town’s officials to

bring in the reality factor of thinking about the recovery process in the context of the next big flood.”

Town officials made themselves available to the community and delivered consistent messaging with updates as appropriate. They monitored public response and updated the message as more information became available. However, they could have benefitted from re-warning. There was some reluctance to warn people about the residual risk of future flood events because of the raw emotions. Although there was uncertainty surrounding the rules and regulations, one thing was certain: the more mitigation, the better. It is important to warn people about the possibility of another flood as people make decisions regarding their rebuilding process, they should be encouraged to go above and beyond the current regulations as they are financially able. The suggested framework provides a simple warning message that can be repeated as necessary. The economic development and community relations manager expressed her concern that many people consider the 2013 a fluke and have put it out of their minds, thinking it cannot happen again in their lifetime. It is important to have a strong, clear, simple warning in each communication so that people can deal with the residual risk of possible flooding.

New and Novel Aspects

A few new and novel aspects presented in the data may contribute to the role of risk communication in impacting mitigation efforts in the recovery process of residents in the confluence neighborhood of Lyons. These aspects are social capital and norms, and lack of regulation.

Social Capital and Norms.

Several respondents referenced the character of the Town of Lyons as a factor in the recovery. Social capital and social norms are concepts discussed earlier in this paper. Because Lyons is a small community with a strong social network, town leaders can capitalize on the existing social capital and norms to help them get their message out. Citizens from the town rallied together to support each other and get the work done.

The Lyons clean-up and construction coordinator stated that Lyons had great communication because the town is small, and the damage was localized and contained, as opposed to a situation in a large city, such as New Orleans that had extensive damage over a large area after Hurricane Katrina in 2005. “We have trailers washed away over there and houses over there. You can see it with your eyeballs and say, okay, here it all is. The town only has 15–20 employees. To watch these people in action and the way they communicated was amazing. We had amazing huge meetings, something like 500... out of 2,000 residents--that is an incredible response for any type of town meeting... It’s an amazing place to be a displaced resident; you can talk to the top officials in your town... If you are going to have a disaster, this is the place to have it because it is the right size.”

According to CM1: “Lyons is probably setting a precedent for the state of Colorado and for a little town. They have done an awesome job and I hope somewhere down the line they truly get recognized for all of that. I think there will probably be a lot of guidelines and programs that will stem from basically what Lyons is doing”

Respondent CM6 stated: “I really think the town did a good job overall.”

As explained by the deputy town clerk, if the mitigation doesn’t happen in the floodplain, the whole town is at risk and homeowner’s insurance is jeopardized. This can be a tool used to

convince people to mitigate. There is an opportunity build on the existing social capital and social norms to encourage mitigation for the good of the community. Additionally, there is an opportunity to encourage participation from all members on the community in the recovery efforts.

Regulation

Until 2013, Lyons did not have regulations for building in the floodplain, in contrast to surrounding communities.

Per the Lyons clean-up and construction coordinator, the town of Lyons only implemented Ordinance 920 concerning flood damage prevention in 2012. Until that point, building in the floodplain was largely unregulated. Boulder County implemented floodplain restrictions following the Big Thompson flood (Simons et al. 1978), however Lyons chose not to adopt those regulations. The homes in the Confluence Neighborhood were built prior to the passing of Ordinance 920, but are subject to the rebuilding requirements.

Lack of regulation allowed structures to be built in the floodplain. Town leaders should develop and implement clear regulations in the floodplain to encourage mitigation and phase out development in the floodplain. Decreasing development in the floodplain will help build resiliency and help to develop clear messaging for town leaders.

Conclusion

In the face of climate change, it is important to learn how people can adapt and mitigate risks. This research informs human dimensions theory and practice. The results of this research can be applied directly by communities recovering from natural disasters. The final chapter of this thesis will discuss the findings from this research and the applications for Lyons, Colorado, and other communities recovering from natural disasters. A unified message that appeals to each

displaced resident individually, but places them into the bigger picture of Lyons can save time for town officials and help displaced residents take a step back from their own situation and understand the necessity of mitigation holistically.

The Confluence, a Neighborhood in Lyons, Colorado

The confluence is an older neighborhood in Lyons with a strong neighborhood identity. Many residents have been living there for several decades and are reluctant to relocate. Moreover, this neighborhood provides low income housing in a town whose property prices are rising; residents likely cannot afford to relocate. This left several homeowners in a difficult position of deciding what to do with their property after the September 2013 flood.

As stated by the stream team recovery task force leader:

“It would be very difficult to tell a family that has been living here for 10 or 50 years, ‘Oh, and by the way, as part of this flood recovery we want to take 15–20 feet of your property and turn it into something that would help mitigate future floods.’ What you can do is start placing ordinances in when that property sells, then they will have to do things for mitigation. As property owners sell property or donate or whatever is the case, hopefully the town will be able to put in some easements to help mitigate future floods.”

The lack of regulation on building in the floodplain in the past has created a situation in which people are vulnerable. Unfortunately, it is not as simple as moving these people to a safer place. Displaced residents who were still emotionally raw were asked to make difficult decisions regarding their property. The mitigation must happen, but it is a matter of deciding out how to distribute the effects equally. The trustees left it to town employees to decide on a case-by-case basis whether home owners could rebuild. No one wanted to be the bad guy dictating what displaced residents had to do. The raw emotions prevented the town leaders from developing a

unified message about holistic recovery and mitigation. Risk communication alone did not have an impact on personal decisions about rebuilding in the floodplain in Lyons.

When community members are successful and share knowledge with others, mitigation is encouraged. Perhaps town leaders could take advantage of these good examples of mitigation to deliver the message to uncooperative or skeptical residents. It is extremely difficult to communicate the risk of another flood event; the language that exists gives the perception of a diminished risk. Even when communicating with educated town members, people did not anticipate the risk of another flood event like the one in 2013. Town officials are looking for new ways to present this information to warn people about the residual risk of large flood events and encourage mitigation in the rebuilding process.

Lyons implemented Ordinance 920, concerning flood damage prevention, in 2012. This regulation restricts new construction in the floodplain and requires mitigation in the rebuilding process. Risk communication can help town leaders educate homeowners on the importance of this regulation and help to ensure compliance as part of a comprehensive strategy to build in mitigation in the event of future flood events.

One opportunity to leverage community efforts is to combine risk communication with the Social capital and norms aspect of the community. Once the town develops a clear set of goals for the recovery effort, they can employ social capital and social norms to disseminate that message and employ the entire community to work towards the common goal. Town leaders and the community at large needs to come together to make hard choices regarding the good of the entire community, while respecting the needs of individual community members. It would be helpful to include advice from people like the watershed masterplan consultant who could bring knowledge and experience from other communities rebuilding after the floods. Additionally, an

outside consultant would have a holistic view on the recovery efforts and what is best for people and the river. Once the clear message is developed, along with a plan, leaders can activate the existing social capital to disseminate the message and work together towards the solution.

Study limitations

This study was limited by time and resources, as well as my personal biography as the researcher. Lyons is a small town and the study would have been richer if it included several cases for comparison. It would have been helpful to have a Spanish speaker to gain access to the Hispanic community. In addition, many Lyons residents remained evacuated or were difficult or impossible to contact. Even after returning to Lyons several times as a volunteer and reaching out to other communities through canvassing, I only could gain access to one neighborhood in Lyons, which was self-identified as “the hole” or the confluence. The topic of recovery in Lyons, especially with displaced residents, was extremely raw, even eight months after the event. Many residents were very frustrated and emotional about the recovery situation and experienced fatigue from the many individuals and organizations trying to gain information; therefore, I found it difficult for ethical reasons to push respondents during questioning. I made an ethical decision to rely on the information provided by town leaders to fill in the gaps to avoid unduly taxing displaced residents.

Chapter 5:

Conclusion and Recommendation for the Town of Lyons

Introduction

In the face of climate change, more frequent and unpredictable extreme weather events should be expected. It is no longer wise to focus efforts on the prevention of change, instead the focus must transition to mitigation of and adaptation to the effects of these changes on communities. The purpose of this research was to study the flood recovery efforts in the confluence neighborhood of Lyons, Colorado. This neighborhood was especially hard-hit by the Colorado Front Range flood event of 2013. Chapter 3 of this paper identified land change in the flood plain in Lyons as well as discussing possible drivers. Chapter 4 of this paper applied a risk communication framework to the recovery efforts of the town of Lyons. The purpose of this chapter is to discuss findings and provide recommendations for Lyons and other communities recovering from floods and other natural disasters. This research is intended to help communities incorporate mitigation into recovery efforts to build their community stronger than they were before a disastrous event occurs. In addition to discussing the results of my research, I applied a systems approach to watershed recovery and incorporated observations from the years since the 2013 flood event.

Town officials in Lyons felt their responsibility was to provide information and support to homeowners rebuilding in the flood zone, rather than influencing recovery efforts. They acknowledged the risks associated with building homes in the flood zone, but had a difficult time developing unified messages because they focused on one-on-one crisis management and intervention. Flood victims in Lyons suffered from a loss and needed direction in their recovery. According to Mileti (2012), public behavior can be influenced by clear messages of risk from

trusted community leaders in the Town of Lyons. Community leaders can design and implement clear messages through various methods.

The biggest contributing factors to risk communication in Lyons regarding homeowners rebuilding in the floodplain after the 2013 floods were message content, message delivery, message style and information management. The aspects in which town leaders were successful in implementing the risk communication framework were message delivery, message style, and emotion. Town leaders primarily were effective with information management. Message content, regulation and social capital and norms. needed the most improvement.

The message delivery was diverse and repetitive, and the message style was simple, precise, and consistent. Most homeowners reported having sufficient access to information regarding options for flood recovery efforts. The information was consistent and accurate. Although the clean-up and construction coordinator expressed concern over the accuracy of information on the Facebook page, homeowners reported that the page was updated enough to be accurate and that there were plenty of other channels to confirm the information available. Town leaders were available and proactive about answering questions, holding public meetings, and clearing up misinformation. Town leaders were very sensitive to the emotions of homeowners, which improved relationships and access to communication.

Although communication was diverse, repetitive, and sensitive, the message content was not very strong and the social capital and norms aspect was not utilized effectively in communicating risk to homeowners. The primary message of town leaders was to defer to FEMA and insurance companies regarding guidance on rebuilding homes in the floodplain. Homeowners complained of confusion from conflicting information from FEMA and insurance companies, and of a lack of direction in the rebuilding process. There was a missed opportunity

for town leaders to design a plan that clearly communicated the risk of rebuilding structures in the floodplain and one that proposed alternatives. The town leaders were hesitant to develop strong messaging to avoid alienating homeowners and to maintain important relationships, but this hesitance reduced the strength of their message. Town leaders could improve their message content by clearly explaining the risks associated with building structures in the floodplain, consideration of future floods, and the alternatives and best practices. The first step would be for town leaders to identify the most important information relevant to homeowners. Developing messaging around regulations would help with this step. The second step would be for town leaders to develop a comprehensive strategy for flood recovery and rebuilding in the flood-affected areas. This information could then be distributed through the successful message style and message delivery system developed by town leaders.

Even with improved message content, risk communication alone is not effective to influence behavior during flood recovery efforts for two reasons: town officials do not effectively engage in risk communication, and land owners are not moved by risk communication. If the goal is to increase resilience, a more proactive and holistic approach may be more successful. In the town of Lyons, if town officials developed a strategic approach to flood recovery, they may have been able to influence homeowners to avoid building in the flood plain. This outcome was desirable because it increased the resiliency of the town of Lyons in the face of future flood events. Barriers include property price, population growth and geographic limitations. Town leaders could utilize the existing social capital and norms to help distribute the message and mobilize the community to participate in recovery efforts.

Recommendation for Lyons, Colorado

Many communities in the American West are built in river valleys due to topographic limitations of building on steep slopes. Valleys and floodplains often create flat buildable land, with the cheapest land in the floodplain also being the most vulnerable. This research shows that risk communication does not necessarily lead to the inclusion of mitigation in rebuilding efforts. Instead, respondents expressed that their mitigation efforts were in response to regulations. Communities can use social capital to discourage building in the floodplain. A systems approach to grassroots engagement would encourage watershed protection and discourage building in the floodplain without relying on risk communication on an individual level. Community leaders have an opportunity to design and present consistent messaging using risk communication as part of a holistic solution to affect behavior toward resiliency. In the case of Lyons, town leaders should cooperate with regional watershed groups to design and implement a plan to protect the river corridor from development and encourage homeowners to avoid building in the floodplain. Risk communication can play a role in the strategy, paired with regulation, to encourage homeowners to avoid building structures in the floodplain. The role of risk communication is encouraging the adoption of floodplain regulations.

A Systems Approach – A Local Solution for a Regional Problem

Systems Thinking

Human Dimensions of Natural Resources is an interdisciplinary approach to solving systems problems in natural resources. Systems thinking encourages efforts to identify root causes of problems and seek new opportunities for solutions. According to Meadows (2008), a system is defined as elements, each with a specific function, interconnected in a way to achieve a function or purpose. A systems thinking approach is required to solve the complicated problems

stemming from systemic issues. Risk communication alone was not able to affect behavior in Lyons. The purpose of this section is to apply systems thinking to the flood recovery efforts in Lyons to begin to identify a holistic solution for the flood recovery efforts. Within Lyons, there are diverse stakeholders and complicated social systems. Risk communication is one tool that may be useful in encouraging mitigation in flood recovery efforts, but a more holistic approach is necessary to develop an effective strategy for the flood recovery efforts for Lyons and for the Front Range.

The first step in systems thinking is to identify the elements, connections, and purpose within the system (Meadows, 2008). The system for this discussion is bounded to the flood recovery efforts within the confluence neighborhood of Lyons. The components are the individuals and their homes, town leaders, and the river; the interconnections are of community, as well as the connection between the built and natural environments. The function is to provide shelter and a sense of belonging for the residents within the community, and to increase resiliency in the system to protect from future flood events.

There are several systems at play in this scenario. Each homeowner or resident was an individual connected to each other through the flood and through their community ties. The Confluence neighborhood is nested within the town of Lyons, which is nested within the Front Range of Colorado, which is nested within Colorado and the United States of America. There are local, state, and national programs affecting this situation. Additionally, the weather system and climate change contributed to the flood event. To discuss the flood recovery efforts in Lyons, it is important to understand that this is not an isolated event. Identifying the systems at play and designing a holistic solution will not only be more effective for Lyons, but also can inform mitigation and recovery efforts elsewhere. There are several “system traps”, or problematic

behavior archetypes, at play. Once system traps are identified, systems thinking can be applied to suggest solutions.

The system trap at play is “shifting the burden to the intervener—addiction.” According to Meadows (2008), this system trap occurs when a solution to a systemic problem reduces or disguises the symptoms, but does not actually address the underlying problem. If the intervention designed to correct the problem causes the system to become dependent on the intervention, positive feedback loops are set in motion and the system deteriorates. NFIP and FEMA were solutions created to solve the problem of people building structures in the floodplain. In this case, NFIP and FEMA disaster recovery funds made it possible for people to build their homes in floodplains, treating the symptoms of building in the floodplain without addressing the underlying problem of structures being there in the first place. Therefore, people are “addicted” to these aid programs and continue to build and rebuild their homes in the floodplain. The burden of the problem was transferred to government agencies and to tax payers. The original problem was a lack of initial regulation that allowed people to build in the floodplain, which made them vulnerable to flooding and storms.

The NFIP was an intervention to support people living in the floodplain who were disproportionately from already-vulnerable populations. This well-meaning and efficient intervention stepped in to take some of the load from poor and elderly homeowners in the floodplain. This intervention quickly brought the system to where it should be. Then, the original problem reappeared and flood insurance could not bear the full burden, so FEMA stepped in to help rebuild after flooding disasters. The trap is formed if the intervention undermines the original capacity of the system to maintain itself. In this case, homeowners in floodplains became dependent on NFIP and FEMA funds to rebuild their homes after floods. Rather than solving the

problem of people building their homes in the floodplain, these programs provided a Band-aid that created dependence. The system deteriorates and more and more of the solution is then required.

According to Wessels (2006), a paradigm shift is necessary for the sustainability of this way of life. This paradigm shift results from the aggregate of personal realizations and actions. Local watershed coalitions work with communities to intervene at several key leverage points, and provide the information and tools to make decisions and act to increase personal resilience, which in turn build stronger communities and can help communities learn to adapt to climate change. In this case, rather than focusing solely on their own property, homeowners should be encouraged to consider the common good of the whole community. In turn, community members not directly affected by the floods should take an active interest in the rebuilding process to improve community-wide resilience. Resilience is the ability of an individual, community, or system to return to dynamic equilibrium after a disturbance.

Watershed Collaboration

In the aftermath of the 2013 floods, local watershed coalitions sprang into action to organize the process of rebuilding the rivers and the areas around them. Communities must come together to develop creative and system-wide solutions to threats from climate change. These watershed coalitions were small, locally-organized groups partnering and collaborating at local, regional, state-wide and national levels. The Colorado Watershed Assembly is a state-wide nonprofit that supports collaborative efforts with diverse stakeholders to protect Colorado's natural resources within their watersheds. There are 79 watershed groups in the Colorado Watershed Assembly directory. In Lyons, the Saint Vrain Creek Coalition was formed in

response to the 2013 floods to create a coalition for a more resilient Saint Vrain Creek watershed.

According to their website, the Saint Vrain Creek Coalition is a locally driven, non-governmental, non-regulatory community-based organization that facilitates stewardship and restoration within the Saint Vrain Creek watershed. This coalition develops partnerships to design, fund, and implement stewardship and restoration projects based on scientific research. The Saint Vrain Creek Coalition and other watershed groups work with local communities to design watershed master plans, which take a systems approach to rebuilding and restoration of the river. This method is successful because it is a holistic approach to watershed management. Watershed coalitions can easily collect and disperse information and funds for projects along the river corridor. Additionally, these coalitions invite and encourage collaboration between diverse stakeholders. The Saint Vrain Creek Coalition is working with other communities and watershed coalitions on the Front Range to develop and implement a watershed master plan that takes a systems approach to rebuilding after the 2013 floods and increases resilience locally and regionally. Lyons town leaders and homeowners can participate in the Saint Vrain Creek Coalition to voice concerns, ask questions, gain information, develop projects, and seek funding. The Saint Vrain Creek Coalition can help Lyons town leaders design message content that fits the risk communication framework.

Conclusion

Lyons is one of several communities rebuilding after the 2013 floods on the Front Range of Colorado. Rather than focus on the “Social capital and norms” aspect and the uniqueness of Lyons in the recovery efforts, a systems approach in which community leaders come together to develop and implement an integrated systems approach should be pursued. Participating in the

Saint Vrain Creek Coalition allows town leaders and homeowners to access information and resources to rebuild in the most resilient way. The Saint Vrain Creek Coalition can collaborate with local organizations and tap into regional resources to distill the most accurate and relevant information, as well as providing resources for project planning, funding, and implementation. The information and support from the Saint Vrain Creek Coalition can help town leaders fill in the gaps in their risk communication framework with a combination of risk communication and regulation.

The lessons learned from this research can be applied to most communities recovering from disasters. The risk communication framework can help town leaders develop a communication plan for affected members. Whenever possible, it is best to tap into local and regional resource to help gather, distill, and distribute information and resources. Local and regional non-governmental community-based organizations are best positioned to understand, adapt, and meet local needs. Lyons town leaders are working with the Saint Vrain Creek Coalition to fill in the gaps of their communication efforts and are participating in the Watershed Master Plan process.

The key to increasing community resilience is adapting to disturbances. A watershed approach helps communities to identify potential problems on a regional scale and design appropriate local solutions. While this approach is not perfect, it will help people see the big picture and how they fit into it. The communication coming from the watershed coalitions fits within the risk communication framework. The diversity of stakeholders within the coalitions encourages communication from multiple perspectives and increases the chances that the message filters will reflect the diversity in communities served by the coalitions. The message content will be consistent throughout the region and tailored to specific messages for sub-groups

within the community. The resources available at the coalition level will increase opportunities for expanded message delivery. Watershed coalitions are positioned to accept information from broad resources and design the message style to be simple, precise, and consistent. Watershed coalitions can perform information management on a local and regional scale. Additionally, watershed coalitions serve as a forum for monitoring and re-warning as they engage diverse stakeholders and monitor public response. Watershed coalitions use the risk communication on a regional scale, which allows town leaders to apply the same methods as appropriate on a local scale.

Study Limitations and Future Research Opportunities

This study was limited by the amount of time allowed and my role as researcher, as well as by the conditions following the floods. I had limited time as a graduate student and was required to move out of the Front Range for a job in June 2014. As a graduate researcher, I was limited by my introductory knowledge of qualitative research techniques. Although flood recovery efforts were underway, many affected residents of Lyons were still out of town and unavailable for interviews.

My purpose in completing this thesis was to practice research methods I learned in my graduate classes and apply them in a real-world setting. Additionally, I was interested in learning more about river-protection work in Colorado. This research allowed me to learn about watershed management in Colorado and make professional connections that led to employment as the Eagle Blue Trail coordinator for American Rivers. I wanted my work to be relevant and give something back to the community. During the data collection process, I volunteered in the Lyons community to build relationships with potential interview subjects and to give back the time that participants sacrificed to help with my research. Additionally, I plan to submit my

research to the Sustaining Colorado Watersheds Conference upon completion of this thesis so that I can share my findings with communities continuing the flood recovery process.

Additionally, I am using the skills developed throughout the research and writing process to contribute to Eagle County and the greater conservation community. I am using the skills developed in chapter 3 to monitor properties and compare current conditions to the recorded baseline documentation in my position as stewardship manager for Eagle Valley Land Trust. I am using qualitative methods developed in chapter 4 to build and implement an outreach program to increase Eagle Valley Land Trust's presence in our community. My goal in completing this thesis and the master's program in general was to improve my skills to make me more effective in the environmental conservation field. I will continue putting my skills to work in the environmental conservation field throughout my career.

There are many opportunities for future research on flood recovery and adaptation to climate change. As climate change contributes to more extreme weather events, communities will need to have plans for relief and recovery efforts. It would be interesting to compare the impacts of risk communication on a national and local scale. There is also a great need for research in disaster planning and prevention. It would be interesting to see the impacts of risk communication in flood management planning. Each of these areas of research would contribute to disaster preparation and response.

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Appendix A

SOC 610 Transcribed and Theme Coded Interview Assignment

Interview Guide (Community Member)

A Study of the Application of Risk Communications Frameworks

Self-Introduction and Description of Topic: Hello, I'm Jessica, a researcher from Colorado State University College of Natural Resources. My thesis focuses on risk communication and the flood recovery efforts along the Front Range. I am also looking for new and novel methods to reach affected community members. Specifically, I want to use this information to develop training materials for communities incorporating risk mitigation into disaster recovery efforts. I am attending this meeting because I am interested in how recovery managers and community coalitions are using risk communication frameworks to elicit community participation.

Introduction:

I will protect anonymity in my research by using labels instead of names.

You are being interviewed because: I am interested in looking at your town as a case study for flood recovery in the Front Range.

The purpose of this interview is to understand communication efforts in the flood recovery process.

There are no wrong or right answers. I am trying to understand your perspective and experience.

Feel free to interrupt, ask for clarification, criticize a line of questioning, etc.

May I please record this interview, so that I am more able to focus on what you are saying instead of taking notes?

Were you affected by the floods in September 2013?

What has recovery looked like for you?

Is your home in the floodplain?

If yes, then did you know that when you moved into your home?

If yes, did you understand the risk associated with living in the flood plain?

If yes, what made you choose a home in the floodplain?

What does it mean to you that your home is in the floodplain?

What is your involvement with the Lyon's Community Foundation flood recovery efforts?

Do you remember receiving information about the Lyon's Community Foundation flood recovery efforts?

How did you receive that information?

What form was it in?

Who was it coming from?

What did it say?

Was it easy to understand?

What sources were you receiving information from?

Who do you trust to provide information about flood recovery?

How often did you receive information about recovery efforts?

Are you participating in community flood recovery efforts?

If YES-- What made you decide to participate in the efforts?

If NO—What did you consider when deciding whether to participate?

How would you like to be contacted regarding these efforts?

Appendix B

SOC 610 Transcribed and Theme Coded Interview Assignment

Interview Guide (Community Leader)

A Study of the Application of Risk Communications Frameworks

Self-Introduction and Description of Topic: Hello, I'm Jessica, a researcher from Colorado State University College of Natural Resources. My thesis focuses on risk communication and the flood recovery efforts along the Front Range. I am also looking for new and novel methods to reach affected community members. Specifically, I want to use this information to develop training materials for communities incorporating risk mitigation into disaster recovery efforts. I am attending this meeting because I am interested in how recovery managers and community coalitions are using risk communication frameworks to elicit community participation.

Introduction:

I will protect anonymity in my research by using labels instead of names.

I received your name from: Jeff Crane, Crane Associates consultant with CWCB.

You are being interviewed because: I am interested in looking at your town as a case study for flood recovery in the Front Range.

The purpose of this interview is to understand communication efforts in the flood recovery process.

There are no wrong or right answers, I am trying to understand your perspective and experience.

Feel free to interrupt, ask for clarification, criticize a line of questioning, etc.

May I please record this interview, so that I am more able to focus on what you are saying instead of taking notes?

Background and Involvement--Interviewee

How are you involved in the Community Foundation?

Community Coalitions

What is the Foundation doing related to the flood recovery?

Are you working on a master plan for this watershed?

How are you making decisions about flood recovery efforts?

Communication

How have you communicated recovery decisions to community members?

Who is your target audience in terms of communicating this recovery information?

What methods of communication are you using (e.g., electronic, in-person, print, etc.)?

What type of involvement are you seeking from community members?

How have you been eliciting this involvement?

What are you saying?

How are you saying it?

How are you delivering the message?

Have you experienced problems with misinformation and reluctance to participate
in recovery efforts?

What are some problems you have faced in eliciting participation?

Anything else you want to add?

Appendix C

Interview Face Sheet

Risk Communication in Flood Recovery

Purpose of Interview:

Interviewee Position:

Date and Time of Interview:

Location of Interview:

Relevant Social Characteristics:

Assurances of Confidentiality:

Statement of Potential Risk

Appendix D

Post-Interview Comment Sheet

Risk Communication in Flood Recovery

Setting:

Informant:

Emotional Tone:

Difficulties (methodological or personal):

Feelings and Insight:

Reflections:

Appendix E

Map of Lyons with Parcel Shapefile and Floodplain Overlays

