KEY INFORMANT PERCEPTIONS OF FLOODING AND LANDSLIDES IN WESTERN NORTH CAROLINA, USA FOLLOWING THE 2018 FLOODS AND LANDSLIDES

A Thesis
by
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Abstract

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In May 2018, exceptional flooding and subsequent landslides devastated Western North Carolina (WNC). The growing region is dependent on revenue from tourism and agriculture, is not typically considered water-vulnerable, and few studies have explored flooding or landslides. However, the region is projected to experience elevated water vulnerability due to rapid population growth and increased climatic variability. Recent events highlight the need for communities to have a better understanding of flooding and landslides to inform proactive policies for risk mitigation in WNC. The author conducted phone interviews with key informants from a variety of sectors in Buncombe and Watauga counties to evaluate stakeholder experiences and perceptions relating to the flooding and landslide events in 2018. The interviews were transcribed, coded, and then analyzed using content analysis software. An earlier companion study was completed in 2017-2018 for the same counties but with a focus on drought and wildfire (Andersen et al. 2018). Similar themes to the drought/wildfire study were found, including environment and emergency response. Other common themes of discussion by key informants included flooding risk, vulnerability, and mapping programs. Additional themes

varied by county, which demonstrates the importance of local context with natural disasters. Stakeholders across all sectors placed significant emphasis on communication both within agencies and to the public. Identifying key themes illustrates gaps and issues with communication. Once policymakers are aware of gaps, they may be better equipped to address policy shortcomings, and communities can better understand key informant experiences to prepare for future natural hazards.

Acknowledgments

I am beyond grateful for my time at Appalachian State University and all the support I have received here. I owe many thanks to my advisor, mentor, and friend: Dr. Elizabeth Shay. Her drive to research, teach, and be a devoted family-woman has given me such inspiration. From taking the first class she taught at Appalachian to helping her teach my final class, I have grown so much as her pupil, and I am forever grateful. Additionally, I would like to thank Dr. Richard Crepeau for his constant support and his ability to find opportunities for each of his students to succeed. Dr. Crepeau has helped me become a well-rounded student and always had his door open for me to pop in with any and all questions I had about planning, life, and even a discussion about when his band would be playing next. I would also like to thank Dr. Tabitha Combs for the chance to work on an incredible transportation survey and data collection in college towns. She also has guided my research with incredible knowledge and offered valuable insight throughout my thesis. I am very grateful to my committee and hope to continue to work with them in the future.

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Foreword

The main body of this thesis is formatted to the guidelines for manuscript submission to *Weather, Climate, and Society*, an official journal of the American Meteorological Society. All tables and figures are at the end of this paper.

Introduction

Western North Carolina (WNC) experienced severe flooding in May 2018, which resulted in devastating landslides throughout the Appalachian Mountains. While WNC is historically vulnerable to flooding, there is a lack of research on flooding and ensuing landslides in the region. In 2005, the North Carolina General Assembly approved the landslide mapping program for WNC as part of the Hurricane Recovery Act of 2005 following Hurricane Frances and Hurricane Ivan of 2004. The program would take 20 years to map all 19 counties. However, the state legislature cut funding for landslide mapping programs in 2011; of the 19 counties in WNC, only 4 counties, including Buncombe and Watauga counties, were completed (NC Budget 2018). The devastating effects from recent flooding have sparked a discussion among researchers and practitioners on whether the more frequent and severe weather is a trend for the future. Following the May 2018 flooding and subsequent deadly landslides, on June 1, 2018, the North Carolina legislature approved a new budget with $3.6 million for the NC Department of Environmental Quality to revive the landslide mapping program (NC Budget 2018; Oakes 2018).

To understand the recent trends in regard to flooding and landslides in WNC, the researcher conducted an integrated impact assessment of qualitative data, consisting of key informant interviews, on the recent flash flooding and landslide events in the Southern Appalachian Mountains of WNC (Figure 1). Combs et al. (2016) successfully completed a thorough qualitative analysis with interviews and focus groups to better understand transportation-disadvantage. Combs' research was used as a model for this study. The study area is Buncombe and Watauga counties, both of which have a completed landslide inventory

from the 2005 landslide mapping program. Henderson and Macon were the other two counties completed, but Macon is the only county that has not had a recent landslide event. This research followed the same interview format as an earlier companion study completed in 2017-2018 for the same counties but with a focus on drought and wildfire. This study identified similar themes to the previous study related to adaptive and resiliency planning measures in response to near- and long-term changes in regional water vulnerability, including the perceived increase in frequency of extreme precipitation events. Identifying key themes helps to bring to light gaps and issues with communication. Once policymakers are aware of gaps, they will be better equipped to address policy shortcomings; therefore, communities can have a better understanding of key informant experiences to prepare for future natural hazards.

Key Informant Perceptions of Flooding and Landslides in Western North Carolina, USA Following the 2018 Floods and Landslides

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Abstract

In May 2018, exceptional flooding and subsequent landslides devastated Western North Carolina (WNC). WNC, a growing region dependent on revenue from tourism and agriculture, is not typically considered water-vulnerable, and few studies have explored flooding or landslides. However, the region is projected to experience elevated water vulnerability due to rapid population growth and increased climatic variability. Recent events highlight the need for communities to have a better understanding of flooding and landslides—and how they are perceived—to inform proactive policies for risk mitigation in WNC. The author conducted phone interviews with key informants from a variety of sectors in Buncombe and Watauga counties to evaluate stakeholder experiences and perceptions relating to the flooding and landslide events in 2018. The interviews were transcribed, coded, and then analyzed using content analysis software. An earlier companion study was completed in 2017-2018 for the same counties but with a focus on drought and wildfire (Andersen et al. 2018). Similar themes to the drought/wildfire study were found, including natural resources and environment and emergency response. Other common themes of discussion by key informants included flooding risk, vulnerability, and mapping programs. Additional themes varied by county, which demonstrates the importance of local context with natural disasters. Stakeholders across all sectors placed significant emphasis on communication both within agencies and to the public. Identifying key themes helps to bring to light gaps and issues with communication. Once policymakers are aware of gaps, they will be better equipped to address policy shortcomings; therefore, communities can have a better understanding of key informant experiences to prepare for future natural hazards.

1. Introduction

Western North Carolina (WNC) experienced severe flooding in May 2018, which resulted in devastating landslides throughout the Appalachian Mountains. While WNC is historically vulnerable to flooding, there is a lack of research on flooding and ensuing landslides in the region. In 2005, the North Carolina General Assembly approved the landslide mapping program for WNC as part of the Hurricane Recovery Act of 2005 following Hurricane Frances and Hurricane Ivan of 2004. The program would take 20 years to map all 19 counties. However, the state legislature cut funding for landslide mapping programs in 2011; of the 19 counties in WNC, only 4 counties, including Buncombe and Watauga counties, were completed (NC Budget 2018). The devastating effects from recent flooding have sparked a discussion among researchers and practitioners on whether the more frequent and severe weather is a trend for the future. Following the May 2018 flooding and subsequent deadly landslides, on June 1, 2018, the North Carolina legislature approved a new budget with $3.6 million for the NC Department of Environmental Quality to revive the landslide mapping program (NC Budget 2018).

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earlier companion study completed in 2017-2018 for the same counties but with a focus on drought and wildfire. This study identified similar themes to the previous study related to adaptive and resiliency planning measures in response to near- and long-term changes in regional water vulnerability, including the perceived increase in frequency of extreme precipitation events. Identifying key themes helps to bring to light gaps and issues with communication. Once policymakers are aware of gaps, they will be better equipped to address policy shortcomings; therefore, communities can have a better understanding of key informant experiences to prepare for future natural hazards.

2. Literature Synthesis

2.1 Experience and Perceptions

Andersen et al. (2018) reviewed research relating to public perceptions of climate change in America, finding several studies that identified a relationship between experience and perceived risk of a climatological event (Brody and Zahra 2008; Diggs 1991; Hamilton and Keim 2009; Spence et al. 2011; Woudenberg et al. 2008). One study from the United Kingdom found that individuals who had experienced flooding expressed significantly less uncertainty about climate change and were indirectly more likely to consider reducing their energy use (Spence et al. 2011). This finding suggests that heightened risk perceptions related to a hazardous climatological event and climate change can lead to greater agency among individuals (Andersen et al. 2018).

Two studies add a spatial component to an assessment of public perceptions of climate change (Andersen et al. 2018). A 2007 study of rural areas in nine U.S. states found regional variation in perceptions of climate change that were linked to regional climate, specifically

snow-heavy regions experiencing reduced snowfall (Hamilton and Keim 2009). A 2008 study by Brody and Zahra. compared perceived climate change risk over space with actual experienced regional climate variation. A heightened sense of climate change risk was observed among individuals with an increased sense of physical vulnerability (e.g., those living along the coast). However, these perceptions were limited to publicly well-communicated risks of climate change. Other physical risks (such as living in a 100-year floodplain) did not affect perceptions (Brody and Zahra 2008). This suggests an increased need for regionally specific climate change education and research dissemination. An understanding of local perceptions is a first step to developing a targeted approach to climate change education (Andersen et al. 2018).

2.2 Study Area

This study involved two counties in WNC, Buncombe and Watauga county (Figure 2). Both counties contain regionally dominant urban areas for a majority rural county: Asheville and Boone, respectively. Both sites offered a large pool of potential informants, making them ideal for gauging stakeholder perceptions of natural hazards (Andersen et al. 2018). According to the Census Bureau's 2016 American Community Survey five-year estimates (2011-2016), Buncombe has a population of approximately 250,112, compared to approximately 52,745 in Watauga (U.S. Census Bureau 2018). Both counties are growing, with Buncombe experiencing a population growth rate of 4.95 percent and Watauga experiencing a growth rate of 3.26 percent from 2010 to 2016 (U.S. Census Bureau 2018). The population is predominantly white in Buncombe (91.1 percent) and Watauga (96.4 percent) (Table 1), and both counties have younger populations with higher educational attainment compared to surrounding counties. This is due in part to the presence of the University of North Carolina at Asheville (Buncombe) and

Appalachian State University (Watauga) as well as an abundance of private universities in each county. The population continues to grow across the region and is projected to increase by 12 percent regionally between 2010 and 2030 (N.C. Office of State Budget and Management 2017). The projected growth trend is especially pronounced in Buncombe County (27 percent) and Watauga County (40 percent). Growth is particularly high for elderly populations, a segment more vulnerable to climate-related changes in water resources (NEMAC 2016). In Buncombe County, 19.1% of the population is 65 years and over compared to the national average of 15.2 percent (Table 2; U.S. Census Bureau 2018; Andersen et al. 2018).

Buncombe and Watauga counties differ substantially in economic measures (Andersen et al. 2018; Table 3). The median household income is higher in Buncombe ($46,902) than Watauga ($39,443); similarly, the poverty level is higher in Watauga (31.3 percent) compared to Buncombe (8.79 percent) (Table 3). Differences between the two counties can be attributed in part to the differing sizes of the City of Asheville and the much smaller Town of Boone. Despite these differences, the two counties have similarities that make them ideal for comparing experiences and perceptions relating to the events in 2018. These similarities include mountain geographies, growing economies, large tourism and hospitality sectors, and the presence of municipal, county, and natural resources agencies with knowledgeable staff (Andersen et al. 2018, Table 4).

2.3 Regional Background

The Appalachian Region is considered by some to be “isolated, culturally backwards and economically peripheral”; however, the region is projected to have a 50% population growth from 2000 to 2030 (Guerra et al. 2017). Trends of growth and development are irregular as many

are part-time residents and urbanization is uneven. Additionally, the region's population is characterized by conservative political standings and strong private property rights (Guerra et al. 2017). Historically, the mountainous region of Western North Carolina (WNC) has been characterized by not only an abundant water supply, but also pristine water quality (Andersen et al. 2018). This abundance of quality water provides the region with numerous ecosystem services, not the least of which is a thriving tourism industry centered on river recreation. However, climate change, manifested as increased frequency and severity of flooding, has threatened local mountain communities (Andersen et al. 2018). Moreover, increases in high intensity and short duration precipitation events have increased the frequency of lower recurrence interval floods and runoff-related pollutant toxicities, adversely impacting water quality in the region (Sugg et al. 2016).

2.4 Past Events in Buncombe and Watauga counties

Western North Carolina has a history of flooding and landslides due to the confluence of topography and weather of the region. In July of 1916, Asheville was five feet underwater due to the French Broad River flooding. Six died and the damages exceeded $3 million (NC DEQ). In August 1940, Watauga County was hit by a hurricane that decimated the county and killed fifteen people (NC DEQ). The hurricane caused flash flooding and torrential rainfall that caused landslides up to 200 feet wide, destroying 30 homes, 50 barns and damaging more than 75 homes and farms, making it one of the most disastrous floods in modern history (Campbell 2014). In November 1977, Tropical Depression Nine caused flooding and landslides across WNC, specifically the Bent Creek area near Asheville, with debris flow with a speed of 23 miles per hour (NC DEQ). In September of 1989, Hurricane Hugo caused severe damage to Watauga

County as 800-1,000 people were forced to evacuate, and 7,000 residents did not have power in the days following the storm (Watauga County Remembers Hurricane Hugo 2014). In 2004, Hurricane Frances caused a debris slide-flow approximately 125 feet long. Also in 2004, Hurricane Ivan caused debris flows in Buncombe and surrounding counties (NC DEQ). In 2017, Boone in Watauga County experienced historic flooding on October 23 when the town received 6.75 inches of rain (Lasure 2017). There were thirteen rescues performed, and forty residential units were temporarily condemned. In May 2018, the subtropical depression Alberto caused half a dozen landslides at Grandfather Mountain. On May 30, 2018, a mudslide slammed into a house and caused a gas leak, leading to an explosion that destroyed the house, killing two (Faherty and Esposito 2018).

2.5 Flooding and Flash Flooding

Historically, the United States has focused on federally funded construction of levees and floodwalls to mitigate flash flooding and flooding (Bergsma 2017). In the 20th century, there was a shift was led by geographers to discuss policy alternatives as they created spatial plans for local levels, instead of federal and/or state level. At the federal level, the National Flood Insurance Program and Federal Emergency Management Agency have continued to struggle with managing responsibilities in an ever-changing political climate (Bergsma 2017). This can be seen in North Carolina with the 2011 vote to repeal landslide mapping programs. The program was created in 2004 after five people died from a mudslide in Macon County (Associated Press 2018). The goal of the program was to map 19 counties in WNC, but was repealed after just four counties were mapped; both Watauga and Buncombe counties were among the counties mapped. After the recent mudslides in WNC killing three, legislators

allocated 3.6 million dollars to revive the program (Associated Press 2018).While researchers have continued to study flooding and flash floods, there is great uncertainty in precipitation, and it remains one of the greatest challenges in short-term weather forecasting (Jessup and Colucci 2012).

Flash floods are defined as "naturally occurring events that have been characterized by the NWS as 'a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam)'." (Saharia et al. 2017). Flash floods are one of the top causes for death by weather-related hazards in America despite decades of research (Tao and Barros 2013; Jessup and Colucci 2012). Often, flash floods occur in mountainous regions that have steep slopes as well as small catchment areas, which can be easily overwhelmed by runoff and rainfall during short periods of time, thus triggering landslides and mudslides (Tao and Barros 2013).

In 2014 alone, direct flood related damages totaled $2.86 billion in the United States, and there were 55 flood-related deaths recorded (Saharia et al. 2017). The cost of damage caused by flooding has been steadily increasing and is expected to continue as scientists believe there will be an increase in intense rainfall for the southeastern United States (Saharia et al. 2017; Dourte, Fraisse, and Bartels 2015). In fact, when comparing extreme rainfall from 1955-1984 and 1985-2014, researchers found 53 percent more extreme rainfall days during 1985-2014 than 1955-1984. Researchers then confirmed their findings by anecdotal accounts of more extreme weather by agricultural producers and workers in the southeastern United States (Dourte, Fraisse, and Bartels 2015).

2.6 Landslides, Slope Movement, and Mudslides

There are nine different types of landslides, but the Appalachian Region experiences two: rock falls and debris flows (Guerra et al. 2017). Landslide mapping is difficult to complete, and the most important indicator for landslide susceptibility is slope, followed by soil type (Davis, Chong, and Ohlmacher 2003). North Carolina Geological Survey (NCGS) landslide trigger threshold is, “heavy rain event with five or more inches falling within twenty-four hours” (Guerra et al. 2017). Since 1876, the landslide trigger has been met 21 times, and several other heavy rain events have gotten close to that threshold (Guerra et al. 2017).

Creating a landslide inventory map requires field surveys, air photos, and historical landslide records, which require a lot of time and effort (Nandi and Shakoor 2010). However, a community can use a landslide inventory map to prepare places that are susceptible to landslides. Another method of preparing communities for landslides is a precipitation-induced landslide early warning system (Baum and Godt 2010). This is not feasible for all communities as it can be expensive and not very practical, but it is important to note the public is uninformed. Without tools such as a landslide inventory map or an early warning system, agencies are unable to prepare the public. Additionally, only a small population will ever witness or experience a landslide, due to their infrequent nature, and the public will move into landslide-prone areas without noticing or do so unknowingly (Baum and Godt 2010).

2.7 Additional Flood Risk

Most Appalachian flooding comes during the winter and spring, although some also occurs due to the summer/fall hurricanes that produce significant rainfall and dangerous flooding (Lecce 2000; Rostom and Lin 2015; Wright, Knuston, and Smith 2015). Tropical cyclones have

caused 58 percent of 5-year rain events in the summer and 71 percent in the fall in the southeastern United States (Dourte, Fraisse, and Bartels 2015). However, researchers believe the number of tropical cyclones, which form over the Atlantic Ocean and make landfall, will decrease by 27 percent for the eastern United States by the late 21st century (Wright, Knutson and Smith 2015).

For the Appalachian Region, 76 percent of annual flooding occurs between December and April (Leece 2000). This is caused by the Atlantic Ocean's orographic uplift where the Gulf of Mexico forms cyclones that produce extreme precipitation in addition to snowmelt. Both cause prominent flooding throughout the winter and spring months and less flooding in the summer and fall (Leece 2000). There is a risk of snowmelt flood related risk (Graybeal and Leathers 2006). In fact, southern Appalachia has snowmelt flood returns that occur between 10-200 years, which means there is not a great risk of snowmelt, but it is still important to note (Graybeal and Leathers 2006).

2.8 Natural Disasters and Perceptions

Better understanding of public perceptions about drought may contribute to informed scientific and policy discussions and may support sound decision-making and planning (Andersen et al. 2018). The relationship between personal experience and perceived risk of water-related climatological events, including floods, droughts, and wildfires, is well-established (Brody and Zahra 2008; Diggs 1991; Hamilton and Keim 2009; Spence et al. 2011; Woudenberg et al. 2008). Individuals who experience these events firsthand express less uncertainty about climate change and greater propensity for hazard mitigation. This suggests that heightened

perceptions related to hazardous climatological events can lead to greater agency among individuals (Andersen et al. 2018).

Additionally, spatial location influences perceptions of climate change in the United States (Andersen et. al 2018). A study of rural areas in nine states found regional variation in perceptions of climate change that was linked to regional climate, specifically snow-heavy regions experiencing reduced snowfall (Hamilton and Keim 2009). Brody and Zahra (2008) compared perceived climate change risk over space with actual experienced regional climate variation. A heightened sense of climate change was observed among individuals within close proximity to risk, such as those living on the coast. However, these perceptions were limited to widely publicized risks of climate change; other physical risks, such as living in a floodplain, did not affect perceptions (Brody and Zahra 2008). This suggests a need for region-specific approaches to climate change education. Furthermore, individual characteristics, including social, economic, demographic, and ideological variables, significantly influence perceptions of climate change, highlighting the importance of considering location (Brody and Zahra 2008; Hamilton and Keim 2009; Andersen et al. 2018)

3. Methods

The objective of this thesis is to gauge regional perceptions of flooding and landslides among knowledgeable stakeholders through the collection and analysis of qualitative data. These data take the form of interviews with key informants in Buncombe and Watauga counties. Understanding of stakeholders' and local residents' perceptions can be used to inform mitigation policies, develop educational initiatives, and identify scientific gaps (Andersen et al. 2018). Following Andersen et al. study, the researcher compiled initial lists

of informants knowledgeable about flooding and landslides in Buncombe and Watauga counties (2018). These informants came from professional networks and publicly available materials about flooding-relevant agencies, companies, and organizations. The researcher identified additional informants and added them to the lists using a snowball recruiting technique based on suggestions by initial informants.

3.1 Research Questions

The goal of this research is to assess the viability of adaptive measures. The goal is achieved through engagement with stakeholders and residents through key informant interviews. To reach this goal, research was divided into two questions:

1) What perceptions do stakeholders (local officials and leaders) and affected residents hold with regard to flooding and landslide risk and recent events in the Southern Appalachians?
2) What types of information are shared with residents—before events (risk awareness), during events (emergency instructions), and after events (recovery support), and how and when is it shared?

3.2 Interviews

A semi-structured interview instrument consisting of 9 questions was created and then reviewed by the Appalachian State University Institutional Review Board (IRB #17-0272; Figure 2). The instrument contains questions, focused on flooding and landslides, that apply to six major themes (Figure 3). Interviews with informants lasted 10 to 30 minutes and were conducted

individually by either the researcher or by Graduate Assistant Alan Toney. To ensure accuracy, each interview was recorded on two recording devices then manually transcribed and analyzed.

Prior to interviewing, the researcher created an informant list of over 150 key informants in the following fields: Local/County/Regional Government Planning (LGP), Emergency/Safety (ES), Resource Agencies (RS), Schools and Health Systems (SH), Private Sector (PS), and Agriculture and Livestock (AL). These fields were chosen due to informants' expertise, experience, and/or their knowledge of landslides and flooding. All key informants were emailed the week of October 21, 2018, using the IRB-approved recruiting email. The target goal was 30 interviews, and 31 interviews were conducted: 15 from Buncombe County, 11 from Watauga County, and 6 from the Region/State (Table 5). One interview could not be transcribed because of the low-quality audio recording and technical difficulties, so it is not included in the analysis. The interviews took place between October 24 and December 5, 2018. All interviews occurred on the phone and were recorded with the verbal consent of the key informants. All key informants were informed of the risks and that their identities may be guessed by readers. Additionally, key informants were free to decline to answer any question and could stop participating at any time.

3.3 Atlas.ti Coding

Preliminary analysis of transcripts yielded 111 codes that emerged from the interviews; these were sorted naturally into six code groups (major themes), as shown in Figure 4. Transcript management and coding employed Atlas.ti 8.4, a software program that enables systematic content analysis of qualitative data. This study follows the methods of Andersen et al. (2018) to

identify patterns and major themes in interview responses for natural hazards in WNC. The transcripts were double-coded by members of the research team. The transcriptions were then reviewed, and the 111 codes were assigned to sections. Additional codes or free codes, were created to fill a gap in the code list. The total code count came to 126 codes; Dr. Shay added 10 codes and the researcher added 5 codes.

3.4 Reconciliation

After all of the interviews were reviewed and coded, they were reconciled. For duplicate codes with differing quotation lengths, the reconciler chose to utilize the more extensive choice or to create a new, larger quotation for the code (Andersen et al. 2018). The average number of codes per transcript was 30. The reconciled transcripts were analyzed to determine major themes. A word cloud and corresponding code frequency table were produced to identify commonly used codes. Matrices were produced to compare code occurrence by sector to illustrate and summarize code co-occurrences (Andersen et al. 2018).

4. Results and Discussion

The largest number of codes were associated with Education and Public Awareness (25), followed by Emergency Response (24), Natural Resources and Environment (23), Communications (20), Economics (17), and Governance and Policy (16). Figure 5 is a matrix detailing the code groups by sector and location. The codes were used 3,125 times. The most frequently used codes were Flooding Risk (Natural Resources) with 193 quotations and Vulnerability to Flooding and Landslides (Natural Resources) with 95 quotations. Table 6 shows

the 20 most commonly occurring codes. The frequency code counts reflect the repeated use of various terms used by informants.

Figure 6 is a word cloud illustrating the most frequently used words in coded quotations. Like frequency code counts, the frequency words reflect the repeated use of various terms used by informants, but they also reflect the interview instrument itself. For example, among the most frequently used words are “flooding,” “landslides,” and “water,” and knowledge-related words such as “think,” “know,” and “like.” Words like “the,” “a,” and “and” were removed from the word cloud via Atlas.ti word list. Other frequently used words were related to the major themes of emergency response, resources, and communication.

4.1 Contextual Variations in Findings

Matrices were produced to compare the coding results between the employment sectors and their location (counties or region/state). Figure 7 shows the importance of themes, which varied by sector and location. Both Natural Resources and Environment and Emergency Response appeared as important themes across nearly all professional sectors and locations. In contrast, Governance and Policy was cited much less frequently. Communications, Economics, and Education and Public Awareness were cited about the same number of times. This differs from the previous study of Drought/Wildfire, where Education and Communications code groups were among the most prevalent themes.

When looking at themes by sector, informants most frequently discussed topics relating to their profession. For example, the Emergency/Safety sector (19%) was the most dominant among informants for Emergency Response; the Local/County/Regional Government Planning (15.9%) sector was the most dominant in the Governance code group; and the Resource Agencies

(14.7%) sector was the most dominant in the Natural Resources code group (Figure 7). Informants from the Emergency/Safety sector had 21.9% of codes related to “Emergency Management”; informants from the Resource Agency sector had 25% of codes related to “Frequency”; and Local/County/Regional Government Planning had 15.7% of codes related to “Government Websites” (Figure 7).

Table 6 shows the 20 most common individual code frequency variations across professional sectors and locations. The individual code frequency table details the greater variation among professional sectors than the more general thematic code groups do. Natural Resources and Environment included “Flooding Risk,” “Flash Flood,” and “Landslide.” Emergency Response included “Vulnerability to Flooding and Landslide,” “Emergency Management,” and “Transportation (Rds., Bridge, Infrastructure).”

However, some informants spoke about themes that were not directly related to their employment sector. Informants in the Schools and Health Systems sector, for example, had their highest percentage of codes at 13% for “Agriculture,” which is surprising as school and health are not thought of as being tied to agriculture. This high code frequency may be partially explained by the focus of flooding on farm lands causing contamination, which renders the food produced dangerous and unfit for consumption. Additionally, the Schools and Health Systems sector also had a high percentage of codes at 10% for “Predictive Models.” Researchers might be able to explain this trend by the School and Health Systems utilizing predictive models to make decisions in their workplace.

The Private Sector had 19.1% of codes related to “Transportation: Rds., Bridges, Infrastructure.” The Emergency/Safety sector most frequently spoke about codes related to “Flash Floods,” with 43.2%, and the Local/County/Regional Government and Policy sector had

17.1% of codes related to “Federal.” The Agriculture and Livestock sector had 24.1% of codes related to “Agriculture,” and informants from the Resource Agency sector had 29.3% of codes related to “Response.”

Since Buncombe County had the most key informants, 15 out of the top 20 frequency codes had higher percentage values in responses from there. The most common codes by location for Buncombe County were Flash Flooding (Emergency Response) with 43.2%, Transportation (Rds, Bridges, Infrastructure- Emergency Response) with 42.6%, and Flash Flood (Natural Resources and Environment) with 37.3%. Researchers might be able to explain this trend by the strong history of flooding of the French Broad River in the city of Asheville. Additionally, this reinforces the idea that flash flooding from a natural resources perspective causes an emergency response, and then roads, bridges and infrastructure are at risk or impassable, causing their own emergency response.

For Watauga County, the most common code frequency was Federal (Governance and Policy) with 26.8% of codes; for Region/State, the most common code frequency was Frequency (Natural Resources and Environments) with 18.8% of codes. It was surprising that only two codes were the most common frequency by location in Watauga County since it had the second highest number of key informants. Additionally, the trend of the code Federal having 26.8% of the codes suggests that Watauga relies on federal regulation and aid before, during, and after natural hazard events such as flooding and landslide. Watauga and Region/State having the highest frequency code by location for Frequency (Natural Resources and Environments) could indicate a trend in extreme weather events becoming more frequent.

The Region/State location had the highest codes of Emergency Management (Emergency Response) with 26% of the codes, Data Sharing (Communications) with 32.7% of the codes, TV

(Communications) with 20.9% of codes, and Data (Governance and Policy) with 25% of the codes. It is not surprising that the highest frequency codes by location for Region/State are Emergency Management, Data, and Data Sharing. (Emergency managers and state employees are headquartered in another city but cover either the state of North Carolina as a whole or the WNC region.) Additionally, between the state and regional offices there is a lot of communication about events, regulation and policy, and risk; therefore, it is not surprising that Data Sharing and Data are the second and third highest frequency codes for Region/State location.

Figure 8 shows the top 20 most frequent codes in a matrix to see the most commonly paired codes. The most frequently used together codes with 21 was Flooding Risk (Natural Resources) and Flash Flood (Economics), which indicates the devastating effects flooding can have on the community. The second most frequently used codes together with 14 was Flooding Risk (Natural Resources) and Creeks/Streams/Rivers (Natural Resources). This trend is not surprising since flooding of creeks, streams, and rivers can raise flooding risk for residents.

4.2 Notable Trends

Key informant interviews revealed several notable trends for flooding and landslides in WNC. Natural Resources and Environment was the most frequent theme among responses. This indicates the majority of concerns among key informants were water-related hazards impacting the community and landscape. Concerns about Vulnerability to Flooding and Landslides was a key concern among informants. Many key informants focused on Flooding Risk and the Financial Impacts associated with flash flooding. landslides, and their perceived vulnerability and risk to flooding and landslides. Other financial impacts concerned the NC Landslide

Inventory mapping program that was revived after the May 2018 hazard events. Additionally, many key informants discussed how flooding and landslides affected their ability to either get to their jobs and/or home or even complete the jobs due to flooding and landslides impacting the road systems. Key informants also discussed how flooding particularly affected agriculture and livestock, an example being, “It impacted mostly due to erosion and because we have, we have animals that just don't do as well in heavy rain such as chickens and turkeys and stuff like that animals like that… also just as a farmer, you don't want to be driving around in your fields a lot when it's, when they're super saturated it can impact the ground and make the grass impacted as well.” Overall, informants were more knowledgeable and aware of flooding compared to the subsequent landslides that are less frequently seen and therefore, discussed.

Emergency Response was frequently discussed by informants and often included themes of Communications. Informants often detailed the lack of communication about roads, bridges, and infrastructure data being up to date during flooding events causing emergency services issues and a lack of public awareness. This was surprising since key informant felt there was a mostly strong inter-agency communication with data and data sharing. However, this suggests a need for a comprehensive, real time updating website that provides flood information for the public and emergency services about road systems. One informant detailed just how alone they felt, “So we were cut off from large sections of our district for emergency response. So that was disturbing to drive by a road and see that it says closed and it is one of the major roads...And we are supposed to be automatically notified, the county dispatch is supposed to be notified but nobody was. And that happens all the time.”

When key informants discussed Governance and Policy, there was a strong push to use flooding and landslide events to inform the public and also agricultural and livestock sectors to

prepare their properties for future events. Utilizing federal funding like FEMA, local governments and government agencies are educating and providing assistance before and after flooding events. However, some key informants noted how there is a lack of understanding for homeowners about flood risk and purchasing insurance. One key informant described pushing their significant other to purchase flood insurance, their thought was “well I don’t need that because I don’t live in a flood zone, but that doesn’t mean that your house won’t flood if there is a severe weather event.” Additionally, research revealed a shocking discovery: Insurance does not cover landslide events. Although there is federal and state money and education programs about flooding and landslides, insurance does not cover landslides and those affected by a landslide. Key informants suggested people need to do their own research to understand their risk and what is covered by insurance.

When looking at risk for flooding and landslides, most key informants discussed the abundance of information available to residents. Government websites include the Landslide Inventory maps, GIS formatted maps to identify flood zones and landslide prone areas, ordinances about building and flood risk, and reports on flooding and landslide events. Almost three quarters of key informants suggested a real-time and/or predictive model on a government website that would provide information to residents about the event, and information after the event. Although, one key informant discussed the Landslide Inventory mapping program as being outdated and perhaps should not be used as a risk assessor for landslides since a majority of landslides occurred in Watauga County in 1940 when there were, “a lot less trees and vegetation in 1940. Which really contributed to the landslides. There were a lot of logging that went on in Watauga County in those days.”

Communication about event informant among key informants was largely through phone alerts, TV and word of mouth. One key informant felt there was an overuse of flash flood warnings suggesting that, “It makes me less likely to pay attention to a flood warning when it is right in my backyard.” However, most key informants agree there is an increased frequency of flooding, which could partially explain the overuse of warnings. Surprisingly, when talking about flooding data, a key informant found no statistically significant increase in the past twenty years with regards to flooding events.

The key informant feedback reveals the WNC region prioritizing of Natural Resources and Environment, Emergency Response, Communication, and the translation of these themes as concerns to policy changes following the flooding and landslide events of May 2018. Responses from key informants demonstrate minor variations in thought by location, which can be explained by the differences in landscape, demographics, resources, policies, and exposure to water-related hazards (Andersen et al, 2018). These findings highlight the complexities of coordinating education initiatives, mitigating responses, and analyzing risk across the region with locations variation in size, economic scale and governance.

5. Conclusion

In May 2018, the southeastern United States experienced severe flooding in May 2018, which resulted in unprecedented landslides throughout the Appalachian Mountains in Western North Carolina (WNC). In the future, water-related hazards and extreme weather events could threaten the southeast more frequently, indicating a need for better understanding of stakeholder perceptions of flooding and landslides to strengthen mitigation policies (Andersen et al. 2018). To gain a better understanding of the May 2018 events, I conducted interviews with key

informants from Buncombe and Watauga Counties as well as regional and state employees and analyzed the results in Atlas.ti. Key informant feedback demonstrates how experiences and perceptions of flooding and landslides varied by employment sector and location, but also reflected the regional concerns about natural resources, communications and emergency response. The findings of this paper indicate stakeholders recognize the severity of the flooding and subsequent landslides in May 2018, but do not recognize the severity of those hazards equally due to the more common nature of flooding in the region.

There are limitations to this study as previously mentioned. Qualitative data offers great insight but is not easily generalizable. Additionally, with qualitative data there can be inherent bias and the possibility of the Hawthorne Effect. However, the key informant interviews offered valuable information, and the questions went through a vetting process to reduce any bias. Unlike the previous study on drought and wildfire, there were only two people coding the interviews, so there could be bias there, too. However, the analysis had to be completed by me as it is my thesis, so the bias cannot be fixed. An additional limit is the Census Bureau's American Community Survey statistics, which uses five years of sampling to estimate data on the population and has errors since it is not reporting the whole population.

Using the drought and wildfire study as a guide, the research methods were the same as the study was replicated but with a focus on flooding and landslides. Before interviewing, the IRB at Appalachian State University reviewed the study to protect key informants and their privacy. All instruments of this study have been approved by the IRB. The interviews were semi-structured, meaning each key informant was asked the same questions, but allowed flexibility for interviewees to discuss items they felt were important to mention.

When completing the literature review, there was an apparent gap on flooding and landslide perceptions at the local, regional, and state levels. This is particularly true for the Appalachian region. While the region is known to have landslides and flooding, the literature paints a different picture as the research is focused on previous precipitation norms and landslides on the West Coast. This research identified key themes of Environments, Emergency Response, and Communications so that communities and policy makers can have a better understanding of experiences and perceptions of flooding and landslides, as well as prepare for future hazards.

Conclusively, the findings provide insight for researchers and practitioners interested in enhancing communication about, during, and after flooding and landslide events. Key informants identified several areas that would benefit from future research, particularly regarding communication of risk, about road systems, and effective messaging. In the future, this work would benefit from collaboration between researchers and practitioners to foster a relationship with critical individuals and agencies, such as the participants in this study (Andersen et al 2018). In conclusion, effective communication of the results of this study to both the public and policymakers will be crucial for empowering and protecting communities in the western North Carolina region.

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Table 1. Demographics, Race.

Race	**Buncombe County**	**Watauga County**	**North Carolina**	**United States**
White	91.12%	96.36%	71.30%	75.95%
Black or African American	7.48%	1.74%	22.87%	13.84%
American Indian & Alaska Native	1.07%	1.37%	1.96%	1.70%
Asian	1.61%	1.38%	3.09%	6.17%
Hispanic or Latino	6.29%	3.41%	8.90%	17.33%
Other	1.35%	1.59%	3.47%	5.69%

Table 2. Socially Vulnerable Populations.

Socially Vulnerable Populations Percents	**Buncombe County**	**Watauga County**	**North Carolina**	**United States**
Persons Under 5 Years	5.17%	3.47%	6.10%	6.24%
Persons 65 Years & Over	18.03%	14.08%	14.68%	14.50%
Veterans with Disability	12.91%	9.80%	12.34%	11.34%

Table 3. Economically Vulnerable Populations.

Economically Vulnerable Populations	**Buncombe County**	**Watauga County**	**North Carolina**	**United States**
Persons in Poverty	21,986	16,509	1,670,059	48,102,282
Median Household Income	46,902	39,443	48,256	55,322

Table 4. Employment Industries Population, 2016.

Employment Industries Population 16 years and Older (2012-2016)	**Buncombe**	**Watauga**	**North Carolina**	**United States**
Agriculture, Forestry, Fishing and Hunting, and Mining	0.87%	0.81%	1.37%	1.92%
Construction	6.41%	7.37%	6.68%	6.25%
Manufacturing	9.67%	4.18%	12.39%	10.35%
Wholesale Trade	1.88%	1.09%	2.64%	2.70%
Retail Trade	13.21%	14.11%	11.88%	11.51%
Transportation and Warehousing, and Utilities	2.81%	2.15%	4.31%	5.01%
Information	1.57%	1.22%	1.83%	2.12%
Finance and Insurance, and Real Estate and Leasing	5.52%	5.34%	6.33%	6.58%
Professional, Scientific, and Management, and Administrative and Waste Management	10.52%	7.96%	10.34%	11.16%
Educational Services, and Health Care and Social Assistance	25.93%	31.35%	23.36%	23.11%
Arts, Entertainment, and Recreation, and Accommodations and Food Services	13.32%	17.23%	9.60%	9.67%
Other, except Public Administration	5.20%	5.13%	4.90%	4.92%
Public Administration	3.08%	2.05%	4.38%	4.71%

Table 5. Interviews by sector and location.

Sector	**All**	**Buncombe**	**Watauga**	**Region/State**
Agriculture and Livestock (AL)	3	2	1	0
Emergency, Safety (ES)	5	3	0	2
Local/County/Regional Government, Planning (LGP)	6	2	3	1
Private Sector (PS)	4	2	1	1
Resource Agencies (RA)	9	4	3	2
Schools and Health (SH)	3	2	1	0
Total	*30*	*15*	*9*	*6*

Table 6. The most frequently used codes, ranked.

Code	Group	Count
Flooding Risk	Natural Resources & Environment	193
Vulnerability to Flooding and Landslide	Emergency Response	95
Mapping Program	Economics	81
Flash Flood	Economics	78
Flash Flood	Natural Resources & Environment	75
Landslide	Natural Resources & Environment	74
Inter-Agency	Communication	74
Emergency Management	Emergency Response	73
Creeks/Streams/Rivers	Natural Resources & Environment	62
Drought	Natural Resources & Environment	58
General Education and Awareness	Communications	56
Agriculture	Economics	54
Data Sharing	Communications	52
Government Websites	Education & Public Awareness	51
Predictive Models	Communication	50
Data	Governance & Policy	48
Frequency	Natural Resources	48
Transportation (Rd., Bridge, Infrastructure)	Emergency Response	47
Flash Floods	Emergency Response	44
TV	Natural Resources & Environment	43
Federal	Governance & Policy	41
Response	Education & Public Awareness	41

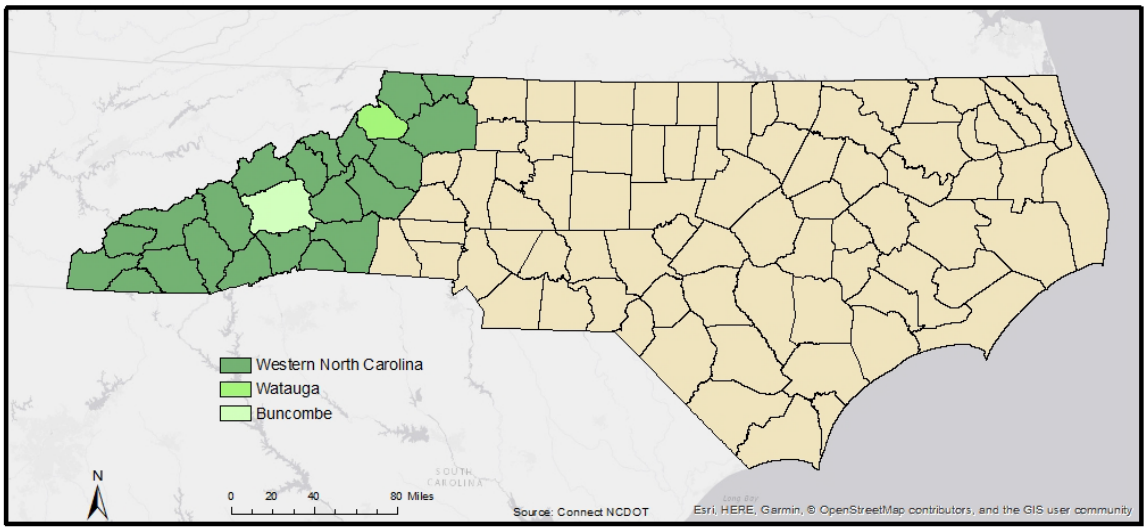

Fig. 1. Western North Carolina, USA and my study area.

Key informant interview guide and informed consent script (read aloud)

Thank you for your willingness to speak with us. My name is [X]. I am from the department of Geography and Planning at Appalachian State University. As mentioned in our email, I am interested in understanding how the 2018 flood and landslide events impacted the local community. Since your work may be affected by or involved with flooding and landslides, I value your perspective on the challenges faced by the community this season.

This interview will last 20-30 mins. I will ask you to describe how flooding or landslides relate to your work, any community impacts you observed or experienced, and any professional response to these events.

You are free to decline to answer any question, and to stop participating at any time.

I will record this phone call so that we can accurately transcribe your responses. Access to the recordings will be limited to the research team, comprising five faculty and staff members (Crepeau, Dempsey, Runkle, Shay, Sugg) and several student assistants. I will not identify you or use any personal identifying information in any presentation or written reports. However, I note that you are a key informant with exposure in your community, and as such your views may be known and your identity guessed by readers.

There is no known risk to you, nor is there any incentive or payment provided to you. I will ask for your verbal consent to be interview and recorded before we begin asking questions.

I would now like to turn on the recording device and begin taping the interview. Is that okay with you? If so, I will start recording now.

Fig. 2. Key informant interview consent script.

The following questions ask about your experiences and perceptions of flooding and landslides:
1. How does flooding impact your work?
2. What is the process for making decisions in your community or business during a flood?
3. If there was a risk of flooding or landslides in your community, how would you find out?
4. How do you inform your community or service population about flood and landslide risk?
5. How did the recent flooding and landslide affect your job? How did they impact the local community?
6. Has your recent experience with flooding and landslides altered your approach to your work? If yes, how?
7. Do you think drought or flooding pose a greater risk to your community?
8. Is there a need for products (e.g. maps, resources, predictive models) that could improve public awareness about hazards risk? If yes, what types of products would be most helpful?
9. Do you have any other comments or insights you would like to share with us?

Fig. 3. Semi-structured interview questions.

Economics	Education & Public Awareness	Emergency Response	Governance and Policy	Environment	Communications
Advanced Technology	Access to technology	Advanced Technology	Advanced Technology	Access to Drinking Water	Agriculture
Agriculture	Advanced Technology	Chronic vs. Acute Disasters	City/County	Agriculture	Cell phone and internet coverage
Culverts	Cell phone & internet coverage	Disaster or emergency declaration	Data	Creeks/Streams/Rivers	Citizen Reports
Drought	Development and human activity	Emergency Management	Drought	Culverts	Data sharing
Erosion	Drought	Emergency Shelters	Erosion	Data	Extreme Weather
Extreme Weather	Extreme Weather	Extreme Weather	Federal	Drought	Governmental Website
Financial Impacts	Fire	Fire	Flash flood	Erosion	Information Exchange
Fire	Flash flood	First Responders	Governmental Website	Extreme Weather	Inter-agency
Flash flood	General Education & awareness (not during an event)	Flash flood	Insurance	Fieldwork	Isolation
Governmental Website	Governmental Website	Government Website	Phone Alerts (App and Governmental)	Fire	Overuse of warnings
Hurricane/Tropical Storm	Historical Flooding (1990 and 2004)	Health Concerns	Real Time Updates	Flash flood	Print
Insurance	Hurricane/Tropical Storm	Hurricane/Tropical Storm	Response	Flooding Risk	Phone Alerts (App and Governmental)
Livestock	Insurance	Isolation	Sign up/subscribe	Floodplains and floodway management	Radios
Mapping Program	interagency	Real Time Updates	State	Forestry	Real Time Updates
Recreation	Isolation	Recreation	Tourism	Frequency	Sign up/subscribe
Tourism	Phone Alerts (App & Governmental)	Recovery	Transportation (Rd. Bridges, infrastructure)	Governmental Website	Social Media
Transportation (Rd. Bridges, infrastructure)	Real Time Updates	Resources		Landslides	Transportation (Rd. Bridges, infrastructure)
	Resilience	Response		Landslide Risk	TV
	Response	Safety		Real Time Updates	Website (Non-governmental)
	Sign up/subscribe	Sign up/subscribe		Springs/Wells	Word of mouth
	Social Impacts	Transportation (Rd. Bridges, infrastructure)		Urban-Wildlife Interface	
	Social Media	Vulnerability to flooding or Landslide			
	Tourism	Word of Mouth			
	Transportation (Rd. Bridges, infrastructure)				
	Word of Mouth				

Fig. 4. Code List for Analysis.

Code Group	Sector						Location		
	AL	ES	LGP	PS	RA	SH	B	W	RS
Communications	3.4%	14.2%	3.4%	12.2%	10.2%	4.5%	28.0%	10.2%	13.9%
Economics	13.3%	7.9%	4.8%	10.7%	8.2%	7.1%	26.6%	11.3%	10.2%
Education and Public Awareness	2.6%	9.5%	7.5%	8.6%	15.6%	5.2%	25.9%	10.7%	14.4%
Emergency Response	2.0%	19.0%	5.5%	8.8%	10.6%	3.1%	30.4%	8.0%	12.7%
Governance and Policy	3.3%	14.2%	15.9%	4.0%	10.3%	1.7%	17.2%	15.9%	17.5%
Environment	5.5%	10.2%	6.2%	9.8%	14.7%	4.0%	26.5%	13.2%	9.9%

Fig. 5. Matrix of code group frequency by sector and location.

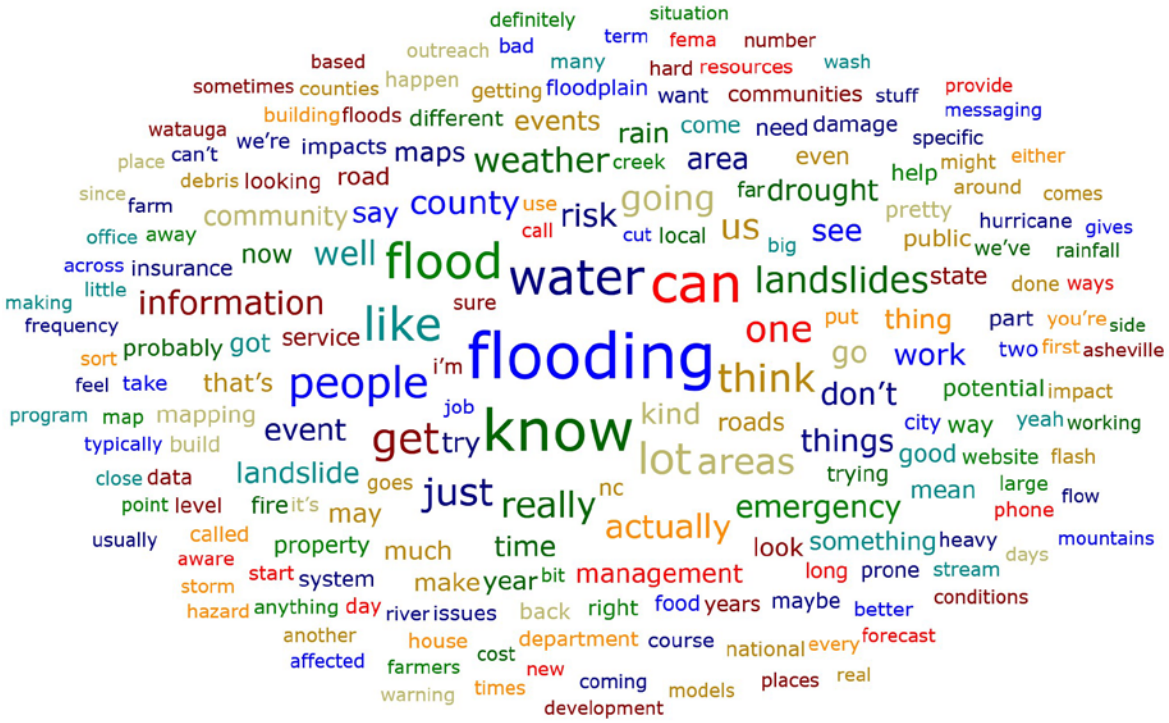

Fig. 6. Word cloud from coded interviews.

Code	Sector						Location		
	AL	ES	LGP	PS	RA	SH	B	W	SR
Flooding Risk (Environment)	4.7%	10.9%	9.3%	11.4%	9.3%	4.7%	23.8%	16.6%	9.3%
Vulnerability to Flooding or Landslide (Emergency Response)	2.1%	10.5%	8.4%	7.4%	16.8%	3.2%	24.2%	13.7%	13.7%
Mapping Program (Economics)	1.2%	12.3%	9.9%	4.9%	18.5%	2.5%	23.5%	12.3%	14.8%
Flash Flood (Economics)	16.7%	7.7%	3.8%	14.1%	2.6%	5.1%	25.6%	16.7%	7.7%
Flash Flood (Environment)	5.3%	9.3%	1.3%	10.7%	20.0%	4.0%	37.3%	6.7%	5.3%
Landslide (Environment)	4.1%	9.5%	2.7%	10.8%	20.3%	1.4%	31.1%	10.8%	9.5%
Inter-Agency (Communications)	0.0%	18.9%	5.4%	1.4%	18.9%	4.1%	32.4%	4.1%	14.9%
Emergency Management (Emergency Response)	0.0%	21.9%	9.6%	5.5%	11.0%	1.4%	19.2%	5.5%	26.0%
Creeks/Streams/Rivers (Environment)	11.3%	6.5%	4.8%	6.5%	21.0%	0.0%	29.0%	9.7%	11.3%
Drought (Environment)	3.4%	13.8%	1.7%	12.1%	13.8%	6.9%	29.3%	8.6%	10.3%
General Education and Awareness (Communication)	1.8%	12.5%	8.9%	8.9%	14.3%	3.6%	25.0%	8.9%	16.1%
Agriculture (Economics)	24.1%	11.1%	0.0%	0.0%	7.4%	13.0%	29.6%	3.7%	11.1%
Data Sharing (Communications)	0.0%	23.1%	0.0%	5.8%	17.3%	1.9%	13.5%	5.8%	32.7%
Government Websites (Education & Public Awareness)	2.0%	17.6%	15.7%	2.0%	9.8%	3.9%	17.6%	13.7%	17.6%
Predictive Models (Communications)	8.0%	6.0%	6.0%	2.0%	16.0%	10.0%	22.0%	18.0%	12.0%
Data (Governance & Policy)	2.1%	25.0%	2.1%	8.3%	6.3%	4.2%	12.5%	14.6%	25.0%
Frequency (Environment)	4.2%	6.3%	6.3%	6.3%	25.0%	0.0%	14.6%	18.8%	18.8%
Transportation (Emergency Response) (Rd., Bridges, Infrastructure)	6.4%	19.1%	0.0%	19.1%	4.3%	0.0%	42.6%	6.4%	2.1%
Flash Flood (Emergency Response)	2.3%	43.2%	0.0%	4.5%	0.0%	0.0%	43.2%	0.0%	6.8%
TV (Communications)	9.3%	11.6%	7.0%	16.3%	0.0%	7.0%	18.6%	9.3%	20.9%
Federal (Governance & Policy	14.6%	2.4%	17.1%	4.9%	4.9%	2.4%	19.5%	26.8%	7.3%
Response (Education & Public Awareness)	2.4%	2.4%	0.0%	9.8%	29.3%	2.4%	24.4%	14.6%	14.6%

Fig. 7. Matrix of code dominance by sector and county for the most common codes.

	Agriculture (Economics)	Creeks/Streams/Rivers (Natural Resources & Environment)	Data (Governance & Policy)	Data Sharing (Communications)	Drought (Natural Resources & Environment)	Emergency Management (Emergency Response)	Federal (Governance & Policy)	Flood (Economics)	Flash Flood (Emergency Response)	Flash Flood (Natural Resources & Environment)	Flooding Risk (Natural Resources & Environment)	Frequency (Natural Resources & Environment)	General Education and Awareness (Communication)	Government Websites (Education & Public Awareness)	Inter-Agency (Communications)	Landslide (Natural Resource & Environment)	Mapping Program (Economics)	Predictive Models (Communications)	Response (Education & Public Awareness)	Transportation (Emergency Response) (Rd., Bridges, Infrastructure)	TV (Communications)	Vulnerability to Flooding or Landslide (Emergency Response)
Agriculture (Economics)	0																					
Creeks/Streams/Rivers (Natural Resources)	4	0																				
Data (Governance)	1	1	0																			
Data Sharing (Communications)	0	2	5	0																		
Drought (Natural Resources)	3	3	0	0	0																	
Emergency Management (Emergency Response)	1	1	5	8	0	0																
Federal (Governance)	2	6	3	1	0	1	0															
Flash Flood (Economics)	7	5	0	0	9	0	1	0														
Flash Flood (Emergency Response)	3	3	2	1	2	3	0	3	0													
Flash Flood (Natural Resources)	4	8	1	1	3	1	0	6	4	0												
Flooding Risk (Natural Resources)	7	14	3	5	9	5	4	21	8	11	0											
Frequency (Natural Resources)	0	2	1	1	0	0	3	1	1	4	11	0										
General Education and Awareness (Communication)	3	2	1	3	0	1	0	1	0	1	10	1	0									
Government Websites (Education & Public Awareness)	0	2	3	0	0	0	5	0	1	1	3	0	3	0								
Inter-Agency (Communications)	1	1	4	10	0	10	2	0	3	3	9	1	2	1	0							
Landslide (Natural Resource)	0	3	0	0	0	1	0	0	2	3	7	2	2	3	2	0						
Mapping Program (Economics)	0	3	10	9	1	1	4	0	0	1	11	2	5	7	6	7	0					
Predictive Models (Communications)	0	3	6	7	0	4	5	0	1	2	4	3	1	4	3	0	6	0				
Response (Education & Public Awareness)	2	0	1	2	0	1	3	1	0	0	1	2	6	1	2	3	2	3	0			
Transportation (Emergency Response) (Rd., Bridges, Infrastructure)	1	2	1	1	0	2	1	4	6	4	9	1	0	0	2	5	0	1	0	0		
TV (Communications)	0	0	1	1	0	2	1	0	0	0	1	0	1	2	0	1	0	0	1	0	0	
Vulnerability to Flooding or Landslide (Emergency Response)	2	4	1	5	2	2	2	2	2	6	24	6	5	3	6	6	11	6	4	1	1	0

Fig. 8. Word cloud from coded interviews.

Vita

Abie Nicole Bonevac was raised in Charlotte, North Carolina. While she loved the city life, Abie was excited at the opportunity to move to Boone, a small town in the mountains, so she chose to attend Appalachian State University.

As an undergraduate, Abie served on the executive boards of Knitters and Crocheters, the Geographical Society, Student Planning Association, and Appalachian State Chapter of the American Society for Photogrammetry and Remote Sensing. As a junior Abie conducted research on perceptions of drought and wildfire following the 2016 wildfire season in the southeastern United States. Abie expanded her work and presented her research at the North Carolina American Planning Association Conference in September 2017. As a senior, Abie researched travel behavior in college students at Appalachian State University and the University of Georgia in Athens. Abie served as the College of Arts and Sciences Representative, which she continued into graduate school. In 2018, Abie was second author on "Understanding Key Informant Experiences and Perceptions of the 2016 Drought and Wildfires in Western North Carolina, USA." She was also awarded Outstanding Planning Student at the North Carolina Planning Association Conference in September of 2018. Abie graduated summa cum laude with a Bachelor of Science degrees in Geography-GIS and Community and Regional Planning in May 2018.

As a member of the Accelerated Admission Program, Abie continued her previous research on vulnerability in western North Carolina with a focus on flooding and landslides

under the direction of Dr. Elizabeth Shay. Abie began her second year of graduate school at Appalachian in August 2018. Upon graduating with a Master of Arts in Geography in May 2019, Abie hopes to work for a local government in North Carolina.