

Rural Flood Resilience & Adaptation

A Study of Rural Appalachia and Williamson, West Virginia

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Problem Statement

Rural, Appalachian, low-capacity communities are facing increased inland flooding, exacerbated by climate change, while lacking adequate planning tools to reach flood resilience.

Purpose

Every state in the nation is experiencing increased flooding, as a particular result of increased extreme precipitation events. Planning emphasis in this realm has largely been focused on coastal regions, but inland flooding is a growing issue of climate change nationally and globally; "Inland flooding poses a massive threat to millions of homes across the country, but this risk sometimes flies under the radar when media stories focus on large coastal storms and flooding events" (National Flood Services nd.). There is a growing urgency to understand flooding for communities outside of these coastal cities, and beyond that, outside of 'cities' themselves; inland rural spaces are not immune from flooding. Resiliency planning, designed for small, more rural communities, will be a necessary tool to prepare, mitigate, and adapt to climate change impacts and severe flooding for small town America.

Holistic inland flood planning — that connects adaptation and mitigation to concepts of resilience — will allow states to allocate their resources and plan more effectively and efficiently to curb inland flooding. Planning should include actionable strategies to positively influence policy and programs across stakeholders at every level: from resident to state office. This paper is an effort to situate this type of planning in rural Appalachia, and to design a framework and recommendations that significantly support often vulnerable, low-capacity, rural Appalachian communities.

Introduction

Climate Change & Extreme Weather Events

Flooding is the highest costing and most prevalent hazard, annually on average, that cities face in the United States; “Ninety percent of all natural disasters in the U.S. involve flooding” (FEMA & NOAA 2010). For instance, in the last year, and more generally the last decade, the United States has faced historic flooding. Last year alone, the US experienced eighteen weather or climate disaster events where overall costs exceeded \$1 billion. Of these events that totaled over \$165 billion in losses, one of which was the historic flooding event that occurred in Kentucky and Missouri from July 26-28 (NCEI 2023); Central Appalachia is a setting rife with social disparities that will continue to be exacerbated by climate change and extreme inland flooding, more specifically.

Most flood research has focused around and sought to address coastal city flooding and sea level rise, as well as the necessary emphasis on densely populated urban areas with high flood concerns. The aim of this paper, however, is to focus on communities at the fringe of climate concern and news reporting, as related to planning. Inland flooding is becoming an increasing issue of resilience and climate change for the nation. Previously identified high-risk flood areas are now not the only places of concern, as around “25% of flood insurance claims come from moderate-to low-risk areas” (FEMA & NOAA 2010). Even these numbers do not accurately represent all in need as records show that only around 4% of US homeowners have flood insurance and many more are unable to afford insurance for a variety of socioeconomic reasons (Moore 2022).

The EPA and others have identified heavy precipitation as a climate change indicator and reports show that “Extreme One-Day Precipitation Events” have begun to cover a greater percentage of land area in the United States (EPA & NOAA 2021). Ultimately, a growing percentage of precipitation falling on US soil has occurred through intense single-day rain events, due to a warming climate — these events drive the majority of inland flooding and billions in damage every year (USGCRP 2017; Wobus, et al. 2017; Moustakis et al., 2021). The Center for Climate and Energy Solutions defines these extreme precipitation events as “instances in which the amount of rain or snow experienced in a location substantially exceeds what is normal” and reports that the Midwest and Northeast have recorded the strongest increases in weather events of this type (“Extreme Precipitation”, n.d.). As the Earth heats one degree Celsius, the air can trap around 7% more water vapor therefore allowing for more intense rain events and an increased opportunity for damaging inland flooding (“Extreme Precipitation”, n.d.).

Rural Planning to Scale & in Context

Some scholars have introduced climate change migration theories. These theories place emphasis on populations from the southeastern and southwestern parts of the United States moving into Central Appalachia as a way to escape climate change impacts (Hirschman 2022). Placing merit behind this theory would rely heavily on efficient and effective planning for these communities, especially for flood adaptation and mitigation. Rural planning is diverse, so approaching it through a local social lens is important to effectively prepare communities for future flood events. This is possible through the combination of Resilience planning, Adaptation and Mitigation Planning — using social vulnerability measures to best design flood adaptation and mitigation plans for rural Appalachian communities. Ironically, this approach will rely heavily on the State and Regional planning practices, to invert the burden for small-scale communities already strapped for resources and expertise, beyond their unique local knowledge.

Beyond theories such as this, assessing the transferability and applicability of best practices within these planning spaces, for resilience, adaptation, or mitigation, will be key to providing adequate recommendations for these communities. Rural Planning works to protect/ conserve natural resources and rural character while also improving quality of life for residents. For instance, Washington State's Department of Community, Trade and Economic Development separates rural planning approaches into four considerations: "(1) protection of rural character; (2) provision of rural services; (3) reconciliation of existing development with the need to protect rural character; and (4) encouragement of appropriate economic development" (DCTED 1999). This approach allows unique communities to define their characters and development patterns. These considerations align with plans for mitigation, adaptation, and resilience within rural Appalachian communities. Clear approaches like these also allow for simple, realistic guiding questions to be the foundation of planning initiatives.

The majority of existing resilience planning is centered on urban resilience which, as defined by the American Planning Association (APA), is the "capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience" (Stromberg 2017). The APA lists stressors like high unemployment, at-risk and aging infrastructure, and drought as examples of common stresses to cities. Acute shocks differ in that they are shorter-term, higher-impact events that exacerbate these existing stresses; "acute shocks are the devastating occurrences that often get conversations about resilience going: earthquakes, floods, disease outbreaks, terrorist attacks" (Stromberg 2017). Similarly, the Environmental Finance Center, at Sacramento State, assessed that resilience planning includes various types of activities that all seek the same goals: "(1) actions that ensure communities have access to critical lifeline needs, services, and capital, in the period following a disaster; and 2) actions that reduce risk from natural and human-driven hazards

over the long-term, reducing the likelihood that communities suffer from multiple disasters over time that compound” (EFC 2020, 2). This is essentially a definition to expand two main ideas: adaptation and mitigation, respectively.

In this paper, resilience will move beyond the city to the “rural” sphere of the United States. Urban resilience and rural resilience are similar in theory, but practice shows that rural communities face more prevalent barriers to resilience. Rural communities are more dependent on natural resources, face more physical isolation, are less economically diverse, usually have higher poverty rates and lower educational attainment than urban communities. These communities also live with poor and aging infrastructure, decentralized, low-resource governance, and many rural areas lack access to critical healthcare and technologies like broadband (Ajilore and Willingham 2019). These factors exacerbate their vulnerability to climate change and their ability to achieve significant resilience.

Literature Review

To best supplement recommendations, it is first necessary to understand rural communities. Their spatial and demographic characteristics vary throughout the nation, and unique spaces call for unique solutions and approaches. This section will first generally describe rural areas, then discuss complications or vulnerabilities of these communities. Finally, this section will provide a synthesis of Resilience Planning, Adaptation and Mitigation Planning, with reference to rural Central Appalachia and its unique social and cultural characteristics.

Rural Areas: Central Appalachia

Spatially

Spatially, rural counties follow the general rule that they are neither part of a recognized metropolitan area, nor are they directly adjacent to one. According to the 2014 National Climate Assessment, over 95% of the United States land area was considered rural but its residents only made up about 19% of the US population (Hales & Hohenstein 2014). A more recent study, by the National Institute of Food and Agriculture, through the United States Department of Agriculture (USDA), estimates that rural land area is closer to 72% and is home to almost 50 million people (Delheimer 2022).

Beyond this overtly spatial definition of rural and in the context of this paper, rural areas of Appalachia are also geographically unique. The Appalachian mountains were formed almost 500 million years ago and are the oldest mountain range in North America. The central region, or Central Appalachia, is home to some of the world's oldest river systems and a

highly biologically diverse forest system. This also makes it a prime location for a diverse set of species as well, both flora and fauna. Topography and elevation range throughout Central Appalachia with West Virginia boasting the highest average elevation by state, east of the Mississippi River. It also has a history steeped in extraction of its rich natural resources — its forests, water, and energy resources like coal or natural gas (“Central Appalachia” n.d.).

Above, the map depicts Central Appalachia which is the primary spatial setting for this paper and its uses. According to the US Census Bureau, Central Appalachia comprises hundreds of counties spread between five states; these states include West Virginia, Southwest Virginia, Eastern Kentucky, East Tennessee, and Western North Carolina. Rural land use is commonly thought of as farmland, but it also can host mining land, forest land, or general working land — these uses take various shapes and sizes, adding to the existing uniqueness of these communities.

Demographically

Alongside spatial definitions or characterizations of rural areas in Central Appalachia, rural spaces are also demographically unique. To better understand these characterizations however, a discussion of definitions for ‘rural’ are warranted.

There exist issues associated with planning for rural areas because it simply depends on who one asks (whether that be the Census Bureau or other governmental or non-governmental agencies, local rural residents, etc.), the answer will mostly always be different. There are over a dozen federal definitions of ‘rural’ depending on which agency is being asked. Rural communities tend to be lumped together and overgeneralized to the point of cultural loss: “A common narrative portrays “Rural America” as one big place with one set of similar people and facing similar challenges. Yet, in reality, rural America’s geographic, demographic, and socioeconomic landscapes are remarkably diverse” (Chinni and Pinkus 2019). Demographically speaking, rural spaces are very complex across the nation. In light of this however, there are some shared qualities that have been identified among rural communities — that can be further condensed to rural Appalachian communities.

The American Communities Project (ACP) released a report in 2019 titled *A New Portrait of Rural America* that evaluated and dissected some of the nuances of rural America. In their evaluation towards a new understanding of ‘rural America’, the ACP assessed a collection of 2,243 rural counties in the United States to comprise the “ACP Rural Universe” (Chinni and Pinkus 2019). Within this ACP universe, the counties are then further classified under nine ACP rural county types: *African American South, Aging Farmlands, Evangelical Hubs, Graying America, Hispanic Centers, LDS Enclaves, Native American Lands, Rural Middle America, and Working Class Country* (Chinni and Pinkus 2019). In the Aging Farmlands, Working Class Country, and Rural Middle American, the median counties are more than 90% white, indicating little racial or ethnic diversity in these communities (Chinni and Pinkus 2019, 4).

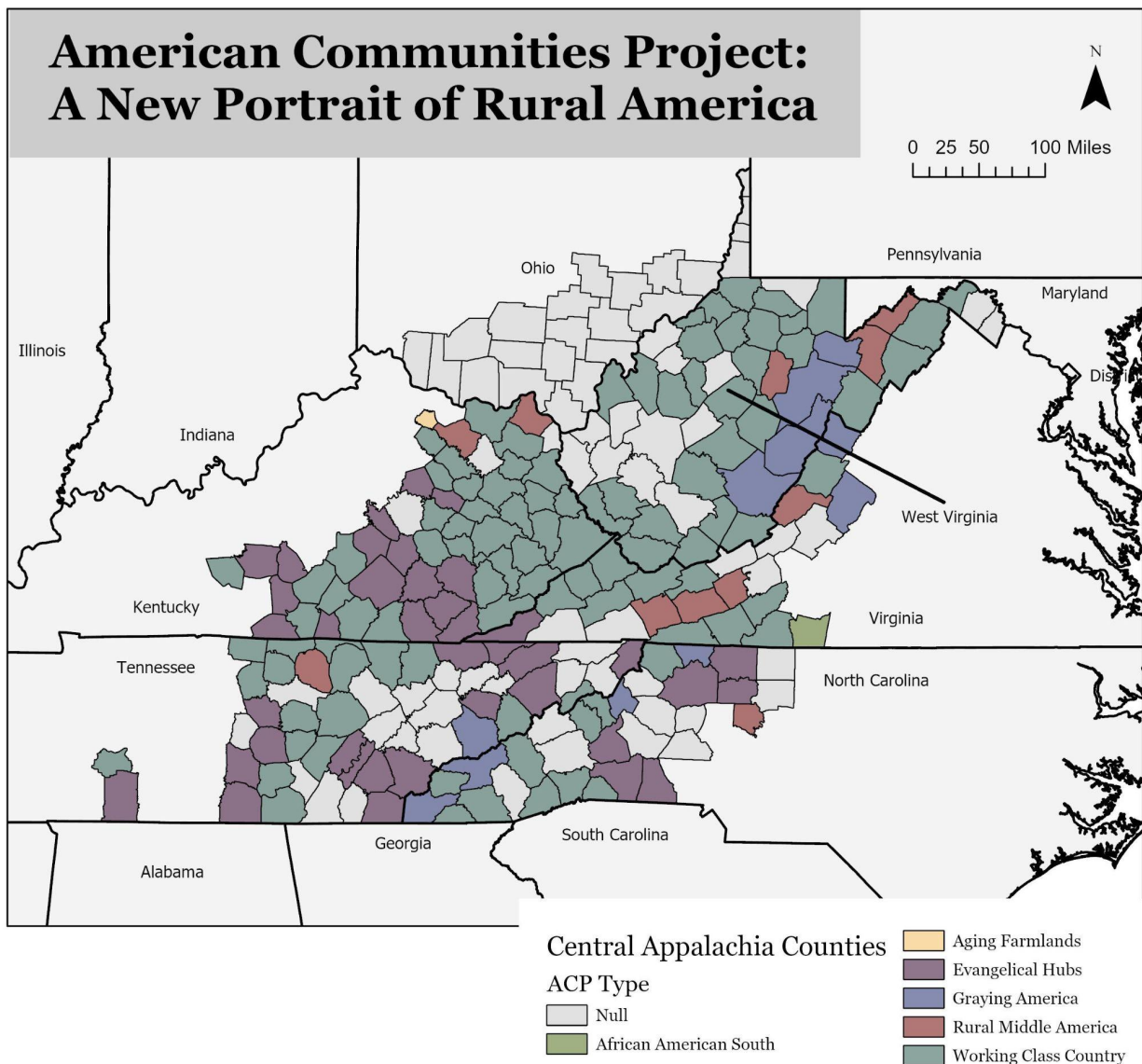


Figure 1. ACP Types for Counties of Central Appalachia (Data sourced from American Communities Project & Appalachian Regional Commission).

But Appalachia is as unique as its physical and social vulnerabilities. The Appalachian Regional Commission (ARC) compared Rural Appalachia to other areas of the United States identified as rural and found key distinctions. The Appalachian Region is made up of 423 counties and one-fourth of these counties are designated “rural”. Broadly, they fell behind Non-Appalachian Rural numbers in minority numbers, educational attainment, higher rates of poverty, and fewer households having access to computer technology and broadband access. Around 2.5 million people reside in rural Appalachia with a median age of 42.4. Education wise, Central Appalachia saw increases in educational attainment, with 80%

of adults completing high school since 2016. Higher education of those 25-64 sits a little under 20% for adults with a bachelor's degree. Over 20% of Appalachian persons live in poverty and median household income is more than \$9,000 below that of other rural counties, nationally. Technological infrastructure is interesting in that almost 83% of households own one or more computer devices, 74% of households have broadband, but over 22% of households exist without access to the internet for rural Appalachia ("Rural Appalachia Compared" n.d.).

These rural American counties also tend to have an aging population, with ~20% being 65 years of age or older, while the national average is 16% (Chinni and Pinkus 2019, 4). However, ACP's report also revealed that, proportionally, there are still large populations of young people, under 18, in parts of rural America with numbers fairly equivalent to the national average. This last demographic measure alludes to an issue of retention (Chinni and Pinkus 2019, 4). Being able to retain an adolescent-transitioning-to-young adult population is an ongoing issue, especially for rural communities and economic opportunity plays a key role in this. And although more than half of the 2,243 rural counties evaluated by ACP have faced population decline (around 3% decrease since 2010), overall rural American numbers have grown by 1.4 million people in the same time, making rural planning and its thoughtful application imperative for much of the United States (Chinni and Pinkus 2019, 4; "Rural Appalachia Compared" n.d.).

Rural Complications for Addressing Climate Change Impacts

The effects of climate change are exacerbated in rural areas already burdened by physical and social vulnerabilities, like those discussed above. This section will examine aspects of both physical and social vulnerability, while situating these issues in Central Appalachia, with emphasis on their relation to flooding.

Physical & Social Vulnerability

Rural communities, inherently by their definition, are set outside of urban or metro areas, thus making them physically isolated from high-capacity urban centers. Referencing the spatial characteristics of rural communities discussed previously, physical isolation from critical services is compounded with individual isolation, or neighborhood isolation, as homes are set apart from low-capacity rural centers as well.

Social stressors also contribute to the impacts of climate change and influence community resilience. In rural areas factors like income, educational attainment, poverty, and limited demographic variation increase vulnerability ("Rural Impacts" n.d.). Limited economic diversity makes these communities less flexible to change, which is the opposite of resilience.

For much of Central Appalachia, rural communities do not rely on agriculture — a common overgeneralization — but are instead small service economies. According to the ACP, more than 20% of people in every rural county work in educational service, health care, or social assistance — schools and hospitals or government institutions often ranked as primary employers for these communities (Chinni and Pinkus 2019, 6). A large chunk of Central Appalachian counties, as designated by the ACP, are *Working Class Country* which present as mostly rural in nature and are the least diverse in the American Communities Project; “93% white, 1% African American and 2% Hispanic” (“Working Class Country” n.d.). For this Working Class Country, almost 14% of jobs offered are in the manufacturing sector (Chinni and Pinkus 2019, 6). Average median household incomes for these counties across the United States are around \$20,000 below the national median income (around \$50,000) (“Working Class Country” n.d.). The communities also tend to have lower education rates and higher poverty rates.

There is often an added stressor to healthcare systems in communities that have high rates of opioid misuse/substance misuse. Substance abuse is a national phenomenon experienced in both urban American, rural America, and anywhere in between. According to a National Survey on Drug Use and Health (NSDUH), in 2021 8.2 million adults reported misusing prescription pain relievers at least once the year before — 1.2 million of those people resided outside a metropolitan area (RHI n.d.). Rural Central Appalachia does not escape this trend, but instead ranks high in the number of High Intensity Drug Trafficking Areas (HIDTA), as reported by the US Office of National Drug Control Policy (Appalachian HIDTA n.d.). This illustrates that substance misuse is prevalent in rural areas and is often a symptom of other contributing vulnerability factors such as low educational attainment, poverty, unemployment, and isolation — much of this is discussed above (RHI n.d.).



Figure 2. HIDTA Counties in Appalachia, as defined by the Office of National Drug Control Policy, omitting western North Carolina which would be relevant to the spatial setting of this research (Map sourced from the Office of National Drug Policy 2022).

Substance use or misuse can also be especially challenging to fight in low-capacity communities for lack of prevention, treatment, or recovery resources, and existing resources are spread too thin (RHI n.d.). These drugs and their addictions do not discriminate based on class, economic status, gender, or even age. Drug-related deaths can happen to anyone across a community (JH Consulting 2017, 46). According to the USDA, in 2020 adults (ages 35-44) experienced the highest rates of deaths due to drug overdose but those younger (ages 15-24) experienced the percentage increase for deaths due to drugs from 2019 (Hedegaard et al. 2020). Interestingly, there is also research showing a link between opioid abuse in rural America and other factors, including extreme weather/natural disasters as well as income level; aggregate counts of presidentially declared disasters have significant impact on opioid use/deaths from opioid use (Goetz and Davlasheridze 2018). This highlights the need for community-scale health support planning for these communities as an additional way to be better prepared to combat climate change impacts, like intense floods.

Other public health concerns include financial measures to recovery/resilience and flood-vulnerable industries. Regarding financial measures, another factor of social vulnerability, and blatantly applicable to this paper, is the lack of flood insurance for many residents of rural communities, especially those of Central Appalachia. Most often, flood insurance is a question of affordability, which goes beyond even just flood insurance: from

pre-flood to recovery stages. Those in poverty or cost-burdened have fewer resources to obtain flood insurance or even recover from flood events (Rhubart and Sun 2021; Fothergill 2004). Flood damage does not fall under standard homeowners or renters insurance so it must be purchased separately from either the federal government or private institutions. Typically, flood insurance costs around \$1,000 annually through FEMA's National Flood Insurance Program (NFIP), which is a substantial financial commitment for many households (Frank 2022). The Insurance Information Institute estimates that only 4% of homeowners nationwide have flood insurance despite that almost 90% of disasters in the US involve flooding (Moore 2022; Santana & Phillis 2022).

Extractive industries, like mining, which is prevalent in Central Appalachia compound another potential health risk for communities facing flooding. For industries like coal, flooding can disrupt and spread hazardous wastes associated with mining to local surface and ground waters, or put people directly in contact with contaminants in standing flood waters (Rhubart and Sun 2021). Mining practices contribute to an increased probability of flood likelihood (e.g. Mountaintop Removal Mining/ Surface Mining) (Rhubart and Sun 2021). Consequently, communities like those of rural Central Appalachia that depend on natural resource extraction may be at higher risks for flood impact, both environmentally and in terms of public health.

Still, these communities are heavily reliant on the natural environment/natural resources and are, at times, at the mercy of it. As climate change progresses, the leading hazards for rural Appalachian communities including extreme precipitation events, flooding, landslides and subsidence, and even drought will all influence flood resilience. These hazards, and the possibility of their increasing occurrence, will also detrimentally affect potential uses of these places; it will shift the settings of where rural economic activities (like forestry, mining, and recreation) can sustain and prosper (Hales and Hohenstein 2014). In summation, climate change will only increase limited economic diversity so planning in these spaces remains critical.

Rural Resilience Planning

Rural Resilience Planning seeks to assess the climate vulnerability of communities in order to better prepare them for the future. Resilience is the ability to prepare and plan for, to recover from, and to successfully adapt to adverse events — in this case flood resilience, at the rural level (ULI 2015). Evaluating the social capital of rural communities often reveals unique strengths in regards to resilience. Understanding existing social networks, community capital, and environmental capital within rural communities serves as the framework for evaluating rural resilience beyond an agricultural or natural-resource-based past — there too exists an economic capital necessary to manage hazardous flooding events (Kowalczyk 2020, 11; Wozniak-Brown 2019). These together, determine resilience capacity for rural communities.

Despite existing vulnerabilities and climate change complications, rural communities are known for strong social characteristics: active volunteer bases, traditions of independence and neighborliness, skilled natural resource knowledge, strong and active faith-based institutions, resourceful decision making, inventive inter-municipal and inter-departmental partnerships, and more (Wozniak-Brown 2019). The path to actionable resilience plans should occur through hearty public participation in order to identify critical resources, communication gaps, and priority adaptation actions. Resilience planning should also happen adjacent to existing planning initiatives like comprehensive planning or existing hazard mitigation plans (Wozniak-Brown 2019). Public participation is more complicated for rural communities, especially those facing gaps in technology infrastructure, as modern outreach becomes more reliant on social media (Wozniak-Brown 2019). Striking balance between community strengths, existing social networks, and resilience plans based on vulnerability/risk assessment is how to best prepare flood-prone rural Appalachia.

Effective adaptation and mitigation measures are undoubtedly linked to specific local conditions/ needs and account for existing social and community capital. Limited economic and social diversity, discussed earlier, impact a community's ability to address climate change and flood disasters. Thus resilience planning must also account for the quality and availability of natural resources, the legacies of their historic use, and changing industry needs — these critical factors directly contribute to or limit social and economic capacity (Hales et al. 2014). Here, sustainable land use and development is the key tool to control the types of development occurring, regardless of community size. Aspects of development such as location, concentration, intensity play a role in resilience. Besides land use, this paper will focus on transportation and infrastructure systems, public health and emergency response systems, and the role of governance as adaptation areas most necessary to reach flood-resilience; these will be discussed later in this paper.

Rural Adaptation & Management

In tandem with resilience planning and in the context of this paper, responding to climate change complications and increased inland flooding will require innovative and realistic adaptations. Three areas of adaptation-need have been identified within rural transportation/infrastructure systems, public health and emergency response sectors/ systems, and local governance (Hales and Hohenstein 2014). This section seeks to develop broader topics than the flood-specific accommodation tactics like green and gray infrastructure that will be discussed in the *Best Practices* section further in this paper.

The Intergovernmental Panel on Climate Change (IPCC) notes that mitigation and adaptation are complementary approaches used to reduce negative risk and impacts of climate change (IPCC 2014). Adaptation refers to planning that addresses current risk, that

also is able to respond to future risk. Mitigation is a long-term planning tool to reduce climate change impacts to come, and overall (IPCC 2014; “What is the Difference” n.d.).

Local Governance

In regards to local governance, the state is often the most capable facilitator in adaptation and mitigation planning. This is important for rural communities that lack the governance structure or capacity necessary to implement many adaptation plans. State governments provide a top-down approach of relief coordination, they most likely already invest the largest share of public funding for flood mitigation within states, and often determine how best federal dollars should be spent within their state. This makes them key actors in guiding flood adaptation and mitigation efforts, whether it be large infrastructure changes or public education in regards to flood risk and preparation services for individuals and households. State action also allows for greater control and impact at larger watershed scales – planning, adaptation, or mitigation by county or rural community limits the possible positive impact projects, policies, or plans could have on an entire watershed. As facilitators, State governments manage and mediate relationships between local governments, potential existing special water plans, land development or use changes, and federal agencies undertaking floodplain management and funding eligibility (like the Federal Emergency Management Agency, or FEMA and the US Army Corps of Engineers).

For instance, in order to qualify for Federal Emergency Management Agency funding, especially necessary in the aftermath of flood hazard events, State governments must develop environmental hazard plans (often State Hazard Mitigation Plans or SHMPs) – these plans are often the extent of flood planning for some communities. State governments also control core policy tools and state police powers to legislatively ensure health and safety for their inhabitants; of course, they are not unlimited powers and states are subject to their own political systems. These reasons further highlight the necessary role of State governments in local community flood adaptation and mitigation, increasingly necessary for rural communities of Appalachia (Burnstein and Rogin 2022).

This importance of State government extends to the State plans themselves, which are often flawed. In a report by the Urban Institute, researchers conducted an in-depth document review of 148 relevant State plans, surveyed from all 50 states. These plans were active flood plans or they referenced some form of flood plan. The survey revealed several patterns, fleshed out below (Burnstein and Rogin 2022).

- **Flooding was rarely a large component of most plans reviewed.** Aside from hazard plans, coastal plans, the majority of plans were climate plans; resilience plans focused mostly on shocks and stressors in regards to local hazards; water plans dealt mostly with quality and quantity of water. Flood mitigation, adaptation, and resilience should plan from a holistic view.

- **The majority of plans surveyed did not include a meaningful analysis of social vulnerability.** Only 22 states, and 24 plans had included social vulnerability alongside a geographic risk analysis (purely natural hazards) but as this paper discusses, demographic and socioeconomic factors influence resilience, as well as best adapt to and mitigate the effects of climate change and major flood events. As discussed in the section before, reiterated here, assessing social vulnerability is a key step in achieving resilience.
- **More than half of the plans surveyed were created in a year or less.** This limits the time for significant public engagement or public opinion to drive flood plans for their unique communities.
- **Few plans included specific plans or strategies to support low-capacity localities (i.e., geographically isolated with limited government resources, low resources, or a lack of technical skills); also, monitoring/ improvement measurement strategies for localities to address flood hazards were not included.** This disregards the level of assistance that many local, more rural communities need in order to best plan for flood adaptation and mitigation efforts.
- **Contractors or consultants played extensive roles in producing state plans.** This could potentially limit or omit local connection or social/ institutional knowledge from the flood plan development process. Local emergency management departments will, at the end of the day, be the first line of defense and response for localized flood disasters, so they should be emphasized in the planning process.

This paper gives added emphasis to the fourth pattern. Presenting the case for strengthened rural mitigation and adaptation planning for low-capacity localities, particularly for rural Appalachian communities, is the aim of this paper.

Transportation & Infrastructure

Alongside supporting local governance through the State, rural transportation and infrastructure must also be strengthened to best plan resilience, through adaptation. This is the physical structure that is necessary to facilitate increased governmental and social capacity for rural communities as reliable infrastructure is essential to community prosperity, security, and resilience (Puentes 2015; “Critical Infrastructure” 2019).

A 2021 First Street Foundation comprehensive report, titled “The 3rd National Risk Assessment: Infrastructure on the Brink,” assessed flooding risk to all states in the United States. Relevant to this section of the paper are the risk assessed to (1) roads, (2) ‘critical infrastructure’ (airports, fire stations, hospitals, police stations, superfund/hazardous waste sites, water outfalls, and wastewater treatment facilities), and (3) ‘social infrastructure’ (government buildings, historic buildings, houses of worship, museums, and schools) as

defined by the First Street Foundation; “Risk in this report is quantified as the unique level of flooding for each infrastructure type relative to operational thresholds, as established by the federal government and other authoritative bodies” (First Street Foundation 2021). The report estimates that currently, 2 million miles of road (25%) are at risk and that an additional 200,000 miles will become at risk by 2051 while almost 40,000 critical infrastructure facilities (25%) are at risk currently (and an expected 6% increase in risk expected by 2051). Simultaneously, an estimated 71,717 individual social infrastructure facilities are currently at risk for flooding (17%) with a projected increase to almost 78,000 by 2051 (First Street Foundation 2021, 3).

According to the American Society of Civil Engineers (ASCE), infrastructure in the United States is in mediocre condition. For instance, the ASCE’s 2021 America’s Infrastructure Report Card rated various infrastructure systems on a letter grade scale, from A+ to D-. Bridges received a C: “42% of all bridges are at least 50 years old, and 46,154, or 7.5% of the nation’s bridges, are considered structurally deficient, meaning they are in ‘poor’ condition” (ASCE 2021, 19). Similarly, Dams received a D, as the number of high-hazard-potential dams, in which failures would cause direct loss of human life, has more than doubled in the last 20 years as “development steadily encroaches on once rural dams and reservoirs” (ASCE 2021, 26).

The First Street Foundation report also identified persistent patterns of flood risk vulnerability in lesser known flood zones, including the Appalachian Mountain regions of West Virginia and Kentucky — states well within the Central Appalachian region (First Street Foundation 2021, 4). For instance, the report identified 50,284 miles of roads, 1,107 infrastructure facilities, and 968 social infrastructure facilities with operational flood risk for the state of West Virginia, as of 2021 (First Street Foundation 2021, 155).

Public Health & Emergency Response

Another aspect of flood adaptation planning highly relevant to rural communities is the importance of public health infrastructure and emergency response sectors/ systems. Transportation and infrastructure networks influence access to healthcare and emergency response greatly — services that are critical to the overall health of communities (Sieber et al. 2020). Drawing on the *Physical & Social Vulnerability* section from before, we note that existing conditions such as the opioid epidemic are real stressors to rural Appalachian communities and their ability to adapt to or mitigate climate change impacts. Climate change only exacerbates existing points of social vulnerability and applies potential further pressure to public health systems. The WHO defines climate resilient health systems as “capable to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stress, so as to bring sustained improvements in population health, despite an unstable climate” (World Health Organization 2015)

In addition, an aspect of emergency response is the preparedness and capacity of these existing healthcare systems (“Rural Impacts” n.d.). Many Central Appalachian healthcare systems are already overburdened due to limited resources and high-demand outside of natural disasters. Flooding events have potential impacts on broader community health and well-being. Direct impacts present as immediate damages/loss of life. Outside of direct impacts, indirect impacts include environmental system issues like vector-, food-, and water-borne diseases, other natural hazards such as landslides or subsidence, mine collapses. There are also socially mediated effects such as mental illness, population displacement, amplified poverty and retarded economic growth, and the list goes on (Ebi et al. 2018; World Health Organization 2015).

Health adaptation to climate change works to strengthen health systems to better prepare for and manage impacts. The World Health Organization (WHO) has developed an *Operational Framework for Building Climate Resilient Health Systems* which offers guidance for health systems and public health programming to increase and support their capacity to provide health services under duress, at the influence of climate change. It outlines six building blocks of health systems as: 1) leadership and governance, 2) health workforce, 3) health information systems, 4) essential medical products and technologies, 5) service delivery, and 6) financing (World Health Organization 2015). This document and its framework influenced the US Climate Resilience Toolkit, referenced extensively in this paper. In the interest of this paper, specific attention is given to critical facilities which host each of the six building blocks.

Critical facilities are facilities for which disruption would cause significant harm to a functioning community; they include hospitals, shelter, power generation, etc. (Guenther & Balbus 2014; FEMA 2014). Health care workers are first responders and hospitals serve as safe spaces in times of need – health care facilities can provide health services, access to clean water and food, shelter and more, especially for disadvantaged, low-capacity communities such as flood-prone rural Appalachia. Due to the rise of extreme precipitation events and higher risk for flooding, it is important for communities, states, and local policy makers to standardize adaptation designs to flood-proof hospitals and other critical healthcare facilities – especially those located in or adjacent to floodplains or waterways (Guenther & Balbus 2014, 23).

Climate Change Mitigation

Mitigation planning, more broadly in the context of climate change, is the planning path to primarily reduce greenhouse gas emissions (GHGs) in an effort to limit global warming (IPCC 2014). It can also refer to human interventions to reduce sources of other pollutants or substances in an effort to limit the effects of climate change. For instance, particulate matter pollution, nitrogen oxides, volatile organic compounds, and others are examples of substances, beyond greenhouse gasses, that influence climate change (Wozniak-Brown

2019). This distinction is made to note that mitigation planning can mean different things depending on the context of its intended use.

Best Practices

For most communities, including rural Central Appalachia, adaptation and mitigation will take the form of either green infrastructure or gray infrastructure. For most cases, the combination into hybrid solutions have the most potential to “safeguard the security provided by infrastructure while providing the benefits of natural approaches” (Jongman 2018, 2). Hardware infrastructure must then be supported, designed, and planned through resilience planning initiatives. This section outlines these topics through a synthesis of best practices for reducing flood risk and building flood resilience. Nature-based solutions are also often cheaper solutions, long-term, than exclusively gray solutions (“Building Community Resilience” 2021).

Green - Nature Based Solutions

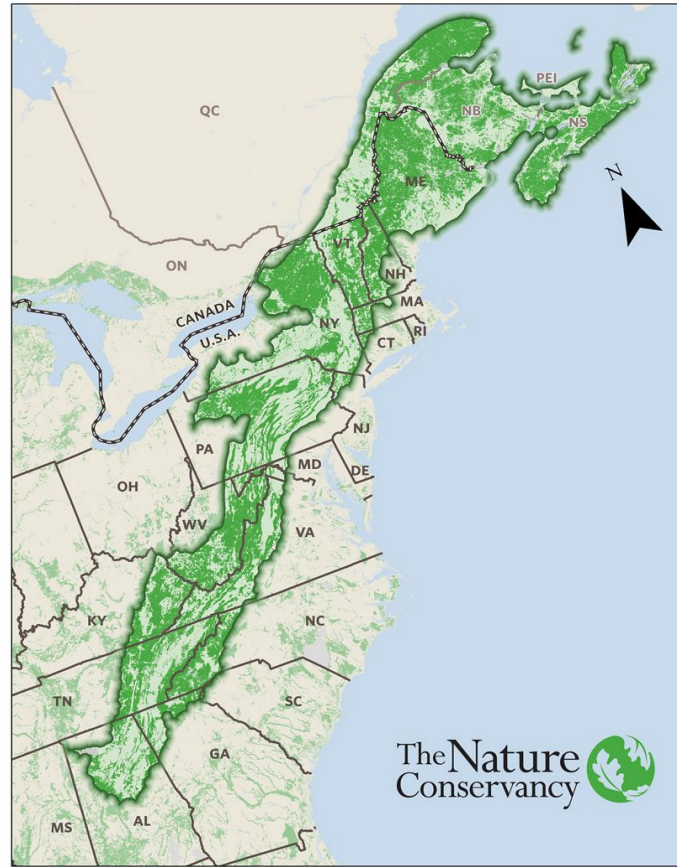
According to the National Mitigation Investment Strategy, nature-based, or green, solutions are cost-effective approaches to mitigating and adapting to hazards like extreme precipitation events and flooding. They work as natural designs integrated into a community’s existing built environment or its natural areas (“Building Community Resilience” 2021). The primary difference between natural/ green infrastructure and the natural environment is that green infrastructure is managed and maintained (“Building Community Resilience” 2021; Roy 2018). Rural communities have strong natural resource systems so, nature-based solutions are not only actionable in these settings but should be the primary focus. Returning to the concept of rural resilience discussed above, environmental capacity is a key component to achieving resilience; protecting and leveraging the natural environment to better curb the effects of flooding, exacerbated by climate change, is paramount to small town America’s survival.

- **Watershed Level.** Most focus should be concentrated at the watershed level for rural Central Appalachia. Watershed scale initiatives take long-term planning and broad coordination. Drawing on previous discussion of local governance and the importance of state participation and regional planning, green infrastructure at the watershed level can take many forms.

Land Conservation.

This is the conservation to preserve open space; land or conservation easements can be bought or obtained through land donations. Exurbanation, when urban residents leave cities to live and develop in rural areas, is outpacing updates to land use regulations and environmental regulation for many rural areas, especially Appalachia (“Building Community Resilience” 2021; Brownson et al. 2020).

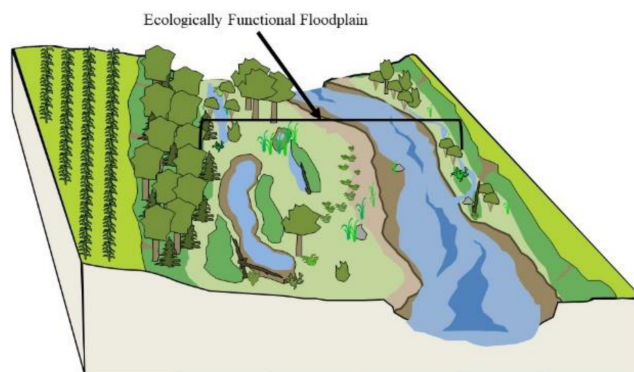
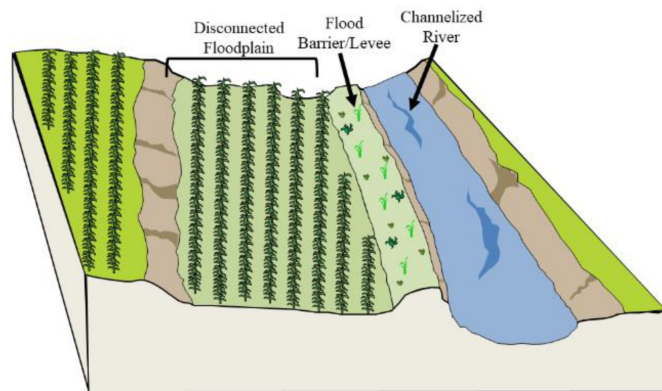
Conservation land trusts can be important tools in low-capacity areas with limited political power and/or lack of regulation (Brownson et al. 2020).



The Appalachian Mountains (TNC n.d.).

Floodplain/Waterway Restoration.

Protected floodplains keep waterways healthy by controlling floodwaters, limiting erosion, filtering runoff, and they provide critical habitats for local wildlife; Floodplain restoration reconnects the floodplain to the waterway (“Building Community Resilience” 2021). Appalachia is rife with ecological disturbance, especially due to mining and timber harvest operations; a restoration ecology/community-based conservation approach is a critical tool for addressing these historical floodplain issues in low-capacity communities (Heil 2019).



Disconnected vs. Functional Floodplain (Gordon et al. 2020).

Wetland Restoration & Protection.

Restoring and protecting wetlands improves water quality and reduces chance for flooding; they filter, absorb water, and reduce/slow runoff; flood attenuation by wetlands protect downstream communities (“Building Community Resilience” 2021; “Wetlands of West Virginia” n.d.). Volunteer based restoration, through conservation organizations, can be a driving force in low-capacity communities (WVDEP & WVDNR 2021).



WV Wetland (“Wetlands of West Virginia” n.d.).

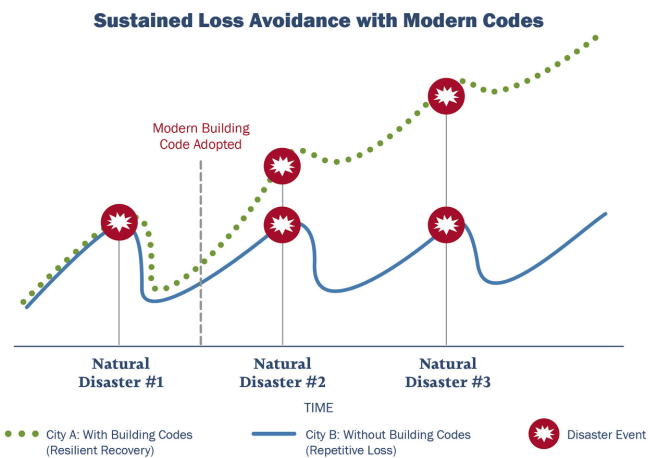
Gray

In contrast, gray infrastructure tends to be public works structures specifically designed to provide a single-service under particular scenarios. For instance, water treatment requires gray infrastructure such as water treatment plants, pipes, basins, etc. to treat water effectively but these plants do little else (“Building Community Resilience” 2021).

→ **Local Scale/ Property-Level.** Most gray infrastructure practices occur on a local scale in line with specific in-town objectives, specific to each local governing body.

Design Standards/ Building Codes.

There are monetary benefits to adopting hazard resistant building codes and design standards. Building codes address many hazard concerns and contribute to better public health and safety, and flood resiliency (“Protecting Communities” 2020).



(“Protecting Communities” 2020)

Structural Flood Protection (e.g. flood walls, dams, levees).

Flood control structures provide defense against continued small flooding events — so maintenance of these structures is key. Structures like these are often the first line of defense for flooding to protect structures from flood damage (USAID 2012). For instance, flood walls are useful for areas where space is limited — this is the case for many small towns built along waterways (US Army Corps of Engineers et al. 2017).



Flood Control Structure, Florida (University of Florida n.d.)

Land Use Management

Land Use Planning.

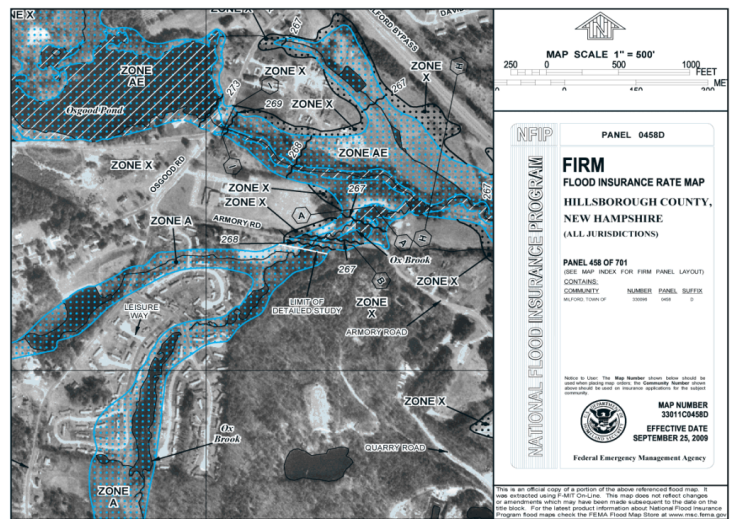
Risk-informed land use planning can often curb flood risk. Planning allows for smart development — away from high-risk areas, especially floodplains. Regulation of development in floodplains works with the National Flood Insurance Program to best plan where development should be limited (“Chapter 15” n.d.).

Zoning.

Zoning works with land use planning to regulate compatible and non-compatible uses of land — these are uniquely specific to each locality that uses them (“Chapter 15” n.d.). They also include design standards for each zone — including set-backs for structures, sizes, and density allowances. Zoning and regulation can also be used to protect certain areas, such as wetlands, sensitive flood areas, or conservation space.

The National Flood Insurance Program (NFIP).

In 1968, the National Flood Insurance Act was passed which initiated the NFIP. The intention of the NFIP was to reduce flood damages but the program often puts burden on those that don’t need it (those outside coastal areas) and FEMA flood insurance rate maps are outdated in regards to climate change and other outside influences (Pralle 2019; Kreisel & Landry 2004). The program also suffers from low-funding and low participation rates (Tier 2021). The NFIP is the US’s primary flood mitigation tool, so updating it will be crucial in years to come.



Example FIRM, from Hillsborough County, New Hampshire (Flood Partners n.d.).

Resilience

The aim of flood resilience in the interest of this paper, is to move away from traditional 'reactive' disaster response/flood management and transition into 'proactive' adaptation, mitigation, and preventative resilience. This is illustrated in the figure below to guide understanding of priority goals in the effort that they are transferable to rural Central Appalachian communities. Resilience begins with the identification of places with possibilities of high flood risk and vulnerability: risk assessment. This step, comprehensive disaster risk knowledge, is essential for best allocating resources and developing policies that curb adverse consequences of flooding events (Rhubart and Sun 2021; UNDRR 2017). Risk reduction initiatives are then supported by resilience planning through institutional/governing support and preparedness, public health systems resilience, and infrastructure adaptations as discussed in previous sections.

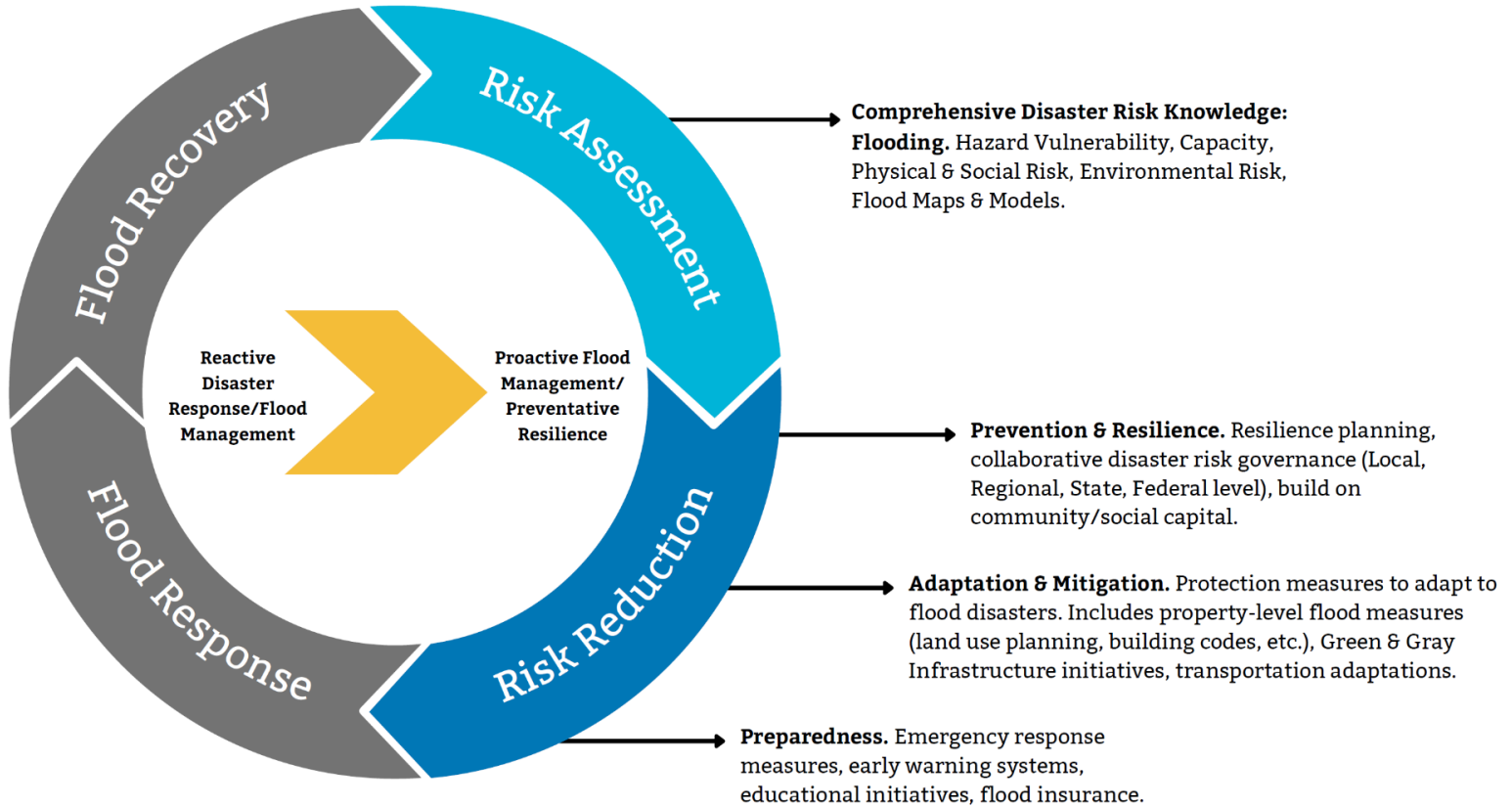


Figure 3. Flood Resilience/Risk Priority Framework. Premised, sourced and modified from (Surminski & Thieken 2017); (Mehryar & Surminski 2020); (UNDRR 2017).

Reactive disaster response often frays communities further and can chip away at future capacity to recover or respond to disaster events, and some academic research has found a relationship between US disaster spending and reinforced inequality (Wilson et al. 2021). Access to assistance is compounded by social vulnerabilities and low-capacity, disadvantaged populations face more barriers to flood assistance and recovery. For instance, in regards to FEMA flood assistance, reports are showing that low-income populations are experiencing disproportionately high rejection rates for federal assistance, independent of level of damage (Wilson et al. 2021). This trend extends to lower-income areas and recovery assistance seems to follow higher valued homes and personal properties (Wilson et al. 2021; Emrich et al. 2020). These instances highlight the failures of current flood management systems, especially in communities with limited social or economic mobility, like much of rural Central Appalachia, and reinforce the need for robust resilience planning (in combination with adaptation and mitigation planning).

Case Study Analysis

This section applies the previously discussed knowledge, planning practices, and resilience techniques in context: a rural Central Appalachian community — Williamson, West Virginia. This research aims to define tools and frame resilience approaches ideal for planners, community leaders, and decision makers in rural Appalachian communities who anticipate long-term flood risk of their communities and wish to use proactive approaches towards flood resilience.

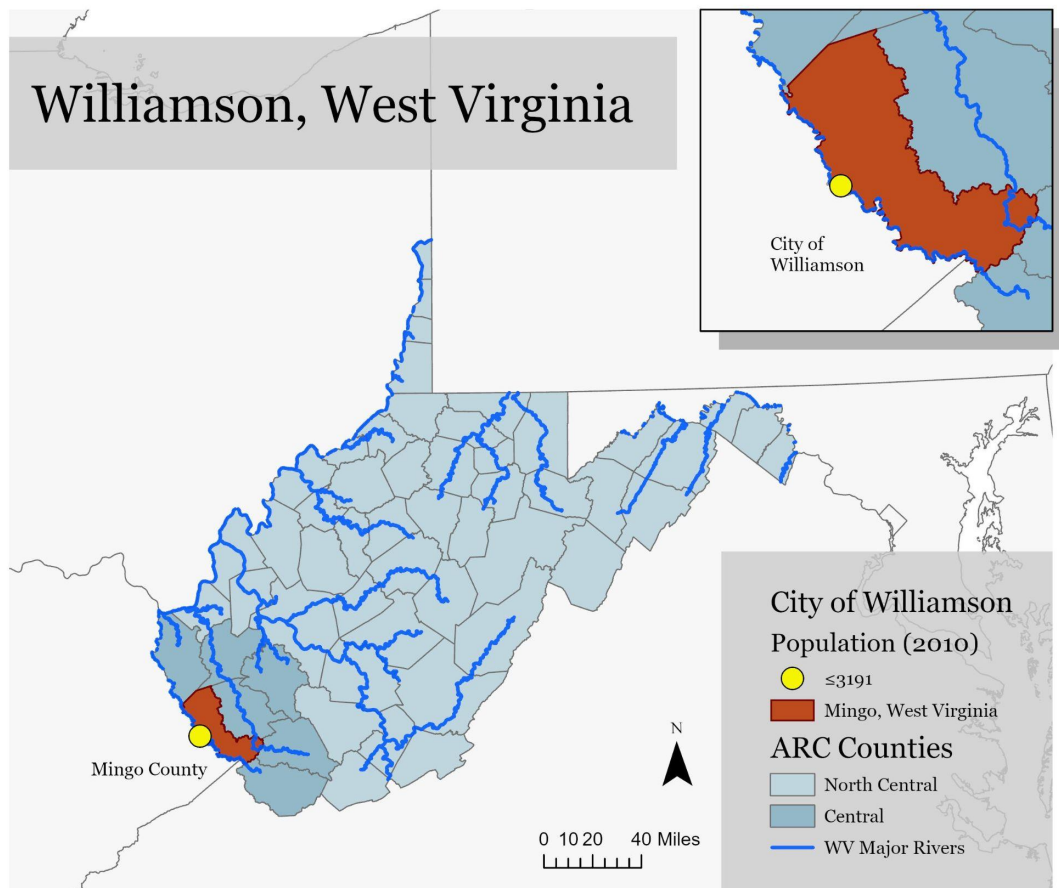


Figure 4. Williamson, West Virginia — a city within Mingo County, West Virginia (Data sourced from Appalachian Regional Commission; Census Bureau of the United States 2010; ESRI).

State & Community Profile: Williamson, West Virginia



Figure 5. Williamson, West Virginia aerial view (Photo by Wes Wilson through the Tug Valley Chamber of Commerce 2018).

Williamson, West Virginia was incorporated in 1905 at the height of the coal boom for much of Central Appalachia. It is the county seat of Mingo County, beside the Tug Fork of the Big Sandy River. The town is also on the West Virginia-Kentucky state line and a major Norfolk Southern Railroad runs through Williamson. The population peaked close to 9,000 people in 1950 but the population has steadily declined to closer to 3,000 in 2020 (WV Encyclopedia n.d.; Census Bureau 2020). Alongside this population decline is a shrinking workforce accompanied by aging residents. Mingo County, as a whole, is considered a Persistent Poverty County, by the Congressional Research Service, which means poverty rates have been 20% or higher over the last 3 decades (Plymale et al. 2022). In 2020, jobs had been slashed in half to 2010 numbers: from 8,267 to 4,271, according to the Bureau of Labor Statistics (BLS 2021). The top employers or industries included 1) Educational services, Healthcare and Social Assistance, 2) Natural Resources and Mining, and 3) Trade, Transportation and warehousing, and Utilities (Plymale et al. 2022).

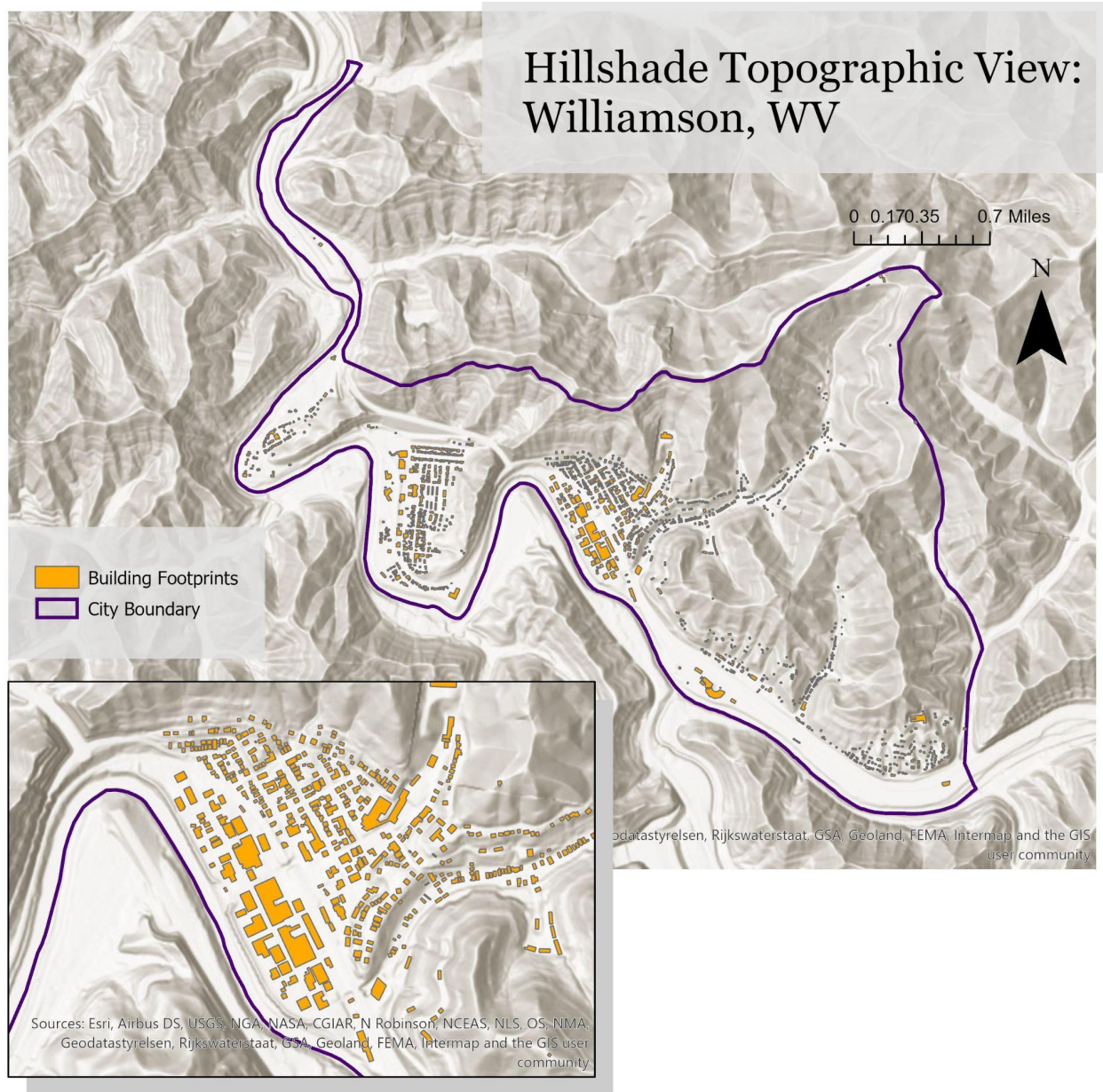


Figure 6. Hillshade Topographic Elevation view of Williamson, WV with building footprints in bright orange to show distribution of structures and development density along the Tug Fork — the flood wall protects these structures (Sourced from ESRI; Automatic Knowledge & Microsoft Building Data Source).



Figure 7. Google Earth 3D axis view of Williamson, WV to highlight the extreme topography changes that contribute to fast flooding of lower valley towns (Sourced from Google Earth 2023).

Flood Experience

West Virginia faces inland flooding hazards only (flooding and flash floods), as the state is landlocked in the heart of the Appalachian Mountains. Flooding is the number one natural hazard for the state of West Virginia and according to NOAA, ‘excessive rainfall’ is the number one cause of flooding as water accumulates faster than soil absorption can occur (JH Consulting 2017, 50). Many rural communities of the state are at risk for flooding because they are nestled between steep mountain sides, cut by rivers and streams to create narrow valleys — making the state prone to flooding.

The most recent deadly flood event occurred in June of 2016, in which 23 people were killed in a ‘1,000-year flood’. The road repair alone was almost \$50 million and over 2000 people were temporarily displaced. Following this event, the state established a Resiliency office but it has done little to address flooding for the state. This is common history for West Virginia, as one article wrote: “West Virginia has had a comprehensive flood mitigation plan on the books since 2004, though officials have taken little concrete action to implement it” (Beyer 2022). This plan, the first ever West Virginia Statewide Flood Protection Plan, was developed

and presented by the West Virginia Flood Protection Task Force in 2004. Since then, no actions have been taken and the task force was quickly disbanded — the planning existed but failure of implementation very likely contributed to 23 deaths in that 2016 flood.

This city of Williamson, West Virginia was chosen as the primary study area because it is representative of rural Central Appalachian communities facing inland flooding. It has also been the setting of historically devastating flood events. For instance, in April of 1977, intense rain led to historic water levels for the Tug Fork River, the waterway that runs through Williamson. It led to dozens of homes and businesses being destroyed and parts of the community were under 30-50 feet of water (Peyton 2022; WV Encyclopedia n.d.). Just seven years later, in 1984, the small city saw another major flood and although it was less damaging, some locals believed it killed hopes for many in the community (Peyton 2022). There is a strong relationship between mental health effects and disaster recovery/natural disaster victims, so it is easy to recognize the importance of this opinion (Green & Solomon 1995). In 1991, the Army Corps of Engineers completed a flood wall that wraps around the city's waterfront edge, preventing further flooding events but the historic floods remain important to the City's history. This presence of existing substantial gray infrastructure was an additional reason Williamson is the case study community. It illustrates that major state and federally led involvement can benefit communities and support them towards flood resilience.



Figure 8. Tug Fork River alongside Williamson, West Virginia (Photo by author 2023).



Figure 9. Flood gate for Williamson, West Virginia along the Tug Fork River (Photo by author 2023).

Governance

As of January 2019, West Virginia is a Home rule state, meaning that cities and towns have powers and duties by their own design; “Home Rule gives cities and towns the ability to implement ordinances, resolutions, rules, and regulations that fit their specific dynamics” (WV Municipal League n.d.). Funding and direction for adaptation and mitigation planning (specifically Hazard Mitigation Plans) is funneled through state agencies. The West Virginia Division of Homeland Security and Emergency Management is the primary agency responsible for implementation strategies and plans within the state — or of related activities. Descriptions of relevant state and local organizations are provided.

→ State Level.

- ◆ **West Virginia State Resiliency Office (WVSRO).** This West Virginia office was established in April 2017, following the deadly 2016 summer floods in response to the lack of flood preparedness in the state. The West Virginia legislature passed House Bill 2935 which created the Resiliency office as well as a joint legislative committee to address flooding across the state. The SRO’s mission statement is as follows: “Minimize the loss of life and property, maintain economic stability, and improve recovery time by coordinating with stakeholders to implement disaster resilient strategies” (WVSRO n.d.).

- ◆ **West Virginia Division of Homeland Security & Emergency Management (WVDHSEM).** This division works to ensure the protection of life and property through coordination efforts, guidance, and assistance to local emergency managers and first responders. WVDHSEM enforces actions directed and controlled by the Governor and their office — an implementation tool. The Division includes multiple branches that oversee specific areas of preparedness, mitigation, and response and recovery: Preparedness and Response, Technological Hazards, Mitigation and Recovery, WV Intelligence Fusion Center, Mission Support, General Staff, Grants, and Administration and Finance (WVEMD 2018).
- ◆ **West Virginia Conservation Agency (WVCA).** The governing body for the WV Conservation Agency has existed since the early 1900s but in 2002, the state Legislature changed their name from the “Soil Conservation Committee” to “State Conservation Committee” to reflect their wider interests and responsibilities, beyond soil. This committee oversees the WVCA with the mission to “provide for and promote the protection and conservation of West Virginia’s soil, land, water and related resources for the health, safety and general welfare of the state’s citizens” (WVCA n.d.). This agency led the last update of the WV Flood Protection Plan in 2004, in partnership with the US Army Corps of Engineers. The agency regularly oversees dam and stream maintenance for much of the state, at regional levels.
- ◆ **West Virginia Department of Environmental Protection (WVDEP).** The DEP enforces state and federal environmental laws for West Virginia in the interest of air, water, and land. Its Division of Water and Waste Management is relevant to this paper as it works at the watershed level, but mostly focuses on controlling hazardous waste, solid waste, and surface and groundwater pollution (“Water and Waste” n.d.). DEP also works with agencies to protect wetlands through monitoring, restoration, and regulation (“Wetland Assessment” n.d.).

→ **Regional Level.**

- ◆ **Regional Planning & Development Councils (Regional PDCs).** In 1971, the Regional Planning and Development Act mandated that the state of West Virginia separated into 11 development districts or regions. This was an effort to better utilize funding resources and maximize small communities’ chances of funding, as well as to foster community and collaboration on a larger scale. The Regional Councils focus on water and sewer facilities, infrastructure, transportation, employment and industry, housing, health care, education, recreation, and more. They often offer local jurisdictions innovative

approaches to planning and goal prioritization through a multitude of services including (varies by Council Region): “grant writing, labor compliance, Section 3 and Title VI adherence, 5G solicitation assistance, workforce development, intergovernmental reviews, census report updates, public and governmental engagement strategies, environmental reviews, financial administration, drawdowns, account maintenance, income surveys, mapping capabilities, aging services and programs, revolving loan funds that assist new and expanding business, and a wealth of programmatic knowledge” (WVARC n.d.).

Plans & Initiatives

West Virginia Currently has three state-level plans relevant to this paper: the 2018 State Hazard Mitigation Plan (SHMP), the 2004 West Virginia Flood Protection Plan, and the West Virginia Wetland Program Plan. Regional Plans include the 2017 Region 2 Multijurisdictional Hazard Mitigation Plan.

→ State Level.

- ◆ **West Virginia Statewide Standard Hazard Mitigation Plan (SHMP), 2018.** This plan reviews statewide natural hazards to guide in reducing loss and preventing injury throughout the state. It is developed by the West Virginia Division of Homeland Security and Emergency Management (WVDHSEM). The Disaster Mitigation Act of 2000 regulates states to include hazard mitigation plans and WV, since 2004, has been able to receive non-emergency Stafford Act assistance and federal pre-disaster mitigation funding for maintaining this SHMP. The plan does include a section to connect the state hazard mitigation plans to any applicable regional or local hazard mitigation plans, including flooding.
- ◆ **West Virginia Flood Protection Plan, 2004.** The flood protection plan, last updated in 2004, was intended to provide a flood planning for short-term, long-term goals, and implementation strategies for six specific goals: 1) reduce unnecessary loss of lives because of flooding, 2) reduce property damages due to flooding, 3) develop tools to manage flood loss and floodplains, 4) promote technical and legislative tools to reduce runoff due to development, 5) reduce personal and economic loss due to flooding, and 6) protect waterways and floodplains throughout the state (WV Flood Protection Plan 2004). The plan is currently outdated and is insufficient in risk understanding for effective planning initiatives (Tony 2022).
- ◆ **West Virginia Wetland Program Plan, 2021-2025.** This plan, published in 2021 by the WV Department of Environmental Protection and the WV Division of Natural Resources, in an effort to protect and restore wetland areas for West

Virginia. The report notes that wetlands for the state are close to 100,000 acres and are vital to biodiversity, water quality, and flood protection (WVDEP & WVDNR 2021). The plan also outlines actions that the state and relevant partners should take (between 2021-2025) to improve the wetland program and wetland conservation. This plan could be a strong foundation for more general state and local flood plans — it is more recent and structurally sound than existing historical plans.

→ **Regional Level.**

- ◆ **Region 2 Multi-Jurisdictional Hazard Mitigation Plan, 2017.** This plan is specific to Region 2, which includes Mingo County, which Williamson lies within. Much like the SHMP the regional plan lists hazards specific to its region, including a risk index for each identified hazard. The plan notes that floods are the greatest threat to property and lives and come in different forms: floods, flash floods, riverine floods, etc. The 2017 update was unique to previous plans in that it attempted to include a more diverse group of stakeholders in the planning process such as floodplain managers and community watershed groups (JH Consulting 2017).

Public Opinion

Public opinion is often negative in regards to flooding events and initiatives in Central Appalachia, especially for rural communities. Flood Plain Management occurs on a county-scale but the department is located in Williamson's downtown at the County Courthouse. When speaking to the Mingo County Flood Plain Manager and the local Tug Valley Chamber of Commerce, there seemed to be no current state or local initiatives to build flood resilience or new flood plans. No one interviewed had any knowledge of any flood-related news or initiatives but did quickly reference the City's history of devastating floods. The Flood Plain Manager also serves as the Director of 911 Mapping and Addressing, highlighting how strained and spread local departments can be — she was responsible for field work and data collection/entry in order to keep up to date with properties, structure, and flood plain mapping.

The mapping, through a WV GIS service, is fairly new for the community, as the current director began building it in 2013 and it remains an ongoing process as new permits and changes occur regularly. The Manager divulged that the previous position holder had retired well into his old age and primarily kept the position as a political seat — the department ran on outdated physical maps, some without flood plains added. The department and recommendation for permits would not have passed review and it seems to have been a real labor of love for the current Manager to get the department up to specs. For many properties and structures, the Manager had to go back and ask residents to fill out paperwork associated with their permits that should have been obtained before the structures were

even built — an oversight of the previous Manager that further complicates the current Manager's job.

The department enforces flood design standards and building codes at the property level, but these as in all cases, primarily apply to new development as it is easier to build design in from the start than to retroactively build up to flood code. The Manager confirmed that most residents the office handles do not have flood insurance. An interesting point here is that much of the recurring property flood damage for this area is not housing damage, but is bridge damage; many properties have access drives that cross streams and waterways. These often get washed out in flooding events and recovery funds do not always cover these issues, but most residents cannot afford to rebuild.

One area of contention related to the recovery funds, and imparted by the County Flood Plain Manager, is historically poor experience with FEMA. In low-capacity communities like Williamson and Mingo County there seems to be a lack of initiative to assist, unless disasters make headlines and even less so if they are not Presidentially Declared Disasters. Anecdotally, there was a significant flood in February of last year that left much of the County and its residents with extensive damage, but FEMA did not arrive on site in the County until June. The Manager relayed that they had been proactive in recording and documenting damage, because FEMA would have written off their need for recovery assistance without it. People had already built back, cleaned up, and addressed their own issues without the intervention of the federal system because they had to — damage would not wait for a tardy response. Positions like the Manager's are extremely vital to community resilience, capital, and wellbeing. Another personal story that the Manager shared is: an older woman in Mingo wanted to drop her flood insurance because rates were going up but the Manager implored her to keep it as her home resided in a flood plain. Not too long after, a flood came and left the elderly woman's home severely damaged and she personally thanked the Manager for convincing her to keep her flood insurance saying "I would have had nothing" without it.

But these individuals are usually not enough to create resilience and should not have to bear the full load of a community's flood needs. Most are frustrated with the organizations and lack of action that is occurring in the state. Although the state has governing bodies like the Legislative Committee on Flooding, even for members these efforts are going nowhere. For instance, Democratic state Senator Stephen Baldwin was reported as stating that the committee was not focusing on flood prevention and instead was primarily rehashing the state's previous unsuccessful recovery response (Patterson 2020). Likewise, the SRO has had similar news coverage and most news reports reveal that the office has done very little in the way of plans, projects, or collaboration efforts beyond claims for future flood plan updates (Tony 2021; Patterson 2020).

Findings/Recommendations

Climate change will only increase flood risk for all community types, but rural Central Appalachian communities subject to unique social and physical vulnerabilities will require unique solutions and planning efforts to achieve flood resilience. By studying the experience of Williamson, West Virginia, this paper provides support for other rural communities, planners, and decision makers to best prepare their communities for flood risk and flood resilience through innovative adaptation and mitigation. Those with adequate resources, such as the state, should have a responsibility to support low-capacity communities in efforts to achieve community, climate, and flood resilience.

Recommendations.

Dedicated State Appointed Agency.

In order to effectively mitigate flood hazards, there should be direct state regulation in order to best enforce lasting change (Burby & French 1980). Much of the critique of West Virginia's flood management planning has been the lack of implementation. In a state as divided and physically vulnerable, as limited in state or local funding, and with a population in need of assistance as WV, cohesive enforcement would be largely beneficial. As of 2020, the office of Resiliency has only one employee, and has no direct authority to implement flood mitigation solutions. The original intentions of the House Bill 2935, which created a joint legislative committee to address flooding as well as the Resiliency Office, were allegedly to "coordinate all economic and community resiliency planning and implementation efforts, including but not limited to flood protection programs and activities in the state" (Patterson 2020). Carolyn Kousky, executive director of the Risk Management and Decision Processes Center at the University of Pennsylvania's Wharton School, said that "a lot of it is left up to what local governments choose to do...Smaller and less affluent communities might not have the resources or the expertise" (Patterson 2020). Following this, a strong resiliency office with state power could greatly influence flood mitigation for West Virginia, and subsequently Region 2; if these counties already have to band together for the planning process, surely their implementation and enforcement goals would benefit from one consolidated and united state entity.

Planning to Support Low-Capacity, Local Communities.

Building capacity at local levels would improve flood resilience. Partnering with existing programs such as the Association of State Floodplain Managers, in an effort to introduce, implement, and reinforce flood resilience, adaptation in connection to existing mitigation plans would empower local communities. There should also be an effort to enhance local capacity to gain access to federal flood mitigation funding and support resources for community-guided flood planning efforts. This ties back to the strong social capital that is often overlooked in these communities — leverage community strengths to plan for the future. The current approach, assessed through both the literature review and community

input, reveals that flood management and adaptation is a siloed, reactive process. Actively engaging with these low-capacity communities, their uniquely knowledgeable local experts, and connecting with state and federal governing bodies is a pragmatic approach to flood resilience.

Improved Infrastructure.

Improved infrastructure is needed for the state as a whole. There are serious infrastructure issues that are ripe for failure in the region. The state should update any infrastructure that can fail in a flood and take full inventory of their maintenance needs; this includes bridges, dams, water and wastewater systems, energy infrastructure, and transportation networks. With relatively new bills like the Improved Infrastructure and Jobs Act (IIJA), which is even more promising because it is expanding the definition of infrastructure to include things like broadband, there are more streams of federal and state funding than before.

Programs like BRIC, or Building Resilient Infrastructure and Communities, are examples of investments (supported by the IIJA) in proven flood solutions for communities. FEMA awards funds for community-level projects to build resilience ahead of disasters — preventative funding (American Flood Coalition 2021). Similarly, the STORM Act, or Safeguarding Tomorrow Through Ongoing Risk Mitigation, allows FEMA to provide grants to states to set up loan funds to local governments towards hazard mitigation and risk reduction; the IIJA provides \$500 million to STORM and can finance various water, infrastructure, disaster-related, and community development projects (“Infrastructure Deal” 2021). A dedicated state agency and coordinated effort to support planning in low-capacity, rural Central Appalachian communities could take advantage of opportunities such as these.

Public Health & Emergency Response Coordination/Support.

Flooding events and disasters more generally, can disrupt health services, contribute to pollution and contaminated waters, impact food systems, and impact mental and emotional well-being. Holistic adaptation and mitigation plans should include critical understandings of community health and emergency response systems available to low-capacity spaces. Public health workers, although often the first line of defense for disasters, are infrequently a part of the planning process (“Guide to Expanding Mitigation” n.d.). Health departments, at the local and state levels, are often initial stakeholders identified in the collaborative Health System process. Public health agencies are vital to the mitigation process and should at least be included in local, regional hazard mitigation plans, as required by the state.

Vulnerable populations rely more on existing health systems that only become more stressed during natural disaster events. Groups including older adults, children, those institutionalized, historically marginalized populations, people with disabilities, and those experiencing homelessness usually require additional support, even more so in times of duress (Schroeder & Bouldin 2019). Flood adaptation and mitigation plans should include public health and emergency response frameworks to best prepare for increasing extreme

precipitation events — especially when public health infrastructure is multi-use and often already equipped to handle some level of emergency.

Waterway & Wetland Restoration.

Rural Appalachia could also benefit from effective and streamlined waterway and wetland restoration as a mitigation tool. Green infrastructure reduces stormwater runoff and reduces flood risk. They also lessen the flow of harmful nutrients, pollution, and debris by acting as a buffer between the overworked stream and flooding towns; “Riverine wetlands are especially useful in storing and holding flows, including peak flows, which tend to produce flood damage” (EPA 2022). This adaptation can also be incorporated into a CRS program. For example, Virginia’s “Wetlands Watch” completed a study to create a framework for local communities to document nature-based credits via the National Flood Insurance Program’s Community Response System (Jarbeau 2017). Surprisingly, West Virginia is not starting at ground zero for wetland restoration. It would be best to leverage existing plans: the West Virginia Wetland Program Plan. The plan specifically notes that development of natural land, or undisturbed land, is the largest threat to wetlands — “Construction, extractive industries, and floodplain development all contribute to wetland loss in the state” (WVDEP & WVDNR 2021, 3). While climate change is exacerbating major storm events like extreme precipitation followed by intense inland flooding, wetlands are a key tool to stabilize water cycles, for regional watersheds and thus local, low-capacity rural communities.

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