Building Flood Resilience in West Virginia Through Community Engaged Research

Jamie Shinn (SUNY ESF), Aaron Maxwell (WVU), Behrang Bidadian (WVU), Annie Mahmoudi (WVU)

February 25, 2026 - Presentation to WVU Center for Resilient Communities

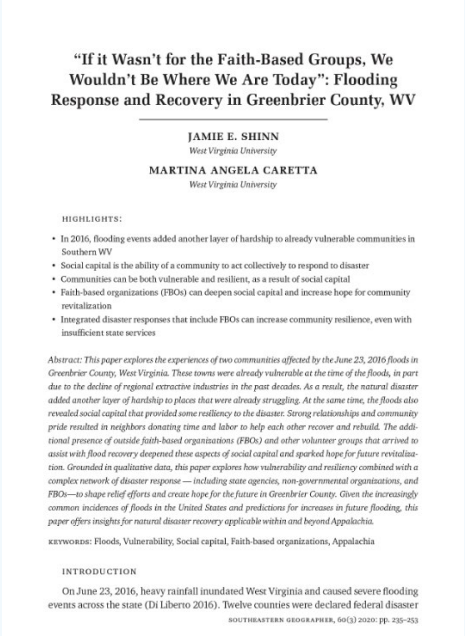
Context: Flood Risk in West Virginia

- WV ranked nationally at or near top for flood risk indicators
- June 2016 Flood: 10 in. of rain in 18 hours
- 23 people killed
- 5,000+ homes and businesses destroyed or damaged
- $1 billion in damages

Drone Footage of 2016 flood in Rainelle, WV

Context: Early Research Insights

- Vulnerability and resilience can exist side-by-side, due to social capital
- Disaster response and recovery involves complex network of actors, with gaps
- Implications for disaster response in places with socio-economic challenges



"If it Wasn't for the Faith-Based Groups, We Wouldn't Be Where We Are Today": Flooding Response and Recovery in Greenbrier County, WV

JAMIE E. SHINN
West Virginia University
MARTINA ANGELA CARETTA
West Virginia University

HIGHLIGHTS:

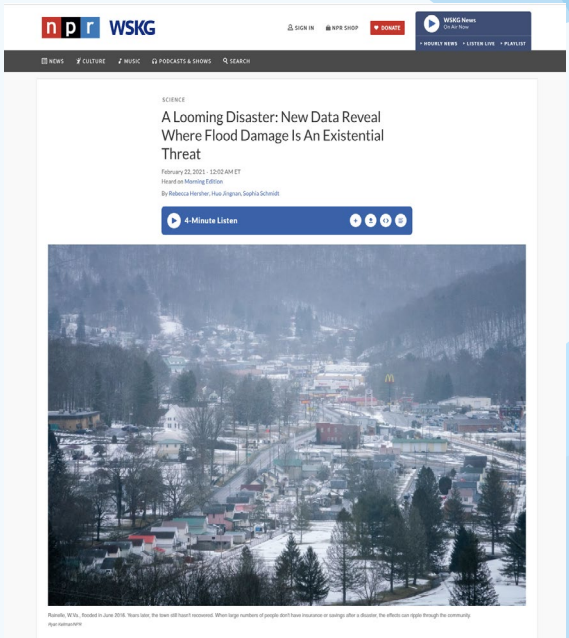
- In 2016, flooding events added another layer of hardship to already vulnerable communities in Southern WV
- Social capital is the ability of a community to act collectively to respond to disaster
- Communities can be both vulnerable and resilient, as a result of social capital
- Faith-based organizations (FBOs) can deepen social capital and increase hope for community revitalization
- Integrated disaster responses that include FBOs can increase community resilience, even with insufficient state services

Abstract: This paper explores the experiences of two communities affected by the June 23, 2016 floods in Greenbrier County, West Virginia. These towns were already vulnerable at the time of the floods, in part due to the decline of regional extractive industries in the past decades. As a result, the natural disaster added another layer of hardship to places that were already struggling. At the same time, the floods also revealed social capital that provided some resiliency to the disaster. Strong relationships and community pride resulted in neighbors donating time and labor to help each other recover and rebuild. The additional presence of outside faith-based organizations (FBOs) and other volunteer groups that arrived to assist with flood recovery deepened these aspects of social capital and sparked hope for future revitalization. Grounded in qualitative data, this paper explores how vulnerability and resiliency combined with a complex network of disaster response — including state agencies, non-governmental organizations, and FBOs—to shape relief efforts and create hope for the future in Greenbrier County. Given the increasingly common incidences of floods in the United States and predictions for increases in future flooding, this paper offers insights for natural disaster recovery applicable within and beyond Appalachia.

KEYWORDS: Floods, Vulnerability, Social capital, Faith-based organizations, Appalachia

INTRODUCTION

On June 23, 2016, heavy rainfall inundated West Virginia and caused severe flooding events across the state (Di Liberto 2016). Twelve counties were declared federal disaster



npr WSKG

SCIENCE

A Looming Disaster: New Data Reveal Where Flood Damage Is An Existential Threat

February 22, 2021 · 12:02 AM ET

Heard on Morning Edition

By Rebecca Hersher, Huo Jingnan, Sophia Schmidt

4-Minute Listen

A National Research and Action Competition Driven By Community Priorities

The Civic Innovation Challenge is a multi-agency, federal government research and action competition that aims to fund ready-to-implement, research-based pilot projects that have the potential for scalable, sustainable, and transferable impact on community-identified priorities. It aims to flip the community-university dynamic, inviting communities to identify civic priorities ripe for innovation and to then partner with researchers to address those priorities.

U.S. Department of Homeland Security	U.S. National Science Foundation	U.S. Department of Energy	U.S. Department of Agriculture
Co-Lead and Co-Funder	Challenge Lead and Funder	Co-Lead and Co-Funder	Co-Lead and Co-Funder

More information available at: https://nsfcivicinnovation.org/

The WVFRF Team

- **Dr. Jamie Shinn**, Project Leader, Assistant Professor of Environmental Studies at the SUNY College of Environmental Science and Forestry (SUNY ESF)
- **Dr. Aaron Maxwell**, Project Co-leader, Assistant Professor of Geography at WVU
- **Julian Levine**, Project Co-leader, Director of Population Health & Community Engagement at the West Virginia School of Osteopathic Medicine
- **Kurt Donaldson**, Director, West Virginia GIS Technical Center
- **Eric Hopkins, Behrang Bidadian, & Annie Mahmoudi,** WV GIS Technical Center
- **Katherine Garvey & Jared Anderson**, WVU Land Use and Sustainable Development Law Clinic
- **Robert Martin & Edwin Martin**, West Virginia State Resiliency Office (SRO)
- **David Lumsden**, Episcopal Diocese of WV
- **Paula Brown**, Greenbrier County Homeland Security & Emergency Management
- **West Virginia Voluntary Organizations Active in Disasters** (WV VOAD)
- **Debbie Sizemore**, Williamsburg Area Response Team (WART)
- **Cathy Rennard**, Former Disaster Case Manager Supervisor for WV VOAD
- **Andrea Cass**, PhD student, SUNY ESF

ESF
GIS TC
West Virginia
Voluntary Organizations
Active in Disaster
COOPERATION | COMMUNICATION | COORDINATION | COLLABORATION
Meadow
River Valley
Building Trails To A Bright Future
WVFRF

Stage 1 of the WVFRF (2022-2023)

Stage 1 Research Objective:

Document lessons learned from the 2016 flood in Greenbrier County, WV to determine gaps in organizational capacity, cross-organization coordination, and flood risk knowledge that need to be filled for more comprehensive flood response and long-term flood recovery in WV

Community focus group in Rainelle

Stage 1 Activities:

- Surveyed 2,215 residents on flooding
- Held 7 Community and virtual focus groups
- Created flood risk visualizations & conducted participatory GIS

Stage 1 Findings

1: Residents significantly impacted by and not fully recovered from past floods, are not prepared for future floods

2: Need for greater pre-disaster preparation and coordination

3: Need for additional pre-disaster capacity building and flood risk assessment tools

You can only work with the tools that are given to you…. And if you're not given the tools to make change before an event happens, then you are forever going to be saying, okay, well, what can we do differently?

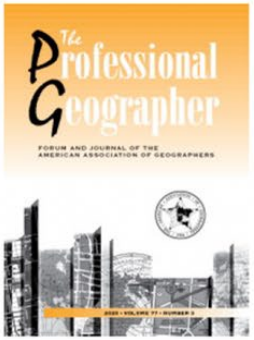
-Stage 1 Participant

Project Recommendations

Table 1: Project recommendations for building flood resilience in Greenbrier County

Recommendation	Level of Focus	Key Stakeholders
Educate individuals and communities on their flood risk, including training for realtors & high impact area residents	Household/ Community	Floodplain Managers, Emergency Management, City/County Government
Educate individuals and communities on updated FEMA floodplain maps, their vulnerabilities, the National Flood Insurance Program (NFIP) and participation in Community Rating System (CRS)	Household/ Community/ County	Floodplain Managers, Emergency Management, City/County/State Government
Confirm shelters are safely out of the floodplain and relocate if needed	Community	Floodplain Managers, Emergency Management, City/County Governments
Create plan for long-term relocation of key facilities (e.g., police and fire stations, schools, town halls) out of floodplain	Community	Region 4 Planning and Development Council, Floodplain Managers, Emergency Management, City Government
Engage in long-term planning for Open Space Preservation (OSP) for flood mitigation	Community	Floodplain Managers, City Government
Create plans for disaster response management, including communications, community asset mapping, volunteer coordination, and provision of mental health care	Community/ County	Community Leadership, Floodplain Managers, Emergency Management, City/County Government
Create early warning systems for disaster events	Community/ County	Floodplain Managers, Emergency Management, City Government
Increase proactive floodplain mitigation, management, and permitting with integration of efforts from local to state levels	Community/ County/ State	Community Members, Floodplain Managers, Emergency Management, City/County/State Government
Increase training and funding for disaster recovery case managers at local and state levels	Community/ State	WV VOAD, WV Ready, State Government
Train substantial damage assessment and recovery teams so they are disaster ready	Community/ State	WV VOAD, Americorps, Emergency Management, City Governments, WV Emergency Management
Increase funding for mitigation (including nature-based solutions)	State	WV Emergency Management, State Government

Stage 1 Findings



The Professional Geographer

Routledge
Taylor & Francis Group

ISSN: 0033-0124 (Print) 1467-9272 (Online) Journal homepage: www.tandfonline.com/journals/rtpg20

Building Flood Resilience in West Virginia through Community-Engaged Research

Jamie E. Shinn, Behrang Bidadian, Annie Mahmoudi, Aaron Maxwell & Julian Levine

Stage 2 of the WVFRF

Stage 2 objective: Create a freely available online resource containing materials created by our project to support residents, local leaders, non-profits, and state officials in efforts to increase flood resiliency for WV communities through improved knowledge about flood risk, floodplain management, and comprehensive disaster response and recovery.

Stage 2 Research Questions:

1: How fully have West Virginians recovered from past floods, and how resilient are they against future flooding?

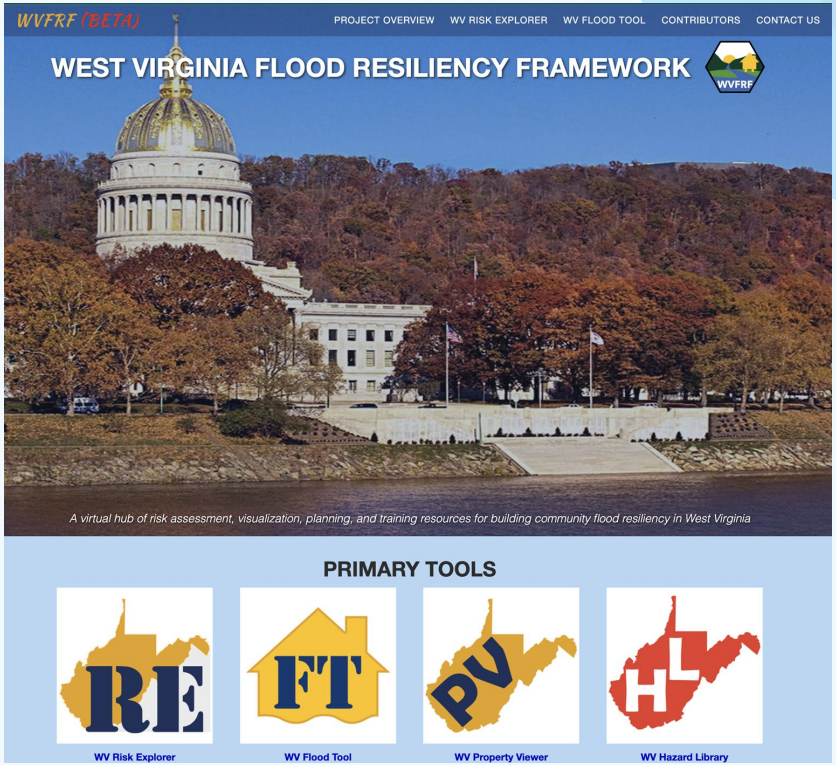
2: What flood risk knowledge is needed to promote comprehensive pre-disaster resilience in WV?

3: What are best practices to build cross-organizational coordination to promote comprehensive pre-disaster resilience in WV?

4: Can previously identified gaps in community-level capacity be improved through creation and delivery of accessible training to build resilience?

Stage 2 Activities(2023-2025)

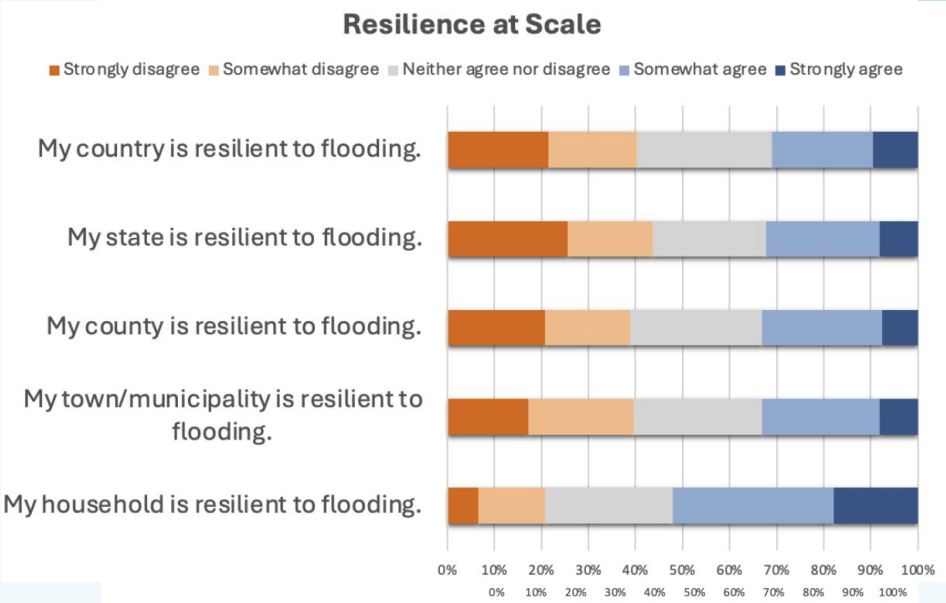
- Statewide **survey** on flood recovery and preparation
- **Symposium** on Building Flood Resiliency in WV Communities
- Floodplain management **trainings**
- Creation of **visualizations and reports** to communicate flood risk statewide at nine geographic scales
- Creation of in-depth flood risk **visualizations** for six high-risk communities
- **Creation of WVFRF:** A virtual hub of risk assessment, visualization, planning, and training resources for building community flood resiliency in West Virginia



Screenshot of WVRF

WV Survey on Flood Recovery & Preparation

- February 2024-May 2024
- 1,228 responses
- Summary of analysis available on WVFRF Hazards Library



Building Flood Resiliency in West Virginia Communities Symposium March 12 & 13, 2024

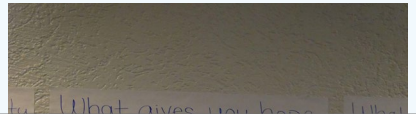
Symposium Goals

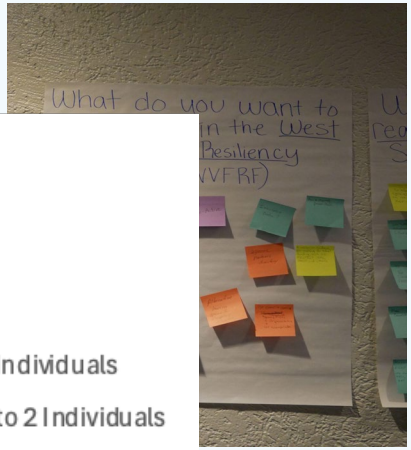
Create common understanding of who the main players are their capabilities before, during, and after a flood

Increase understanding of how each organizations can better coordinate efforts in each phase of a disaster

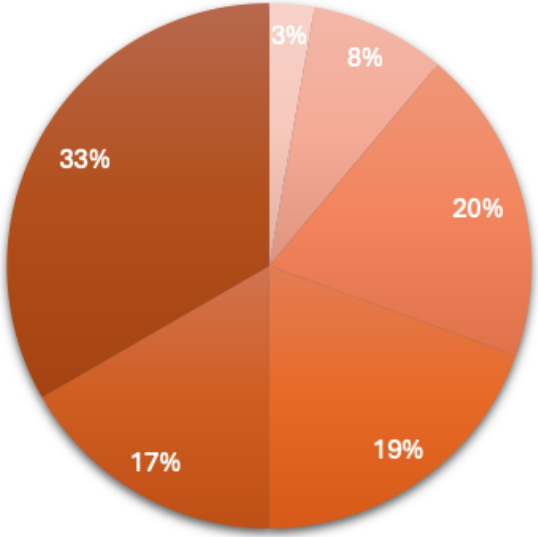
Deepen understanding of barriers to coordination between organizations

Identify considerations that contribute to or detract from community resiliency

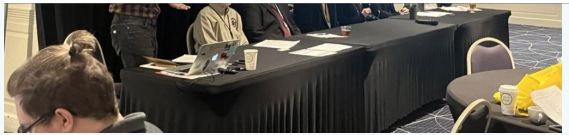




New Connections Post-Symposium

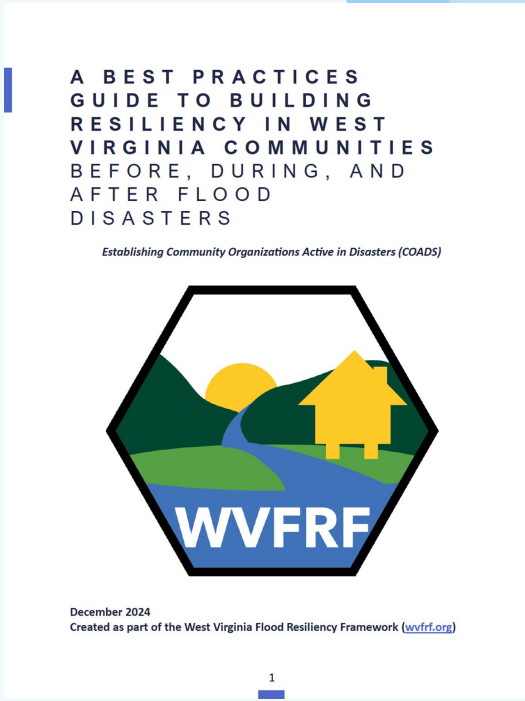


0 Individuals
1 to 2 Individuals
3 to 5 Individuals
5 to 7 Individuals
7 to 9 Individuals
10+ Individuals



Co-creation of Best Practices Guide

- Objective: support creation of Community Organizations Active in Disaster (COADs)
- COADs are groups of like-minded people or organizations working toward common purpose of increasing community disaster resilience through cooperation, communication, coordination, and collaboration (the “4 Cs”)
- COADs will encompass the phases of emergency management: mitigation, prevention, preparedness, response and recovery


A BEST PRACTICES GUIDE TO BUILDING RESILIENCY IN WEST VIRGINIA COMMUNITIES BEFORE, DURING, AND AFTER FLOOD DISASTERS

Establishing Community Organizations Active in Disasters (COADS)

WVFRF

December 2024
Created as part of the West Virginia Flood Resiliency Framework (wvfrf.org)

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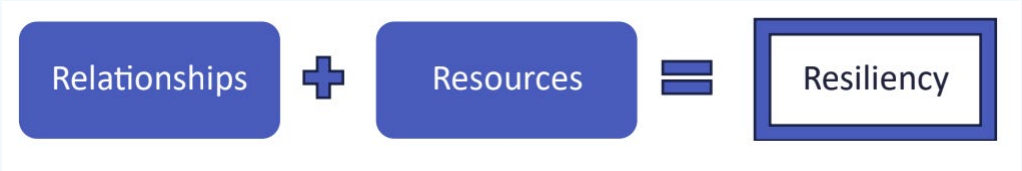


Best Practices Guide

TABLE OF CONTENTS

Available on WVFRF website, and PDF can be shared

Best Practices Guide

STEP 1: CREATE AN EMERGENCY COMMUNICATION PLAN

- MONITOR: Stay up to date with the National Weather Service and Emergency Management.
- EMERGENCY CALL LIST: Create a digital and paper copy of an emergency call list. Cell phones may not work in a disaster, so include landlines when possible. See Appendix 1 to get started.
- RESOURCE LIST: Create a digital and paper copy of emergency resources available in the community.
- INSURANCE INFO: Create a digital and paper file with insurance policy information for your town or community, including policy numbers and phone numbers for claims.
- MEET REGULARLY: Establish quarterly meetings to review and revise emergency planning documents. Consider working with local LEPC.
- BLUE SKIES TRAINING: Consider implementing "blue skies" training exercises to practice emergency response.
    - 211: If a 211 system is not already in place, consider contracting with a call center to receive requests for assistance. You can find more info at: https://www.211.org/
- PLAN FOR INFORMATION DISSEMINATION: Determine how you will disseminate information in a disaster. Social media may be an effective way to disseminate useful information, but it can also be the source of bad information.
- PLAN FOR A PIO: Determine who will be a Public Information Officer to be the point person to spread essential information quickly and efficiently during a disaster.

STEP 2: CREATE AN EMERGENCY RESPONSE PLAN

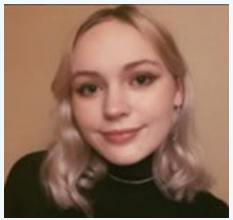
- EMERGENCY RESOURCES MAP: Create an emergency resources map including things like shelters, distribution sites, higher ground areas, etc.
- FEMA PUBLIC ASSISTANCE: Connect with a FEMA Public Assistance consultant who can assist with pre-disaster training related to eligible spending and reimbursement.
- FIND A RELIABLE CONSULTANT: Municipalities and counties will be bombarded with solicitations from disaster services consultants, and they are not all reliable. **Do not wait until the disaster to find a reliable consultant, from FEMA or elsewhere.**
- VEHICLES AND EQUIPMENT: Make sure each town supervisor or plant operator is assigned to get vehicles and other equipment to higher ground as soon as a flood is expected.
- CENTRAL SUPPLY LOGISTICS: Establish a central supply point for receiving and disseminating supplies and donations.
- PLAN FOR UNSOLICITED VOLUNTEERS: Have a plan in place for managing unsolicited volunteers. They will require supervision to put their skills to use appropriately.
- RECOVERY COMMITTEES: Consider creating a county level disaster Recovery Committee to coordinate beyond typical functions of LEPCs.

Insights from the WVFRF process

- Community engagement, from local to state scales, is key to identifying needs and priorities
- Working in partnership is key to identifying and achieving common goals
- Building and strengthening networks increases resilience

West Virginia GIS Tech Center

- Kurt Donaldson
  - Director/Project Manager
- Aaron Maxwell
  - Faculty Director
- WVGISTC Staff
  - 2 GIS Programmers/ Developers (Yibing Han and Dr. Yalin Yang)
  - 3 GIS Analysts (Shannon Maynard, Dr. Behrang Bidadian, and Sara Lusher)



WV GIS Technical Center
WVU Department of Geology & Geography
330 Brooks Hall
P.O. Box 6300
Morgantown, WV 26506
Phone: (304) 293-0557
Fax: (304) 293-6522

Mission

- Reduce duplication of data development efforts among organizations
- Catalog and distribute GIS spatial data and information free-of-charge through the internet
- Coordinate acquisition of new data additions to the West Virginia Spatial Data Infrastructure
- Assist with strategic planning, development, and implementation of statewide mapping guidelines
- Provide advisory services and training programs in the field of geographic information science
- Conduct research and provide education towards improvement of geographic information technologies

Establishment

- Executive Order 4-93 (November 1993)
- Through West Virginia Geological and Economic Survey and Department of Commerce
- On April 23, 1998 Governor Cecil Underwood dedicated the center in new facilities in the Department of Geology and Geography at WVU
- Provide coordination and technical support in the development and operation of geographic information systems (GIS) for the state's spatial data infrastructure
- Statewide geospatial activities are coordinated through the WV Office of GIS Coordination

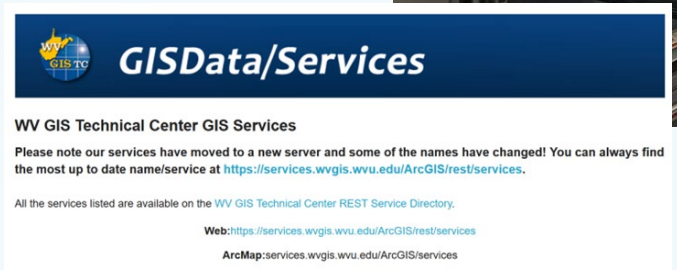
Original faculty directors
Dr. Greg Elms (left)
Dr. Trevor Harris (right)

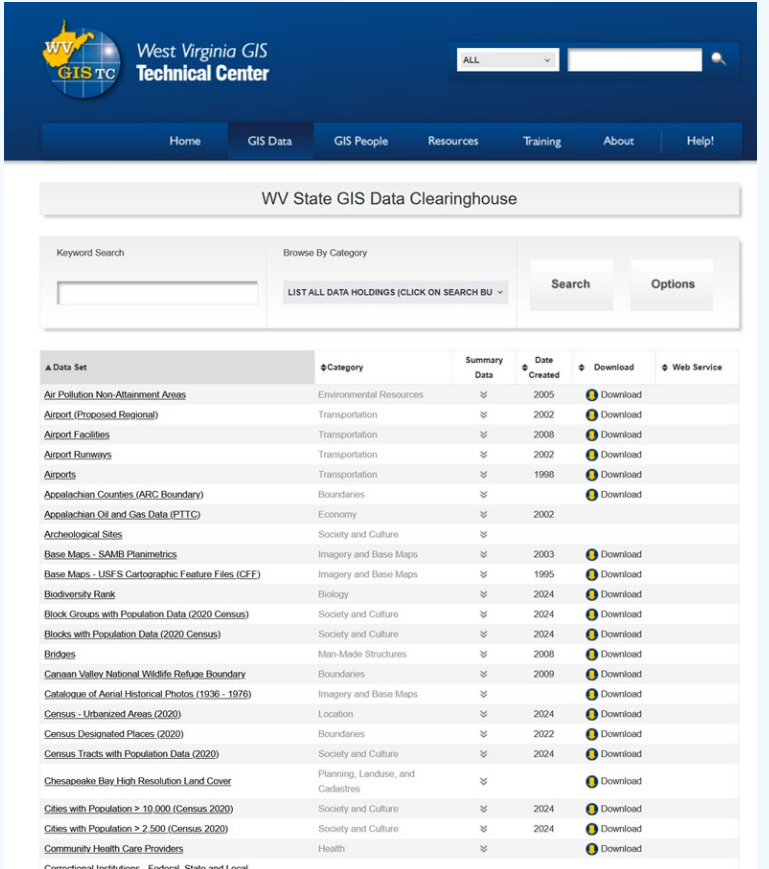
WEST VIRGINIA DEPARTMENT of COMMERCE

WVGES
GEOLOGY UNDERLIES IT ALL

Services to the State

- Over 300 unique datasets and 120 web services
- Valued at more than $70 million



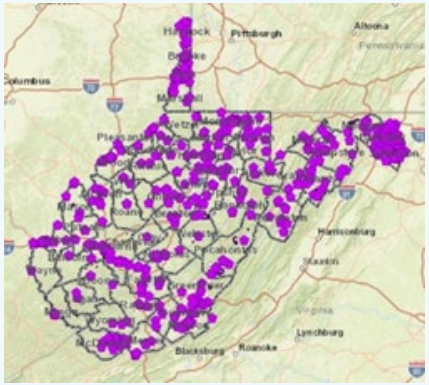


Data Set	Category	Summary Data	Date Created	Download	Web Service
Air Pollution Non-Attainment Areas	Environmental Resources		2005	Download	
Airport (Proposed Regional)	Transportation		2002	Download	
Airport Facilities	Transportation		2008	Download	
Airport Runways	Transportation		2002	Download	
Airports	Transportation		1998	Download	
Appalachian Counties (ARC Boundary)	Boundaries			Download	
Appalachian Oil and Gas Data (PTTC)	Economy		2002		
Archeological Sites	Society and Culture				
Base Maps - SAMB Planimetrics	Imagery and Base Maps		2003	Download	
Base Maps - USFS Cartographic Feature Files (CFF)	Imagery and Base Maps		1995	Download	
Biodiversity Rank	Biology		2024	Download	
Block Groups with Population Data (2020 Census)	Society and Culture		2024	Download	
Blocks with Population Data (2020 Census)	Society and Culture		2024	Download	
Bridges	Man-Made Structures		2008	Download	
Canaan Valley National Wildlife Refuge Boundary	Boundaries		2009	Download	
Catalogue of Aerial Historical Photos (1936 - 1976)	Imagery and Base Maps			Download	
Census - Urbanized Areas (2020)	Location		2024	Download	
Census Designated Places (2020)	Boundaries		2022	Download	
Census Tracts with Population Data (2020)	Society and Culture		2024	Download	
Chesapeake Bay High Resolution Land Cover	Planning, Landuse, and Cadastres			Download	
Cities with Population > 10,000 (Census 2020)	Society and Culture		2024	Download	
Cities with Population > 2,500 (Census 2020)	Society and Culture		2024	Download	
Community Health Care Providers	Health			Download	
Correctional Institutions - Federal, State and Local					

Apps


West Virginia Trail Inventory


WV Elevation and LIDAR Download Tool


Pittsburgh
Altoona
Columbus
Harrisonburg
Lynchburg
Blacksburg
Roanoke


FT


RE


PV


Virginia DNR
ting, Trapping & Fishing Map Application
Hunting & Trapping
Fishing
Hunting Regulations
Fishing Regulations
Licensing Information


Landslide Tools
Explore additional tools and resources related to landslides.
Outreach Materials to Mitigate Landslide Risks


WVFRF

Flood Disasters in WV

- 64 Federally-Declared Flood Disasters since 1953
- 220 Loss of Lives

July 1961 (22 + 2 landslide fatalities)
Kanawha County

February 1972 (123 fatalities including 4 missing)
Buffalo Creek

November 1985 (49 fatalities)
Moorefield, Hardy County

June 2016 (23 fatalities)

Rainelle, Greenbrier County

Clendenin, Kanawha County

Richwood, Nicholas County

February 2025 (3 fatalities)

Mingo County

Williamson, Mingo County

McDowell County

Pre-Disaster Planning

- **Risk ⇔ Potential Losses**

The risk triangle (Crichton, 2002, p.126)

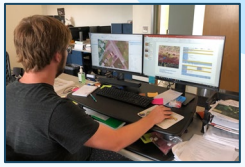
Risk Assessment

- **Hazard Mapping** ⇨ FEMA Flood Insurance Rate Map (FIRM)

- **Exposure Assessment (Building-Level)** ⇨ **WV Floodplain Building Inventory (BI)**

  Funded by: FEMA Hazard Mitigation Grant Program (HMGP) and State Hazard Mitigation Office

  - All primary (insurable) structures in the 1%-annual-chance (100-yr) floodplain
  - Community Assets (Historical & Non-Historical) in the 100-yr floodplain
  - Essential Facilities in the 100-yr and 500-yr floodplains

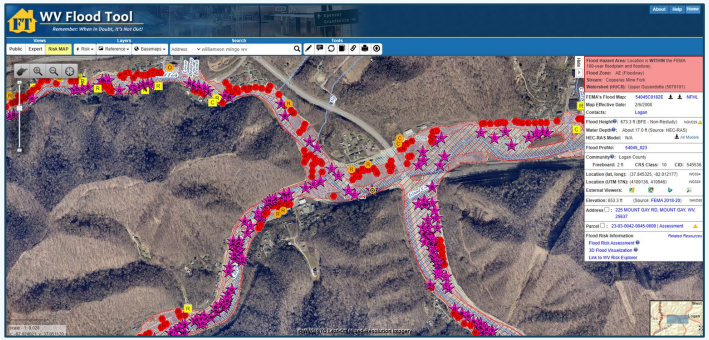


Community Assets:

Essential Facilities:

Detailed building characteristics from tax assessment +
Number of displaced people from residential buildings

Manual process of identification +
Programmed scripts to extract and process data

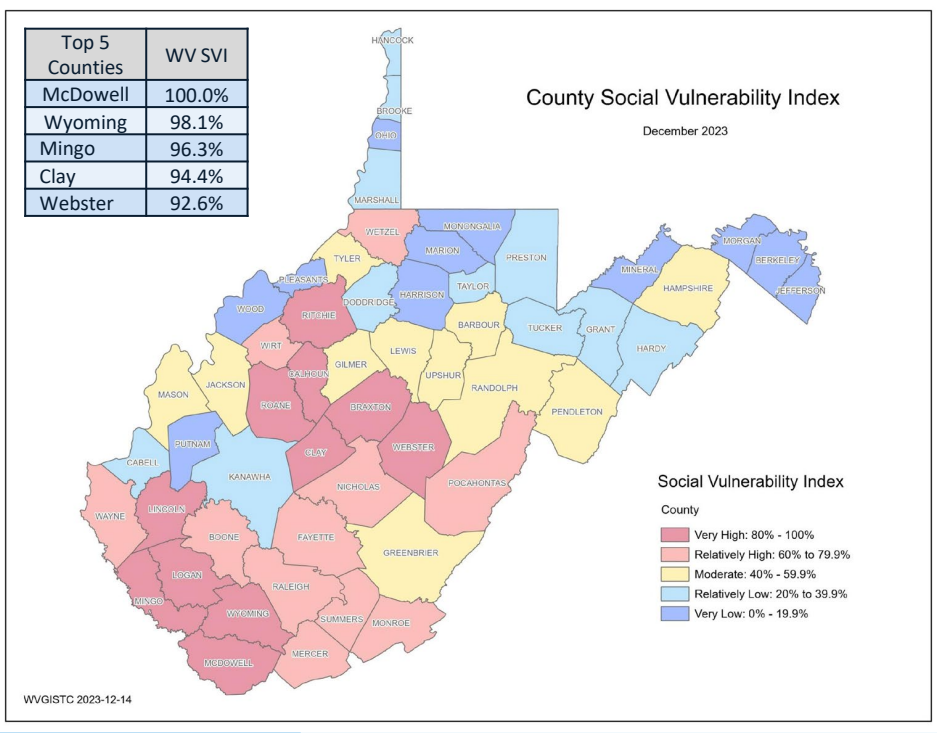


Product: **WV Flood Tool** mapwv.gov/flood

Risk Assessment…

- **Vulnerability Assessment ➡ WV Social Vulnerability Index (WV SVI)**
  Funded by: CIVIC, NSF
  Localized Approach

Top 5 Counties	WV SVI
McDowell	100.0%
Wyoming	98.1%
Mingo	96.3%
Clay	94.4%
Webster	92.6%



Social Vulnerability Index (WV SVI) (0% to 100%)
Combines indicators of:

- **Poverty Rate**
- **Unemployment Rate**
- **Vulnerable Ages Rate**
- **Disability Rate**
- **Population without a High School Diploma**
- **Population Change**
- **Median Housing Unit Value**
- **Percentage of Mobile Homes in Housing Units**

Ranks geographic entities at five scales:

- Community
  - Incorporated Place
  - Unincorporated Area
- County
- WV PDC Region

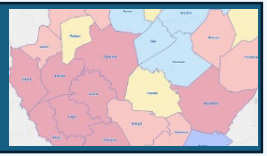
Aggregated at Multiple Scales

Political Boundaries

State

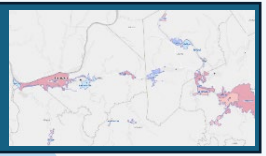
PDC Regions (11)

Counties (55)

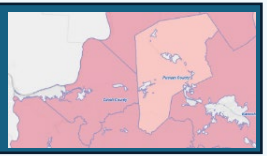


Communities (284)

Incorporated Places (229)

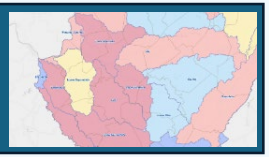


Unincorporated Areas (55)



Drainage Areas / Streams

Watersheds (33)



Streams/Rivers (156)

Property Levels

Parcels

Buildings

WV Flood Risk Index

Based on experience from phase I in Greenbrier County

Overall Flood Risk

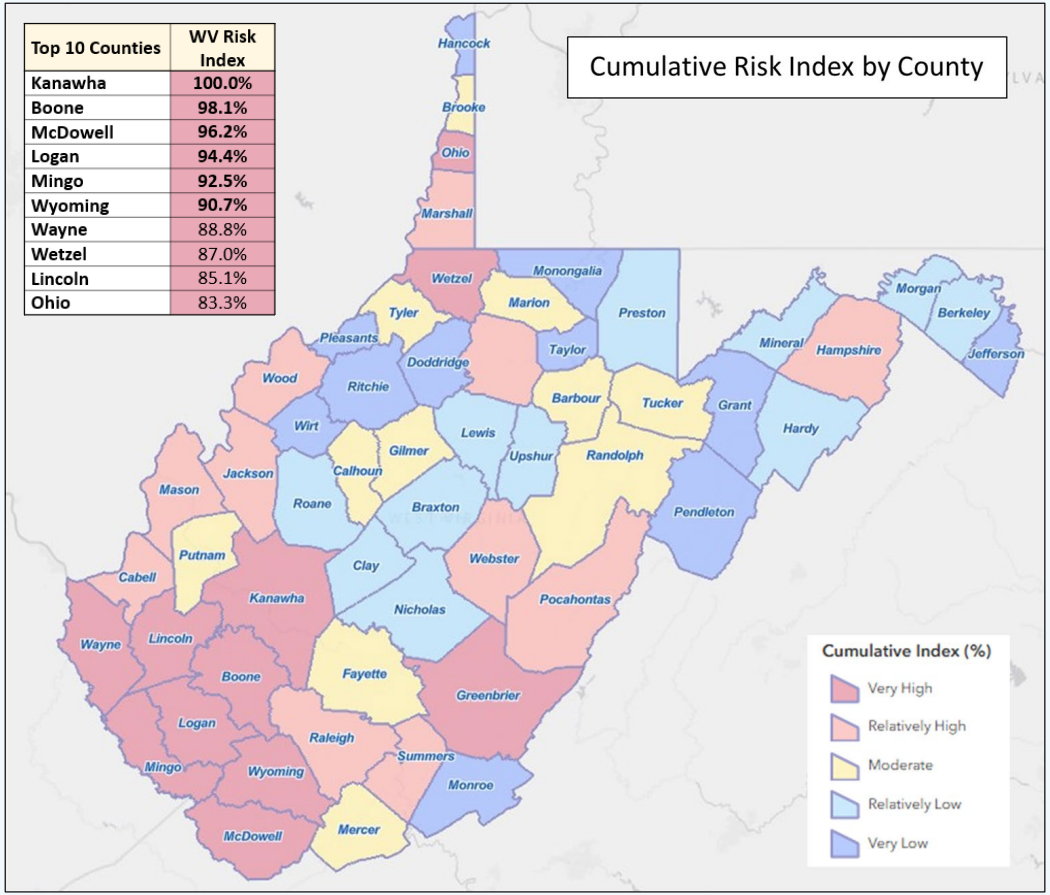
(1) FLOODPLAIN CHARACTERISTICS	(2) BUILDING EXPOSURE	(3) BUILDING CHARACTERISTICS	(4) CRITICAL INFRASTRUCTURE	(5) COMMUNITY ASSETS	(6) BUILDING DAMAGE LOSS	(7) PEOPLE / SOCIAL VULNERABILITIES	(8) OTHER HAZARDS
Floodplain Area	Building Floodplain Count[1 2]	Building Value[1 2]	Essential Facilities	Historical Assets	Substantial Damage Estimates*[1 2]	Population in Floodplain	Landslides
Floodplain Length[1 2]	Building Floodway Count[1 2]	Mobile Homes	Roads Inundated	Non-Historical Assets	Previous Claims	Population Displaced	Karst**
Floodplain Depth[1 2]	Building Floodplain Ratio[2]	Basement			Repetitive Losses	WV Social Vulnerability Index	Dam/Levee Failure**
Flood Disaster Frequency	Building Density[1 2]	One Story					
		Building Year*					

Used for the Index

* Multiple Indicators ** In Progress [1] River/Stream Indicator [2] Watershed Indicator

WV Flood Risk Index…

Top 10 Counties	WV Risk Index
Kanawha	100.0%
Boone	98.1%
McDowell	96.2%
Logan	94.4%
Mingo	92.5%
Wyoming	90.7%
Wayne	88.8%
Wetzel	87.0%
Lincoln	85.1%
Ohio	83.3%



West Virginia Risk Explorer (WVRE)

www.wvfrf.org/wvre

Risk Assessment Tools

- Localized riverine flood risk assessment by quantifying and aggregating detailed building-level data at multiple scales
- Help identify the communities most at risk of riverine flooding for efficient allocation of limited mitigation resources

Building/Property-Level

Aggregated

Mitigation Assessment Tools

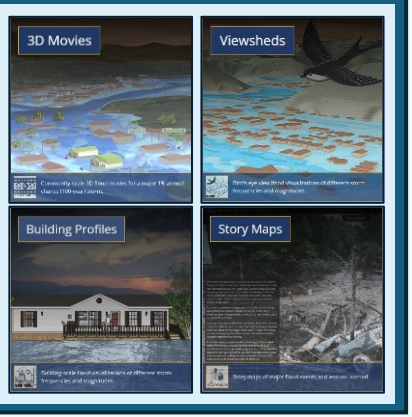
- Quantifies mitigation efforts such as elevation, relocation, and buyouts and calculation of loss estimates
- Enable planners and decision-makers to evaluate past and ongoing efforts, identify gaps, and prioritize future investments

Mitigated Structures Dashboard

Open-Space Mitigation Dashboard

Risk Communication Tools

- Scenario-based 2D and 3D visualizations effective risk communication
- Facilitate risk comprehension for various stakeholders to support informed decision making and encourage public engagemer



Hazard Library and Data Access

- Access to online hazard resources including data, documents, and media searchable by title, subject, event, geography, and more.
- Allow users to access comprehensive datasets for use in analyses, maps, or applications to support planning, research, and decision-making related to hazard mitigation and response

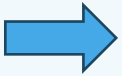
Risk Communication

- **Stakeholders**

Risk Communication Tools

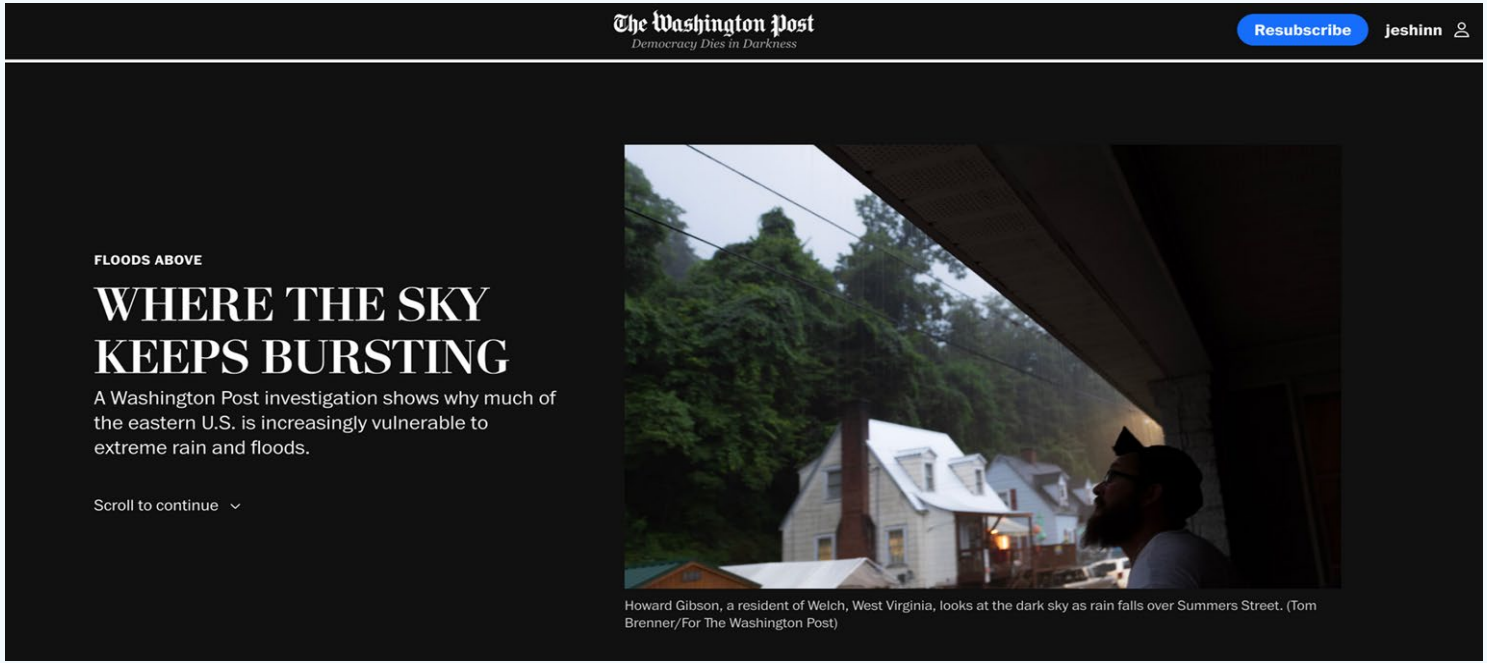
Funded by: CIVIC, NSF

- Facilitating risk comprehension For different groups of stakeholders



https://www.wvfrf.org/wvre/visualization/home/

Application in Action



NOV 12 WASHINGTON POST ARTICLE: HTTPS://WAPO.ST/47MDVXI

Thank you & Questions

WV Flood Resiliency Framework: www.wvfrf.org
WV Risk Explorer: www.wvfrf.org/wvre
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