



The River Styx (pictured) flows underground through Mammoth Cave and exits into the Green River, carrying rainwater that serves as a drinking water source for downstream communities such as Edmonson County and Brownsville County. But, fertilizers and pesticides from farm off-run get washed into sinkholes and end up in the underground rivers, potentially contaminating the freshwater sources. Photograph courtesy National Park Service.

Boosting resilience to mitigate climate change

AGU's Thriving Earth Exchange helps Kentucky residents work toward hazard preparedness

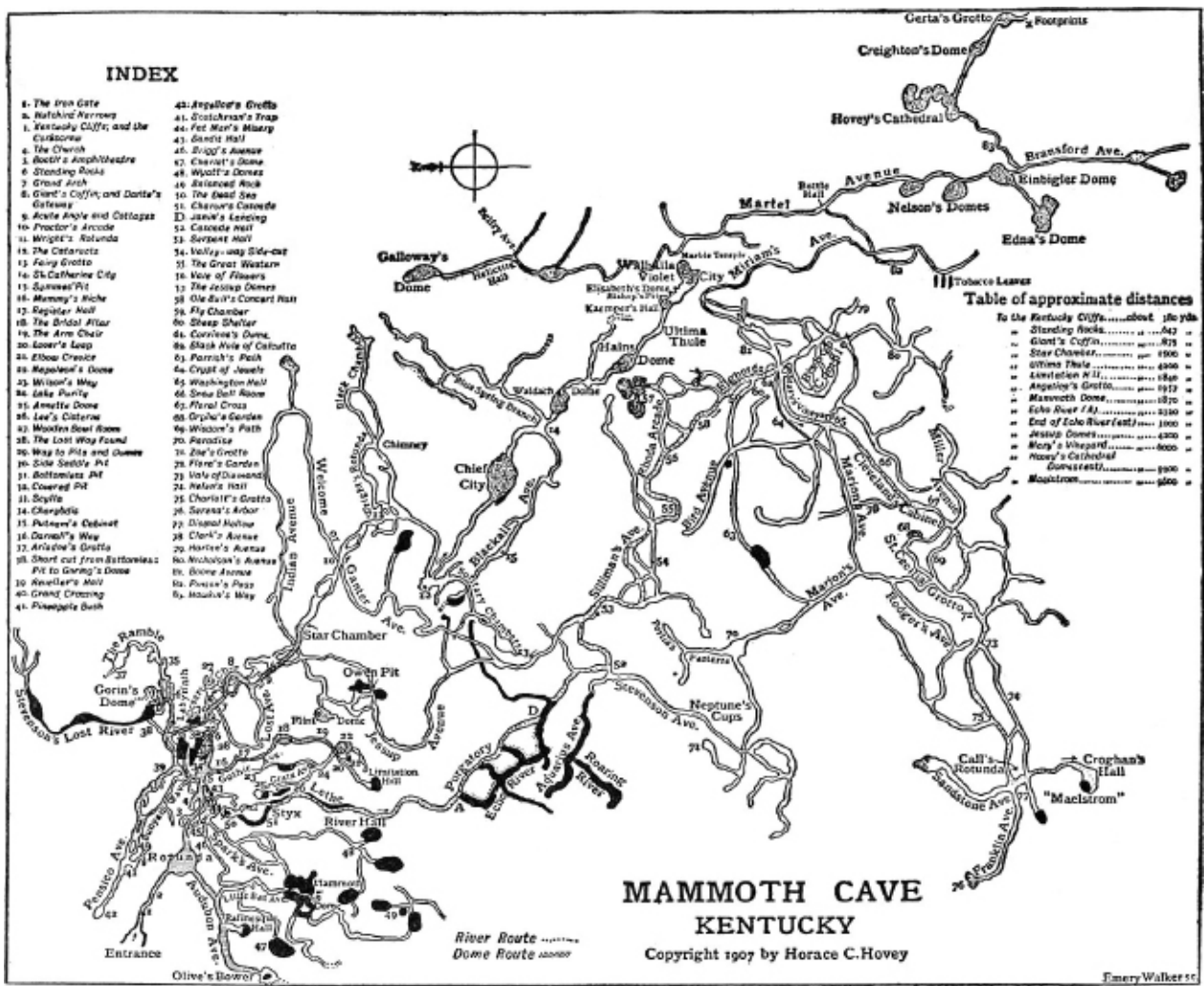
Mammoth Cave, just outside Bowling Green, Kentucky, is one of the best known geological wonders of the world, representing one of the longest cave systems at 360 miles of tunnels. Fifty-three acres of limestone rock, eroded and dissolved by underground water, have shaped the rolling and green hills above. Yet, sinkholes remain a perennial problem for the region, known as a karst landscape, characterized by springs, caves, sinkholes, fissures, and underground streams. The dramatic variations within this landscape (if you think about it as an architectural section) mean that all of the levels within that section are dependent upon each other. Much of these variations are related to Mammoth Cave.

South-central Kentucky is a region made up of 10 counties served by the Barren River Area Development District (BRADD), whose mission is to preserve and enhance the quality of life and economic prosperity for

its residents through regional collaboration. Resilience—and planning to thrive amid current and future threats—is more than a buzzword for BRADD. It's a foundation.

"We are designated by the U.S. Economic Development Administration, a bureau of the U.S. Department of Commerce, to be the regional planning organization for our 10-county footprint," said Emily Hathcock, BRADD's Associate Director of Planning & Development. "As part of that, we maintain two regional plans that are federally-designated. One of those is our comprehensive economic development strategy and one of those is our regional hazard mitigation plan."

BRADD has two primary arms as an agency. First, the Community and Economic Department provides technical assistance and support to local elected officials and stakeholders as they complete projects that improve the quality of life for residents. Services include anything from grant writing or grant administration to helping local governments calculate budgets. The second is the Area Agency on Aging and Independent Living. They provide direct social services to residents to keep them out of long-term institutional care—everything from case management services to providing senior services such as meal delivery.

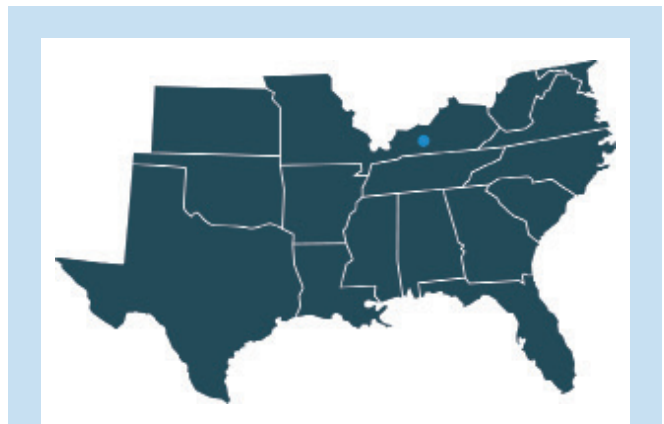


Mammoth Cave, just outside Bowling Green, Kentucky, is one of the best known geological wonders of the world, representing one of the longest cave systems at 360 miles of tunnels, depicted in this 1907 map by Horace C. Hovey and engraved by Emery Walker, published in the 11th edition of Encyclopædia Britannica. Public domain.

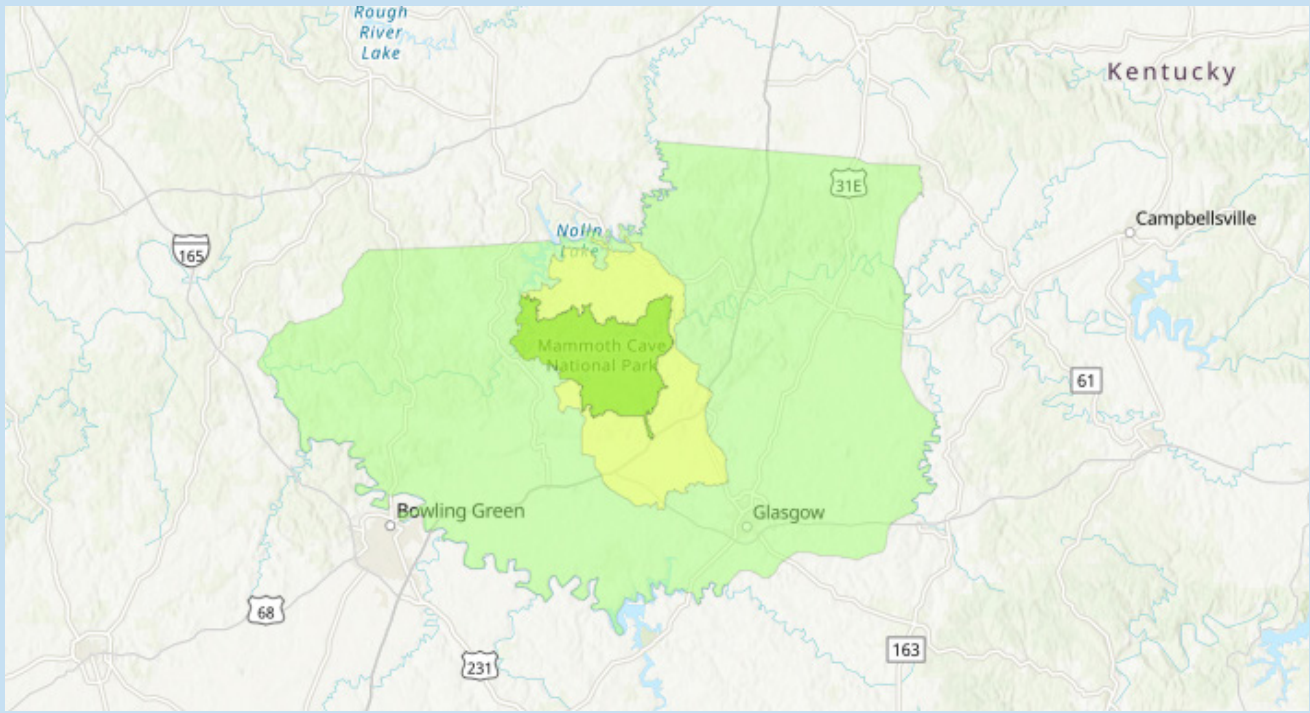
In updating its Multi-Hazard Mitigation Plan every five years, it works with business and community stakeholders BRADD works with, as well as local emergency managers, regional trans-ortation planners, and water- and waste-water utility providers, in addition to regular meetings with the board of directors.

Yet, one group that BRADD has never previously consulted with is scientists, whose data and observations are critical to securing Federal Emergency Management Agency (FEMA) grant funding to identify and mitigate the impact of climate change in the form of hazards that might imperil future resilience.

“Our regional hazard mitigation plan is one that FEMA requires for communities to be able to receive FEMA mitigation grant funding,” said Hathcock. “For us, it is evaluating natural hazards and their impact on each community and then creating projects to lessen that impact.”



South-central Kentucky, centered on Bowling Green, is a region made up of 10 counties served by the Barren River Area Development District (BRADD), whose mission is to preserve and enhance the quality of life and economic prosperity for its residents through regional collaboration.



Since 1941, Mammoth Cave National Park has formed the core protected area of the Mammoth Cave Biosphere Region (dark green), recognized in 1991. Groundwater recharge enters Mammoth Cave from a wider catchment area (yellow) than the boundaries of the park, itself. The economic relationship to the park extends even wider (light green), encompassing tourism, manufacturing, agriculture, utilities, transportation, and trades. Map courtesy BRADD.

Of particular importance are vulnerable populations within the region, which she notes are aging Kentuckians and minors, both of which struggle with mobility, and non-native English speakers, who might struggle to interpret critical information. BRADD hopes to develop safety nets to help these residents in case of an emergency event. Hathcock and her team hope to combine new data on these vulnerable populations, as well as compile historical data and climate projections, to come up with a complete picture of the region’s risk profile to identify next steps.

In South Central Kentucky, and in dozens of communities around the country, AGU’s Thriving Earth Exchange serves as a connector and facilitator to bring together communities who have self-identified concerns, fellows who organize and administer community-based projects that address those concerns, and experts who can address the specific scientific issues that come to bear on the projects. The Thriving Earth Exchange trains and convenes fellows during the course of their projects, offers limited monetary support, and provides opportunities for community members to create awareness of the scientific challenges that projects raise and, ideally, help solve, as well as opportunities for fellows to share their work.

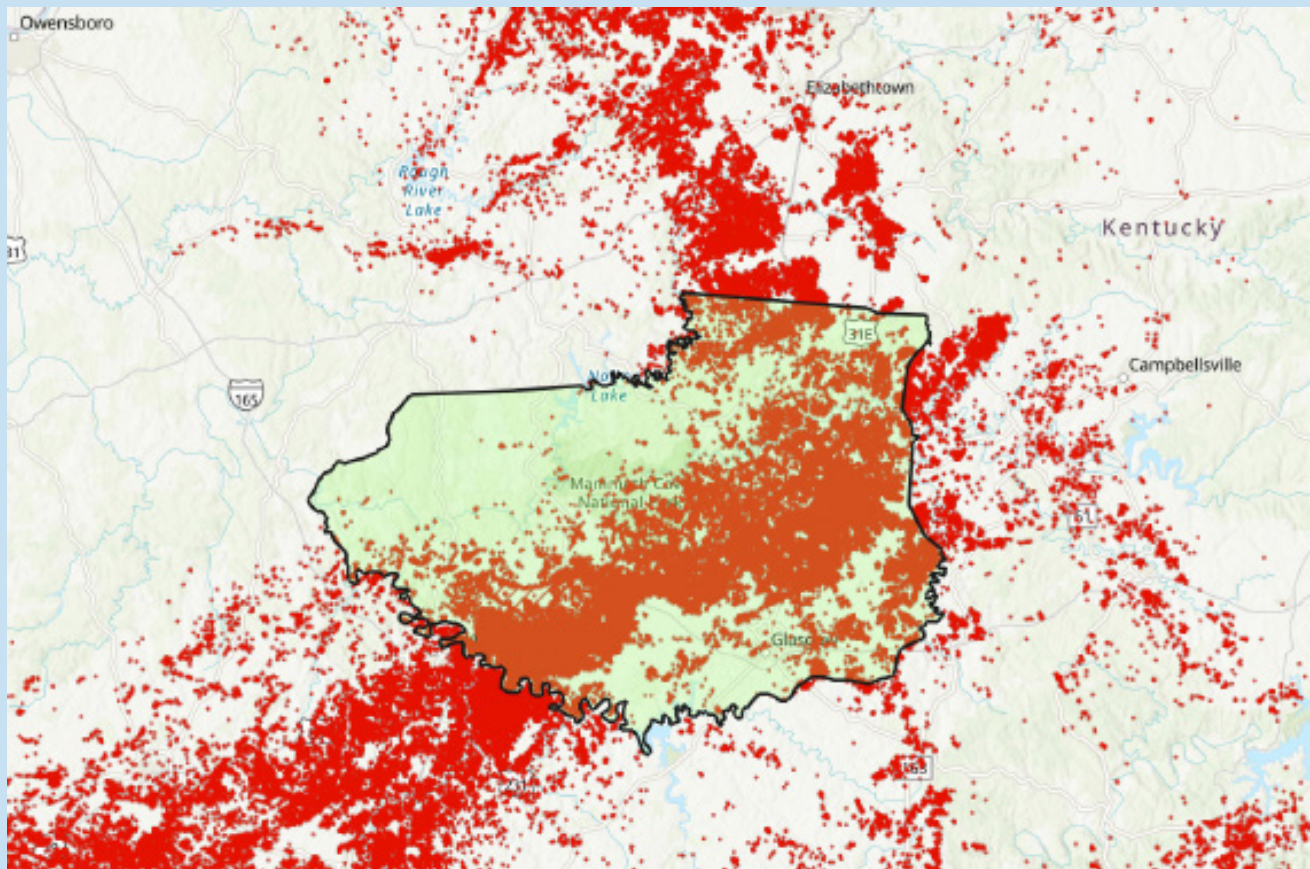
Hazard mitigation in Kentucky

Hazard mitigation plans are required under the Stafford Act of 2001, which allows the President of the United

States to direct federal agencies in the event of an emergency to provide resources. These plans assess the likelihood that a natural hazard will occur and formulate how our communities can better prepare through projects and strategies. Most importantly, a Hazard Mitigation Plan makes a community eligible for mitigation funding through FEMA—to lessen the effects of disasters, and reduce loss of life and property. To be eligible, state, tribal, and local governments must first determine the common natural catastrophe risks and vulnerabilities in their region. Then, they must pursue long-term policies for safeguarding people and property from similar occurrences.

BRADD’s plan was developed in partnership with ten counties, twenty-five incorporated cities, and numerous nonprofit stakeholders, as well as Thriving Earth Exchange Community Science Fellow Aradhana Roberts, a PhD Candidate at Sweden’s Lund University in the Department of Physical Geography and Ecosystem Science, and Jason Polk, an associate professor of geoscience at Western Kentucky University.

The plan, itself, includes natural, man-made, and hybrid hazards where there is a historical record or the potential of damage caused to people and property, and the hazard categories for this area of Kentucky include dam failure, drought, earthquake, extreme temperatures, flooding, hazardous materials, emerging infectious disease, pandemic, karst/sinkhole, landslide, severe storm, terrorism, tornado, and winter storm.



Fifty-three acres of limestone rock, eroded and dissolved by underground water, have shaped the rolling and green hills above. Yet, sinkholes (in red) remain a perennial problem for the region, known as a karst landscape, characterized by springs, caves, sinkholes, fissures, and underground streams.

“We have about 16 different hazards and not all are natural hazards,” said Hathcock. “We cover events like tornadoes, winter weather, flooding, and extreme temperatures. We’re in a very heavily karst area, which means a lot of sinkholes and caves. We also look at pandemics, drought, landslide, terrorism, and infectious disease.”

Jason Polk studies karst resource management and geochemistry, water resources and sustainability, climate change, and global climate dynamics. His areas of expertise include karst geoscience, paleoclimate reconstruction, climate teleconnection dynamics, multi-proxy climate record analytics, hydrologic monitoring, water quality and quantity assessment, and isotope geochemistry. This project (and BRADD’s specific needs) were a perfect fit for Polk, which AGU’s Thriving Earth Exchange brought on board for the project as a Community Scientist.

Polk says that 40% of Kentucky is considered a karst landscape. He also says that about half the United States is, too—including swaths of Kentucky, Tennessee, Alabama, Georgia, Florida, and other pockets of the East Coast, as well as quite a bit of the Southwest.

“Karst is found across the world—China and Southeast Asia has a vast amount. And it’s in Australia, Africa, and South America. It’s an easy thing to study—it’s anywhere in the world,” he says.

In 2020, the BRADD region had a population of 312,000, a median age of 38.7, and a median household income of \$60,108, with 13% of the population living below the poverty rate and food insecure. The region is predominantly white, representing 83% of the population, and the 17% comprising minority populations include 6% Black, 5% Hispanic, 2.5% Asian, and less than 1% Native American. Kentucky’s mostly rural regions make access to regular resources and services to its communities, no matter their profile, very difficult.

In 2021, the United Nations reported that the top 10 natural disasters occurring in the world were connected by three causes: human-induced greenhouse gas emissions; insufficient disaster risk management; undervaluing of environmental costs and benefits in decision-making. By this standard, BRADD is ahead of the curve in understanding how natural, man-made, and hybrid hazards are linked together and, in a cascade of events, can devastate cities and their regions.

Polk, who carries out research throughout the world and has worked on a number of community-based projects, found great value in the Thriving Earth Exchange program.

“AGU provides a great foundation and training for you to work well with a community and makes sure you have the tools you need, since it’s a unique type of activity—especially talking across different types of expertise levels,” said Polk. “It’s also helpful that AGU vets the projects and provides a lot of structure. It can be really challenging to step into a community-based project and have it turn out badly despite your best intentions.”

Polk also added that from a scientific and researching perspective, the Thriving Earth Exchange is creating what can be a very broad database that could help scientists identify areas to focus or problems to solve.

“On a broader scale, we start to see the commonalities and we’ll be able to fix the problems,” he says.

“Updating FEMA approved Multi-Hazard Mitigation Plan for a more Resilient Community Towards Climate Change Hazards” is a project of AGU’s Thriving Earth Exchange, which advances community solutions to some of the most vexing environmental challenges. Thriving Earth Exchange helps scientists, community leads and sponsors work together to conserve natural resources, mitigate climate change and create awareness of natural hazards and their impacts on communities.

Learn more at thrivingearthexchange.org.

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