

Flood Resilience in Missouri



Executive Summary

The presence of the Mississippi and Missouri Rivers in Missouri creates significant flooding risks for the state. Floods are dangerous and economically costly, and the frequency of major flooding events in Missouri has increased. The National Centers for Environmental Information lists only one flooding event that affected Missouri in each of the 1990s and 2000s that cost over \$1 billion, but five in the 2010s. Projections suggest that Mississippi River flooding alone will cost \$4.2 billion annually by 2030. There are several efforts to address flood resiliency in Missouri. Governor Parson created the Flood Resilience Advisory Working Group after the 2019 floods to assess flood risk and identify priority areas for funding. He also proposed the formation of the Missouri Hydrology Information Center in his recommended budget for 2023. In 2022, the University of Missouri announced the creation of the Missouri Water Center, a research hub whose stated goals include improving protection from floods.

Highlights

- Flooding is the deadliest and among the costliest severe weather hazards in Missouri.
 - The majority of fatalities happen during flash floods and to those in vehicles.
- Missouri is undergoing an above average wet period and climate projections suggest more frequent extreme precipitation events, which will increase future flood risks.
- Missouri is home to multiple flood exposure “hotspots”, where socially vulnerable communities are located in regions with high flood exposure.
- Flood resilience is more effective when it takes a whole watershed approach and is proactive rather than reactive.
- Nationwide, the total costs due to damage from major flooding events in the 2010s was over \$65 billion.
 - Flooding that affected Missouri in the 2010s amounted to \$26.6 billion in total damages.

Limitations

- Scientific projections of future scenarios of climate impacts are based on the best available data and are useful tools for future planning, but because they incorporate unknown assumptions about the future, they have greater levels of uncertainty with distance of projection (i.e., it is easier to predict next year than 50 years from now).
- Missouri-specific data for quantifying various impacts of flooding was not readily available.

Research Background

Flood Risk in Missouri

Flooding History in Missouri

The Mississippi and Missouri Rivers are prone to flooding, creating significant risk to Missouri. The National Weather Service (NWS) lists significant flooding events in Missouri since 1977.¹ From 1977 to 2011, there have been significant flooding events about every 5 to 10 years. In the 2010s, there have been five flooding events that affected Missouri with damages that cost over \$1 billion nationally. However it is not clear what criteria NWS is using to classify a “significant” flooding event. Up-to-date comprehensive lists of all flood events categorized by geographic location are currently not publicly available.

Future Flood Risk

Missouri’s climate has been marked with periods of both wetness and dryness over the last 125 years. However, precipitation patterns are changing, and Missouri is currently experiencing unprecedented wet conditions.² The state has seen both higher levels of annual rainfall and more frequent extreme precipitation events over the last 25 years (**Figure 1**). Climate projections suggest that humid and semi-humid regions like Missouri will face more frequent extreme rainfall events, resulting in greater flood risk.³ Flood risk varies by geography, and is highest in areas with land that has 1% or greater chance of annual flooding (**Figure 2**).

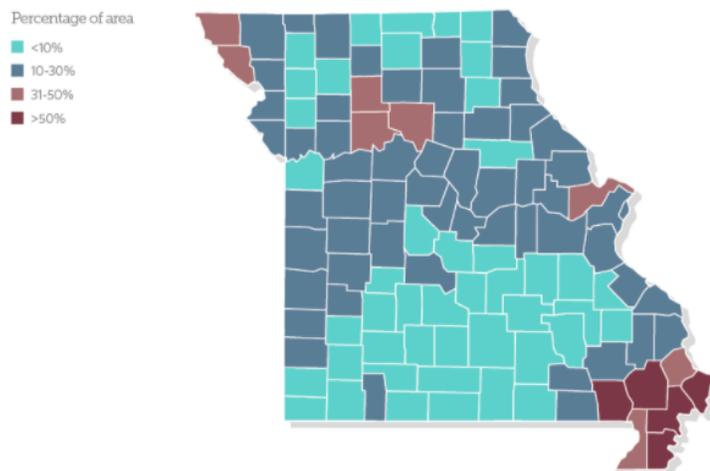
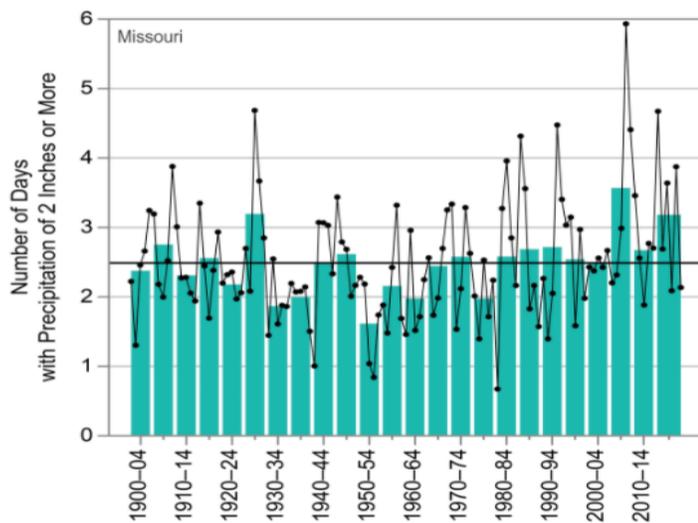


Figure 1. (top) The number of heavy precipitation events in Missouri over 120 years. The dots show annual values, bars show averages over 5-year periods, and the horizontal black line shows the average for the entire period. **Figure 2.** (bottom) The percentage of the land in Missouri counties that have a 1% or higher annual chance of flooding. The greater the percentage (the darker the red), the higher the risk of flooding.⁵

Impacts of Flooding

Economic Impact of Flooding

Levees are used to protect the land around a river from flooding. In the U.S., levees protect more than \$2.3 trillion in assets.⁵ Despite this, the American Society of Civil Engineers gave levees nationwide a “D” grade in its 2021 report card, indicating the need for maintenance and repairs. In Missouri levees surround the Mississippi and Missouri Rivers.

Flooding events in the Midwest can be expensive, even when compared to other natural disasters in the nation.⁷ In 2019 there were 14 weather and climate disasters that individually cost over \$1 billion. The total damage of these events cost \$45 billion. The flooding of the Mississippi, Missouri, and Arkansas river in the same year cost \$20 billion, almost half of the cost of all the billion dollar weather and climate disasters. Nationwide, the total damage done by major flooding events in the 2010s was over \$65 billion.⁸ Billion dollar floods that affected Missouri in the 2010s caused \$26.6 billion in total damages, though this does not mean that all the costs were incurred by Missouri alone.

Observations of expensive flooding events may indicate that they are becoming more frequent, but definitive conclusions cannot be made until more rigorous analysis is performed. The U.S. has experienced more than five times the amount of billion dollar floods in the 2010s (18) when compared to the 2000s (3), even after adjusting for inflation.⁸ Missouri has been affected by seven billion dollar flooding events since 1980. In the 1990s and 2000s there was only one event in each decade while in the 2010s there were five such events. Nationwide, since 2000, flooding has caused an average of \$8 billion annually in damages.⁹ This includes damage to agriculture, including crop loss, contamination, equipment loss, and soil erosion.¹⁰ By 2030, damage costs from the Mississippi river alone are expected to reach \$4.2 billion annually.¹¹

Social Impacts of Flooding

Across the U.S., socially vulnerable demographics are often located in areas with higher flood exposure. Approximately 19 million people live in these “hotspots”, where flood exposure and high percentages of disadvantaged populations converge. St. Louis, MO was identified as a hotspot, as well as many rural communities throughout the state.¹² Flooding is also the deadliest type of severe weather event in Missouri.¹³ The majority of these deaths happen during flash floods, in contrast to floods that happen over days or weeks. Additionally, over half of all flooding deaths have occurred to people in vehicles. There were 50 deaths due to flooding from 2015 to 2019 in Missouri, and 40 of them involved people who were in a vehicle.

Flood Resilience Response Measures

Flood resilience responses are more effective when they take into account the whole watershed, and incorporate programs and policies for agriculture, land-use, and urban stormwater runoff.¹⁴ Nature-based solutions that aim to slow runoff and keep water on site are critical to mitigating the severity of future flooding.¹⁵ In large-scale land-use, the implementation of terraces and retention ponds on slopes along with habitat restoration can reduce the flow rate of runoff.¹⁶ On

agricultural lands, incorporating practices like vegetated strips along waterways, perennial crops, cover crops, and no-till farming increases the absorptive capacity of the soil and reduces flood risk. In urban areas, the incorporation of permeable building materials and green spaces (e.g., rain gardens, tree planting, parks) helps to keep water on site, mimicking natural hydrological cycles.¹⁷

Missouri

In Missouri, Governor Mike Parson created the [Flood Resilience Advisory Working Group](#) to assess flood risk and identify priority areas for funding after the 2019 flood of the Missouri River. In 2020, governors of Missouri, Iowa, Nebraska, and Kansas convened to establish a [Memorandum of Agreement](#) between the four states to cooperate on flood recovery and flood control in the Lower Missouri River Basin. Governor Parson then proposed the formation of the [Missouri Hydrology Information Center](#). If approved, the center will be housed within the Missouri Department of Natural Resources and aims to improve monitoring, mapping, and communication. [SB 984](#) and [HB 2617](#) in the 2022 legislative session would create the Flood Resiliency Act. The act would create a fund which may be used to fund flood resiliency projects. The state may also participate in the development, construction, or renovation of a flood resiliency project as long as it has been approved by the director of the Department of Natural Resources. The state may also initiate a flood resiliency project on its own.

While the state is the key actor in planning for flood resilience, other stakeholders play important roles as well. In Missouri, non-profit organizations and academic institutions have contributed to decision-making and flood planning. In 2022, the University of Missouri announced the creation of the [Missouri Water Center](#), a research hub whose stated goals include improving protection from floods. In another example, state and federal public and private sectors partnered in Atchison County, MO to move a levee back to allow the Missouri River to have more room after damages incurred from the 2019 flood.¹⁸ The project was led by the Atchison County Levee District with help from the U.S. Army Corps of Engineers, The Nature Conservancy, and several state agencies. Levee setbacks provide more space for flood waters, thereby reducing river flow rates and erosion and lessening potential for economic impacts from damaged infrastructure.

Other States' Flood Responses

In 2022, researchers from the Urban Institute developed a [report](#) reviewing flood resilience plans for different states in the U.S. In Iowa, the primary flood related plan is the [State Hazard Mitigation Plan](#). The state also has other groups focused on flood control. The [Iowa Flood Center \(IFC\)](#) is a research and information hub at the University of Iowa that provides flood maps and water monitoring services for the state. Iowa was awarded \$97 million in a [National Disaster Resilience Competition](#) for the development of the [Iowa Watershed Approach \(IWA\)](#), which partners a variety of public and private actors to implement flood control projects. The Iowa General Assembly also created the [Flood Mitigation Board](#), composed of experts from state agencies, the public, and ex-officio legislators, to oversee the disbursement of funds to aid flood related redevelopment. Funds for flood mitigation in Iowa derive from sales tax

increments or appropriations from the General Assembly. Overall, Iowa has limited state-level flood planning but substantive flood mitigation efforts, and much of the onus for flood preparedness is placed on non-state actors like IFC and IWA.

States vary widely in their flood risk as well as state-level flood response and planning measures. Some of the state-level responses to flood risk include (1) Florida's [SB 1954](#), the "Always Ready" law that calls for regular flood risk assessments and updated flood plans, and administers \$100 million/year to flood resilience projects; (2) North Carolina's [Executive Order 80](#) which calls for the creation of a climate risk assessment and resilience plan including a "flood resiliency blueprint", and appropriates \$800 million over 2022–2023 to disaster recovery, planning, and prevention; and (3) Washington's state legislature approved the [Flood Control Assistance Account Program](#) and the [Healthy Environment for All Act](#), which respectively administer funding for flood planning and require agencies to incorporate environmental justice in their plans and programs.

Overall, the [Urban Institute study](#) found that most states did not have explicit flood resilience plans, but instead relied on State Hazard Mitigation Plans which are required by all states to be eligible for federal funding (e.g., FEMA).¹⁹ In all states, the major stakeholders in flood resilience include partnerships between governmental, non-profit, and academic institutions. Federal funding was important for immediate flood recovery but less so for long-term planning if not backfilled with state appropriations. In general, flood plans were drafted quickly after a major disaster and tended to lack public input and attention to disproportionately impacted demographics. Lastly, the report found that most state-level flood plans were reactive rather than proactive and failed to incorporate climate projections of changing precipitation patterns and future flood risk in their planning.¹⁹

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