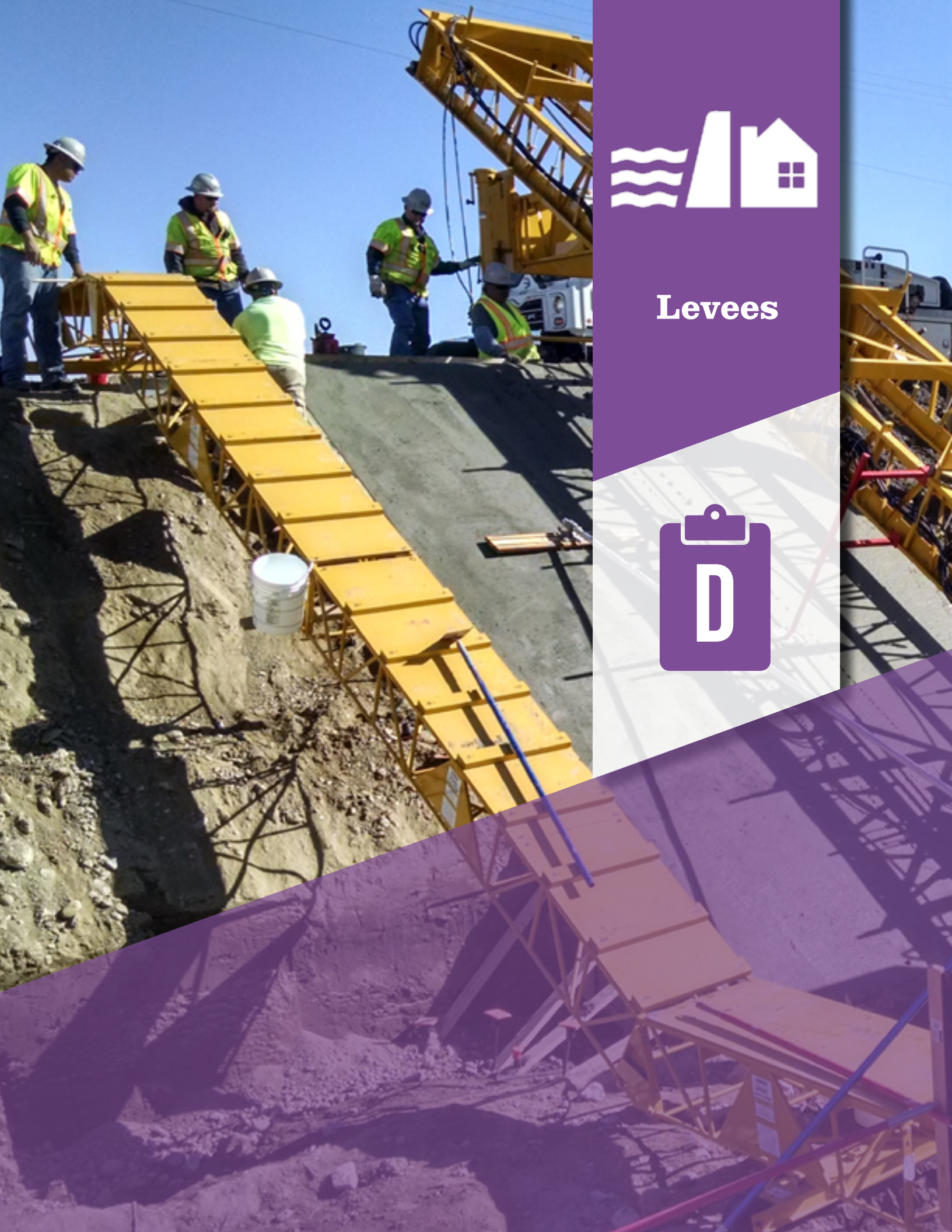

Levees

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EXECUTIVE SUMMARY

Seventeen million people across the nation live or work behind a levee. Levees protect critical infrastructure systems, $2.3 trillion of property, 4,500 schools that collectively enroll over 2 million students, and a range of industries. The National Levee Database contains nearly 30,000 miles of levees across the U.S., and current estimates identify up to 10,000 additional miles of levees outside of the U.S. Army Corps of Engineers (USACE) portfolio whose location and condition are unknown due to complex and varying local ownership.[1] The USACE estimates that $21 billion is needed to improve and maintain the moderate to high-risk levees in its portfolio, which represents only about 15% of the known levees in the U.S.[2] As more extreme weather events result in increased flooding, such as the $20 billion in damages caused by flooding in the Midwest during the spring of 2019, it is now more important than ever to have a complete inventory of the nation's levees and to equip communities with resources to mitigate flood risk and make necessary repairs.

CONDITION & CAPACITY

Communities in all 50 states, the District of Columbia, Puerto Rico, and Guam depend on levees to mitigate flood risk. Earthen embankments make up 97% of all levees, while the remaining 3% are concrete, rock, and steel floodwalls. The nation's levees are, on average, 50 years old, and many were built using engineering standards less rigorous than our current best practices.

Congress authorized the National Levee Safety Act in the Water Resources Development Act of 2007. This legislation created the National Levee Database (NLD) and authorized the inventory, inspection, and risk assessment of all levees within the USACE's portfolio. Since that time, the USACE has inventoried nearly 30,000 miles of levees across the U.S., including approximately 15,000 miles of levees not within their portfolio and whose condition is unknown.

However, this portfolio represents a small portion of all the nation's levees; it is estimated there are up to an additional 10,000 miles of levees in the U.S., but they are difficult to inventory due to the diverse public and private entities that own, operate, and maintain them. Since 2017, the USACE has incorporated a variety of different inventory sources into the NLD; corrected levee alignments (shortening or increasing lengths); recategorized or removed structures that were not levees; and added new levees, all of which brings the database closer to being a complete inventory of levees in the U.S. Most levees yet to be inventoried are anticipated to have a zero to relatively low population (<100 population) behind them.[3]

As of March 2019, the USACE has completed levee risk assessments for three-quarters of the levees within the portfolio. For the remaining quarter, the USACE expects to complete levee risk characterizations in the next few years. Risk relates a levee's condition to the potential consequences for the size of the population living or working behind the levee. The most recent risk assessment shows that less than 4% of levees within the USACE portfolio are characterized as high or very high risk down

from 5% in 2017. Furthermore, 9% of USACE levees are moderate risk, 60% are low risk, and the rest have not been assessed. By comparison, 5% of levees within the USACE portfolio were high or very high risk in 2017. While most levees within the portfolio are characterized as low risk, a larger portion of the population — about 45% — lives or works behind a high- or very high-risk levee. Unfortunately, 80% of high- or very high-risk levees were found to have one or more levee performance concerns that would likely result in a breach prior to overtopping.[4]

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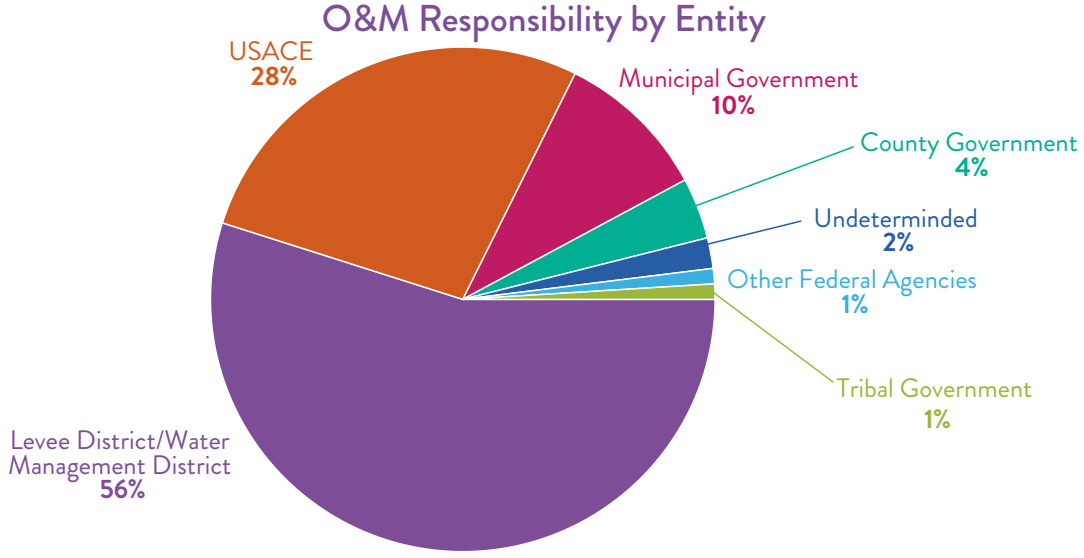
About 500 levee systems nationwide are accredited as part of the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP), and roughly 270 of these levee systems are within the USACE's portfolio. A FEMA-accredited levee is one that is certified by a registered professional engineer; meets the National Flood Insurance Program minimum design, operation, and maintenance requirements; and is expected to provide 1% annual chance flood risk reduction. Approximately 30% of these accredited levees within the USACE's portfolio are characterized as moderate, high, or very high risk. These levee systems have about 3.6 million people living or working behind them and protect $400 billion of property.[5]

OPERATIONS & MAINTENANCE

Roughly 70% of the levees, or nearly 10,000 miles of levees, within the USACE's portfolio are operated and maintained by a non-federal levee sponsor — i.e., a municipality or special district. The remaining levees in the portfolio — about 4,200 miles — are operated and maintained by the USACE. Of the levees operated by an entity other than the USACE, 55% are operated and maintained by a levee district or water management district, while 15% are operated and maintained by municipal or county governments. About 15% of all levee systems within the USACE's levee portfolio have multiple levee sponsors responsible for operation and maintenance.[6]



U.S. ACE Portfolio broken down by entity responsible for O&M and percentage of miles of the total portfolio
Source: USACE 2018 Levee Portfolio Report

Local governments rarely have the resources necessary to properly maintain a levee system; it may not be until a flood event occurs that the levee owner recognizes maintenance must be a priority. Many levees that local governments are charged with managing were built many years ago, and the knowledge of the construction materials may be limited without costly and potentially invasive investigations. Basic problems arise with subsurface conditions such as seepage, undersizing of the structure due to increased floods, and structural issues due to erosion or destruction by tree roots, ground-burrowing animals, or encroaching development. Dedicated funding sources often do not exist for non-federal levee sponsors to operate and maintain their levee systems.

There is currently no national standard or requirement for levee design, construction, or operation and maintenance.[7] However, some states have regulatory authority for the construction and safety of levees.

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FUNDING & FUTURE NEED

In 2018, it was estimated that $21 billion is needed to improve and maintain the moderate- , high- , and very high-risk levees in the USACE's levee portfolio.[8] This estimate does not include any of the levees outside of the USACE portfolio, so the actual cost to improve and maintain levees is likely much higher. Federal funding for non-federally operated and maintained levees is limited, and most levee operation, maintenance, and repair is the responsibility of the levee owner.

Nonetheless, several federal funding programs exist, including the USACE Rehabilitation Program and the National Levee Safety Program. The Rehabilitation Program provides federal repair funds to levees operated and maintained by a non-federal levee sponsor that are damaged by floods or coastal storms.[9]

The Water Resources Reform & Development Act (WRRDA) of 2014 authorized the creation of the National Levee Safety Program, which is modeled after the successful National Dam Safety Program. This program creates levee safety guidelines and a levee rehabilitation program, makes progress toward completing the National Levee Database, provides assistance to states for establishing safety programs, and promotes community education and awareness about levees. In Fiscal Year

Local governments rarely have the resources necessary to properly maintain a levee system; it may not be until a flood event occurs that the levee owner recognizes maintenance must be a priority.

LEVEE CONSTRUCTION IN PUEBLO, COLORADO

2021, appropriators provided just $5 million, even though the National Levee Safety Program is authorized at $79 million per year. Overall, federal funding for levees falls far short of the estimated $21 billion investment need. Fully funding the National Levee Safety Program is critical to identifying the location and condition of all the nation's levees and in protecting people, communities, critical infrastructure systems, and trillions of dollars of property.

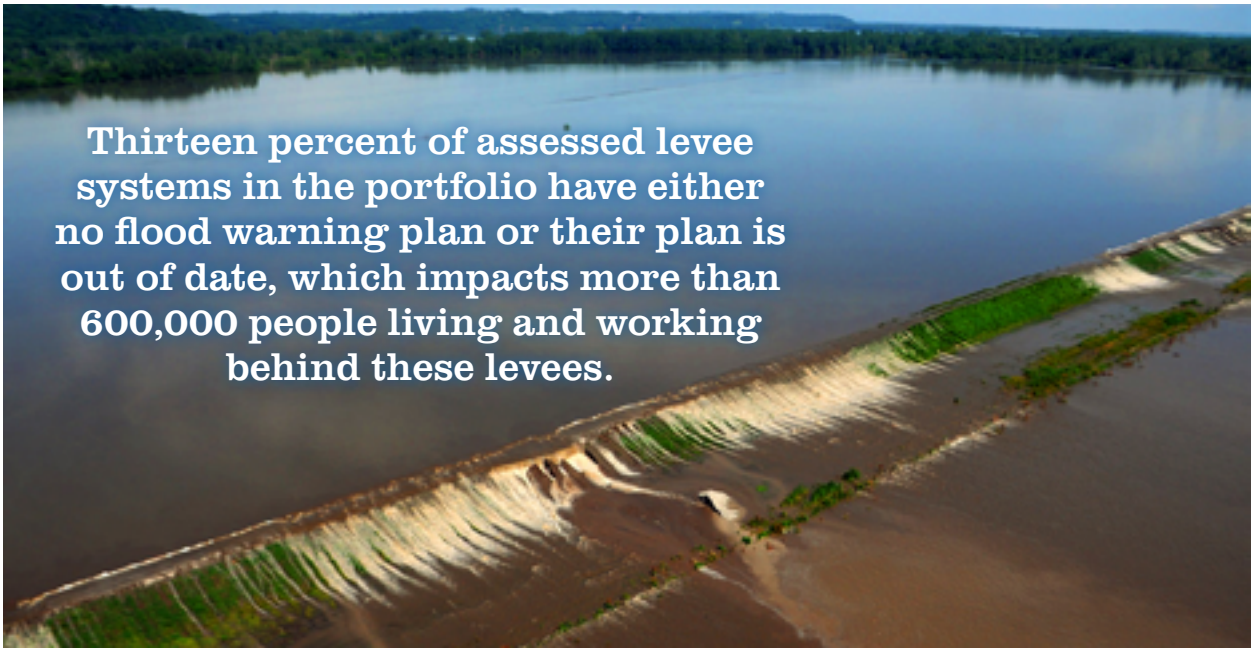
PUBLIC SAFETY & RESILIENCE

Levees are vital components of public safety and help safeguard millions of people, other critical infrastructure systems, and trillions of dollars of property. Over 9 million people — or 86% of the population living behind USACE levees — are concentrated behind about 150 levees, or just 7% of the total USACE levee portfolio.

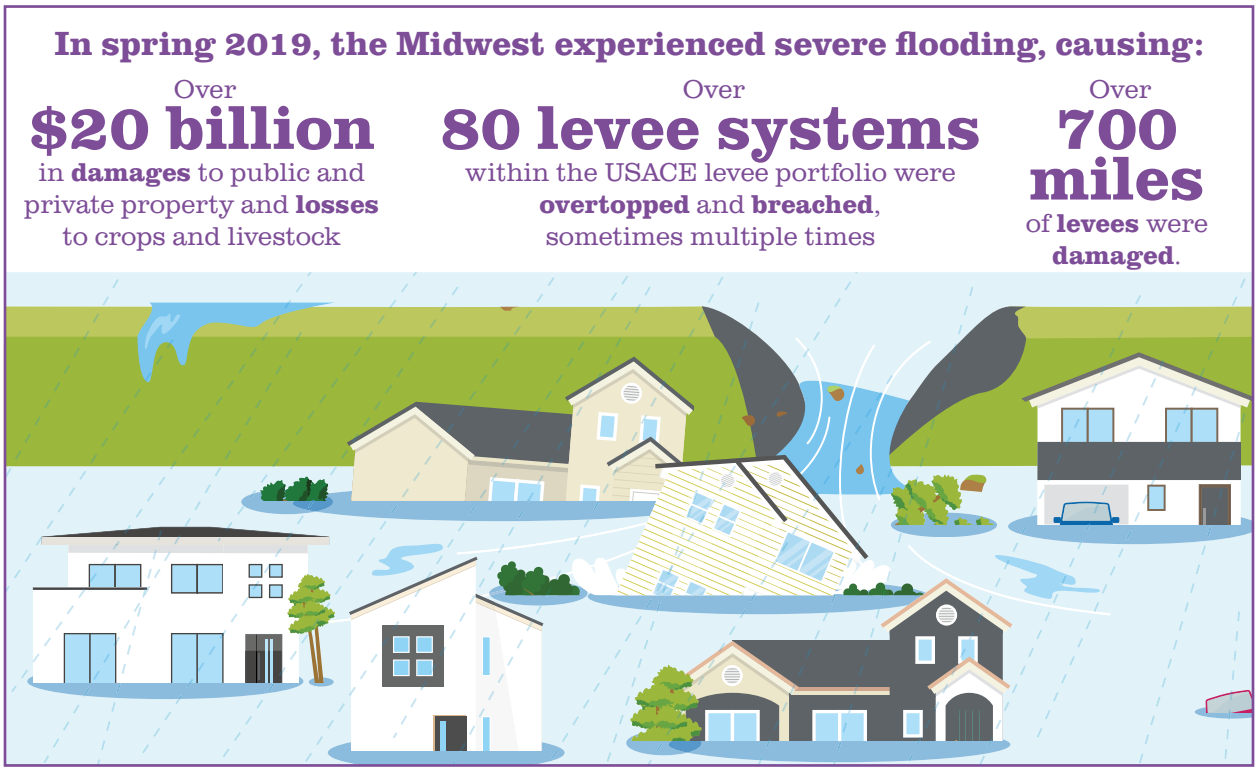
Even well-maintained levees can breach, and water can seep through and underneath them; these effects are hard to detect but can weaken the levee's stability. Frequent extreme weather events put many communities at an increased risk of flooding and levee breaches, including those communities that were previously not in high flood risk areas. In spring 2019, the Midwest experienced severe flooding, causing over $20 billion in damages to public and private property and losses to crops and livestock. Over 80 levee systems within the USACE levee portfolio were overtopped and breached, sometimes multiple times, and over 700 miles of levees were damaged. Preliminary estimates indicate that levee repairs from these floods alone could reach $1 billion.[10] However, it is estimated that USACE levee and shore protection projects prevented almost $350 billion in flood damages from October 2018 to September 2019.[11]

Nearly 40% of the levees in the USACE's portfolio have either a comprehensive emergency plan or recent evacuation success. Thirteen percent of assessed levee systems in the portfolio have either no flood warning plan or their plan is out of date, which impacts more than 600,000 people living and working behind these levees. About 10 million people live and work behind a levee in the USACE portfolio that has some type of flood warning plan; however, nearly 7 million people live in areas that do not have a detailed flood warning plan. Flood warning systems, which include flood inundation maps, contact information for emergency responders, and other key information, are strongly recommended to be included in the development of an Emergency Action Plan for all levee systems. Additionally, more than 3 million people live and work behind levees in communities that are unaware of flood risk.

FEMA and the USACE work collaboratively to incorporate information for levees collected by FEMA



into the NLD in order to increase public awareness about flood risk, and to leverage criteria between existing and new programs to provide incentives for sound flood risk management. While FEMA does not build, own, operate, maintain, or certify levees, they identify flood hazards and work with federal, state, tribal, and local partners to communicate flood risks in areas with levees. The agency is also responsible for determining and establishing flood insurance risk rates.[12] FEMA manages a suite of programs that provide funding to states for mitigation activities that reduce losses and protect life and property from future disaster damages, including the new Building Resilient Infrastructure and Communities (BRIC) Grant Program and the Hazard Mitigation Grant Program (HMGP), among others. Eligible projects include construction of or modification of levees, elevating flood-prone homes or businesses, retrofitting buildings to minimize damage from flooding, and acquiring, demolishing, and/or relocating NFIP-insured property owners.[13]



INNOVATION

Several innovations have emerged in recent years to help maintain and modernize the nation's levees. LIDAR (Light Detection and Ranging) technology is being tested and utilized to help identify levee maintenance issues, assess levee vulnerabilities, and efficiently and cost-effectively target improvements. This technology evaluates risk of catastrophic levee failure and provides continuous and accurate assessments to mitigate risk.[14] In other cases, drones are being used to fly over levees to collect pertinent data; this approach saves time and costs. Additionally, adding field-based sensing in new or existing levees to detect ground motion or seepage of water under levees is being considered to detect potential areas of concern before significant damage occurs.

Further, systems of "fuses" are being evaluated within levee systems that would operate and divert flood water away from areas where there are high concentrations of people, property, and infrastructure. Much like fuses designed to protect electronic devices, levee fuses would be placed to "break" and redirect flood water into lower risk areas. While broken levee "fuses" would require post-flooding repair, the costs to repair the fuses are likely to be dramatically lower than the cost of restoring flood-damaged properties and infrastructure in areas of higher population.

Levees

RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund the National Levee Safety Program at $79 million a year to identify and inventory the location and condition of all the nation's levees — federal and non-federal alike — and complete the National Levee Database.
- Communities can work to reduce the number of new developments behind levees through zoning restrictions and land development regulations.
- Increase resources, education, and outreach efforts to those communities that live and work behind levees in order to communicate to the public the risk to people, property, and critical infrastructure systems behind levees, as well as the risk and consequences of levee failure.
- More broadly deploy and utilize innovative, efficient technologies, such as LIDAR, to quickly assess levees and identify problems.
- When appropriate, encourage property owners behind levees to purchase flood insurance, even if behind an NFIP-accredited levee.
- Increase the number of levees with an emergency action plan and flood warning plan.
- Encourage states to regulate levee safety.
- Consider using risk-based design approach when designing new levees and evaluating existing levees.

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Levees

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