

# Levees



Photo: Water surges onto the road as nature's fury reveals the aftermath of a levee failure; Leli

GRADE  
COMPARISON

2025: D+

2021: D





# LEVEES

## EXECUTIVE SUMMARY

Twenty-three million Americans nationwide live and work behind a levee. The nation's levees guard against flood risk to critical infrastructure systems and protect \$2 trillion worth of property, seven million buildings, and five million acres of farmland. The National Levee Database contains over 24,000 miles of levees across the U.S., but nearly two-thirds have not been assessed for risks posed to the communities behind them. More than half of the nation's levees are operated and maintained at the state and local level. While a national effort to enhance levee safety continues to take shape, including the development of draft National Levee Safety Guidelines, improvements to the National Levee Database, and development of best practices for levee management, more must be done to support states in regulating levees. There are currently limited funding streams for levees and levee safety, as programs like the National Levee Safety Program and Levee Rehabilitation Grant Program have received little federal funding in recent years. The states are also responsible for promoting consistent but flexible best practices for levee operation and management as well as improving and expanding access to funding sources for levee rehabilitation and repair.

## BACKGROUND

In the late 19th and early 20th centuries, periodic flooding in the nation's major river basins led Congress to pass the Flood Control Act of 1917, which authorized the construction of new levee systems and required communities to share in construction costs and assume responsibility for levee maintenance.<sup>1</sup> Further reauthorizations of the Flood Control Act established greater federal interest in the design and construction of levees. More than half of the nation's levees are owned and operated by state and local governments, but more than one-third of the nation's levees have unknown

ownership. Across all 50 states, there are 7,000 levee systems spanning a total of 24,000 miles listed in the National Levee Database. However, the total number of levee systems may be higher, with some estimates indicating as many as 100,000 miles of non-federal levees. Approximately one-third of the nation's levees have been assessed for risk to populations in relation to a levee's condition. Of those levees assessed for risk, 84% are rated as low or very low risk, and about 3% are rated as high or very high.

## CAPACITY AND CONDITION

In every state, including the District of Columbia, Guam, and Puerto Rico, communities depend on levees to protect against flood risk. Earthen embankments make up more than 97% of the nation's levees, whereas approximately 2.5% of levees are concrete, rock, and steel flood walls. The average age of the nation's levees is 61 years old, meaning that many are not built up to modern codes and standards.<sup>2</sup>

Since the National Levee Safety Program was first authorized in 2007, the U.S. Army Corps of Engineers (USACE) has cataloged more than 24,000 miles of levees in the National Levee Database.<sup>3</sup> As of 2021, USACE has worked closely with agencies such as the Federal Emergency Management Agency (FEMA) to determine a more accurate accounting of the nation's levees, including identifying structures and entities previously misidentified as levees. Because of this, the database is updated continually as new information becomes available, resulting in fluctuating figures. While it is the most comprehensive data set available on the totality of the nation's levees, it still may not fully represent the total number of levee systems in the U.S. One estimate indicates that there may be as many as 100,000 miles of non-federal levees nationwide; however, as estimates continue to vary, it has led to

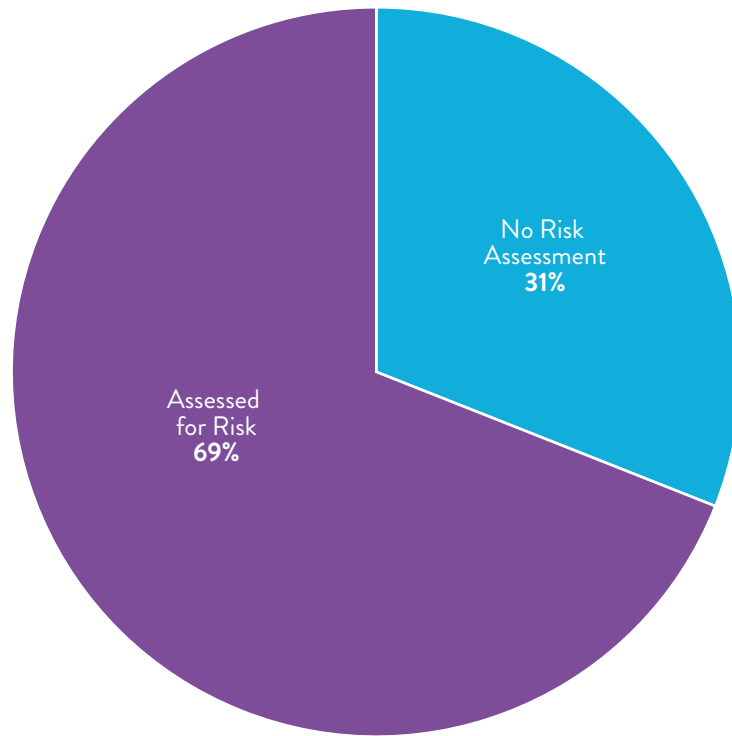
uncertainty regarding the nation's overall levee systems.<sup>4</sup>

There are nearly 7,000 total levee systems listed in the National Levee Database. USACE regularly assesses the risk posed by levee systems in their portfolio, about 23% of the nation's total levees, by relating a levee's condition to the total potential consequences to the population living or working behind the levee. As of November 2024, USACE has completed risk assessments on 97% of the levees in its portfolio.<sup>5</sup> USACE also has authority to conduct one-time reviews of all other levees under the National Levee Safety Program, which includes an assessment of risk. While many states have contributed data to the National Levee Database, there has been limited progress in the development of state levee safety programs since the creation of the National Levee Safety Program in 2007, posing challenges to consistent oversight of non-federal levees outside of USACE's portfolio.<sup>6</sup> However, of the total levee systems nationwide, only about 31% have received a risk assessment. Of the non-USACE levees inspected, nearly 84% were rated as low or very low risk, 13% were rated as moderate risk, and just over 3% were assessed as high or very high risk.<sup>7</sup>



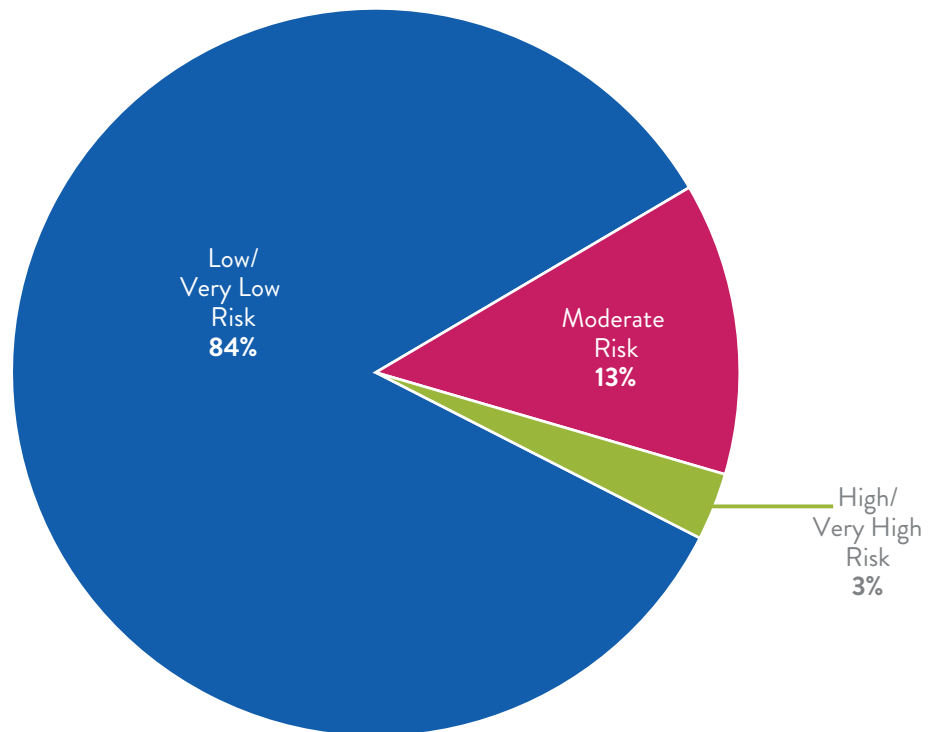
*Photo: Aerial view of old US Route 66 bridge over chain of rocks canal, Pontoon Beach, Illinois; Kent Raney*

## Nationwide Levee Risk Assessments



Source: National Levee Database, U.S. Army Corps of Engineers

## Levee Risk Assessments Nationwide



Source: National Levee Database, U.S. Army Corps of Engineers



More than 1,100 levee systems nationwide are accredited as part of FEMA's National Flood Insurance Program, more than double the amount certified in 2018.<sup>8</sup> Of these, 610 levee systems are within USACE's portfolio, more than twice as many as in 2018. A FEMA-accredited levee is certified by a registered professional engineer; meets the National Flood Insurance Program minimum

design, operation, and maintenance requirements; and is expected to provide a reduction of flood risk from a 1% annual-chance flood (100-year flood). Approximately 27% of these accredited levees within USACE's portfolio are moderate, high, or very high risk. Forty-five levees within USACE's portfolio rated as high or very high risk have either been fully or provisionally accredited.

## FUNDING AND FUTURE NEED

In 2018, USACE estimated a \$21 billion cost to improve and maintain the moderate-, high-, and very high-risk levees in their portfolio. However, the amount did not account for levee systems outside USACE's portfolio, meaning the actual cost is much higher. Given the increasingly severe effects of extreme weather events, aging of the nation's levees, and lack of substantial investment in levee safety and improvements, it is likely that cost has grown significantly since 2021, when ASCE's overall estimate to bring the nation's levees into a state of good repair totaled \$70 billion.

Programs like the National Levee Safety Program and the USACE Levee Rehabilitation Program provide support to states to assist in building levee safety capacity and improvements to existing levees. The Rehabilitation Program provides federal repair funds to levees operated and maintained by a nonfederal levee sponsor damaged by floods or coastal storms.

The Water Resources Development Act (WRDA) of 2022 reauthorized the National Levee Safety Program

through 2028. The program is designed to provide a framework of best practices by developing levee safety guidelines, supporting states in setting up their levee safety programs, and completing the National Levee Database. Since the program's reauthorization, USACE has produced several draft brochures and educational materials to guide levee management for levee owners and to assist states in developing their levee safety programs.

Although USACE has made progress in implementing the National Levee Safety Program, it has not been met with commensurate federal funding. In 2020, Congress appropriated \$15 million to support continued program development. The program's 2022 reauthorization also extended its funding authorization of \$54 million annually. However, aside from the \$29.5 million total for continued growth of the National Levee Database since fiscal year 2021, Congress has not provided any additional appropriation for the National Levee Safety Program.

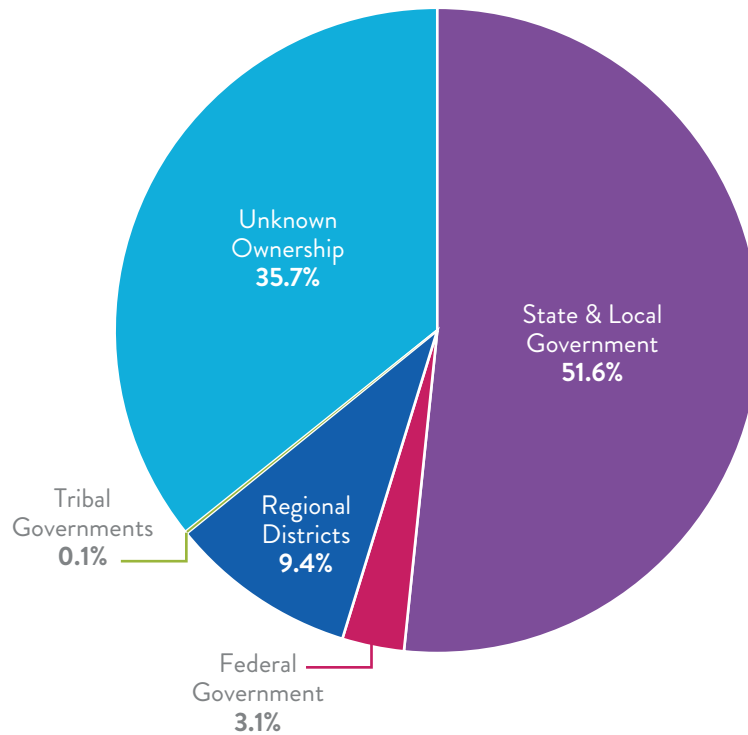
## OPERATION AND MAINTENANCE

**USACE's levee portfolio consists of over 2,000 total levees and spans more than 12,000 miles nationwide.**

Management of these levees falls to various federal, state, and local entities, as well as many private entities. Of the 12,000 miles of levees in the USACE portfolio, 26% (about 3,200 miles) are operated and maintained fully or partially by USACE. Nearly 52% of the total levees in the USACE portfolio are operated and maintained in

whole or partially by state and local governments, more than 9% by regional districts overseen by one or multiple state governments, and just over 3% are federally owned.<sup>9</sup> Beyond USACE's portfolio, more than one-third of the nation's levees have unidentified ownership, which means that critical information about their proper maintenance—and whether a levee is being used for its intended purpose—is unknown.

## Levee Ownership



Source: U.S. Army Corps of Engineers

The National Levee Safety Program was partly designed to help alleviate such challenges. Standing up state levee safety programs can help provide technical assistance to levee owners and operators, support regular inspection and monitoring, and better communicate flood risk to communities. National Levee Safety Guidelines, a draft of which was published by USACE in April of 2024, will provide states with a standard set of best practices for levee operation and management and achieve consistent

nationwide reliability of levees and community resilience in areas behind levees.<sup>10</sup> The 2024 draft guidelines were the first-ever produced and promote best practices for consistent levee safety and reliability. The guidelines cover topics such as strategies to reduce flooding impacts, consideration of the effects of climate change, and addressing the needs of underserved communities impacted by levees.

## PUBLIC SAFETY

The nation's levees protect communities against flood risk. In the U.S., at least 23 million people live behind levees across nearly 2,400 communities in all 50 states.

A recent study found that the percentage of disadvantaged communities living in leveed areas is 41% higher compared to their proportion in non-leveed areas, indicating that these communities are disproportionately concentrated behind levees.<sup>11</sup> Furthermore, these communities often lack adequate flood mitigation infrastructure, such as stormwater systems, and frequently suffer from a lack of critical

resources such as flood insurance, emergency savings, and access to transportation for evacuation, which are needed to respond to flooding events.<sup>12</sup>

All levees are vulnerable to being breached. 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. These residual risks are always present and can stem from flooding that exceeds levee design that leads to overtopping, erosion, and structural failures, in addition to seepage.<sup>13</sup> Frequent extreme weather events put many communities at



an increased risk of flooding and levee breaches, including those previously not in high flood-risk areas. Unfortunately, levee systems are often neglected, in many cases due to cost-benefit determinations that prioritize structures protecting higher-value assets.

In 2023, levee breaches in Pajaro, CA, displaced thousands of residents. The breaches resulted in significant damage or complete destruction of 200 homes, while the surrounding county suffered agricultural losses of more than \$450 million.<sup>14</sup> It was

later found that the levee, built in 1949 (more than 10 years older than the national average age of levees), was never prioritized for repair or rehabilitation, even though the levee experienced inadequate flood protection as early as the 1960s, which resulted in flooding multiple times over nearly eight decades.<sup>15</sup> Local officials in Pajaro had warned about the levee's danger for years. But home and business values in the area did not rise to the level required for repair under the federal government's cost-benefit formula.<sup>16</sup>

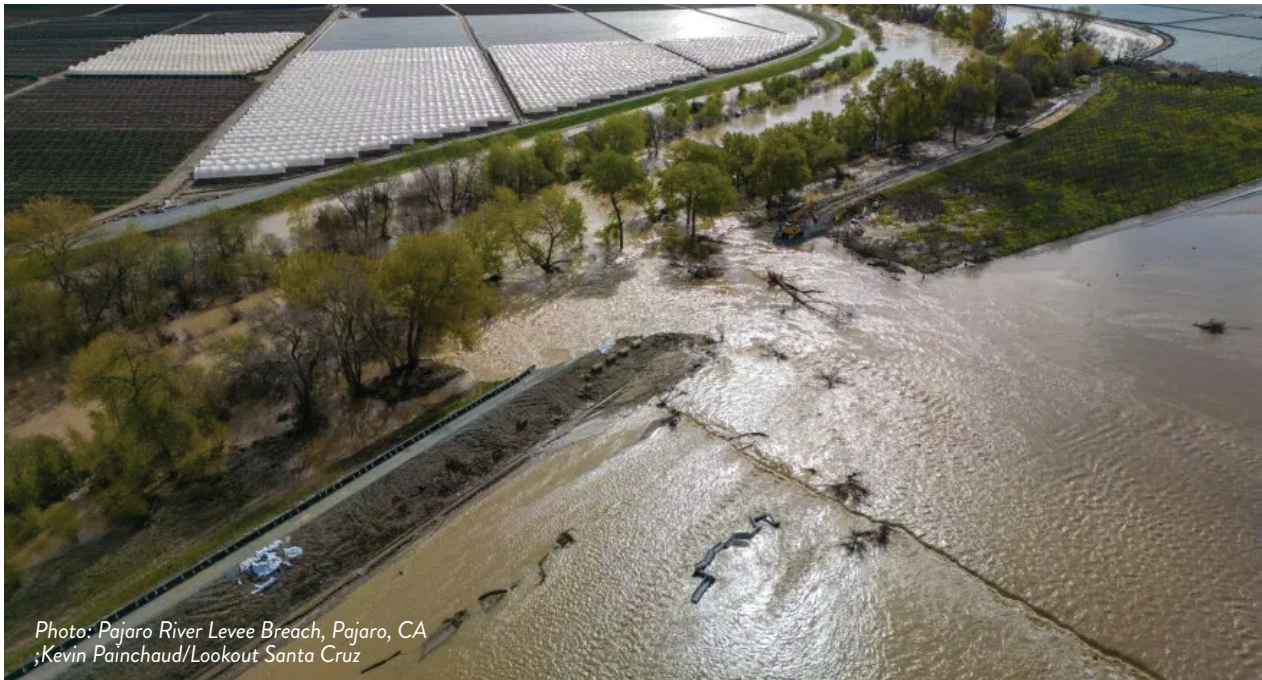


Photo: Pajaro River Levee Breach, Pajaro, CA ;Kevin Painchaud/Lookout Santa Cruz

## RESILIENCE AND INNOVATION

Levee performance and condition can be affected by a number of factors, including extreme weather, funding for safety and maintenance, and age. As climate change increases the frequency and severity of rain events, the added strain on levees is likely to raise the total cost of levee rehabilitation projects. In 2023, a proposed USACE levee rehabilitation project in Colorado Springs, CO, was projected to cost more than \$1 billion.<sup>17</sup> Local governments rarely have the resources necessary to maintain a levee system properly. It may not be until a flood event that the levee owner recognizes maintenance must be a priority.

Many levees that are locally managed were built decades ago, and the knowledge of the construction materials may be limited without costly and potentially

invasive investigations. No national standard for levee construction exists, and many of the nation's levees (some decades old) were designed and built using different processes and standards.<sup>18</sup> At least 641 of the levee systems in USACE's portfolio (nearly 32%) average 60 years old or older, including at least 163 built before 1950.<sup>19</sup> Levees of this age were constructed using data that does not account for the increasingly frequent and intense rain events that these structures have been required to withstand since the 1960s.

In 2022, Congress took action to improve the resilience of the nation's levees. In addition to reauthorizing the National Levee Safety Program, WRDA 2022 amended USACE's Levee Rehabilitation Program to bring flood-

risk reduction and climate resiliency improvement activities under the definition of rehabilitation, thus allowing these types of projects to become eligible for program funding. It also increased the maximum amount of funds a project may receive through the program from \$10 million to \$25 million and gave priority to levee projects in underserved communities.

Congress also has prioritized improved data collection on the frequency and intensity of rainfall by passing the Providing Research and Estimates of Changes in Precipitation (PRECIP) Act in 2022. This law will improve how the National Oceanic and Atmospheric Administration (NOAA) estimates probable maximum precipitation (PMP) to better account for rainfall patterns. Limited or incomplete data regarding PMP and the effects of extreme weather have posed consistent challenges and impediments to levee and levee safety investment.<sup>20</sup> The changes to data collection practices expected to result from the PRECIP Act may also indirectly support a possible boost in funding for levee safety investments.

Passage of the PRECIP Act followed efforts to update the National Weather Service's precipitation frequency standard, ATLAS 14. The forthcoming ATLAS 15 is expected to be completed by 2027. Once complete, it will account for historical trends in precipitation frequency and incorporate the effects of extreme weather into future modeling. Ultimately, this will lead to the collection of more accurate data on rainfall events to improve future levee design and construction projects.

In recent years, several innovative technologies and methods have emerged that may help to maintain structural integrity and improve the performance of the nation's levees. The innovations leverage advancements in materials science, data analytics, and sensing and monitoring technologies to provide more effective and proactive levee management. For example, self-healing concrete incorporates materials that contain healing agents like bacteria or polymers that activate when cracks form and automatically repair minor cracks, thus preventing them from becoming a more severe issue. In addition, the increased use of technology such as uncrewed aerial vehicles (drones) equipped with high-resolution cameras and sensors can cover large areas quickly and use thermal energy to detect erosion and

other signs of distress. Furthermore, robotic systems are currently being developed for levee inspection and maintenance. Systems can navigate challenging terrains and perform tasks such as soil sampling, surface repairs, and deployment of monitoring equipment.

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Another commonly applied approach is interferometric synthetic aperture radar (InSAR), which has been used to monitor levees for nearly two decades. InSAR technology is capable of detecting ground movements with millimeter accuracy, can cover large areas along levees to better indicate areas of erosion, provide continuous monitoring to help assess the overall structural integrity of levees, and can identify stress points and areas of potential failure to allow for more timely maintenance. In the past, InSAR was used to monitor levee systems in the lower Mississippi River area and the California Delta.

Nature-based solutions (NbS) have also become an increasingly popular approach to improving infrastructure resilience. They can be used for various purposes, including flood-risk reduction and stabilizing shorelines. NbS provides multiple benefits such as reducing risks to existing infrastructure systems while increasing their functional lifespan, incorporating natural recovery potential into infrastructure systems, and reducing the harm done to natural ecosystems by the built environment. For example, setback levees push levee embankments away from the river, providing extra space to increase flood protection, reduce erosion, and support healthier riverine and coastal systems.<sup>21</sup>





## RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund the National Levee Safety Program to help states set up state levee safety programs, finalize and promulgate National Levee Safety Guidelines, and strengthen the National Levee Database.
- Reform cost–benefit analysis thresholds to ensure that underserved communities supported by levees are not at greater risk of flooding from levee breaches or prioritized for levee development if needed.
- Encourage efforts at all levels of government to achieve risk assessments for levees.
- Increase resources, education, and outreach efforts to those communities that live and work behind levees to communicate to the public the risks and consequences of levee failure.
- Complete the development of NOAA’s ATLAS 15 precipitation frequency standard, and fund and implement the modernization of maximum probable precipitation estimates prescribed by the PRECIP Act to produce more accurate data on current and future rainfall events.



*Photo: Broken levees pouring water into towns, during massive floods;Topaz*



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