The Wyoming Valley Levee System, located in Wilkes-Barre, PA, June 2020

USACE/Baltimore District

Levees: An Opportunity to Advance Strategic Connections in Flood Risk Management at All Levels of Government

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As flooding becomes more complex due to sea level rise, coastal erosion, wildfires, and changes in precipitation patterns, we no longer have the luxury to think about mitigation programs individually. To manage flood risk in a well-coordinated, efficient, and cost-effective manner requires collaboration at all levels. This article asks the question about how levees fit into this changing scenario, sets the stage for areas to explore, and discusses the roles states can play.

Levee Systems: An Overview

Periodic flood events continue to shine light on the importance of levees and the need for a consistent national approach to better predict levee performance and manage them in the broader community context. Today, levee systems play a critical role in managing flood risk throughout the United States. Yet levees are built by various governmental agencies or by private property owners, often using different standards, materials, and flood scenarios to inform their design. With over 24,000 miles of levees throughout the nation reducing flooding to about 2,400 communities, over 23 million people, and $2.4 trillion in property value (Figure 1), there exists a national need for gaining a more consistent understanding and management of this important infrastructure.

Figure 1 Levee Statistics, National Levee Database

It is important to consider not only the flood risk reduction benefits afforded to the communities behind levees but to also understand how levees interact within the broader watershed: how levees are affected by the operation of upstream dams; how levees influence water elevations upstream and downstream; and how levees may impact the natural environment. States are in a key position to align dams and levees with floodplain management to support community flood resilience in a way that is unique to each state. States also have the authorities and visibility to forge broader strategic connections with national approaches to flood risk management, resiliency, natural resources protection, and equity.

Why Levees and Dams Can't Be Treated the Same Way

Both types of infrastructure are tools in flood risk management and are similar in their technical approaches and practices. However, looking at the landscape a bit more closely, significant differences emerge:

- Levees are part of the fabric of a community (Figure 2). They occupy the floodplain and are a dominant part of the daily landscape, visible from land and water for tens or hundreds of miles. Dams are often (although not always) out of the everyday public view. In addition, levees are recognized by communities as having a more direct impact on flood insurance and floodplain management requirements for the National Flood Insurance Program.
- Societal expectations are somewhat different for levees and dams. Although both dam and levee safety professionals look to prevent catastrophic failure and hold public safety paramount, levee professionals are frequently called upon to manage the impacts of overtopping both on the levee and in the floodplain. Through activities such as reducing pool levels or releasing water, dams can reduce risk of infrastructure failure and uncontrolled overtopping. Typically levees have no such mechanisms and communities rely more often on evacuation, floodproofing, or elevating critical structures and acquiring flood insurance to manage financial vulnerabilities.
- Dams and levees both have flood risk management objectives, but dams are often also constructed to generate hydropower, store water for human use and irrigation, and provide recreational opportunities. Levees are more singular in focus; they exist to allow for use of the floodplain to support a density of economic activity and protect economic investment. Because of their location adjacent to communities, levees are often relied on to reduce the risk of flooding to other types of public infrastructure and lifelines such as water and wastewater infrastructure, energy production, emergency services, schools, local roads, and highways.
- The length of levee systems makes their ownership and operations complicated. Levee systems often comprise multiple sections, each with their own owner/operator. Because they extend for such long distances near transportation routes, there are quite often openings for traffic and pedestrians that need to be closed during high water and pumps started to remove rainwater trapped on the dry side of levee. Inspection, instrumentation, and monitoring is more challenging for levees due to their length and encroachments (e.g., pipes, signs, buildings, human encampments) more difficult to identify and address. One example of a complicated levee is the New Orleans East Bank levee system; it is about 180 miles in length, has 323 closures and seven communities behind it, requiring a complex operational and emergency response plan during flood events. Many rivers have levees on both sides, and there are multiple levees that cross two states.

Figure 2 The View Across the Galena River in Illinois From the Top of the Levee, Including Community Walking Trail

TABLE 1 SOME SIMILARITIES AND DIFFERENCES BETWEEN DAMS AND LEVEES
(Source: National Levee Database and National Inventory of Dams)

SIMILARITIES		DIFFERENCES	
Levees	**Dams**	**Levees**	**Dams**
Average age–60 yrs.	Average age–65 yrs.	Number of Levees: ~7,000	Number of Dams: ~90,000
97% are earthen embankments	80+% greater than 50' tall are earthen embankments	~24,000 miles	~16,000 miles[1]
		70% owned by government entities	65% privately owned
		~700 levees have emergency action plans	Over 12,000 high hazard dams have emergency action plans

[1] This includes the 79,000 dams that have length recorded in the National Inventory of Dams.

The National Levee Safety Program: The Missing Piece to a More Integrated Flood Risk Management Approach

Under the National Levee Safety Program, the U.S Army Corps of Engineers (USACE) and the Federal Emergency Management Agency (FEMA) are developing tools and resources that promote common and consistent best practices for levees.

Not only will the National Levee Safety Program fill a long-needed gap for levees (e.g., national inventory, best practices, levee safety programs) , but it is also intended to work in conjunction with the National Dam Safety Program and the National Flood Insurance Program to improve the overall flood resilience of communities (Figure 3). This triad of programs can work together to support flood risk management for the nation by reducing risk to human life, property, and the environment from dam-related and levee-related hazards (National Dam Safety Program and National Levee Safety

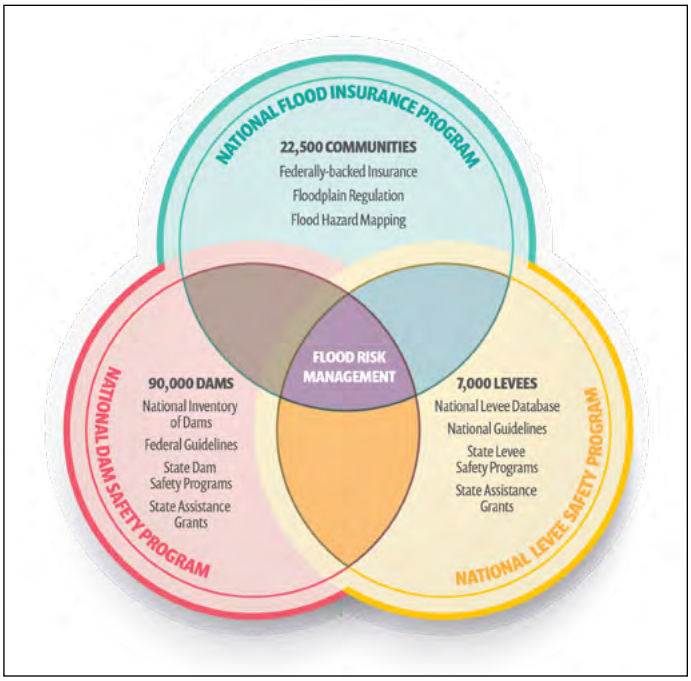


Figure 3 Federal Programs Supporting a More Aware, Prepared, and Flood-Resilient Nation

TABLE 2 ACTIVITIES TO CONSIDER WHEN CREATING A COMPLEMENTARY ROLE FOR THE NATIONAL LEVEE SAFETY PROGRAM

NATIONAL DAM SAFETY PROGRAM	NATIONAL FLOOD INSURANCE PROGRAM
Provide assistance to states to strengthen their state dam safety programs to: • Conduct dam safety training • Increase the number of dam inspections • Increase development, testing and use of emergency action plans • Review and issue permits in a timely manner • Improve coordination with state emergency preparedness officials • Identify dams to be repaired or removed • Conduct dam safety awareness activities	• Ensure communities have legal authorities necessary to adopt and enforce floodplain management regulations • Establish minimum state regulatory requirements consistent with the National Flood Insurance Program • Provide technical and specialized assistance to local governments • Coordinate the activities of various state agencies that affect the National Flood Insurance Program • Provide insurance to homeowners and businesses

Program), mitigate future flood risk and transfer of flood risk through floodplain regulations, and make insurance available to reduce financial vulnerability and help individuals and businesses recover more quickly from floods when they do occur (National Flood Insurance Program). Table 2 summarizes key activities that can be considered when identifying the most important activities that a National Levee Safety Program should promote at all levels in a manner that is complementary and non-duplicative.

This effort is coming at an opportune time. Following several decades of implementation of the National Flood Insurance Program and the National Dam Safety Program, the National Levee Safety Program can take advantage of a lot of experience and lessons learned. Advanced technology in imaging, modeling, databases, and risk estimation has provided a snapshot of levees in just a few years. A combination of available information including databases, surveys, and digital terrain algorithms has identified almost 7,000 levee systems. This information has been overlayed with available data sets to estimate people, property, critical infrastructure, and environmental resources behind and near levees. This levee information can also be easily compared to information in the National Inventory of Dams, FEMA's mapping products, agricultural land, critical wildlife habitat, highway, and public infrastructure locations, and many other interests. Figure 4 shows a screenshot for a levee as seen in the National Levee Database which allows visualization of multiple national datasets allowing information to be more accessible to the public.

Technology Used to Build the Levee Inventory

- *A digital terrain algorithm was first used to identify possible levee structures on the terrain.*
- *A semiautomated tool uses top of levee and cross section data from digital terrain data to confirm the presence of a levee, then combines several possible methods to create leveed area polygons.*

Because all states participate in the National Dam Safety Program and the National Flood Insurance Program, there exists a solid governmental and organizational foundation on which to incorporate levees into activities and governance. **The question is, how can existing programs or governance frameworks integrate with or be adjusted to include levees in a**

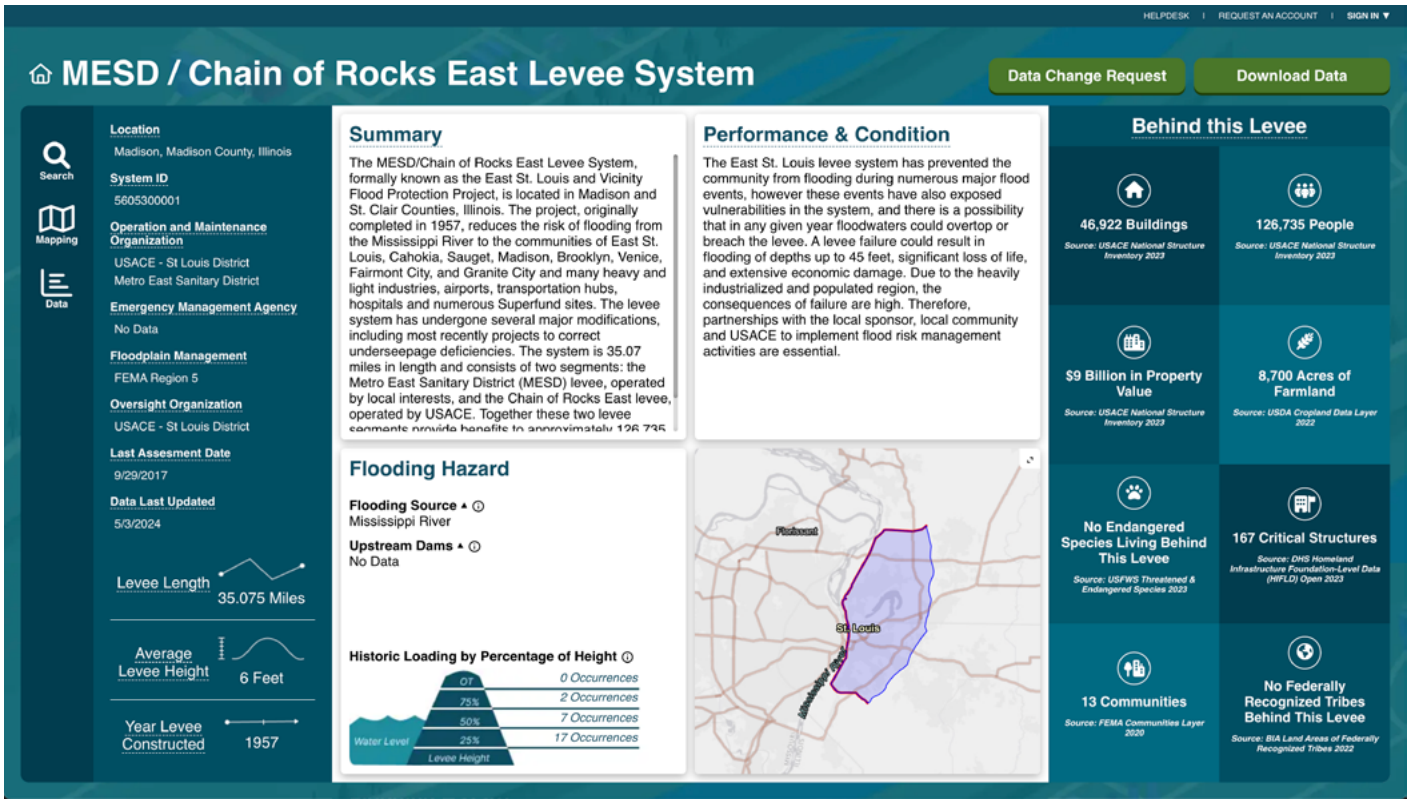


Figure 4 Example of the Main Landing Page of a Particular Levee System

STATE	MILES OF LEVEES	STATE	MILES OF LEVEES	STATE	MILES OF LEVEES
CALIFORNIA	5,069.7	OHIO	196.7	WEST VIRGINIA	37.4
LOUISIANA	3,282.4	SOUTH DAKOTA	182.2	WISCONSIN	33.7
ILLINOIS	2,095.1	NORTH DAKOTA	182.1	NEVADA	29.5
MISSOURI	1,919.6	PENNSYLVANIA	160.0	CONNECTICUT	25.0
ARKANSAS	1,482.3	KENTUCKY	140.1	MARYLAND	22.1
TEXAS	1,242.2	NEW YORK	113.7	GEORGIA	21.8
FLORIDA	1,055.6	MICHIGAN	97.1	VIRGINIA	16.1
MISSISSIPPI	968.7	OKLAHOMA	86.4	SOUTH CAROLINA	15.2
IOWA	730.8	NORTH CAROLINA	77.9	HAWAII	14.3
KANSAS	710.4	NEW JERSEY	77.9	ALABAMA	13.4
WASHINGTON	620.3	TENNESSEE	76.6	RHODE ISLAND	3.8
NEW MEXICO	394.2	UTAH	74.7	NEW HAMPSHIRE	3.7
INDIANA	380.1	MONTANA	74.0	DISTRICT OF COLUMBIA	3.3
NEBRASKA	335.5	COLORADO	70.0	DELAWARE	1.9
ARIZONA	330.7	PUERTO RICO	65.3	MAINE	1.9
OREGON	315.4	ALASKA	53.0	VERMONT	1.0
IDAHO	243.4	MASSACHUSETTS	51.9	GUAM	0.8
MINNESOTA	222.4	WYOMING	49.0	US VIRGIN ISLANDS	0.3

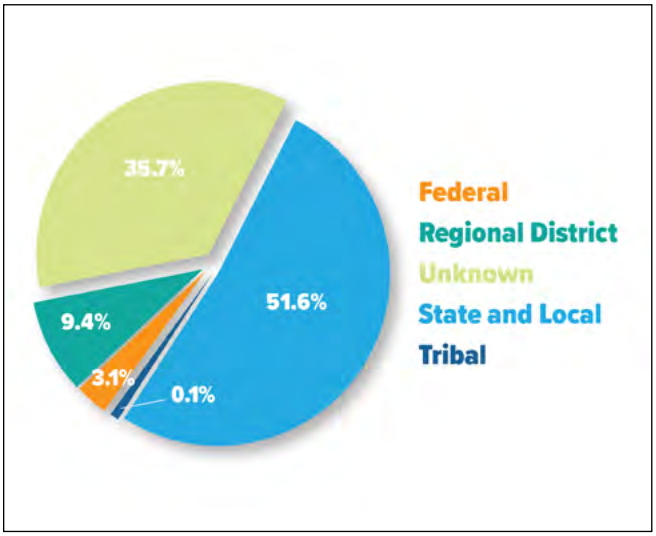
Table 3 Levee Miles per U.S. State and Territory

A Snapshot of Levees from a State Perspective

There are levees in every state (Table 3), but there is considerable variation not only in the total number of levees but the number of people and the amount of property they protect.

The Varied Activities of Levee Owner/Operators

Entities that operate and manage levees are found at all levels of government, with tribes, and in the private sector (Figure 5). Because many entities that operate levees also have other duties related to state or local laws or authorities, there is no such thing as a typical or standard levee operator. A short list of duties that owner/operators such as states, tribes, regional districts, and local governments may have also include floodplain regulation, land use management, communications and outreach, emergency planning, alerts, warnings and evacuations, and floodproofing critical infrastructure and



National Levee Database

Figure 5 Percent Distribution of Levee Ownership

STATE	TOTAL # OF LEVEES IN THE STATE	TOTAL # OF LEVEES OPERATED BY REGIONAL DISTRICTS	STATE	TOTAL # OF LEVEES IN THE STATE	TOTAL # OF LEVEES OPERATED BY REGIONAL DISTRICTS
CALIFORNIA	1,707	99	NORTH DAKOTA	198	6
MISSOURI	287	95	MISSISSIPPI	108	4
ILLINOIS	557	91	SOUTH DAKOTA	99	4
FLORIDA	89	75	MINNESOTA	133	3
ARKANSAS	99	46	OHIO	147	3
TEXAS	231	42	TENNESSEE	17	3
WASHINGTON	334	27	COLORADO	60	2
OREGON	213	21	KENTUCKY	34	2
LOUISIANA	273	20	OKLAHOMA	72	2
KANSAS	345	17	PENNSYLVANIA	200	2
IOWA	177	16	UTAH	45	2
INDIANA	112	15	MICHIGAN	54	1
IDAHO	139	14	NEW MEXICO	127	1
NEBRASKA	126	13	NORTH CAROLINA	22	1
ARIZONA	141	9	WYOMING	31	1
MONTANA	75	6			

Table 4 States Where Regional Districts Operate and Maintain a Portion of the Levee Systems

community lifelines. For the purposes of this paper, those other roles and responsibilities will be discussed separately from the basic set of responsibilities listed here that are common to nearly all levee owner/operators, which include:

- Maintain and repair
- Inspect and assess
- Operate during flood
- Develop a levee emergency action plan and share with local emergency responders
- Plan for rehabilitation and capital improvements

The Role of States

A short survey the Association of State Dam Safety Officials (ASDSO) sent to states in 2006 indicated that 23 states had some involvement with levees. As with dams, state levee program activities are housed within many different types of state organizations, including water resources or environmental organizations, public safety-related programs, or state agencies with broader floodplain management responsibilities. Based on more recent informal conversations, state approaches to levees can generally be grouped into the following high-level categories:

- States that have added "levee" to state dam safety authorities, either through legislation or more informally treating the two types of infrastructure largely the same regarding activities and oversight.
- States that are gathering information to better understand the levee situation in their state. This includes information not only on the levee itself, but financial health of levee districts, assessment technologies, and so on.
- States that have incorporated the needs of levee owners and communities into broader state programs and/or have levee-specific authorities and approaches. This could include technical assistance, emergency planning and response, qualification for state funding programs, incorporating levees into state hazard mitigation plans,[2] and so forth.

In 33 U.S.C. Chapter 46, a term "regional district" is introduced as a subdivision of a state government, or a subdivision of multiple state governments, which is authorized to acquire, construct, operate, and maintain projects for the purpose of flood damage reduction.

The Role of Regional Districts

To make matters more complicated, many states have created regional districts to assist in the management and oversight of levees within their states. Rough estimates[3] indicate there are 643 levee systems across 31 states that are operated and maintained at least partially by regional districts (Table 4). Some states use regional districts more than others, with five states containing more than 60% of the regional districts. About half of the regional districts serve as local sponsors for levees under the jurisdiction of the USACE. The remaining regional districts operate and maintain levees constructed by state and local governments, private entities, and so on.

A review of publicly available documents (e.g., legislation, executive orders, and agency websites) related to the formation and authorities of identified regional districts located in five states[4] revealed that regional districts participate in a variety of authorities and activities. This research indicated that most regional districts can be grouped into two main categories (although care should be taken in extrapolating this information to all states or regional districts).

- The large majority (over 95%) have authorities that focus on upkeep, maintenance, operations, and flood fighting. These entities have authority to collect taxes from those being protected by the levee for those purposes. Some regional districts blend responsibilities for levee upkeep with agricultural drainage purposes. These regional districts are often called levee districts, drainage districts, and/or diking districts.
- A few (less than 5%) have broader responsibilities that include levee operations and maintenance, and have additional responsibilities for floodplain management, natural resources protection, recreation, and other purposes. These regional districts often have names of water management districts, flood protection boards, water agency/authority, flood control and conservation districts, and so on.

The geography and responsibilities of regional districts within a state can also vary (Figure 6). Of the 31 states that have created regional districts with at least some levee management responsibilities, some have districts that cover the entire geography of the state, whereas some states have districts in parts of the state. There are 16 levee systems that cross state lines that include at least one regional district. Not all regional districts within a state have the same authorities and responsibilities.

To get a more current and comprehensive picture of state levee-related activities, ASDSO and the Association of State Floodplain Managers (ASFPM) recently sent a survey to states to better understand the status of authorities, programs, and activities underway at the state level. This survey will provide an updated and more detailed baseline understanding of levee management at the state and regional district levels including:

- Legislation, statutes, and authorities;
- Activities or programs that support levee owner/operators and communities;
- Role and authorities of regional districts within and between states;
- State budgets and funding available to levee owner/operators and communities; and
- Identification of state needs for levee management.

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[2] Hazard mitigation plans exist at the state, tribal, and local community level and identify natural disaster risks and vulnerabilities that are common in their area. After identifying these risks, they develop long-term strategies for protecting people and property from identified events. They are required to apply for certain types of nondisaster assistance from FEMA (42 U.S.C. 5121).

[3] Estimates of probable regional districts were created by searching the National Levee Database on owner/operator names including levee/drainage/diking districts, water management, flood control, and other combinations. These regional districts have not been independently verified except for the 5 states where additional research was conducted. The total number of unique regional districts may be higher as some portion of the segments that have no named sponsors are likely to be regional districts. On the other hand, there may be some duplicates with variations in owner/operator spelling and truncation of names in the National Levee Database.

[4] The five states included in this analysis are Washington, Iowa, Louisiana, Missouri, and Florida, chosen for their geographic distribution and diversity in type and scope of their regional districts.

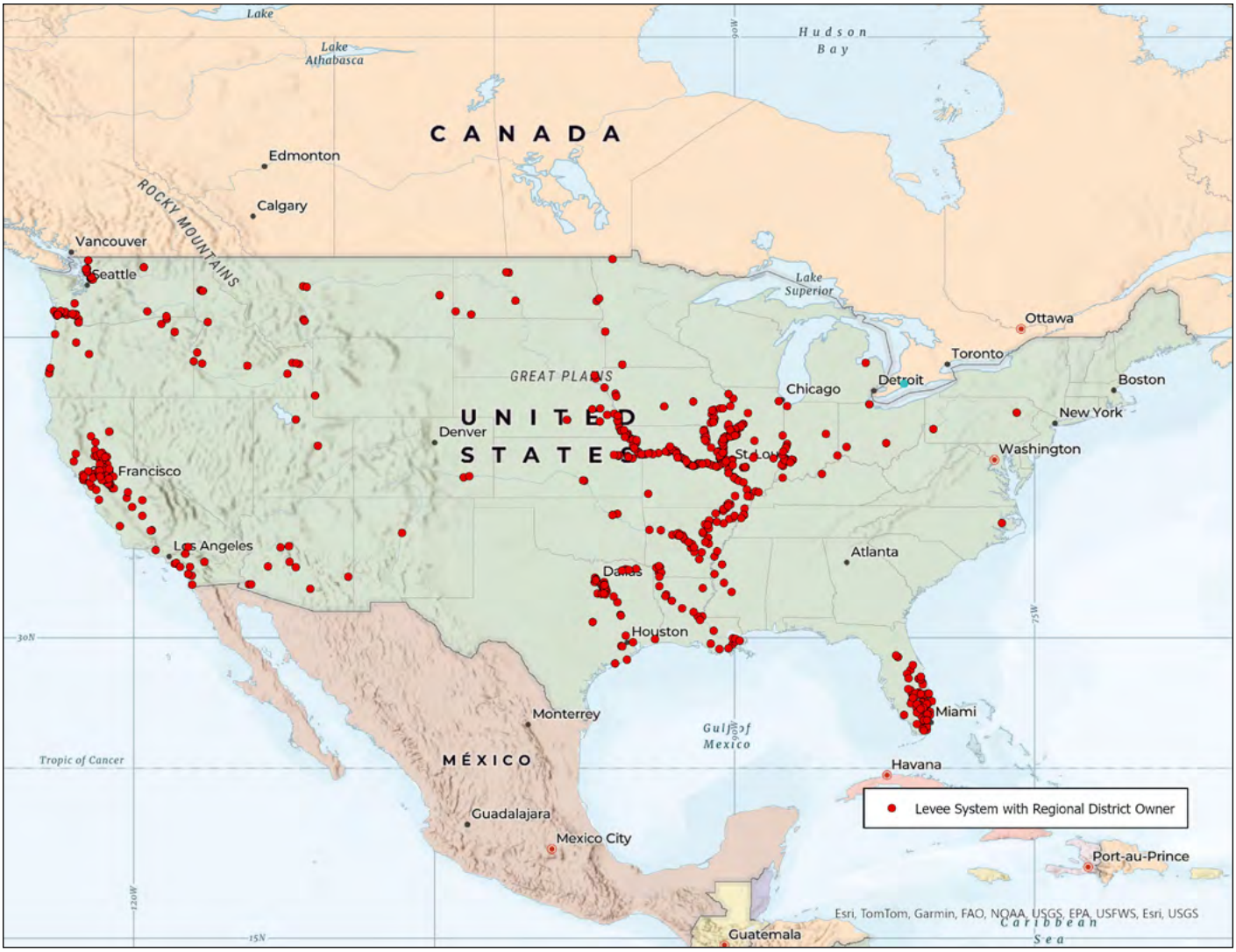

Figure 6 Geographic Distribution of Regional Districts

What's Next for Levees

The purposes of the National Levee Safety Program as envisioned by Congress include encouraging the use of appropriate technical and emergency preparedness practices for levees; supporting public education and awareness related to levees and flood risk; and establishing effective levee safety programs to be the means for accomplishing these purposes.

Suite of Best Practices. The National Levee Safety Program has spent the last several years developing a suite of best practices based on the priorities of stakeholders to improve levee literacy and help achieve nationwide consistency in improving the reliability of levees and resilience of communities behind levees. Once finalized, the first edition of the National Levee Safety Guidelines will provide an up-to-date comprehensive set of best practices that serves the following purposes:

- Levee owner/operators will have a readily available resource to use as a reference for specific levee activities.
- Communities and local officials may better understand the benefits and risks of levees and can integrate reliable levees with overall flood risk management, emergency planning, and public awareness.
- States, regional districts and tribes may incorporate best practices into a variety of state efforts including hazard mitigation, flood risk management, resiliency, and natural/water resources management strategies.

List of Best Practices and Other Resources Being Developed by National Levee Safety Program

- *National Levee Safety Guidelines*
- *Levee Management Guide*
- *Emergency Action Plan Template*
- *Operations and Maintenance Template*
- *Levee Inspection Checklist*
- *Best Practices for Managing Vegetation on Levees*

A Discussion of Roles and Responsibilities to Support Effective Levee Safety Programs. In addition to developing best practices, the National Levee Safety Program is working to move the nation towards an integrated, coordinated set of levee safety programs/practices at the federal, state, regional, and tribal levels to:

- Support levee owner/operators in inspection, assessment, repair, and rehabilitation of levees.
- Work with communities, emergency managers, businesses, and individuals to understand relevant levee-specific information and use that information to raise awareness of and manage flood risks.
- Work collaboratively across programmatic and political jurisdictions to ensure that all communities with levees have access to any needed support.
- Ensure that services are applied in a fair and equitable way across the landscape with special attention to underserved communities, tribes, and individuals particularly vulnerable to flooding.

As in dam safety and floodplain management, states are thought to have a critical role in helping national programs be more efficient by assisting in coordinating among all levels of government and integrating levees in meaningful ways across state strategic investments and related programs such as flood risk management, community resiliency, climate change, natural resources management, and transportation. To begin the national, in-depth discussion to develop an integrated, efficient, and clear framework, the following conceptual roles and responsibilities of government levels could be considered as a starting point (Table 5).

SOME EXAMPLES OF LEVEE ACTIVITIES AND APPROACHES AT THE STATE LEVEL

- Arizona manages hazard mitigation assistance grants for specific levee projects through its Department of Emergency and Military Affairs.
- In early 2024, the state of Arkansas entered into a partnership agreement with USACE to conduct a detailed identification and inventory of levees within the state.
- The California Department of Water Resources integrates levees within a more comprehensive flood risk management program that includes planning, prioritization, and support of projects; emergency planning and response; research and standards development; and operations and maintenance activities. California has grant programs for levee improvements, operations, and maintenance. One such program is the Small Communities Flood Risk Reduction Program, which covers 75–100% of the cost share for projects in communities with populations under 10,000.
- Kentucky, among other states, has included levees and dams as eligible projects under their Clean Water State Revolving Loan Fund.
- In 2023, Iowa adopted new legislation that stood up an Office of Levee Safety and created a $25 million Levee Improvement Fund. They are currently creating a prioritization system to identify the most at-risk levees.
- The Association of Levee Boards of Louisiana educates members about state and federal assistance programs, and helps low-income levee districts apply for grant funding, conduct inspections, and write reports.
- In response to the damaging storms in the mid-2000s, the state of New Hampshire modified its definition and interpretation of a “dam” so that levees around the state (i.e., those that meet a certain height threshold) would have the same regulation requirements as dams. Some of these requirements include frequency of inspections, permits for modifications, condition assessments, and emergency action plans.

FEDERAL AGENCIES	STATES	REGIONAL DISTRICTS	LOCAL GOVERNMENTS
• Develop and track progress against national goals • Develop best practices • Maintain national datasets • Conduct training • Provide funding assistance • Coordinate activities on federal levees	• Coordinate at watershed and interstate levels • Integrate levees into state investment and strategic plans • Regulate floodplains • Coordinate federal assistance • State-level emergency management • Support public awareness • Include levees in state hazard mitigation plans • Assist with levee information/fill gaps	• Implement state-delegated authorities in their area of responsibility • Coordinate regionally • Share information with states	• Manage land use • Enact floodplain ordinances • Conduct warnings and evacuations • Increase community flood awareness • Identify and serve disadvantaged communities • Incorporate levees into community resiliency efforts • Include levees in local hazard mitigation plans

Table 5 High Level Roles in Levee and Flood Risk Management

A Unique Case for Tribes. Discussion and feedback from tribes to date indicate that tribal governments have little interest in developing formal programs like states. Out of 574 federally-recognized tribes, only 5 own/operate levees. Approximately 53 tribes have levees that cross tribal land – these are operated and maintained by a variety of entities including federal agencies and states. Even though they do not play a large role in construction or maintenance, tribes have a keen interest in levees. In addition to universal interests of public safety and reducing flood damages, levees have sometimes been built on or near sacred sites, or in places where traditional foods or medicines grow. Tribes are also actively involved in advocating for the modification, set back, or removal of levees to restore migratory fish and other aquatic species on which they depend and sometimes have treaty rights.[5]

Starting the National Dialogue. The development of the National Levee Safety Program presents the ideal forum to address these challenging topics and questions and start a national dialogue on approaches that integrate levees into flood resiliency goals while remaining scalable to local situations. The following are some of the many questions to be wrestled with as we endeavor to create a framework that raises the level of levee awareness promoting increased stewardship of these important pieces of flood management infrastructure.

- What are the minimum components or best practices that should be encouraged for states, regional districts, and tribes? Where can federal agencies best support?
- Given the complexities of roles and responsibilities across those entities, should a common set of activities be promoted for each level of government, or should activities be more distinct yet coordinated?
- How can we ensure that activities are clear and work in concert with each other while reducing duplication?

[5] These "contracts among nations" recognized and established unique sets of rights, benefits, and conditions for the treaty-making tribes who agreed to cede millions of acres of their homelands to the United States and accept its protection. Like other treaty obligations of the United States, Indian treaties are considered to be "the supreme law of the land," and they are the foundation upon which federal Indian law and the federal Indian trust relationship is based (U.S. Department of Interior, Indian Affairs).

- What is a productive relationship among federal agencies, states, and tribal governments that recognizes tribal sovereignty and treaty rights and supports tribal values, cultures, and interests?
- How do we encourage adoption of consistent, high-level best practices while maintaining the flexibility needed?
- What strategies can we use to ensure equity and access to government programs is incorporated into the National Levee Safety Program?

Conclusion

More work is needed to develop a vision for effective and consistent approaches to levee safety and to articulate the roles levees play in flood risk management and community resiliency. Effective flood risk management requires an integrated effort because responsibility is shared among multiple entities within a complex set of programs and authorities. Levees are no exception.

The National Levee Safety Program provides an opportunity to look hard at the status quo. Multiple sources of flooding can impact the same community and increasing recognition of the importance of naturally functioning floodplains reinforces the fact that levees cannot be the only flood risk management solution most communities consider. Costs to maintain, repair, and improve levees continues to rise, making it challenging to maintain or improve levees. Changing weather patterns mean we can no longer rely on levees in the same way we did in the past; this reality is coming at a time when there are more people and property behind or near levees than ever before. How will states help support an effort to accomplish a unified approach that recognizes their varying legal mechanisms, governance, funding, capabilities, and political realities? Even though the nation has been grappling with flooding for a long time, in some respects the conversations about levees are just beginning.

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ASDSO Peer Reviewers

This article was peer reviewed by Ian Maki, P.E. (California Division of Safety of Dams).