Levees, Risk, Flood Insurance and Community Resilience

Martin McCann
Jack R. Benjamin & Associates, Inc.
Menlo Park, CA

ASDSO / USSD Levees Workshop

Oakland, CA

November 2, 2015
Overarching Theme

Risk-based and risk-informed analysis of levees and flood risks.
Risk-Based Flood Risk

Flood Risks ➔ Flood Premiums
(Real Flood Losses Experienced by Individuals and Communities ➔ Real $$$ Being Charged)
Risk-Informed Flood Risk

Flood Risks ➔ Informs Emergency Planning, Flood Plain Management, Land-Use Planning, Communication, etc.
Focus

• Findings from recent National Research Council / National Academy of Sciences study reports.

• In recent years a number of studies have been done at the request of sponsors to address specific issues or topical areas.
Advising FEMA, NFIP, and USACE

• The National Research Council / National Academy of Engineering is asked from time-to-time to advise FEMA, the NFIP, and USACE, and on matters related to levees, levee safety, and the NFIP.

• The earliest of these studies go back to at least 1982.

• Interesting to note that all but one of the studies that will be identified here have been performed since 2000 (really not to surprising).

• Talk about the insights/recommendations of these studies as they relate to levees, insurance and community resilience.
Advising FEMA, NFIP & USACE

Reports are available for download at: www.nap.edu
Other Related NAS Reports

Reports are available for download at: www.nap.edu
Other Studies Related to Levees and the NFIP

• Congressional Budget Office (CBO) – 155 (NFIP) / 41 (levees)

• Government Accounting Office (GAO) – 584 (NFIP) / 146 (levees)

• Congressional Research Service (CRS) – 570 (NFIP) / 213 (levees)
Attention to Levees, Flood Risk and the NFIP (cont.)

Linda-Oliverhurst, CA 1986

New Orleans, 2005
Attention to Levees, Flood Risk and the NFIP
Will Refer to Three of the Reports Referenced
NAS Study Overview

• Sponsor typically has an issue or concern with regard to an aspect of their program (technical (old or evolving), Congressional, etc.)

• Sponsor and NAS reach agreement on a Work Scope, Schedule and Budget

• Scope tends to be fairly focused (though not always) on specific areas or issues

• Ad Hoc committee is formed (Candidates are identified, nominated and accepted by the NAS). Members serve as volunteers.

• Work of the committees is confidential; open sessions are held during a committees work.
Statement of Task

BOX 1.4
Statement of Task

An ad hoc committee will examine current FEMA treatment of levee insurance programs and provide advice on these levee-related policies. The study will address the following topics regarding how levees are analyzed, (2) flood insurance, (3) risk reduction, and (4) risk communication. The committee will address the following key issues and topics:

(1) RISK ANALYSIS

- Current risk analysis and mapping procedures and guidelines for risk premium rate zones for flood insurance purposes.
- Existing Special Flood Hazard Areas (SFHA) and their corresponding risk premium rates for areas behind accredited and non-accredited levees.
- Existing requirements for levee accreditation under 44 CFR §65.10.

(2) FLOOD INSURANCE

- Flood insurance pricing options for areas behind levees.
- Direct annualized flood loss estimates for residential and commercial structures behind levees.
- Waiving mandatory flood insurance purchase requirements for areas behind accredited levees.

(3) RISK REDUCTION

- Floodplain management, building standards, and land use practices employed behind levees across the nation.
- Engineered overtopping and breaches as a risk reduction or mitigation measure for levee systems.
- Existing and proposed levee-related grants and personal assistance policies. How can communities maximize benefits and reduce risks by using these?
- Mitigation options for communities with levees to help offset risks as investments grow in them and in areas behind levees.
“Under NFIP regulations, homes and commercial buildings located in the SFHA within a participating community may be exempted from the mandatory purchase requirement and land-use regulations when located behind a levee system that has been recognized by FEMA as providing protection against the one percent annual chance flood event, that is, “accredited.” Certification is the technical evidence provided by a levee owner to FEMA demonstrating that the levee system meets the requirements to reduce risk from at least the one percent annual chance flood. Recognizing the need for improving the NFIP’s treatment of levees, FEMA officials approached the National Research Council’s (NRC) Water Science and Technology Board and requested this study.”
Levees and the National Flood Insurance Program
Improving Policies and Practices

- Accredited Levee
- 100 year flood elevation
- Floodplain
- Mandatory Insurance Not Required
  (Not so high, but considered “Dry”)
Levees and the National Flood Insurance Program
Improving Policies and Practices

Non-Accredited Levee
(99 year level of protection)

Insurance is Required / Levee Does Not Exist

100 year flood elevation

Levee is assumed to provide no protection
Levees and the National Flood Insurance Program

Findings

The current NFIP flood hazard analysis is a partial risk-based analysis used with respect to performance of levee systems, where many parts of the analysis are deterministic in fashion. A levee system that is not accredited is not considered in the analysis used to quantify flood risk, even though it provides some (potentially considerable) protection against floods. This encourages communities to construct levee systems that protect only to the one percent annual exceedance flood, enabling new development in areas with significant, but unquantified exposure to catastrophic flood risk. Thus, protection against the one percent annual chance flood event is the de facto design standard for most levees seeking accreditation in the United States, with limited attention given to the consequences (“residual risk”) should a levee fail or be overtopped. Furthermore, levee systems that only marginally meet certification standards are vulnerable to loss of accreditation status. If not properly maintained, the performance of levee systems degrades over time due to erosion, rodent damage, subsidence, and other factors. Further, the frequency and magnitude of flood hazards can increase over time due to natural and anthropogenic causes. Loss of accreditation status can be very disruptive to the affected communities in terms of safety and insurance cost.
Levees and the National Flood Insurance Program
Findings (cont.)

Approach to Flood Risk Analysis

*The NFIP should move to a modern risk analysis* that makes use of modern methods and computational mapping capacity to produce state-of-the-art risk estimates for all areas that are vulnerable to flooding.
Levees and the National Flood Insurance Program
Findings (cont.)

Acturial Soundness of the NFIP

The NFIP is constructed using an actuarially sound formulaic approach for the full-risk classes of policies, but is financially unsound in the aggregate because of constraints (i.e., legislative mandates) that go beyond actuarial considerations.
Levees and the National Flood Insurance Program
Findings (cont.)

Rate Setting

Rate setting for properties behind levees, accredited or not accredited, should be improved by using a modern risk analysis method employing advances in hydrology, meteorology, and geotechnical engineering to more precisely calculate the probability of water inundation levels and the associated damage estimates throughout the area behind the levee in a graduated fashion.
Flood Risk Management

There is a clear need for a comprehensive, tailored approach to flood risk management behind levees that

1) is designed and implemented at the local level;

2) involves federal and state agencies, communities, and households;

3) takes into account possible future conditions; and

4) relies on an effective portfolio of structural measures, nonstructural measures, and insurance to reduce the risk to those behind levees.

To reduce the flood risk to those behind levees, FEMA should encourage communities to develop and implement multi-measure risk management strategies for areas behind accredited levees.
Flood Risk Management

Underlying the flood risk management recommendation is the prior recommendation that a ‘modern’ risk analysis approach be used in order that flood risks (different scenarios and level of risk) are clearly understood.
An ad hoc committee of the National Research Council will analyze and provide conclusions on how dam and levee safety programs may be broadened to include community- and regional-level preparation, response, mitigation, and recovery from potential infrastructure failure.

Holistic systematic approaches to safety analysis. Links between the geotechnical, geologic, hydrologic and hydraulic, and civil-structural engineering aspects of safety and the risks to communities and other stakeholders will be identified. The committee will consider how incorporating mitigation, preparedness, response, and recovery into safety programs can enhance long-term community- and regional-level resilience.

Decision-making and decision-support systems. The committee will summarize how safety information, including stakeholder input, and inspection, monitoring, analysis, and impacts data are used in safety programs for decision making for both infrastructure management and improving community- and regional-level resilience against the primary (e.g., inundation) and secondary impacts (e.g., regional power loss) of infrastructure failure.
The Federal Emergency Management Agency (FEMA) sought advice on how dam and levee safety, in concept and practice, can be expanded to promote the core values of the FEMA mission -- to improve community, regional, and national resilience. The study is intended to aid development of initiatives that help community decision makers reduce risk of, and increase community resilience to, dam or levee failure (see Box S.1 for the statement of task). Two underlying principles are the foundation of discussion in this report.

1. Although the likelihood of uncontrolled water flow from dams and levees can be reduced in most cases, failures will still occur, and
2. Communities can prepare for and mitigate the consequences of failure and can become adaptable in their responses and recoveries.

To enhance community resilience, communities (including dam and levee safety professionals) can institute adaptive processes chosen through collective and collaborative efforts on the basis of mutual appreciation of community priorities, hazards, and consequences.
Conceptual Framework for Resilience-Focused Collaboration Related to Dam and Levee Safety
Collaboration

Enhancing resilience will be most successful when dam and levee safety professionals and other community members and stakeholders identify and manage risk collaboratively in ways that increase understanding and communication of risks, shared needs, and opportunities.

This increases social capital (community connections useful to meet societal objectives) and has benefits for owners and regulators.
Risk-Informed

Risk-informed approaches allow dam and levee professionals to improve their understanding of infrastructure-system operations, performance, vulnerabilities, and the consequences of potential failures, and allow them and the broader community to make better decisions related to dam and levee infrastructure and resilience.
Support Systems

Enhancing resilience requires frequent and collective evaluation of risk, safety, and collaborative processes.

The proposed Maturity Matrix for Assessing Community Engagement can be used . . . at all levels to benchmark and manage the progress of industry and community processes related to safety and engagement.
## Maturity Matrix

<table>
<thead>
<tr>
<th>LEVEL I</th>
<th>LEVEL II</th>
<th>LEVEL III</th>
<th>LEVEL IV</th>
<th>LEVEL V</th>
<th>EXAMPLES OF POSSIBLE OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Activity</td>
<td>Standards-based only</td>
<td>Introduction of additional review criteria (e.g., failure mode analysis)</td>
<td>Application of quantitative risk assessment by using criteria developed by owner or regulator with input from community members and stakeholders</td>
<td>Application of quantitative risk assessment by using criteria that reflect the community’s societal values</td>
<td>Community is fully apprised of current level of risk</td>
</tr>
</tbody>
</table>

**Increasing maturity**
Tying Flood Insurance to Flood Risk for Low-Lying Structures in the Floodplain

Study Charge

An ad hoc committee will conduct a study of pricing negatively elevated structures in the National Flood Insurance Program. Specifically, the committee will:

1. Review current NFIP methods for calculating risk-based premiums for negatively elevated structures, including risk analysis, flood maps, and engineering data.
2. Evaluate alternative approaches for calculating "full risk-based premiums" for negatively elevated structures, considering current actuarial principles and standards.
3. Discuss engineering, hydrologic, and property assessment data and analytical needs associated with fully implementing full risk-based premiums for negatively elevated structures.
4. Discuss feasibility, implementation, and cost of underwriting risk-based premiums for negatively elevated structures, including a comparison of factors used to set risk-based premiums.
Tying Flood Insurance to Flood Risk for Low-Lying Structures in the Floodplain

**Issue**

Today, rates are subsidized for one-fifth of the NFIP’s 5.5 million policies. Structure elevations are not known for most subsidized policies. However, the NFIP believes that most of these structures are negatively elevated, that is, the elevation of the lowest floor (including basement) is lower than the NFIP benchmark for construction standards and floodplain management ordinances—the water surface elevation with a 1 chance in 100 of being exceeded annually (called the 1 percent annual chance exceedance elevation or base flood elevation). Compared to structures built above the base flood elevation, negatively elevated structures are more likely to incur a loss because they are inundated more frequently, and the depths and durations of inundation are greater.
Tying Flood Insurance to Flood Risk for Low-Lying Structures in the Floodplain

Issue
Tying Flood Insurance to Flood Risk for Low-Lying Structures in the Floodplain - Findings

Risk-based Methods
Modern technologies, including analysis tools and improved data collection and management capabilities, enable the development and use of comprehensive risk assessment methods, which could improve NFIP estimates of flood loss.
Loss Models

NFIP claims data for a given depth of flooding are highly variable, suggesting that inundation depth is not the only driver of damage to structures or that the quality of the economic damage and inundation depth reports that support the insurance claims is poor.
Thank You