Flood Risk and Potential for a National Flood Risk Classification System

National Flood Hazard and Risk Workshop
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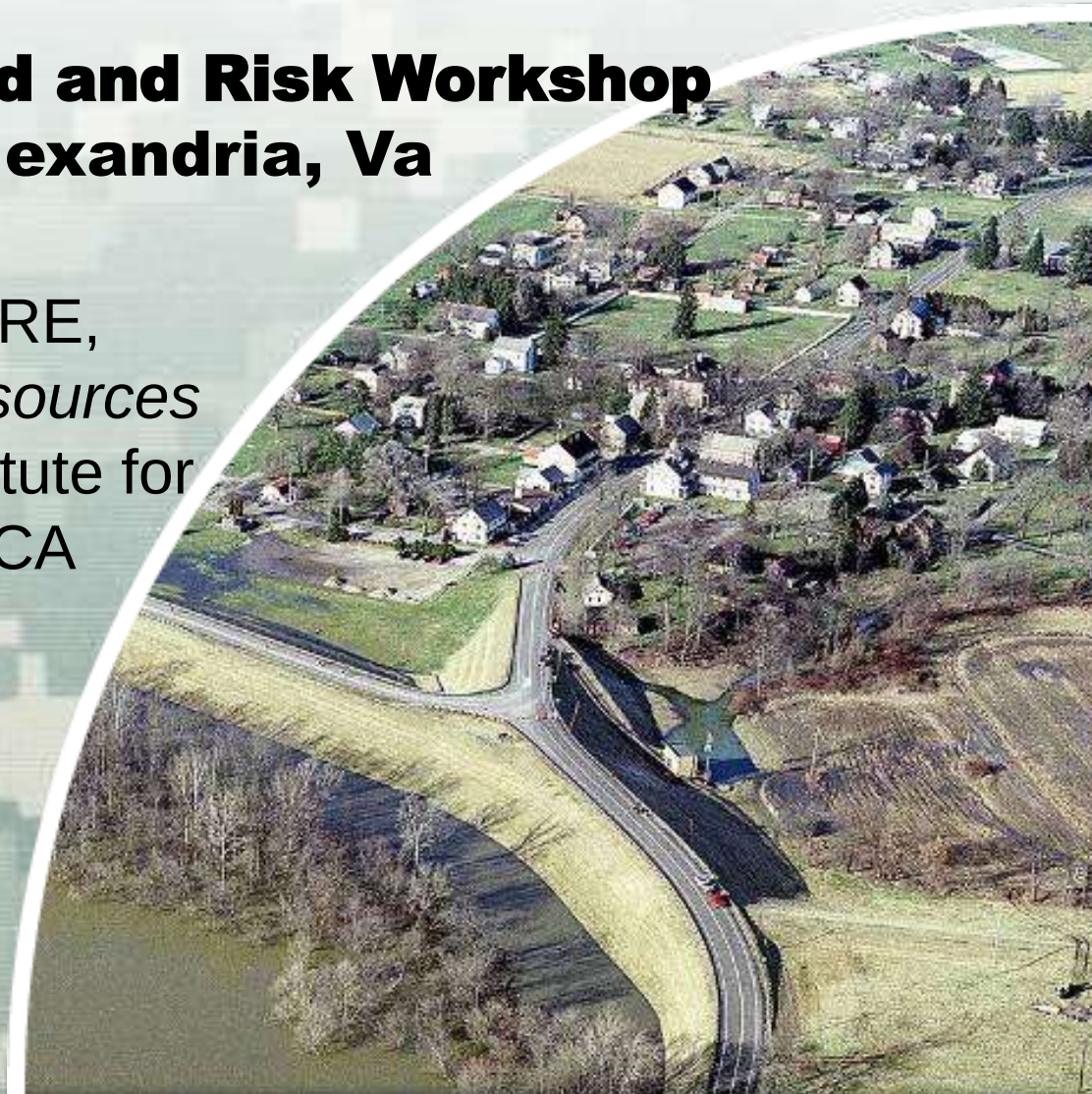

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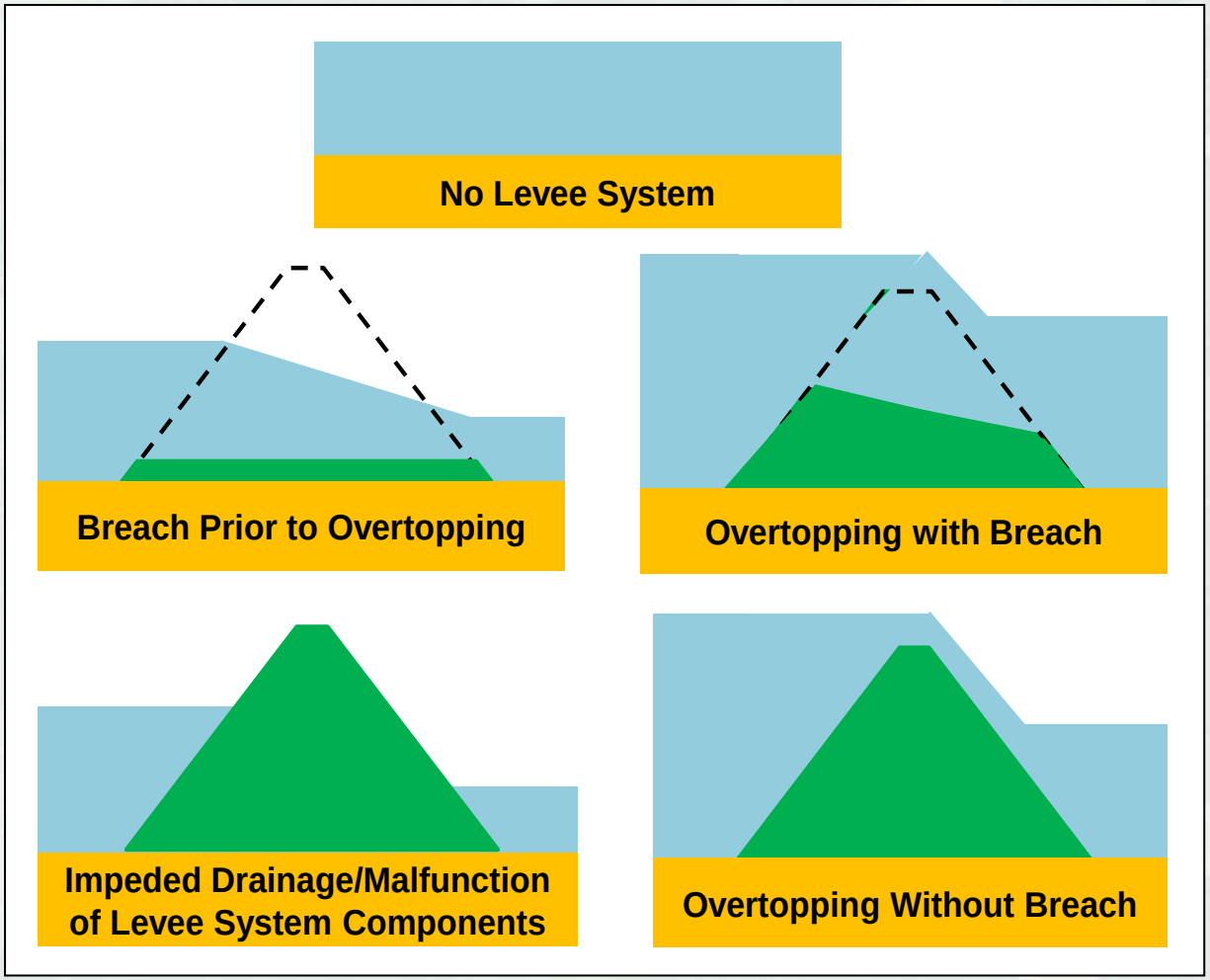
Topics

- Flood Hazard and Flood Risk Defined.
- Inundation Scenarios; Components of Flood Risk.
- Hazard and Risk Classification Systems.
- USACE Safety Program Action Classifications.
- Potential for Extension to National Flood Risk.
- Issues and Caveats
- Possible Way Forward

What is Flood Risk? Hazard?

- Risk - measure of the likelihood and severity of undesirable consequences.
  - Riverine, coastal inundation; urban/rural drainage deficiency.
  - Property damage, life loss, social and environmental losses, other.
  - Flood risk represented by: CDF of loss Vs. Exceedance probability; tabulation of probability Vs. loss; expected (average) values.
- Hazard is something causing un-avoidable danger, peril, risk, or difficulty – *not consequences*.

Inundation Scenarios



Inundation Risk Defined

Flood Plain Flood Risk Defined

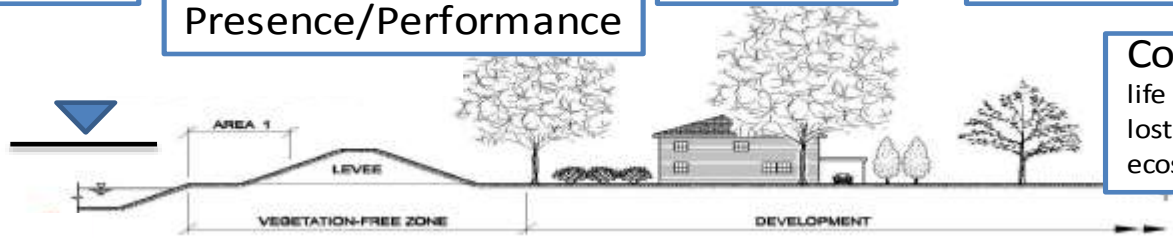
Hazard

Hazard Impedance Presence/Performance

Exposure

Vulnerability

Consequences – life loss, property damage, lost income, other costs, ecosystem degradation.



HAZARD
(What can cause harm?)

PERFORMANCE
(How will the system react?)

EXPOSURE
(Who & What are in harm's way?)

VULNERABILITY
(How susceptible to harm?)

CONSEQUENCE
(How much harm?)

RISK
(Probability and severity of adverse consequences)

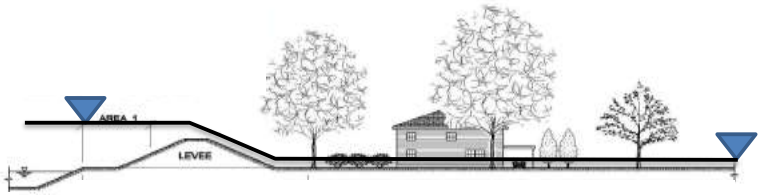
Scenarios and Flood Risk

Natural/No Infrastructure

No Breach (Leveed Area Not Inundated)

Breach Prior To Overtopping

Overtopping With Breach



Overtopping Without Breach

Risk Estimates

- Estimate represents a point in time.
  - Hazard – reflects watershed/shoreline conditions; reservoirs, land use, conveyance.
  - Performance – if present, capacity and integrity of infrastructure like levees/floodwalls.
  - Exposure – people/property/critters in harms way
  - Vulnerability – susceptible to harm; property resilience, move people/property, rescue.

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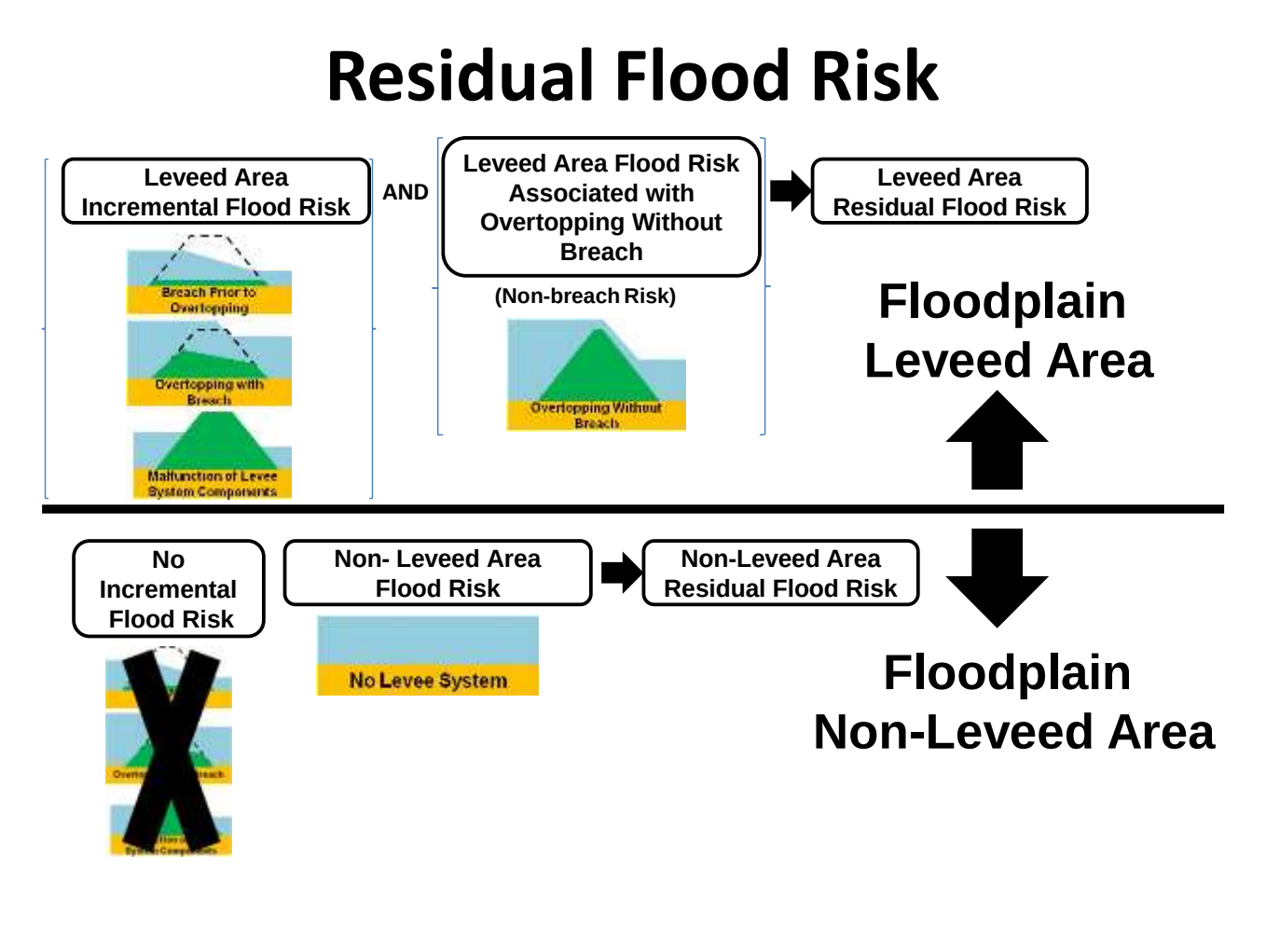
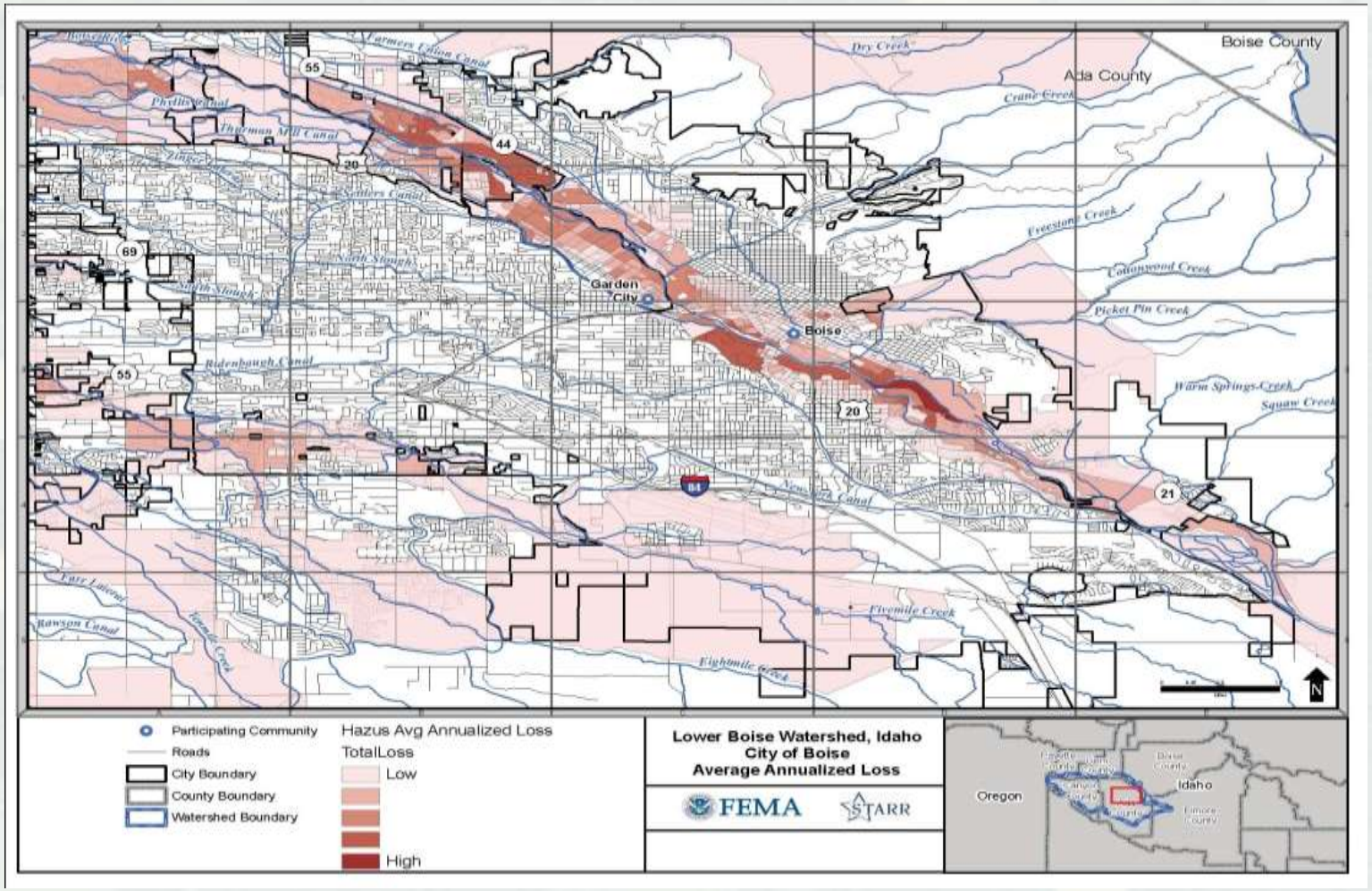
Residual and Incremental Risk

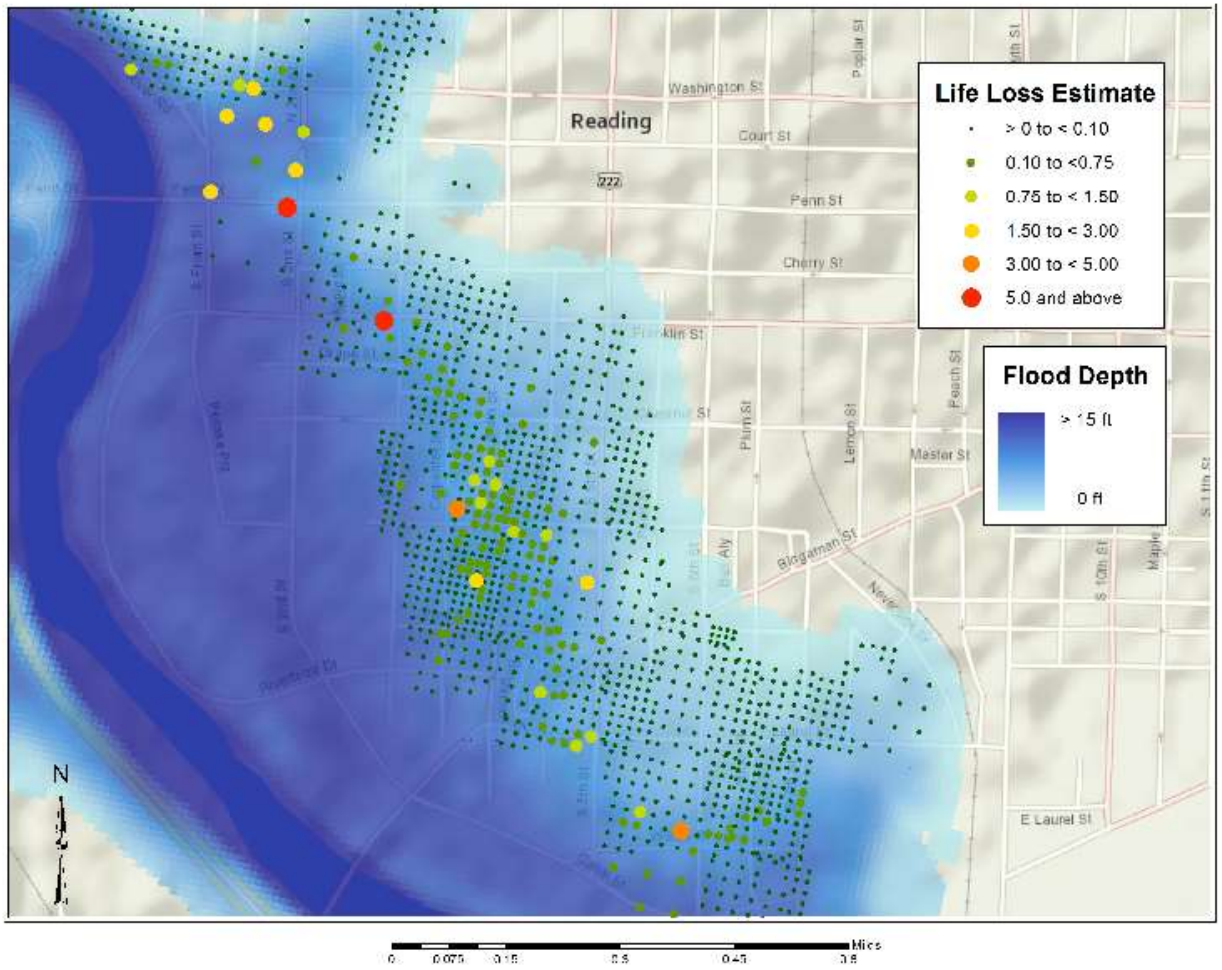


Complexity/Hazard Depiction

Mapping Risk

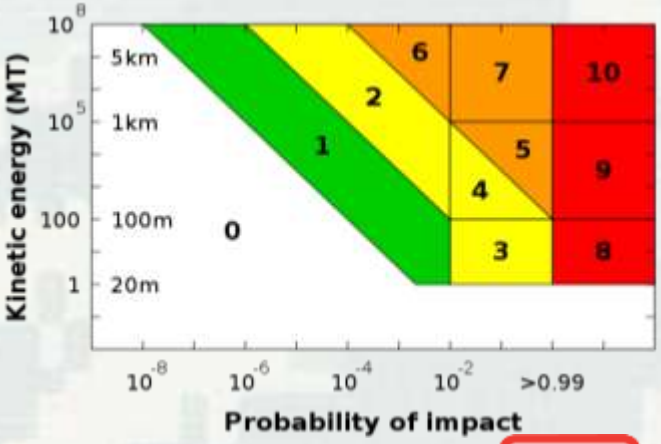


Mapping Risk



Risk Classification – Why, What?

- Extend hazard interpretation to reflect adverse impacts.
- A degree of value interpretation of risk and possible actions.
- Bring key issues to the fore, like life-safety risk.
- Notable Examples: 1) Safffir-Simpson' hurricane scale; 2)Torino Impact Hazard scale; 3) USACE safety programs action classification.



Impetus/purpose of Classifications Levees as Example

- USACE portfolio: 15,000 miles in 2,000 systems
  - Levee systems provide benefits but pose risks.
  - Leveed area can be inundated putting lives and property in danger; make life safety paramount.
  - Desire to characterize and communicate risk and stimulate informed actions by stakeholders.
  - Want to prioritize systems/areas for efficient action.
- Risk metric (LSAC); actions; apply to portfolio; variety of systems; share development; must be done transparently.

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Levee Safety Action Classification

Urgency of Action	Actions	Characteristics
Very High (1)	Actions recommended for each class.	Likelihood of inundation with associated consequences characterizes each class.
High (2)		
Moderate (3)		
Low (4)		
Normal (5)		

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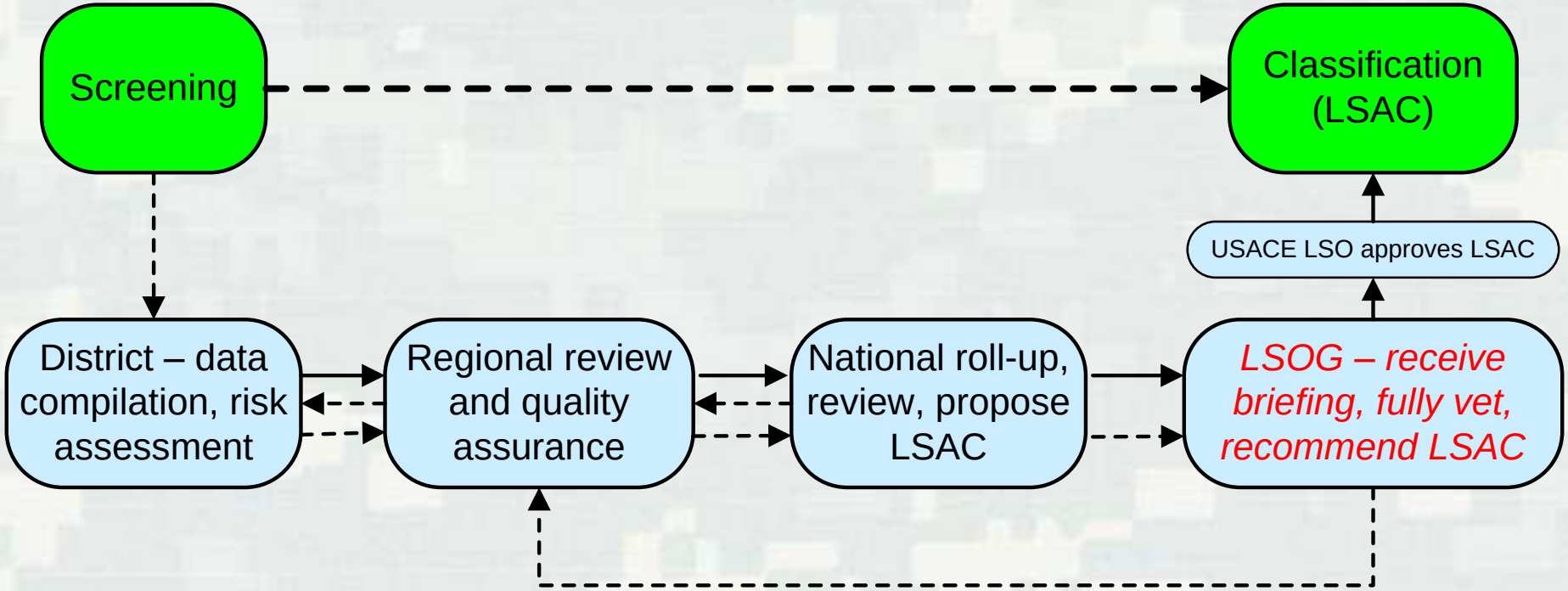
Governance and Vetting



Protocol

Protocol: Levee Safety Action Class (LSAC) Adjustment Guidelines			
URGENCY OF ACTION (LSAC)		**Reasons to adjust Levee Safety Action Class**	
VERY HIGH (1)		**To Class 'High Urgency - 2'** • Studies/Investigations do not support suspected defect or failure mode. • Consequence estimate considered too high (order of magnitude) and not reasonably defensible. • Primary risk driver is overtopping and breach due to overtopping. • Extreme risk is not supported.	
HIGH (2)		**To Class 'Very High Urgency - 1'** • Flood fighting was required during a past event that successfully prevented a breach in progress from continuing to full breach status, thus averting a catastrophe. • Consequences of inundation, including vulnerable critical infrastructure in leveed area, could result in significant local, regional, and national consequences beyond those reflected by the current estimate.	**To Class 'Moderate Urgency - 3'** • Primary risk driver is breach due to overtopping for extremely infrequent events. • History indicates good performance for loadings at or near top of levee. • Egress well planned; population less vulnerable than suggested by current estimate. • Minimal critical infrastructure.

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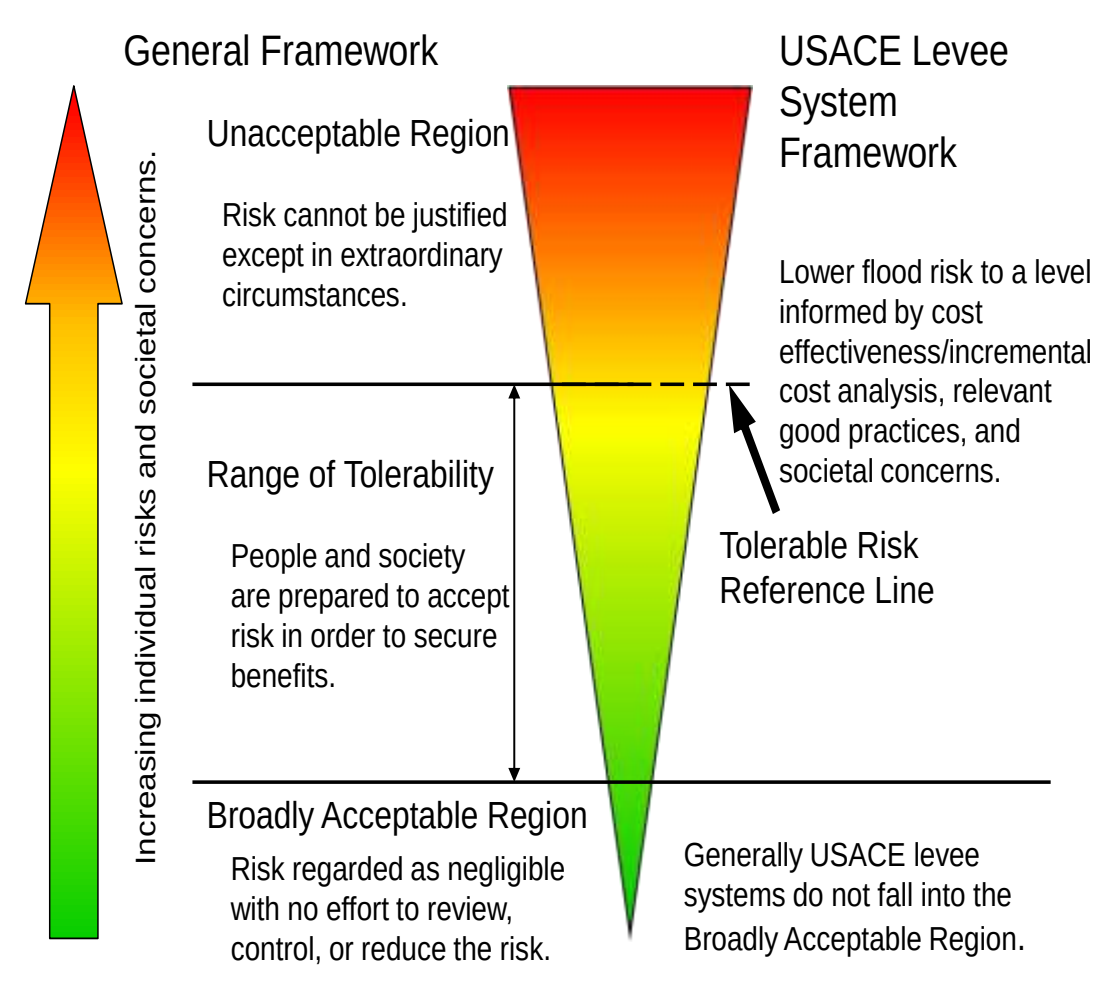
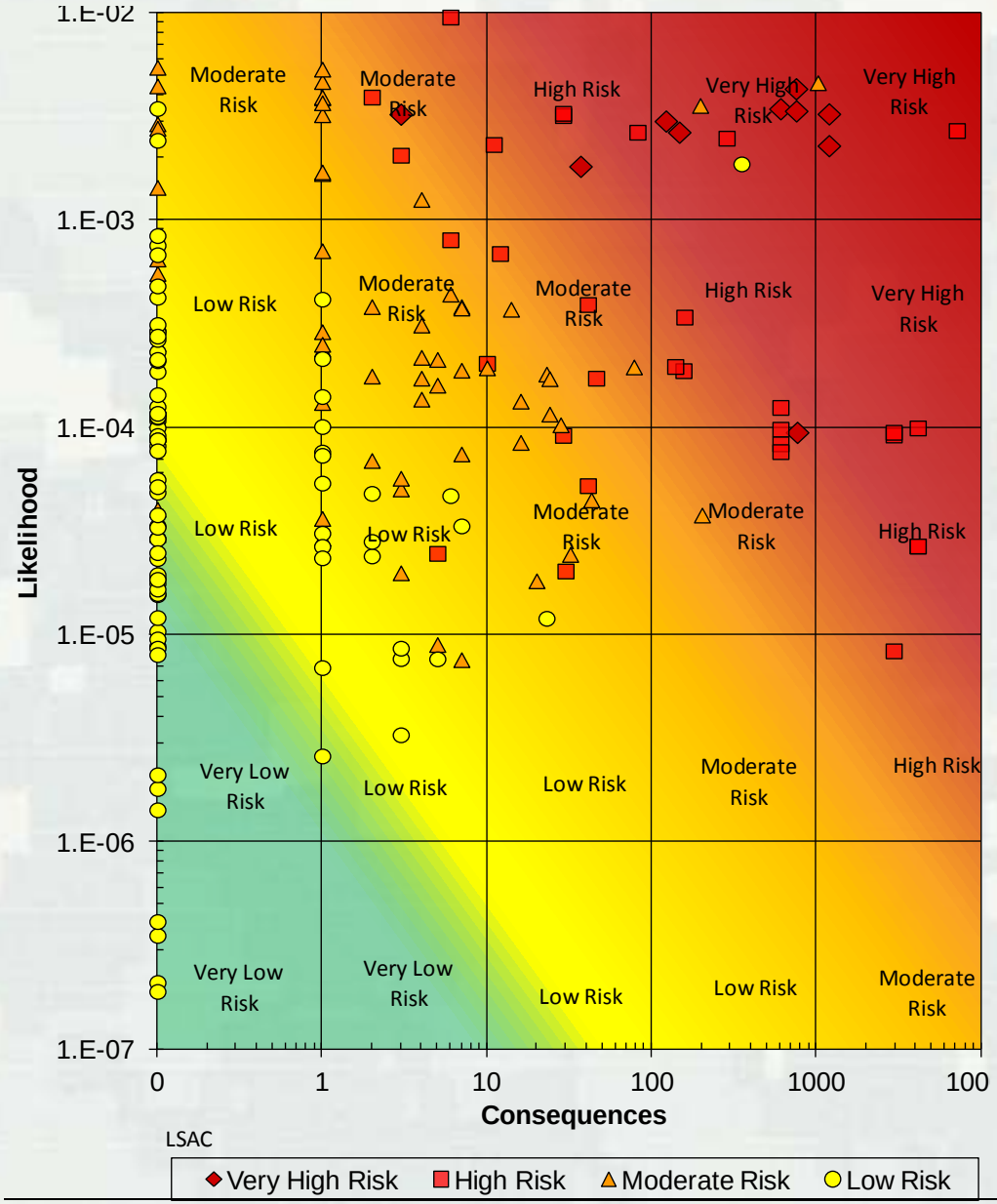
Tolerability of Risk Framework



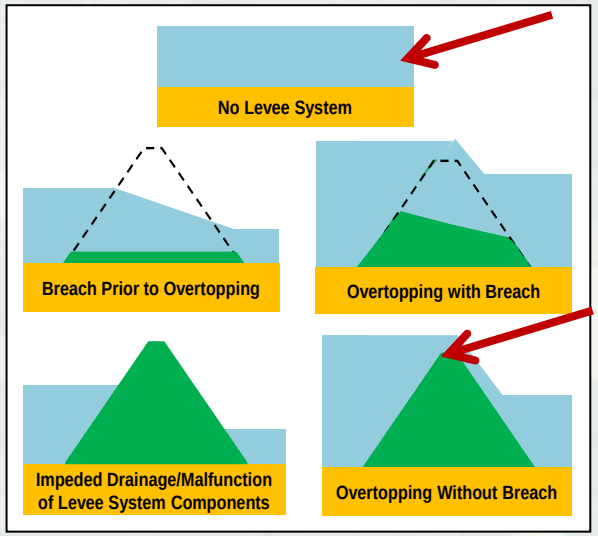
- Risks society willing to live with for benefits.
- Society does not regard as negligible.
- Society confident risks properly managed.
- Risks kept under review and reduced and managed as practicable.

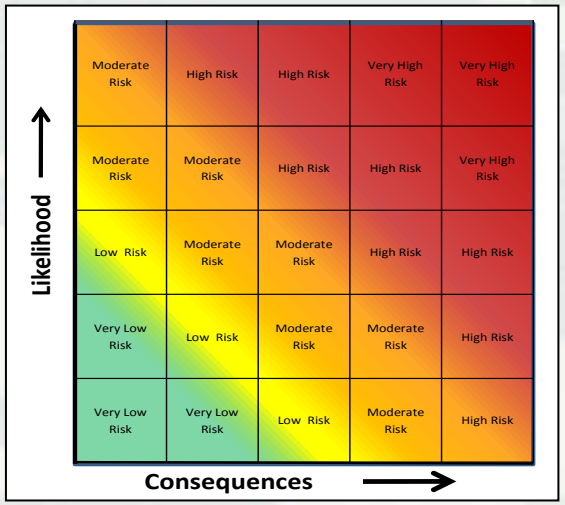


Example Plot of Preliminary Relative Risk From Levee Screening

Extend to National Risk Classification

- Add non-breach and no infrastructure inundation scenarios.
- Accept background life loss TOR criteria and adapt to national purpose.
- Seek to devise property loss TOR criteria to supplement life loss criteria.
- Devise governance and protocol framework for life-safety risk and property loss risk classifications.
- Ponder how to reflect adverse affects of flooding on social and environmental concerns.





Project/floodplain Specific

- Note: Slight nuance from ‘action classification’ with emphasis on urgency, to ‘risk classification’ for characterization.
- Straight forward – apply the levee safety program process to ‘residual risk’.
- Classification table would be very similar albeit with adjustment for no infrastructure.
- Address ‘whether to’ and ‘how to’ aggregate/interpret regionally.

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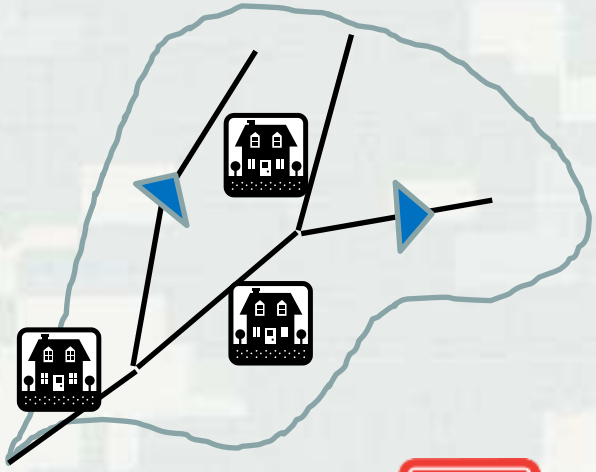
Aggregation, other stuff!

- Complexity in each floodplain – highest risk trumps or . . ?
- Mix of floodplains/ infrastructure & no infrastructure in region; again highest risk or weighting of risk?
- Data availability – USACE programs have gaps in leveed and non-leveed areas.
- None-the-less, could have many/ most of the significant floodplains classified for risk .



GIS layer approach

- Coverages/layers: depth-frequency (w/infrastructure considered if present); population location/density; property/land use location/density; other?
- Risk assessment by grid –life loss and property damage : HAZUS, NFRCT, CWMS/HEC software (HEC-FIA), Levee Screening Tool, etc.
- Classify by grid and aggregate or aggregate grids and classify by floodplain/region?
- Issues of complexity and floodplain/infrastructure mix in how to aggregate remains.

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Data Sources

- FEMA HAZUS data sets.
- FEMA products (DFIRM, RiskMAP, other).
- US Census tract files.
- Other national (NOAA coastal, USGS topo, satellite imagery, etc.
- USACE dam and levee safety program data, risk assessments, LSAC's.
- Other USACE – NLD, CWMS, studies.
- Scope and availability are issues)

A Potential way forward

- Near term:
  - Commission exploratory pilots: project/floodplain specific; GIS coverage approach; other?
  - Identify/use common watersheds; jointly work on aggregation schemes. USACE levee screened?
  - Lessons learned/way ahead 18 mo. to 2 yrs.
- Long term:
  - Monitor safety programs' risk assessments, FEMA RiskMAP, NIFP to risk informed, CWMS.
  - Chart path - national flood risk characterization.

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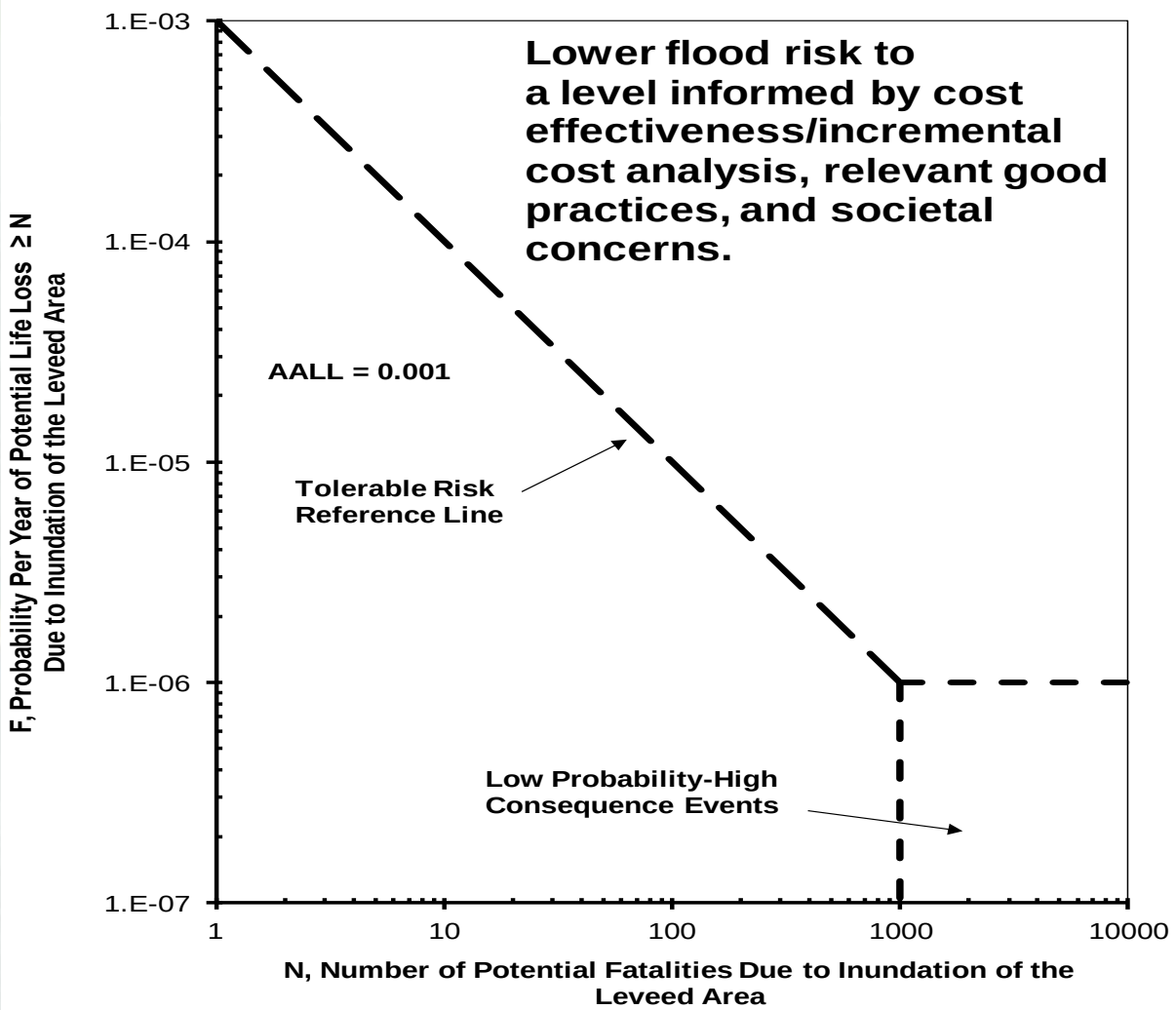
Example TOR Criteria Life Loss