Case Study: Application of Resilience Goals in Transportation Projects

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AECOM

Outline

- The Need for Resilience in Transportation
- The Role of Stormwater
- Rating Systems
- Regulatory Gaps
- Resilience in Transportation
  - Sub-Sector Case Studies
  - Monitoring Programs
- Closing the Regulatory Gaps

The Need for Resilience in Transportation

Factors of Global Change Affect Risk:

- **Sea level rise**
- **Changes in precipitation**
- Changes in temperature

The Need for Resilience in Transportation

"Nuisance" tidal floods surpassing local emergency preparedness thresholds:

- Flood infrastructure
- Trigger NOAA coastal "Advisories"
- Typically reach only 1-2 feet above the threshold
- Have recurrence intervals of <1 year

The 2017 Climate Science Special Report (NCA4 Vol. 1) indicates that cities which experience daily tidal effects will deal with increasingly frequent minor tidal "nuisance" flooding (1-2 ft).

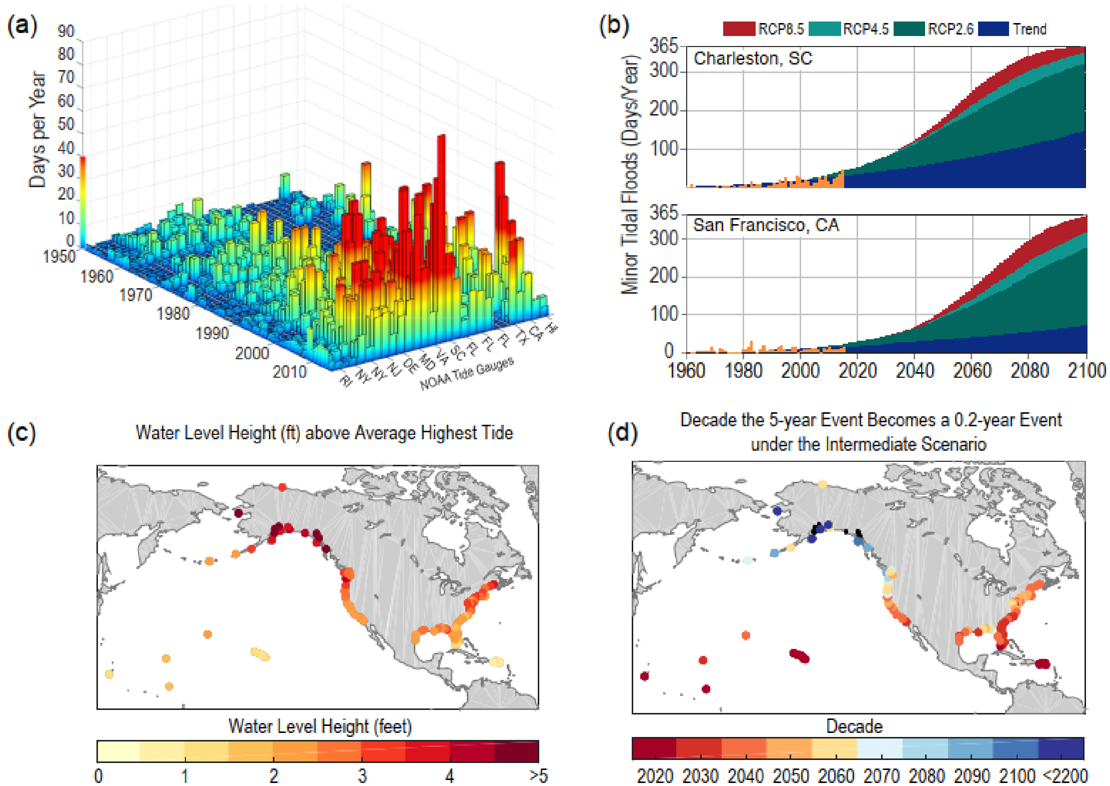
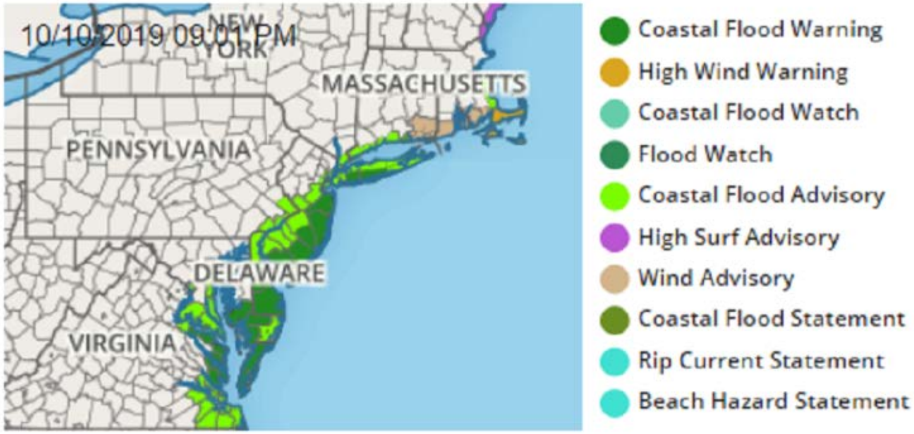


Figure 12.5: (a) Tidal floods (days per year) exceeding NOAA thresholds for minor impacts at 28 NOAA tide gauges through 2015. (b) Historical exceedances (orange), future projections through 2100 based upon the continuation of the historical trend (blue), and future projections under median RCP2.6, 4.5 and 8.5 conditions, for two of the locations—Charleston, SC and San Francisco, CA. (c) Water level heights above average highest tide associated with a local 5-year recurrence probability, and (d) the future decade when the 5-year event becomes a 0.2-year (5 or more times per year) event under the Interagency Intermediate scenario; black dots imply that a 5-year to 0.2-year frequency change does not unfold by 2200 under the Intermediate scenario. (Figure source: (a) adapted from Sweet and Marra 2016,[165] (b) adapted from Sweet and Park 2014,[105] (c) and (d) Sweet et al. 2017[71]).

The Need for Resilience in Transportation

"Nuisance" flooding frequency:

- Has increased 5- to 10- fold since 1960
- Will continue to increase as a result of local relative mean sea level rise (RSL)



Latest weather advisories up for the Mid Atlantic and Northeast. Image: weatherboy.com

"Heavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901 (*high confidence*). There are important regional differences in trends, with the largest increases occurring in the northeastern United States (*high confidence*)."

-2017 Climate Science Special Report (NCA4 Vol. 1)

Extreme Precipitation Has Increased Across Much of the United States

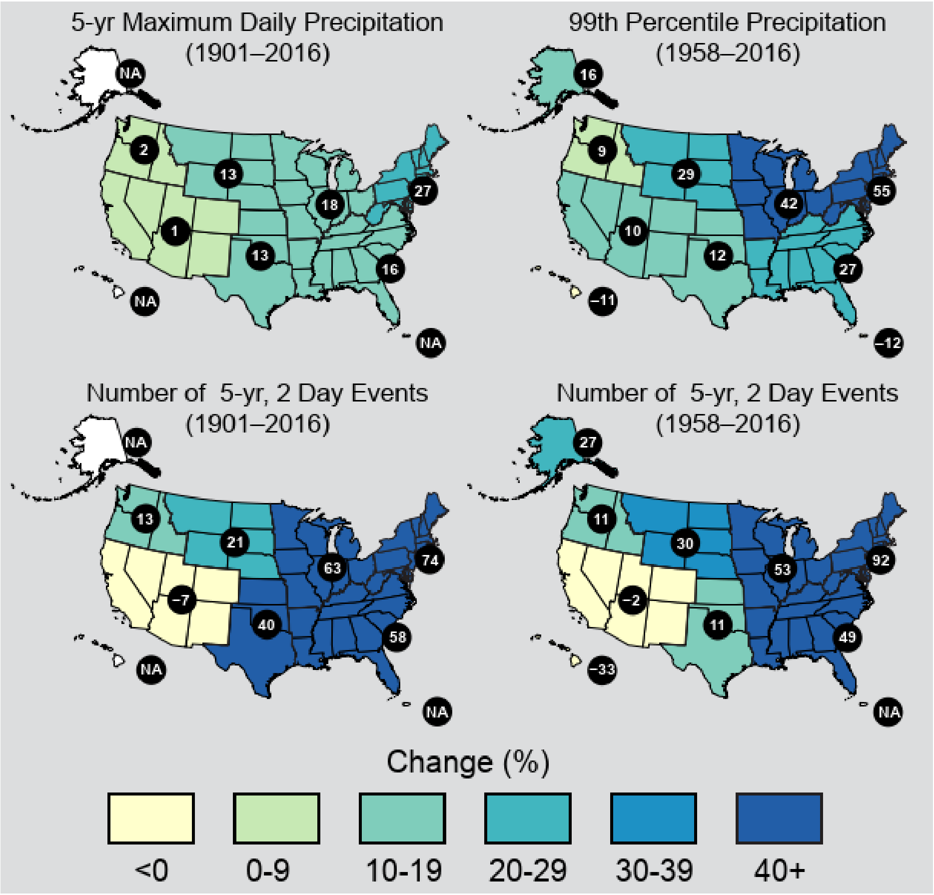


Figure ES.6: These maps show the percentage change in several metrics of extreme precipitation by NCA4 region, including (upper left) the maximum daily precipitation in consecutive 5-year periods; (upper right) the amount of precipitation falling in daily events that exceed the 99th percentile of all non-zero precipitation days (top 1% of all daily precipitation events); (lower left) the number of 2-day events with a precipitation total exceeding the largest 2-day amount that is expected to occur, on average, only once every 5 years, as calculated over 1901–2016; and (lower right) the number of 2-day events with a precipitation total exceeding the largest 2-day amount that is expected to occur, on average, only once every 5 years, as calculated over 1958–2016. The number in each black circle is the percent change over the entire period, either 1901–2016 or 1958–2016. Note that Alaska and Hawai'i are not included in the 1901–2016 maps owing to a lack of observations in the earlier part of the 20th century. *(Figure source: CICS-NC / NOAA NCEI). Based on figure 7.4 in Chapter 7.*

The Need for Resilience in Transportation

- Increase in CSO events
- Accelerated erosion
- Groundwater inundation

- Service disruptions
- Economic losses to the region
- Increased vulnerability in other emergencies

Camden County Police
@CamdenCountyPD

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Flooding causes major traffic problems on I-295, South Jersey highways. PATCO service s...

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The Need for Resilience in Transportation

- Regulatory agencies are working to provide guidelines for resilience
- Planning studies look at historic vulnerabilities, projected risks, and benefit/cost analysis of options for better resilience

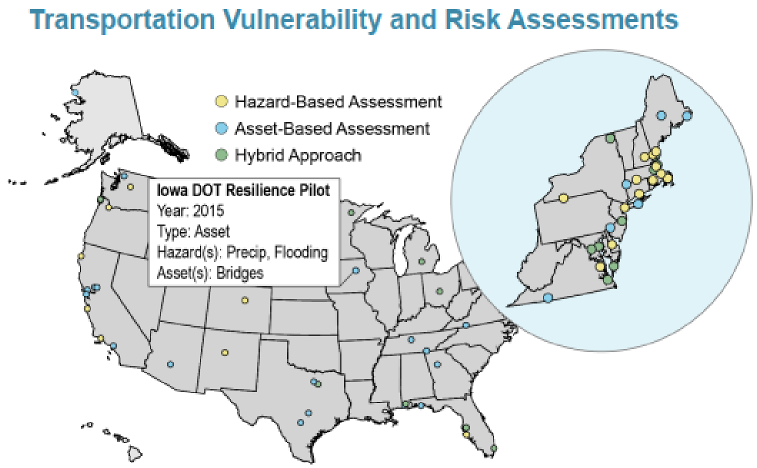


Figure 12.3: This figure shows transportation vulnerability and/or risk assessments from 2012 to 2016 by location. Cumulatively, these vulnerability assessments elucidate national-scale vulnerabilities and progress. Data for the U.S. Caribbean region were not available. See the online version of this map at http://nca2018.globalchange.gov/chapter/12#fig-12-3 to access the complete set of vulnerability and risk assessments. Sources: ICF and U.S. Department of Transportation.

The Role of Stormwater Management

- Agencies may build upon existing regulations
  - FEMA – NFIP
  - **NPDES – MS4 program**
  - **Act 167**

- **Stormwater management is and will be a critical aspect of resilient design in the Northeast region**

The Role of Stormwater Management

Existing stormwater permitting and regulations contain planning and design guidance that could be built upon in the future.

Implementation of adaptation strategies and tools could be accomplished through cyclical updates.

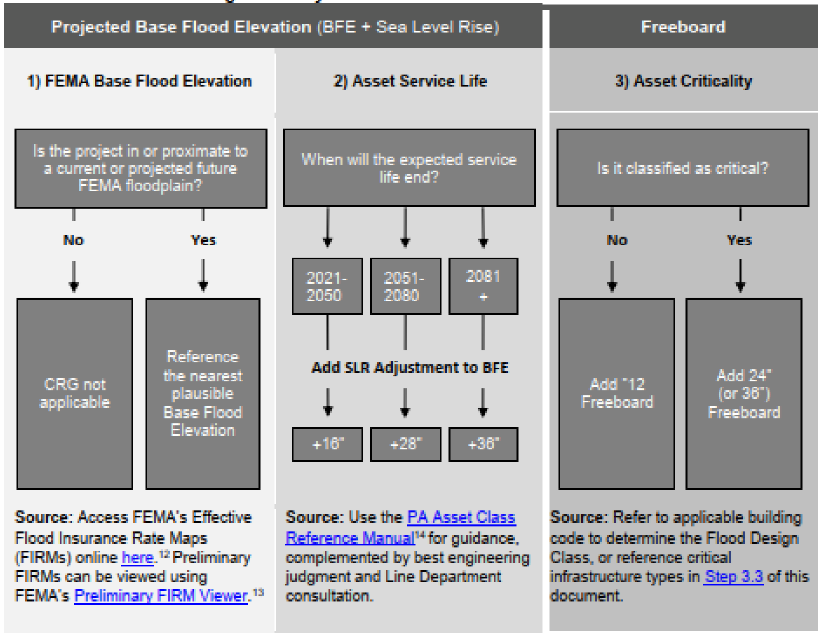
Regionally, stormwater management has opened doors to:

- Municipal / Stakeholder Engagement
- Planning for Maintenance
- Community Partnerships
- Research Partnerships

The Role of Stormwater Management

- Guidelines that specifically address hazard and risk mitigation through design are rare
- Eg: PANYNJ Climate Resilience Design Guidelines

Figure 2: Key Information for DFE Determination



Rating Systems

Rating systems facilitate the coordination of best practices to achieve overall project sustainability and resilience.

How can they help?

- More options for certification than in the past
- <u>**BUT** consider the project and the location</u>
  - Certification will not necessarily help you meet <u>specific</u> needs for project resilience
- Certification can be tricky to implement for projects with design lifetimes of 50-75 years

Rating Systems

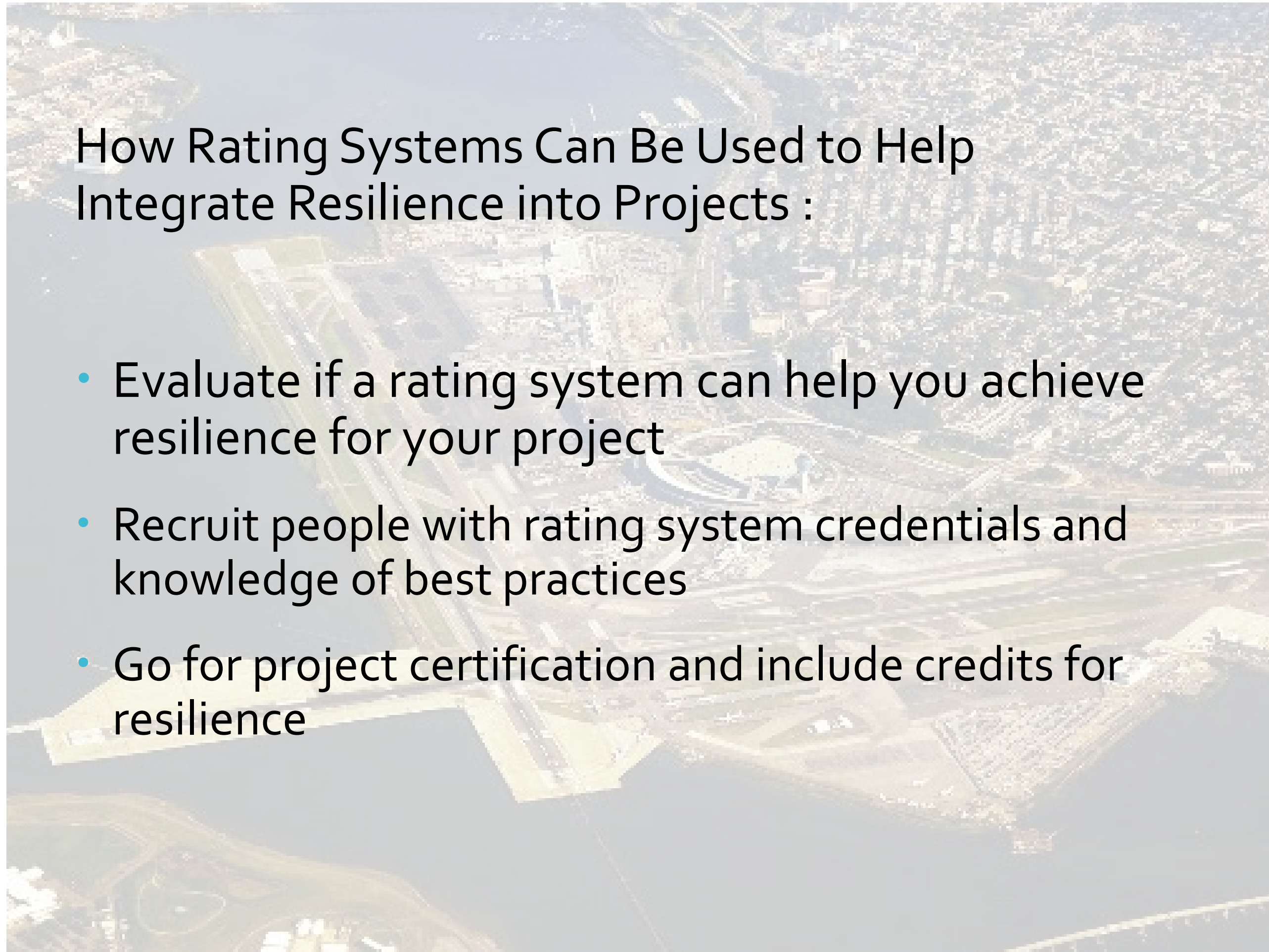
Rating systems facilitate the coordination of best practices to achieve overall project sustainability and resilience.

- LEED
  - Rail stations, airport terminals and hangers, bus terminals, traffic communication centers
- Envision
  - Roads, bridges, railways, navigation routes
  - Specific to Infrastructure
- SITES
  - Streetscapes, multi-use trails
  - Useful where transit must be part of the landscape
- RELi
  - Hazard preparation, adaptation strategies, and long-term risk mitigation for structures

By Patrick Handrigan - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=35029106

Rating Systems

Rating systems facilitate the coordination of best practices to achieve overall project sustainability and resilience.

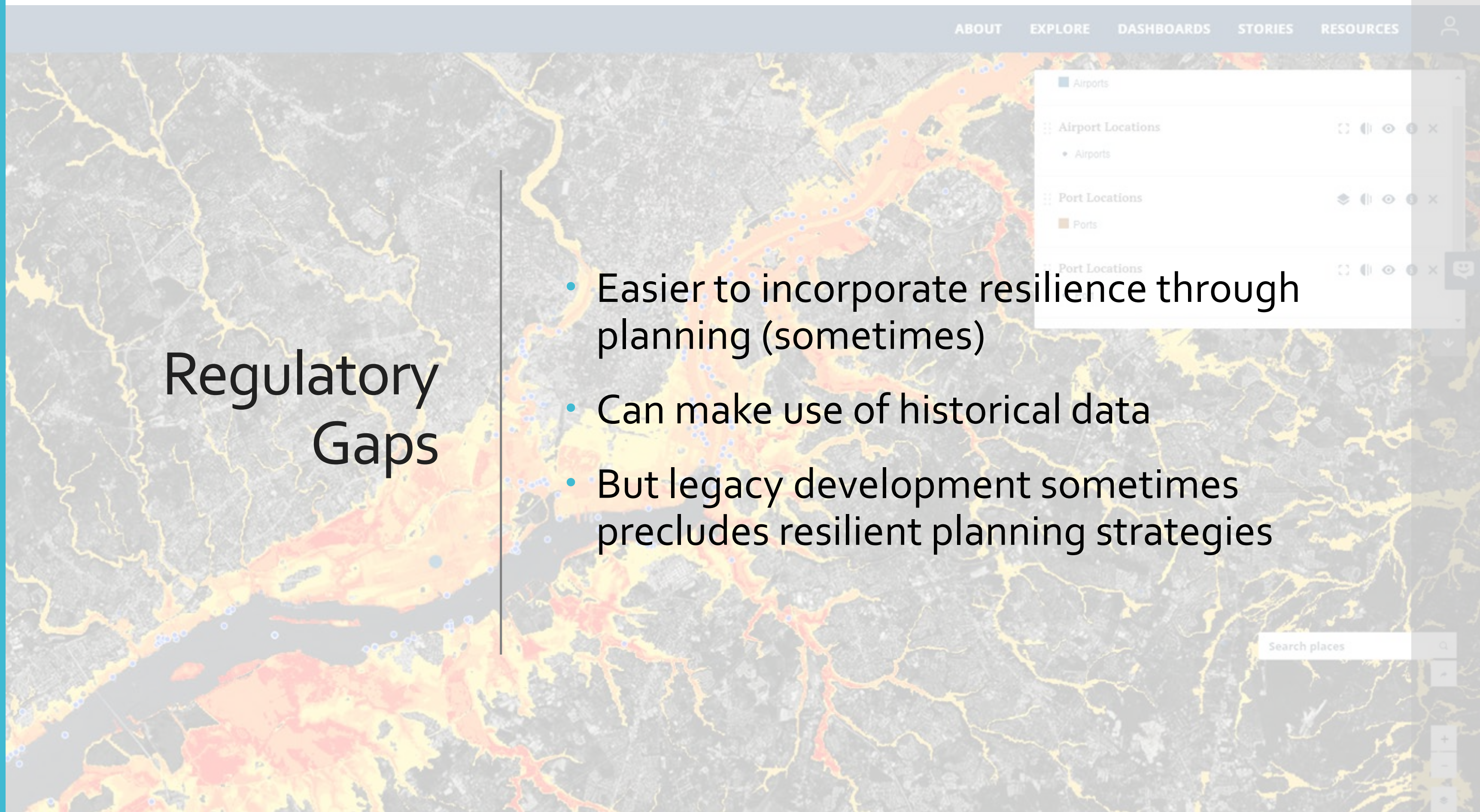


How Rating Systems Can Be Used to Help Integrate Resilience into Projects :

- Evaluate if a rating system can help you achieve resilience for your project
- Recruit people with rating system credentials and knowledge of best practices
- Go for project certification and include credits for resilience

Regulatory Gaps

- Transportation sectors depend on each other, but have differing requirements
- Differences in the way permits are handled between private and public developers
- Maintenance is an emerging topic
  - Budget- and funding-dependent
  - Maintenance for stormwater BMPs is essential to maintaining MS4s



Regulatory Gaps

- Easier to incorporate resilience through planning (sometimes)
- Can make use of historical data
- But legacy development sometimes precludes resilient planning strategies

Regulatory Gaps

Roadblocks to resilient design:

- Project Scope limits
- Budget limits
- For flood and stormwater permitting, agencies may also have to deal with perceived lack of “fairness” among permittees

Regulatory Gaps

- Should guidelines address projects at the planning stage, or at the design and maintenance stage?
  - Realistically…work to coordinate guidelines at all stages
- Some agencies may update existing guidelines to include climate-ready design parameters; other agencies may want to develop independent sets of design guidelines
- What will be our resilience best practices?

Regulatory Gaps

- Design guidelines must allow enough flexibility for systems to adapt
- Public Perception
  - In watersheds that are experiencing rapid development and more frequent flooding, often-used designs, e.g. infiltration/detention basins, may be viewed as contributors to increased flooding
- Where public safety is a concern, design alternatives should still account for project resiliency
  - Example: Karst topography

Local Highways

- Stormwater requirements for redevelopment
- Impervious area increasing in commercial corridors
- Who manages all that runoff?
- Highway agencies held to higher standards than commercial developers

Local Highways

- Controversial history in densely urbanized areas
- Community engagement to uncover pathways towards sustainability and resilience
- Extensive coordination with regulatory agencies
- Introduce monitoring

Airports

- Safety and mitigation of any obstructions to airways
- Where GSI is not practical, other avenues for resilient design open up
- Example – wetland creation for storage of stormwater and flood volumes

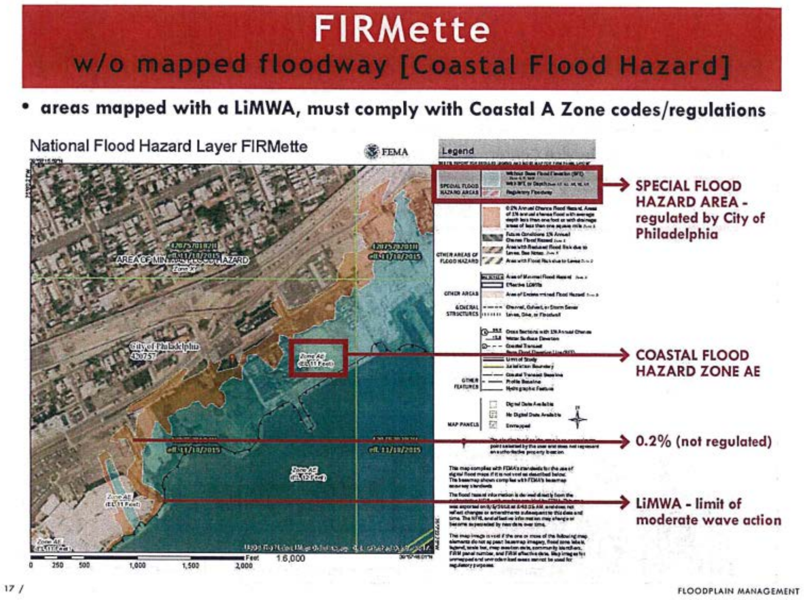
Monitoring Programs

- Partner with universities and citizen groups for monitoring & research
- Give feedback in real-time
  - Get a close-up look at how it's working
  - Data can be used to develop models that dynamically reflect real-world performance
- Reveal maintenance needs sooner
- Depending on project location and scale, monitoring need not be as intensive
  - Just a handful of data parameters can still be valuable, if monitoring is designed correctly

Closing the Regulatory Gaps

- Agencies develop science-based guidelines for resilience
- Engineers can use rating system metrics to inform the design process
- Post-construction monitoring feedback and reporting will help agencies to gradually refine those guidelines

Closing the Regulatory Gaps



- Future guidance for flood resilience will build on current FEMA requirements
- Compliance with FEMA floodplain regulations (currently regulates the 1% annual chance floodplain)
- In the future, could regulate less frequent annual chance floodplain

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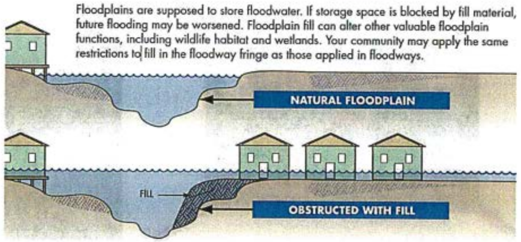
Closing the Regulatory Gaps

BUILDING PERMITS
Fill

- If less than 12”, in-place dry density is not less than 90% of the max. dry density at optimum moisture content determined in accordance with ASTM D 1557Less than 180 days
- If over 12”, then **GEO-TECHNICAL REPORT** (Section 1803 of IBC)
    - Requires Special Inspections
- **Requires** a Zoning Permit, and a Building Permit if over 5,000 SF
- **Requires** a Letter of Map Change [LOMC] if a Hydrologic and Hydraulic study shows any rise in the BFE

Floodplains are supposed to store floodwater. If storage space is blocked by fill material, future flooding may be worsened. Floodplain fill can alter other valuable floodplain functions, including wildlife habitat and wetlands. Your community may apply the same restrictions to fill in the floodway fringe as those applied in floodways.



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FLOODPLAIN MANAGEMENT

- Building permits are required for machinery, equipment, and accessory structures built in special flood hazard areas (SFHAs)
- Placement of fill in flood zone requires additional permitting
- Locally, BFE increased from 12” to 18” (2012)

Questions?
Comments?