



Source: Port of Oakland

ADDRESSING INFRASTRUCTURE VULNERABILITY

IN THE CONTEXT OF URBAN RESILIENCE EFFORTS

Jamie Torres Springer | April 18, 2018

HR&A
Analyze. Advise. Act.

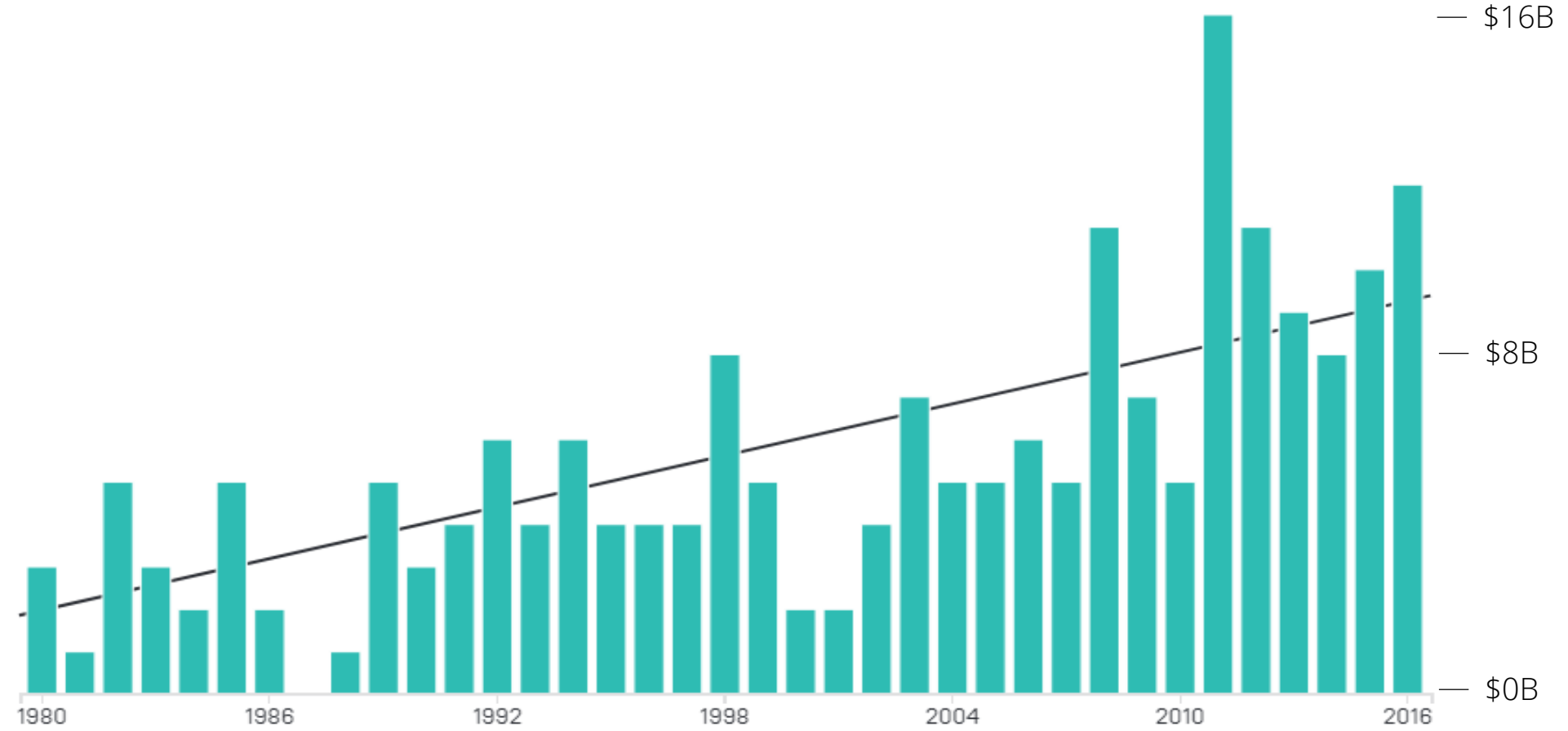
WHY RESILIENCE?

Around the world, disasters are becoming **more frequent and severe as recovery costs are growing.**



Financial losses from adverse events have grown exponentially. Since the 1980s, the **average number of billion dollar-disasters has risen to 5.4 per year.**

ANNUAL FREQUENCY OF BILLION DOLLAR DISASTERS (1980-2016)

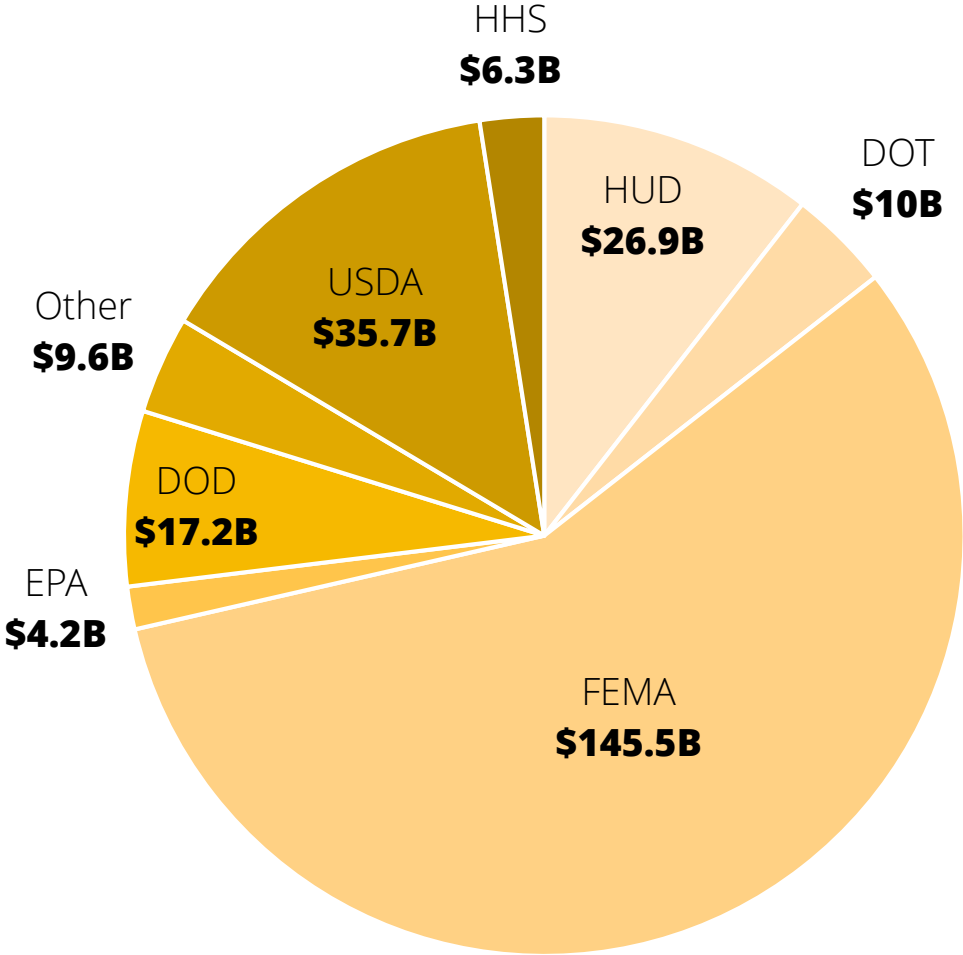


Source: New America
HR&A Advisors, Inc.

As cities are preparing to adapt, **conventional solutions are ill-suited to address the increased risks.**



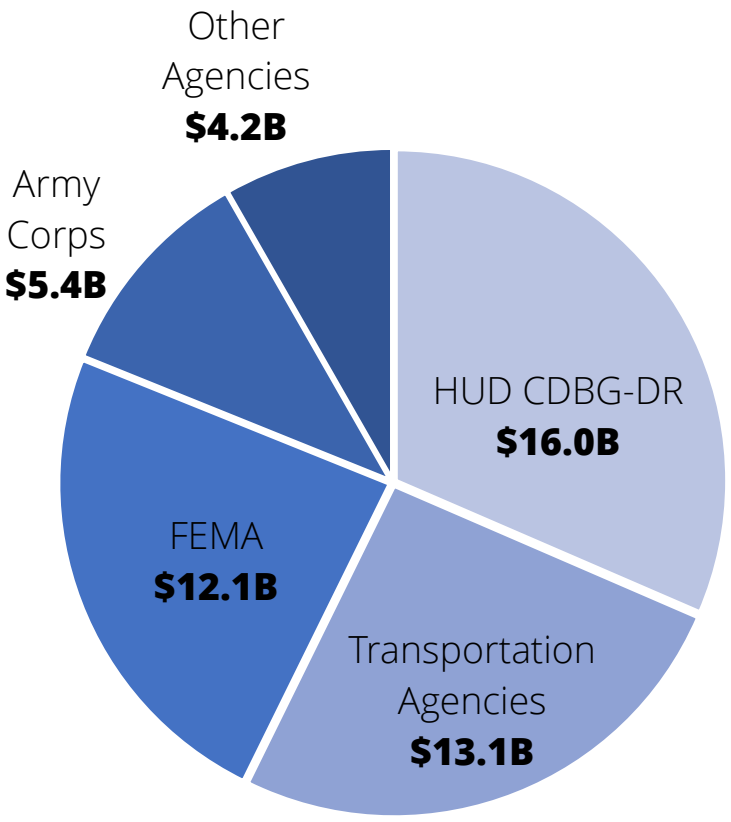
The federal government spent at least **\$277.6 billion from 2005 through 2014** for disaster assistance.



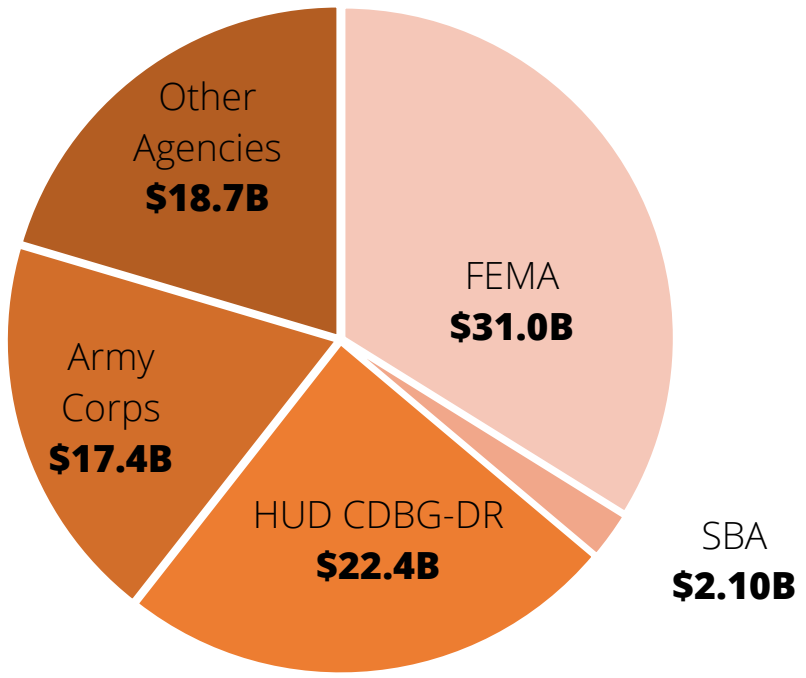
Source: GAO
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After a major disaster, Congress appropriates **disaster recovery funds** through multiple agency programs.

\$50.8B 2013 DISASTER RELIEF APPROPRIATIONS:
Superstorm Sandy

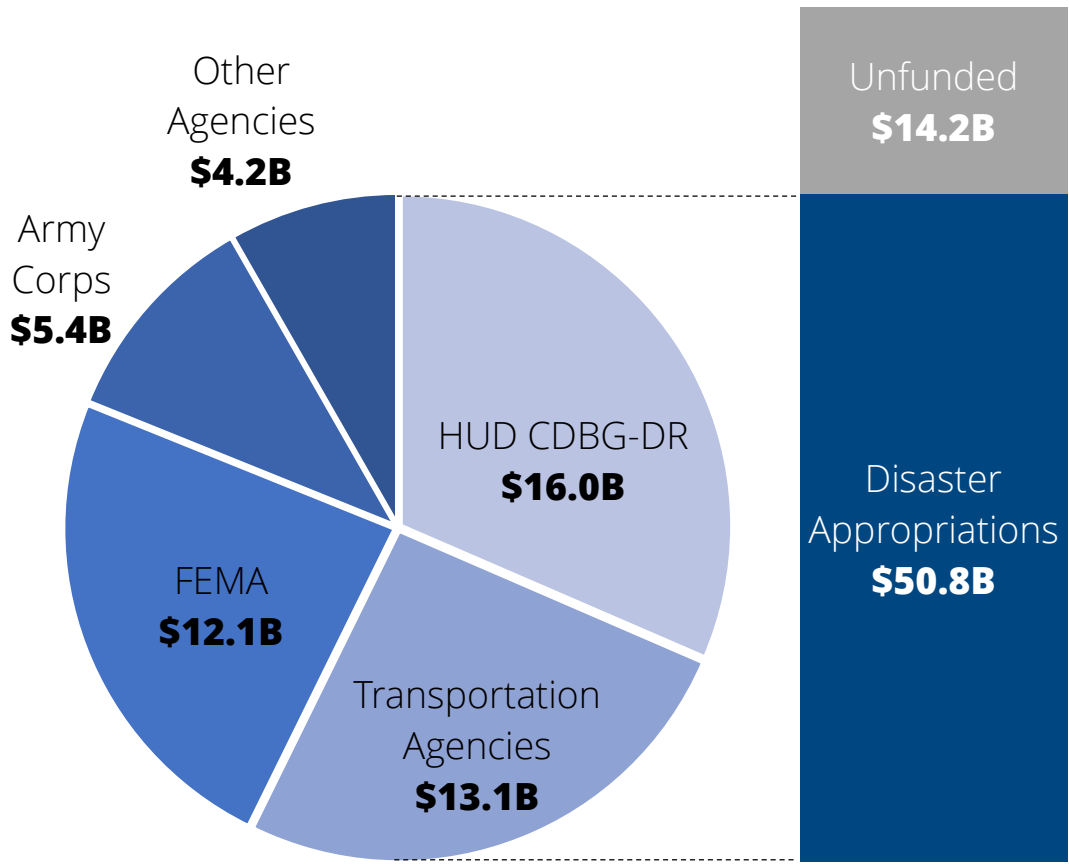


\$91.5B 2017 DISASTER RELIEF APPROPRIATIONS:
Hurricanes Harvey, Irma, and Maria, and California Wildfires

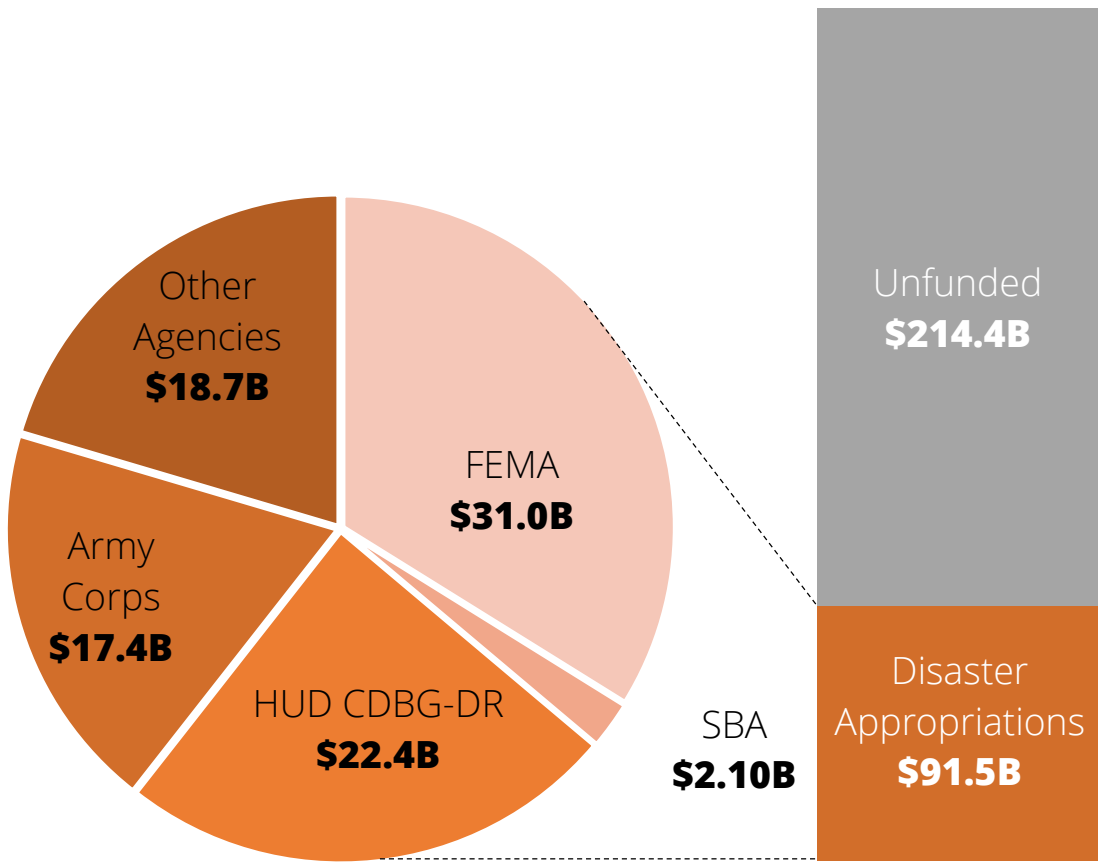


However, federal recovery funding is **unable to cover damages or support adequate mitigation.**

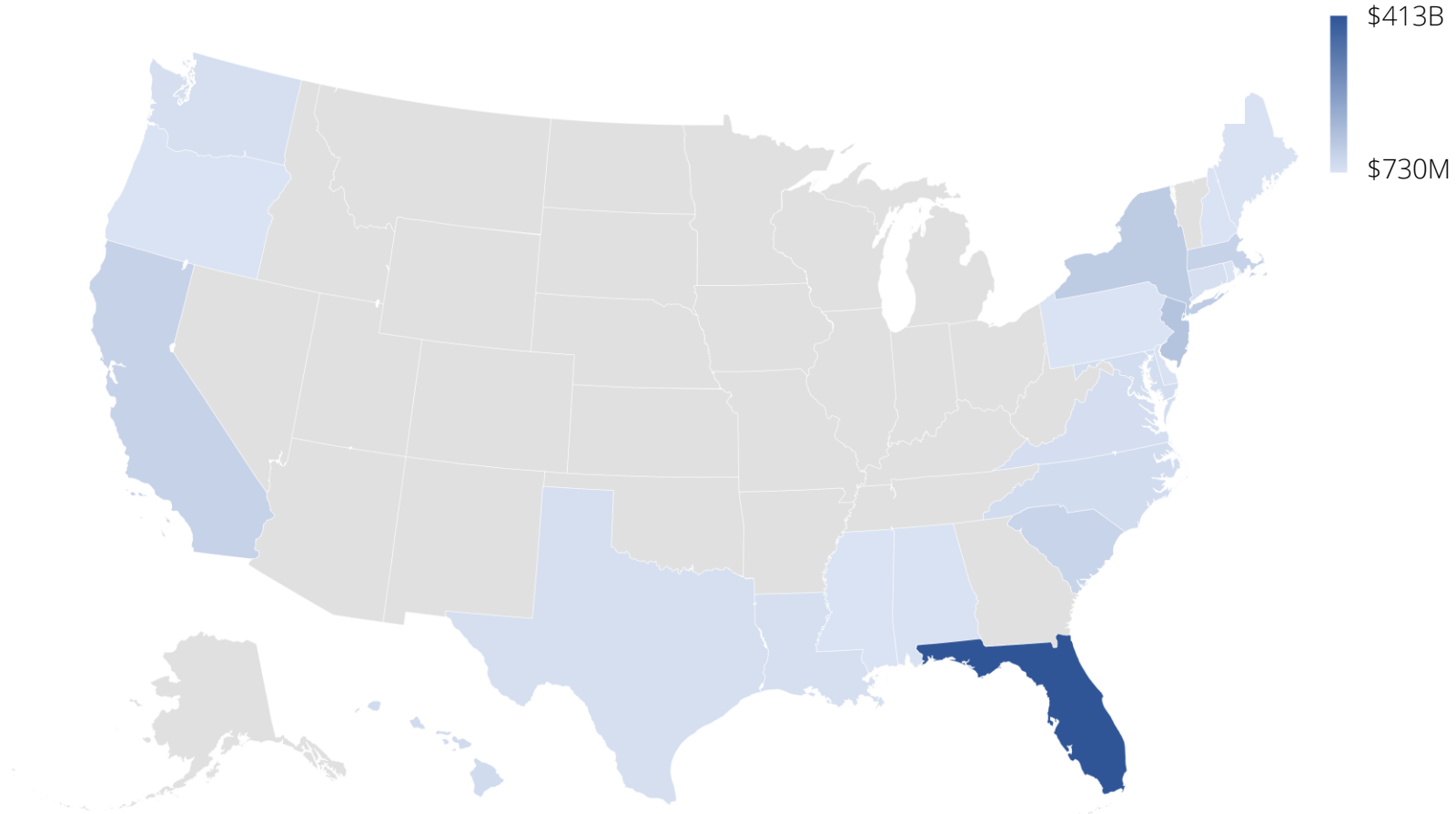
\$65B ESTIMATED DAMAGES FOR 2013



\$306B ESTIMATED DAMAGES FOR 2017



Additionally, with 6 feet of sea level rise currently projected, **over \$880B of property value could be underwater by 2100.**



Source: NOAA and Zillow
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These hazards cannot be considered in isolation. **Increasing climate-related risks are combined with vulnerabilities** to threaten both high value economic assets and vulnerable populations.

Hazards



Storm Surge & Tidal Inundation



Sea Level Rise



Heavy Precipitation



Extreme Heat

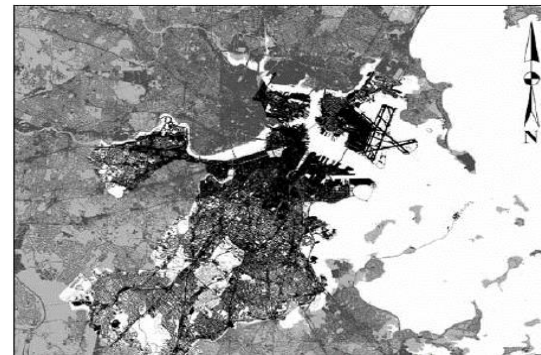
Vulnerabilities



Aging Infrastructure & Housing



Low-Lying, Built on Infill



Impervious Surfaces

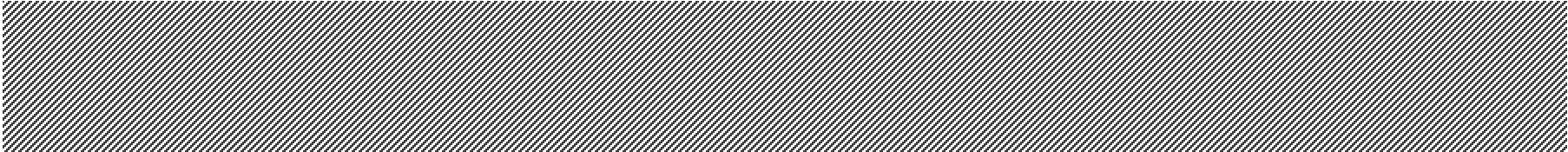


Storm Drain & Sewer Systems

Long-term funding solutions require designing projects to generate **multiple benefits**.

Project Costs

EXPANDED
COST-BENEFIT
ANALYSIS



Project Benefits

Citywide Benefit	Environmental/ Social Benefits	Avoided Damage/ Insurance Savings	Enhanced Property Value
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APPROACHES TO
MONETIZING
BENEFITS

General Fund State & Federal Appropriations	Impact Bonds Philanthropic Funding	Incremental Value Assessment Insurance Levy	Value Capture
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PORTS & CITIES

Based on asset value, American cities take **5 of the top 10 spots** among global port cities ranked by exposed assets, with **a total of \$1.1T in goods at risk**.

City	Population	Exposed Assets	Exposed Assets Ranking
Miami	5.4M	\$416B	1
New York-Newark	18.7M	\$320B	2
New Orleans	1.0M	\$233B	3
Osaka-Kobe	11.3M	\$215B	4
Tokyo	35.1M	\$174B	5
Amsterdam	1.1M	\$128B	6
Rotterdam	1.1M	\$114B	7
Nagoya	3.2M	\$109B	8
Tampa-St Petersburg	2.3M	\$86B	9
Virginia Beach	1.5M	\$84B	10

Note: Dollars in USD

Source: Nicholls, R. (2008)

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In addition to goods, American cities also rank highly among those with **large at-risk populations.**

City	Population	Exposed Population	Exposed Population Ranking
Mumbai	18.2M	2.8M	1
Guangzhou	8.4M	2.7M	2
Shanghai	14.5M	2.4M	3
Miami	5.4M	2.0M	4
Ho Chi Minh City	5.0M	1.9M	5
Kolkata	14.2M	1.9M	6
New York-Newark	18.7M	1.5M	7
Osaka-Kobe	11.3M	1.4M	8
Alexandria	3.8M	1.3M	9
New Orleans	1.0M	1.1M	10

Note: Population in 2005
Source: Nicholls, R. (2008)
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By 2070, the United States' largest port cities will have...

12.5M

PEOPLE AT RISK

\$9T

DOLLAR VALUE OF
GOODS AT RISK

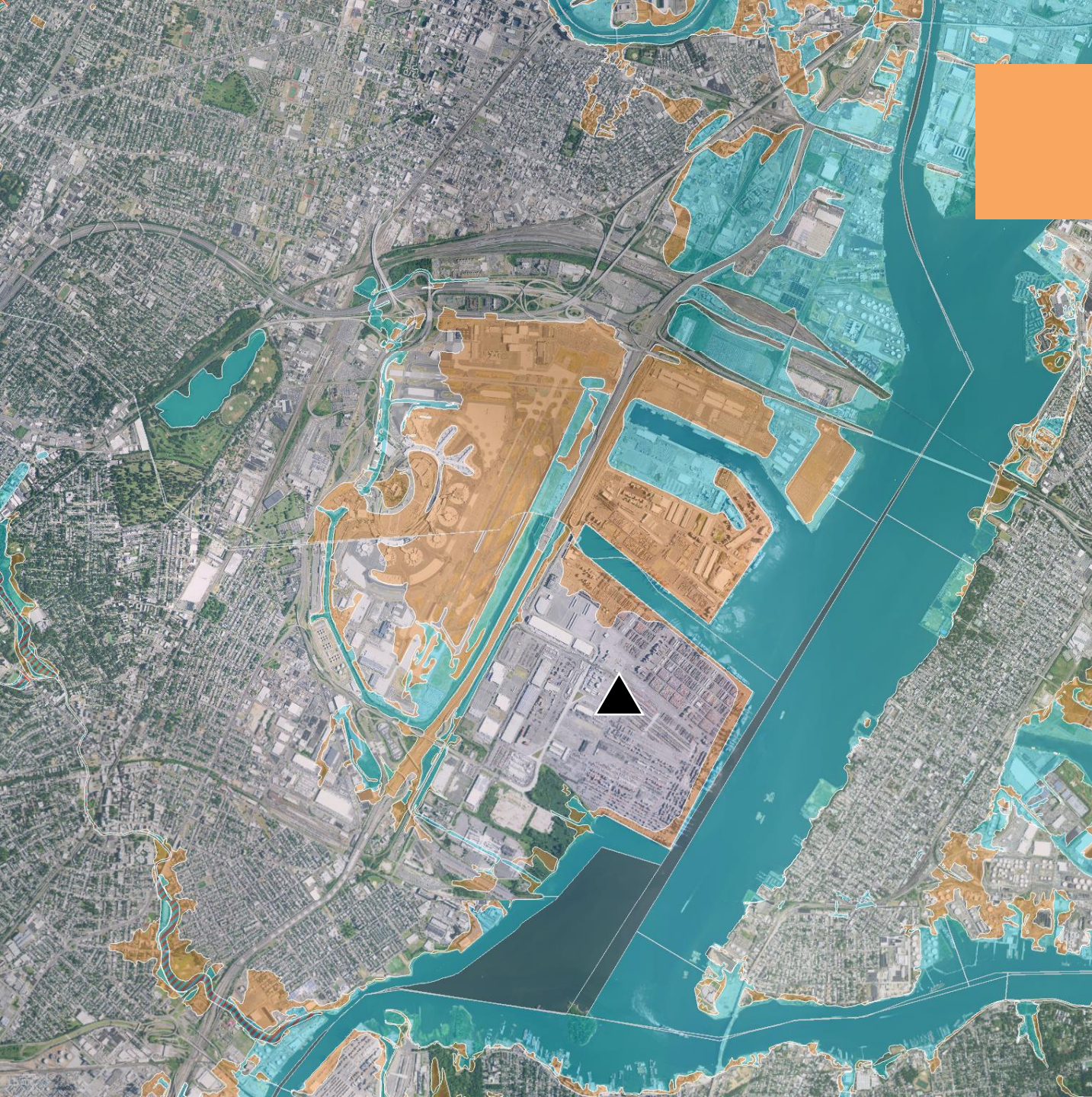
Note: Dollars in USD



Source: Nicholls, R. (2008), includes 17 port cities

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LIMITED RISK

Port of Newark-Elizabeth

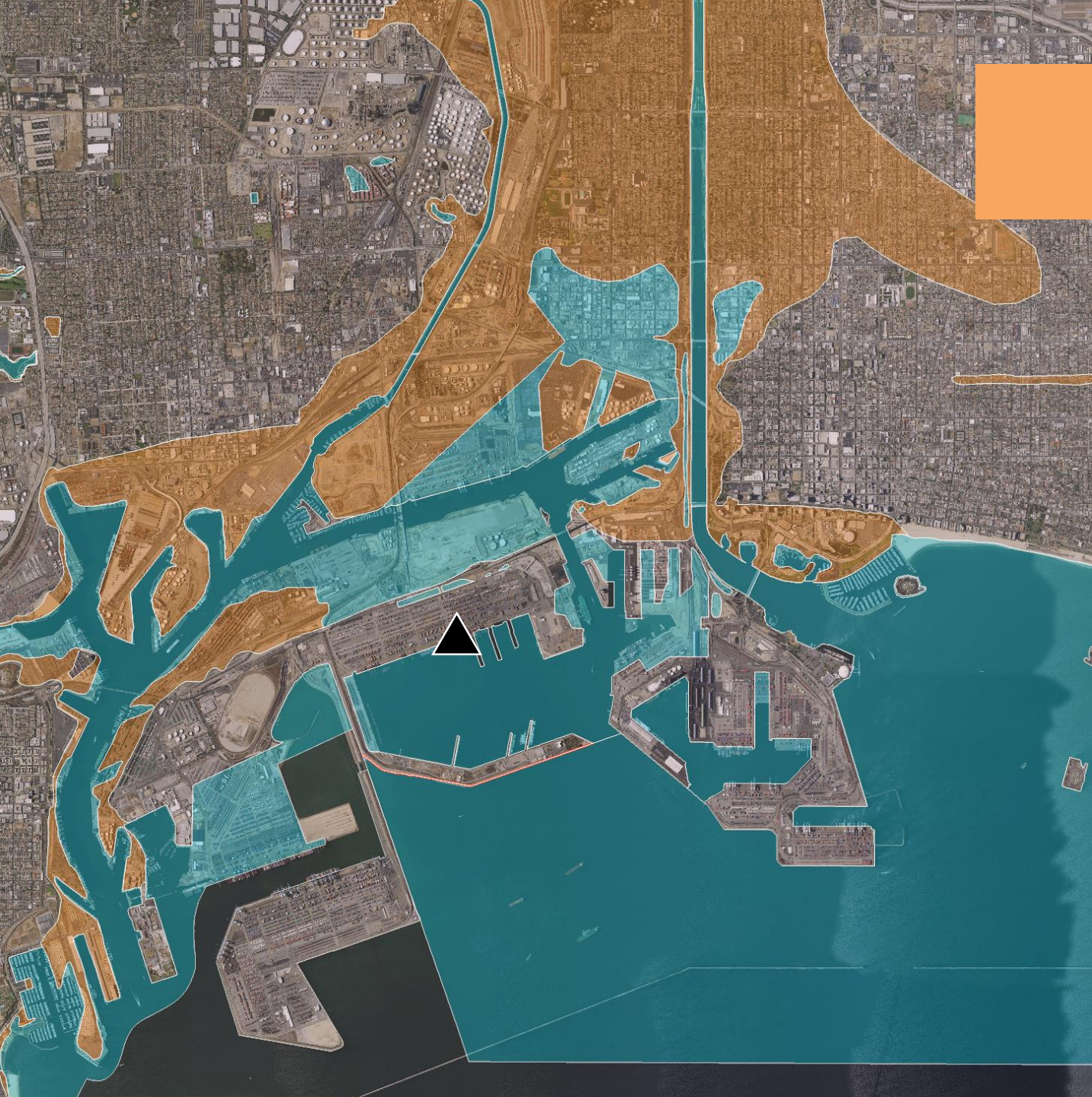




-  High Risk Area
-  Moderate/Low Risk Area

Source: FEMA, APM Terminals
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ISOLATED RISK

Ports of Los Angeles and Long Beach

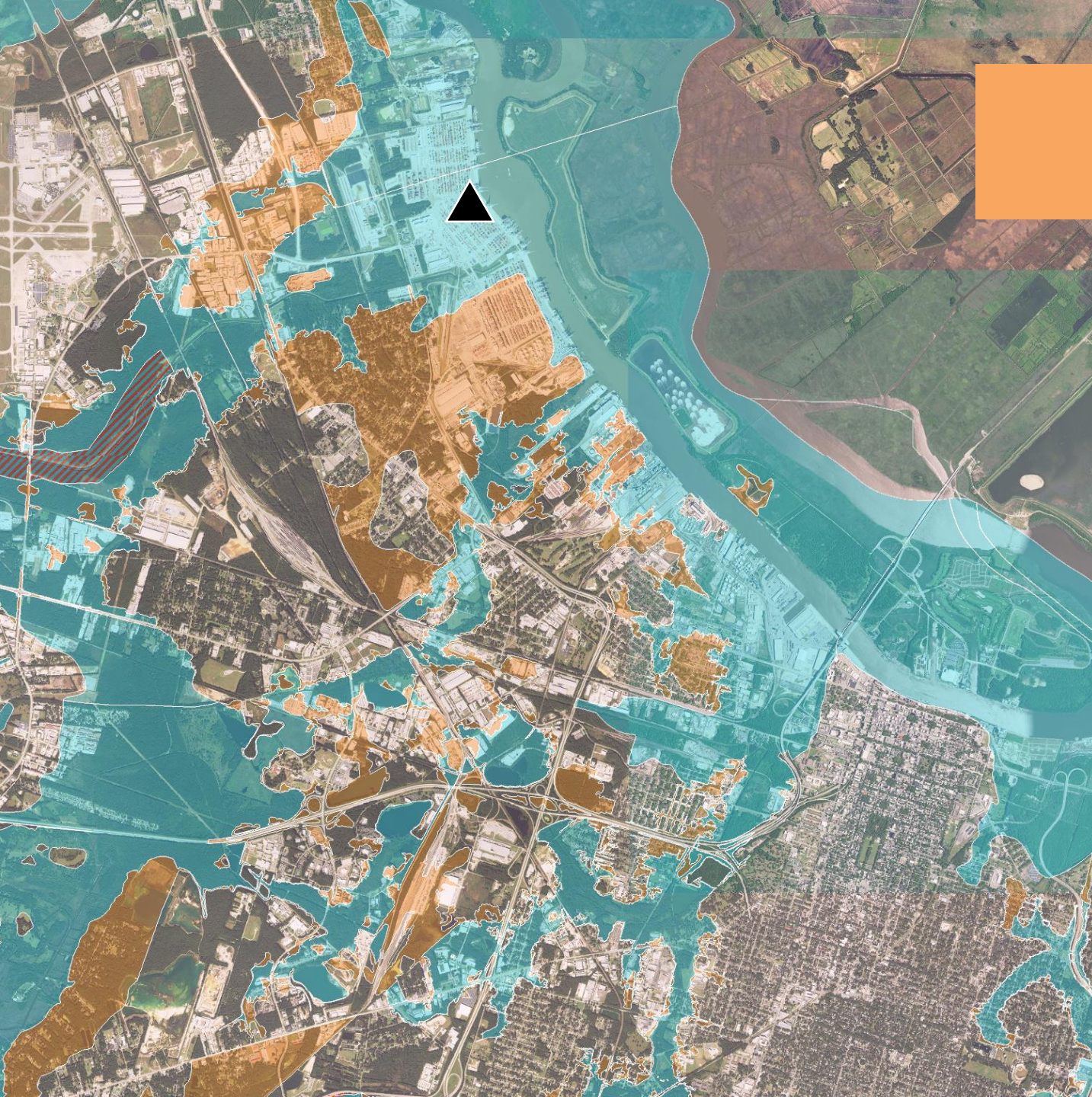




-  High Risk Area
-  Moderate/Low Risk Area

Source: FEMA, Port of Los Angeles
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SHARED RISK

Port of Savannah

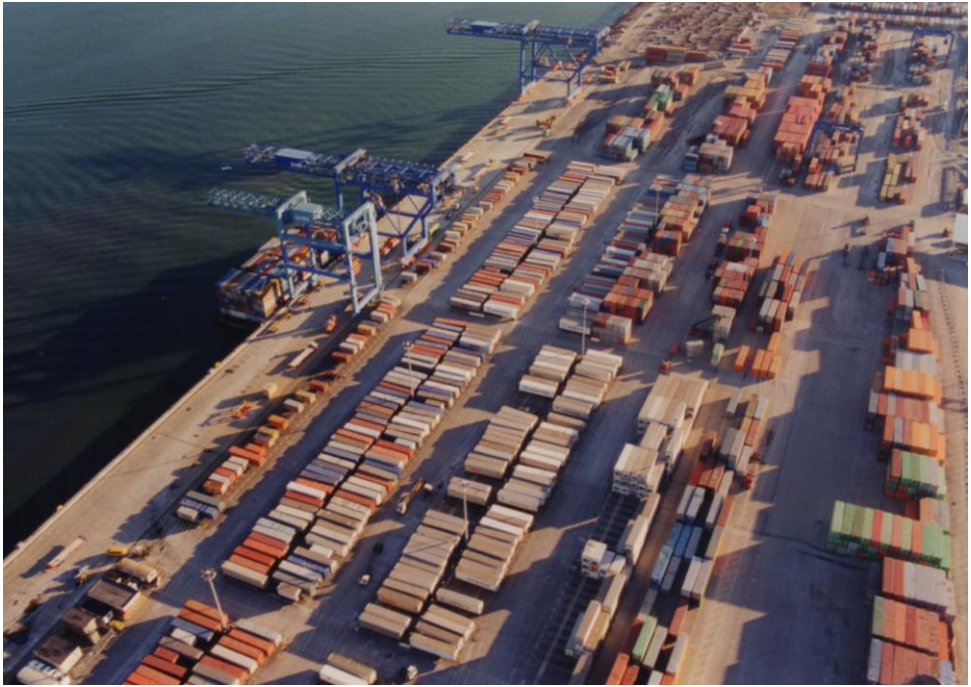
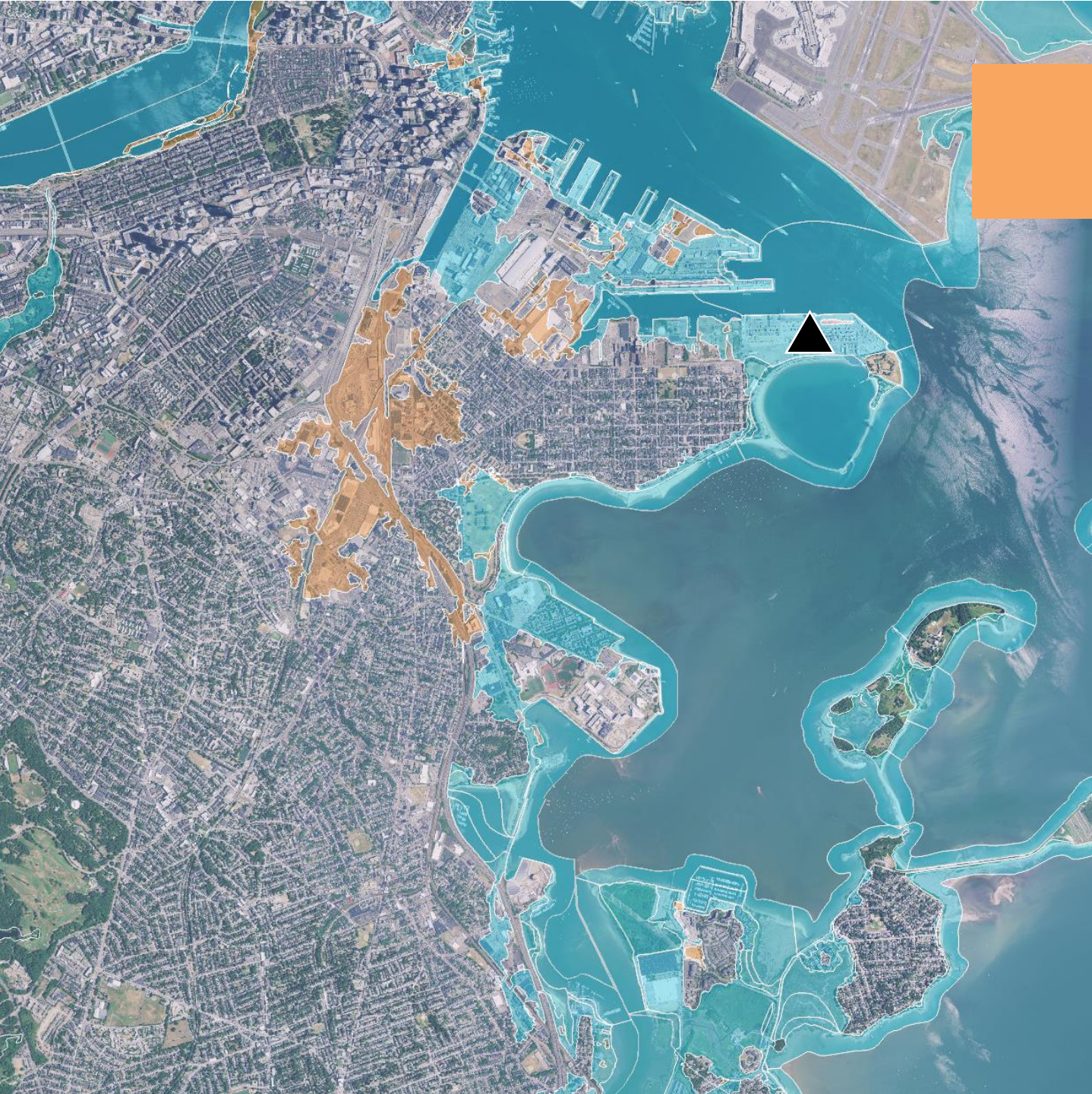


-  High Risk Area
-  Moderate/Low Risk Area

Source: FEMA, Georgia Ports
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INTEGRATED RISK

Port of Boston



- High Risk Area
- Moderate/Low Risk Area

Source: FEMA, Center of Land Use Interpretation
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Resilience Layers can be used to methodically approach resilience challenges, to develop robust solutions that various co-benefits.



UPDATED
CLIMATED
PROJECTIONS



RESILIENT
INFRASTRUCTURE



ADAPTED
BUILDINGS

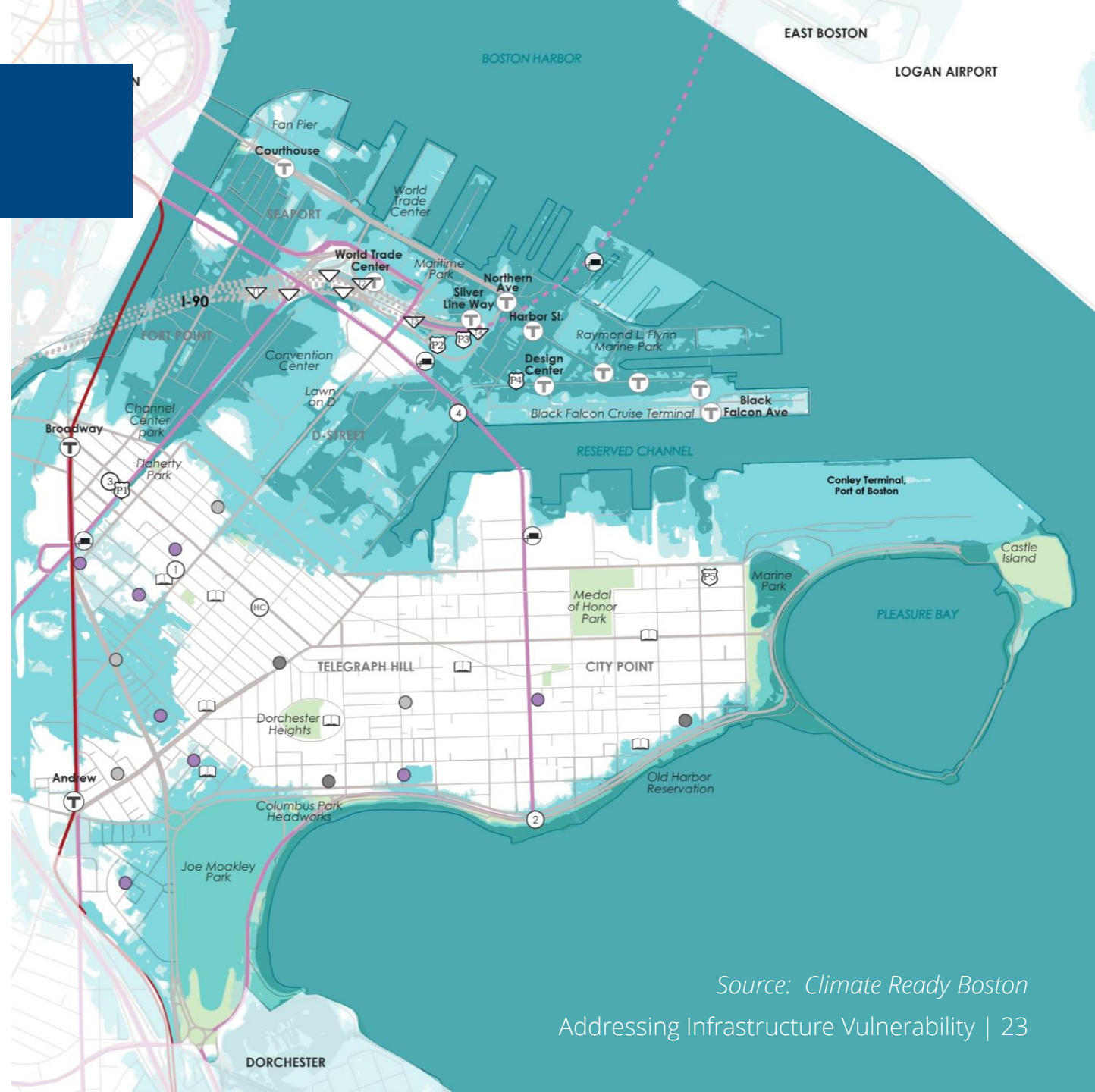


PROTECTED
SHORES

DISTRICT FLOOD PROTECTION

Boston, MA

- **Context:** Of all the areas studied thus far through the *Climate Ready Boston* process, South Boston faces some of the greatest exposure and potential losses to coastal flooding
- **Intervention:** *Climate Ready Boston* recommends creation of a coastal protection system, including studying feasibility for district-scale flood protection in areas like South Boston where significant residential communities and port assets are exposed



IKE DIKE

Houston, TX

- **Context:** Hurricane Ike caused more than \$30 billion in damages, including massive economic losses associated with the temporary closure of the Port of Houston
- **Intervention:** The Ike Dike is a proposed coastal barrier spanning Galveston Island to Bolivar Peninsula, that when complete, will protect the Houston-Galveston region from hurricane-induced storm surge



EAST SIDE COASTAL RESILIENCY

New York, NY

- **Context:** As the first phase of the Rebuild by Design-proposed “Big U,” the East Side Coastal Resiliency Project received \$335M in CDBG-DR funds to reduce coastal flood risk to Manhattan’s east side
- **Intervention:** A 2.2-mile integrated coastal protection system, anchored by a planted berm and recreational areas that will act as a barrier during future storm events to protect shared assets, including power generation stations and subway access





Source: Port of Oakland

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