



Measuring Historic and Probable Flood Losses

City of Baltimore, MARYLAND

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RiskMAP
Increasing Resilience Together



Presentation Summary

- **Rationale for Enhanced HAZUS Analysis**
- **Enhanced HAZUS Risk Assessment - Details**
- **Data Inputs**
- **Potential loss comparison –**
NEW Effective FIRM - 1% Annual Chance flood extent,
Hurricane Isabel (.2% ACE), Hurricane Isabel + SLR,
TS Sandy (Early forecast)
- **Utilizing the Results**



FEMA

Implications of a Changing Climate in the Upper Chesapeake

- **Baltimore City has observed shifting trends in weather patterns and climate conditions**
- **Projected changes in the local climate will affect larger areas of the City**
 - Relative sea-level rise
 - Impacts from natural hazard events
- **Threaten regionally significant assets**
- **Upper Chesapeake Bay – risen more than 1ft. In last century (EPA, 2013)**
 - Predicted to rise 2-5 ft. before the end of the next century (EPA, 2013)
- **What would be impacted by Sea-level rise? (MD State HWY Administration, 2013)**
 - Flood roads, weaken foundations of bridges, causing bridge decks to fail
 - MD - 800 miles of roads inundated (2 ft. of SLR)
 - MD - 3.700 miles of roads under water (2 ft. of SLR)
 - MD - Impact 93 bridges, culverts and highway structures (2ft. Of SLR)

Project Rationale

- **Former coastal FIRMs** for the upper Chesapeake Bay Region were based on a **1978** surge modeling study - Virginia Institute of Marine Science (VIMS)
- **NEW Effective coastal FIRMS** are derived from a **2012** ACOE surge modeling study
 - ✓ Allows much greater resolution to analyze how the surge spreads more inland through smaller inlets and tributaries as well as over land.
 - ✓ Calibrated and **validated** not only to data available from Hurricane Isabel but also with data available from Hurricane Ernesto and Nor'easter Ida.
- **HOWEVER**
 - In many areas of the upper Chesapeake Bay, the NEW effective **Base Flood Elevations (BFEs) are lower** than the former FIRM
 - More **severe storms may occur** = higher storm surge and loss.
- **THEREFORE**
 - Coastal property owners are encouraged to **build above the BFE** and community officials are urged to **regulate to higher building standards.**

Addressing Lower BFEs in the Upper Chesapeake Bay

- **Updated ACOE Engineering Model – Coastal Flooding**
 - Reduced BFEs up to 4 ft.
 - Effective FIRM reduces size of flood zones V and AE
 - Decrease the number of households required to pay flood insurance
- **Improved Coastal Analysis is not reflective of historic flood risk**
 - Can create a false sense of safety for those removed
 - Advanced HAZUS Analysis will validate implementation of higher standards in the .2% chance flood zone



Enhanced HAZUS Risk Assessment

HAZUS Analysis

- City of Baltimore - Coastal
- Hurricane Wind + Coastal Flood
- Complete update to Building + Demographic inventory
- Enhanced Depth grids
 - NEW Effective FIRM
 - Simulating SLR
 - Illustrating historic storms
 - Simulating Forecasted storm extents
- Analyzed mitigation techniques



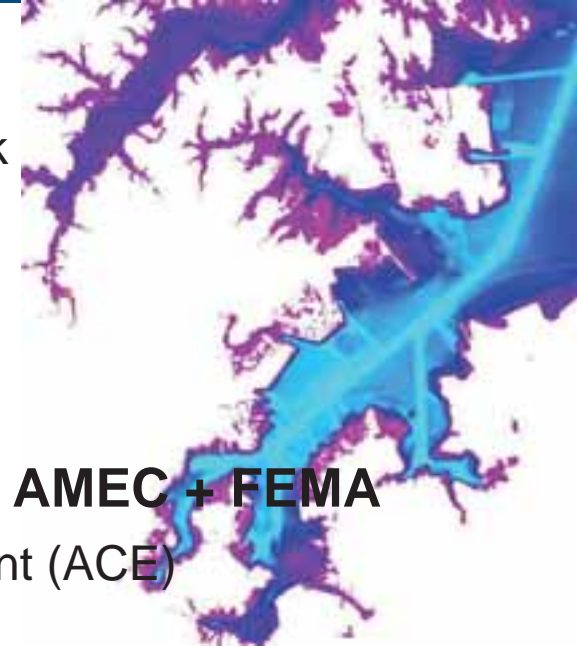
Data Inputs

- **Locally provided data**
 - Land-use, Unit counts, Total built area, Building replacement value, Age of structures
 - Location of Essential Facilities ,Transit infrastructure, Utilities
- **HAZUS Update - 2010 Census Data**
 - Age, Occupancy status, Average rent, Average home value (at Census Tract), Income distribution
- **Enhanced Depth grids**



Data Inputs - Enhanced Depthgrids

- **Depth grids indicate degree of risk**
 - Each cell illustrates a depth of water & degree of risk
 - Can be utilized to calculate flood losses for properties which intersect the flood zone generated by that particular flooding event
- **Enhanced Depth grids – Developed by MDE + AMEC + FEMA**
 - **NEW Effective FIRM** - 1% annual chance flood event (ACE)
 - **Hurricane Isabel** - 7.5 feet NAVD 88 (Equivalent to former 1%, now .2% ACE)
 - **SLR** - Hurricane Isabel + 3 feet, 5 feet, and 7 feet of SLR
 - **Tropical Storm Sandy** (November 1, 2012 - Surge forecast)



Comparing Coastal Flood Extents

Hurricane Isabel



You are Here!

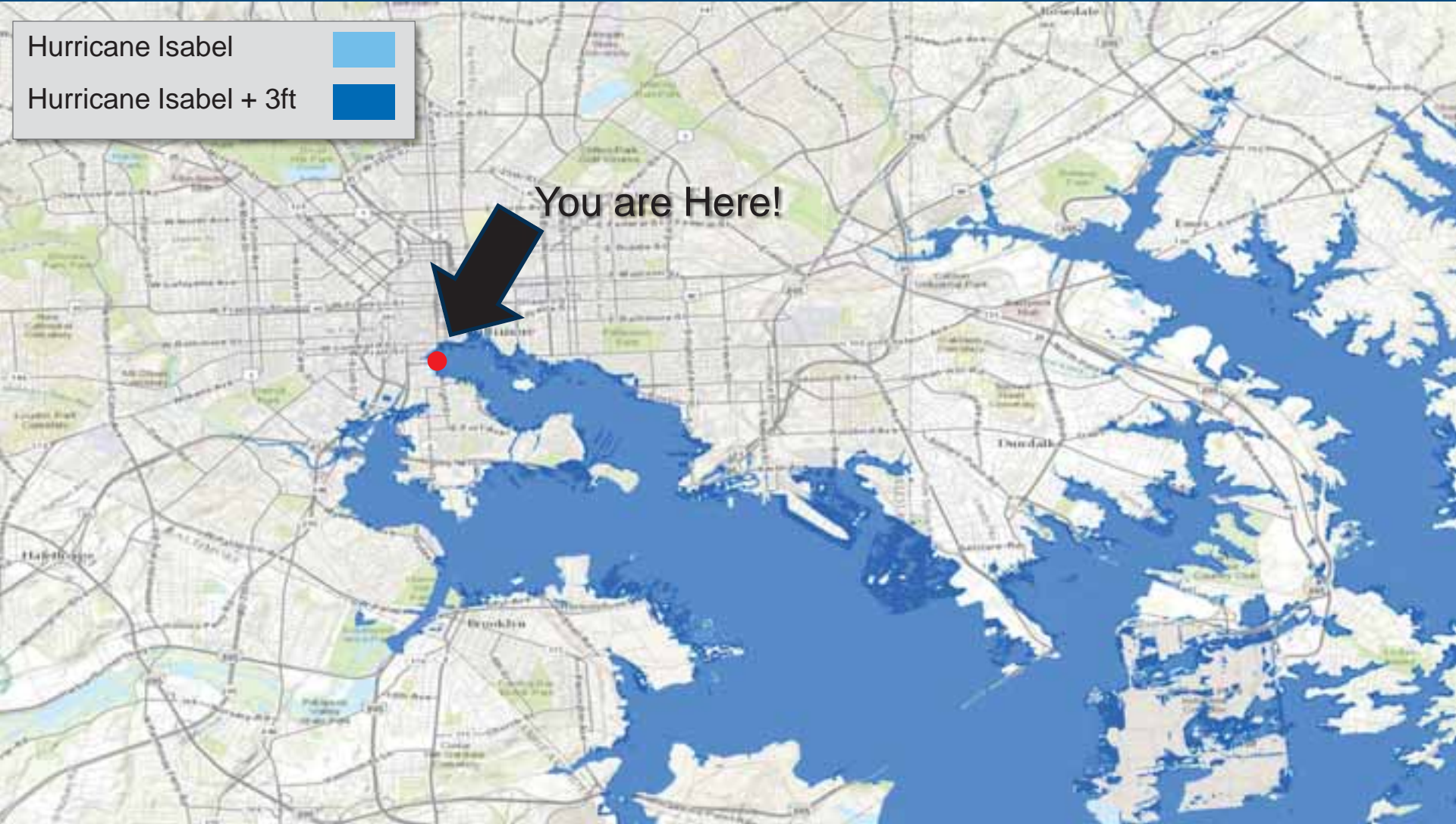


Comparing Coastal Flood Extents




Hurricane Isabel

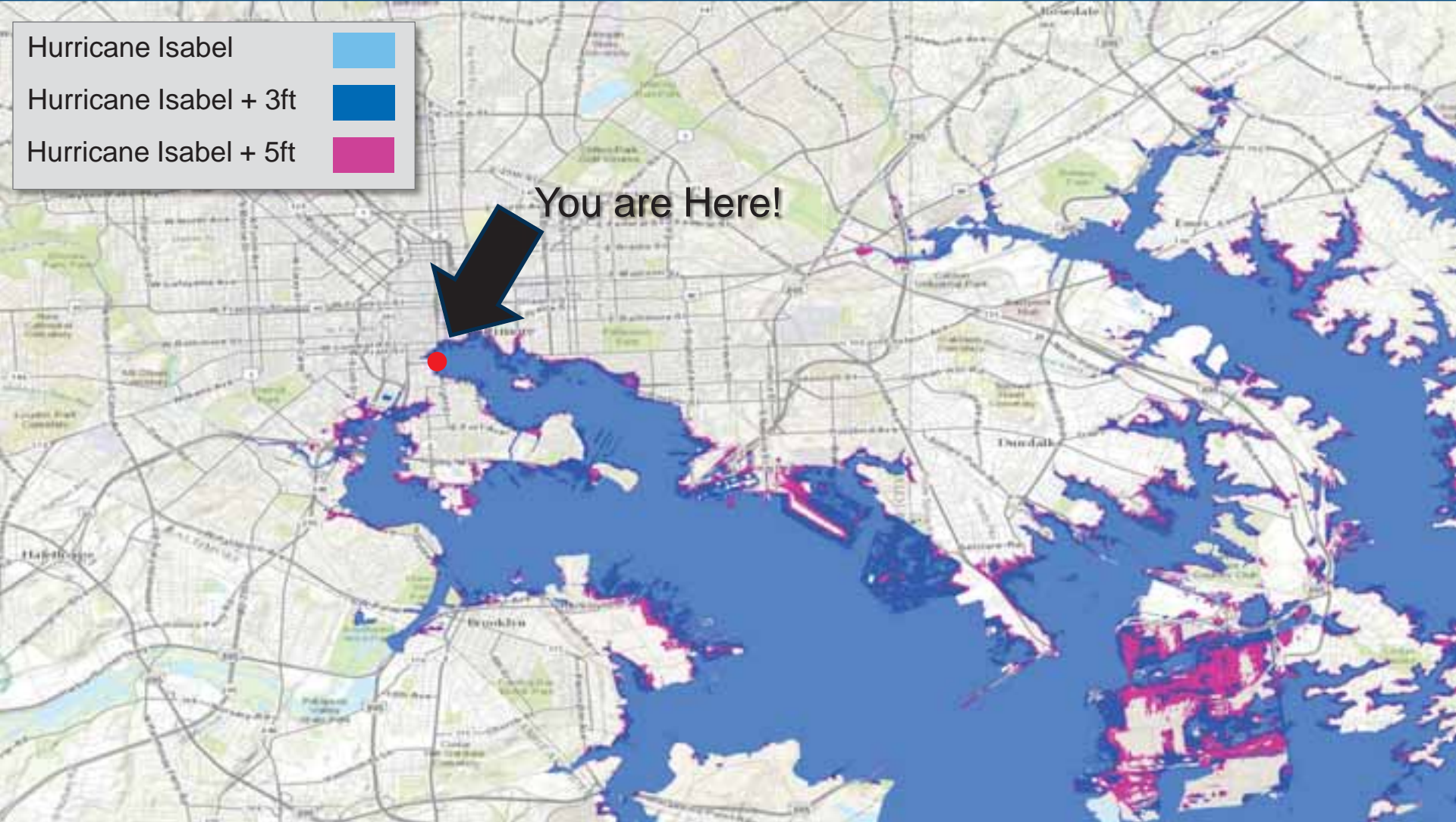


Hurricane Isabel + 3ft



Comparing Coastal Flood Extents

- Hurricane Isabel 
- Hurricane Isabel + 3ft 
- Hurricane Isabel + 5ft 

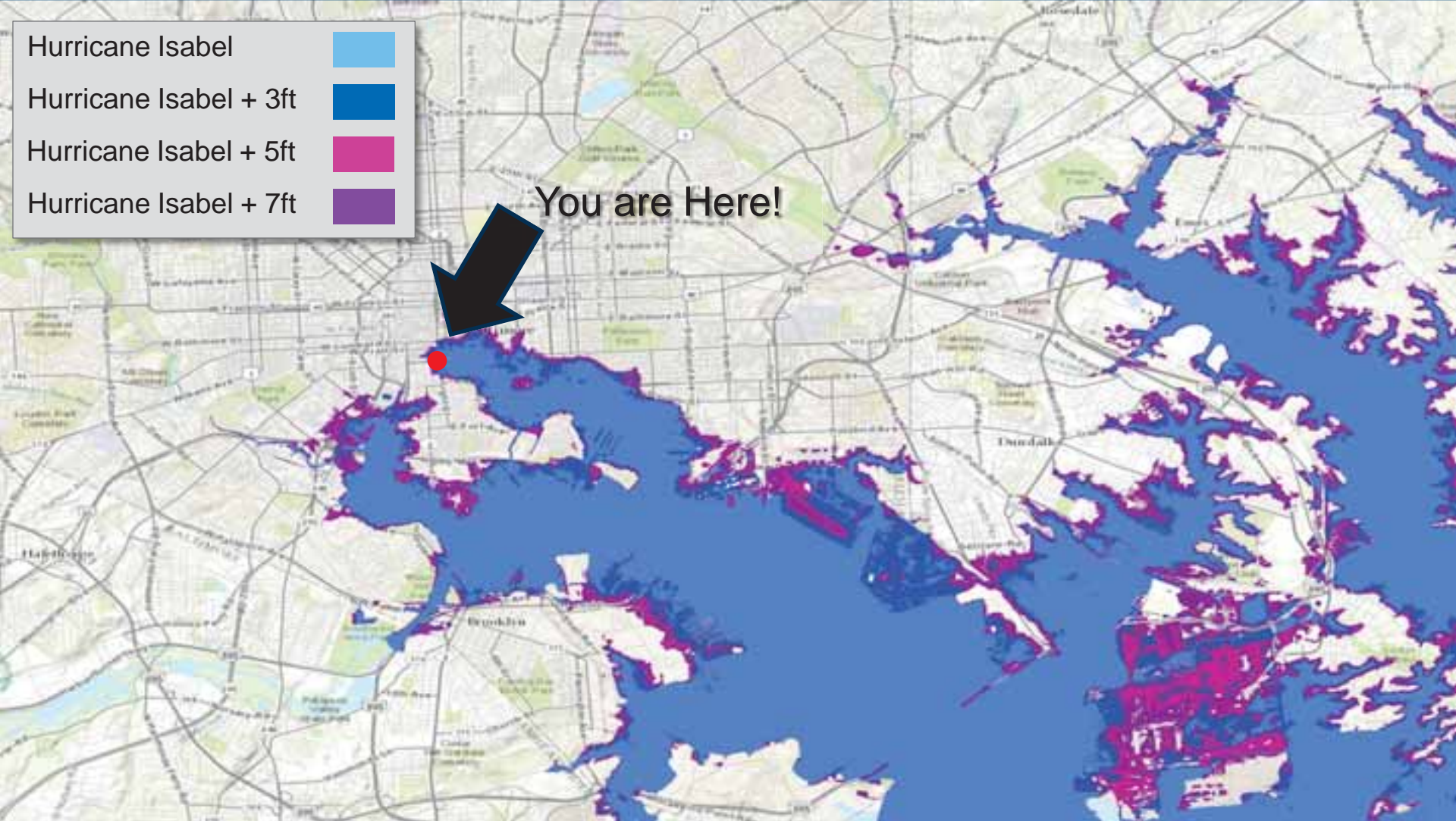


Comparing Coastal Flood Extents

- Hurricane Isabel
- Hurricane Isabel + 3ft
- Hurricane Isabel + 5ft
- Hurricane Isabel + 7ft



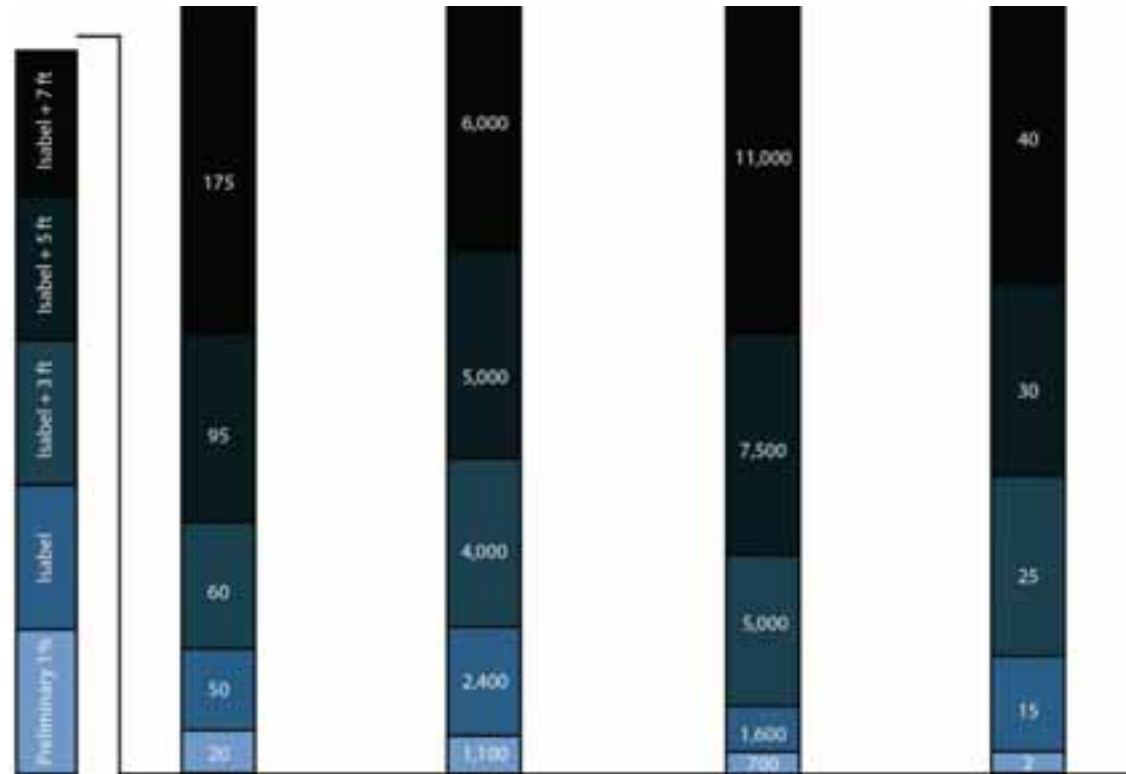
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Coastal Flood Results

- **Comparison of Coastal Flood Losses**

- Structural (Count)
- Shelter Needs (Individuals)
- Debris Generation (trucks)
- Essential Facilities with loss of use (Count)



Substantially Damaged Buildings



People Seeking Shelter



Truckloads of Debris (@ 25 tons/truck)



Essential Facilities with Loss of Use

Data Inputs – TS Sandy Forecasted Surge Extent

- **TS Sandy Forecast Surge Depthgrid**
 - Developed on **November 1, 2012**, by FEMA's Modeling Task Force (MOTF)
 - Incorporates data from the National Hurricane Center's (NHC) Hindcast, hurricane advisory on October 29, 2012 and preliminary field-verified high water marks.
 - Utilizes a 30 M resolution



Comparison of Raster Quality -Hurricane Isabel

You are Here!
Under 2ft - 3ft
of water



Comparison of Raster Quality -TS Sandy Forecast

You are Here!
Under 4ft -5ft
of water



Baltimore dodged a bullet..... This time

- **Hurricane Isabel – 7.5 Ft of Storm surge**
- **TS Sandy – 10-12 Ft of Storm surge forecasted for MD in the Upper Chesapeake**
 - Worse case scenario
 - Destruction of the Baltimore Harbor industry & maritime Industry, Core entertainment/shopping district, & Historic residential neighborhoods
- **TS Sandy Comparison to Hurricane Isabel**
 - 5X the number of structures destroyed
 - \$10.5 Bill more in total economic loss



Comparison of Coastal Losses – Effective FIRM

You are Here!



**Total Economic Loss –
in \$1000**

\$0 - \$45,000



\$45,000 – \$220,000



\$220,000 – \$540,000



\$540,000 - \$4,100,000



Comparison of Coastal Losses – Isabel

You are Here!



**Total Economic Loss –
in \$1000**

\$0 - \$45,000



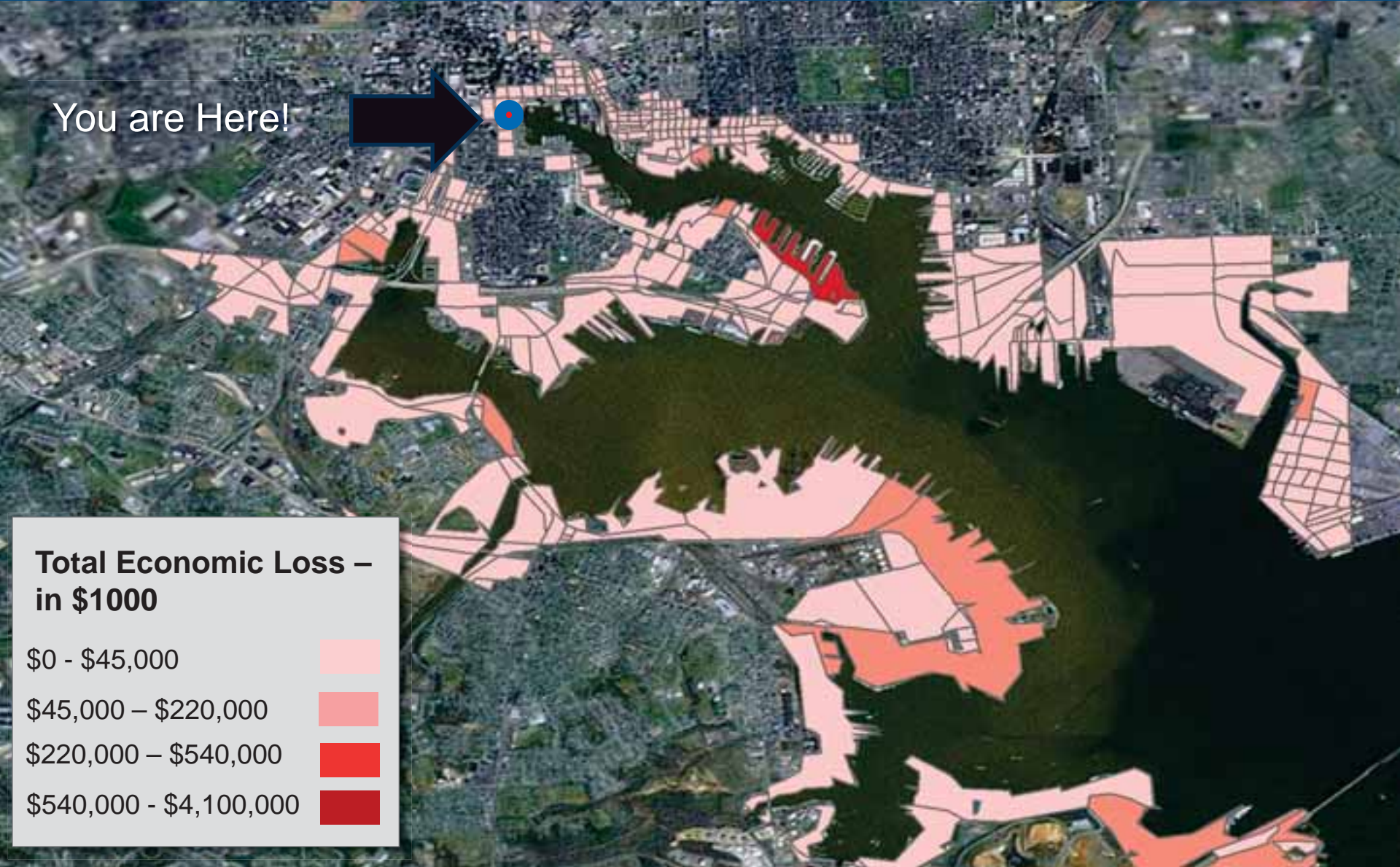
\$45,000 – \$220,000



\$220,000 – \$540,000



\$540,000 - \$4,100,000



Comparison of Coastal Losses – Isabel + 3ft

You are Here!



**Total Economic Loss –
in \$1000**

\$0 - \$45,000



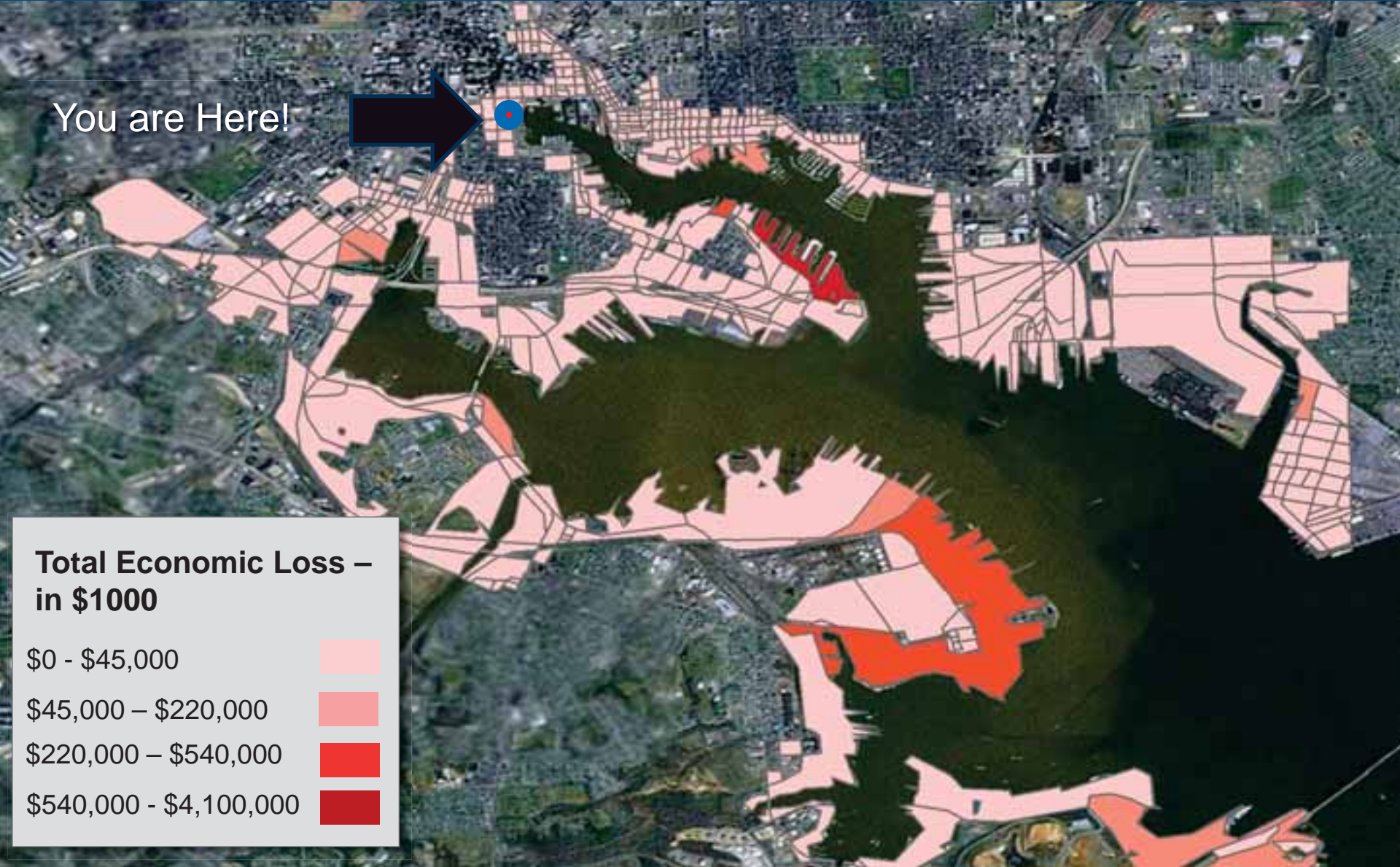
\$45,000 – \$220,000



\$220,000 – \$540,000



\$540,000 - \$4,100,000



Comparison of Coastal Losses – Isabel + 5ft

You are Here!



**Total Economic Loss –
in \$1000**

\$0 - \$45,000



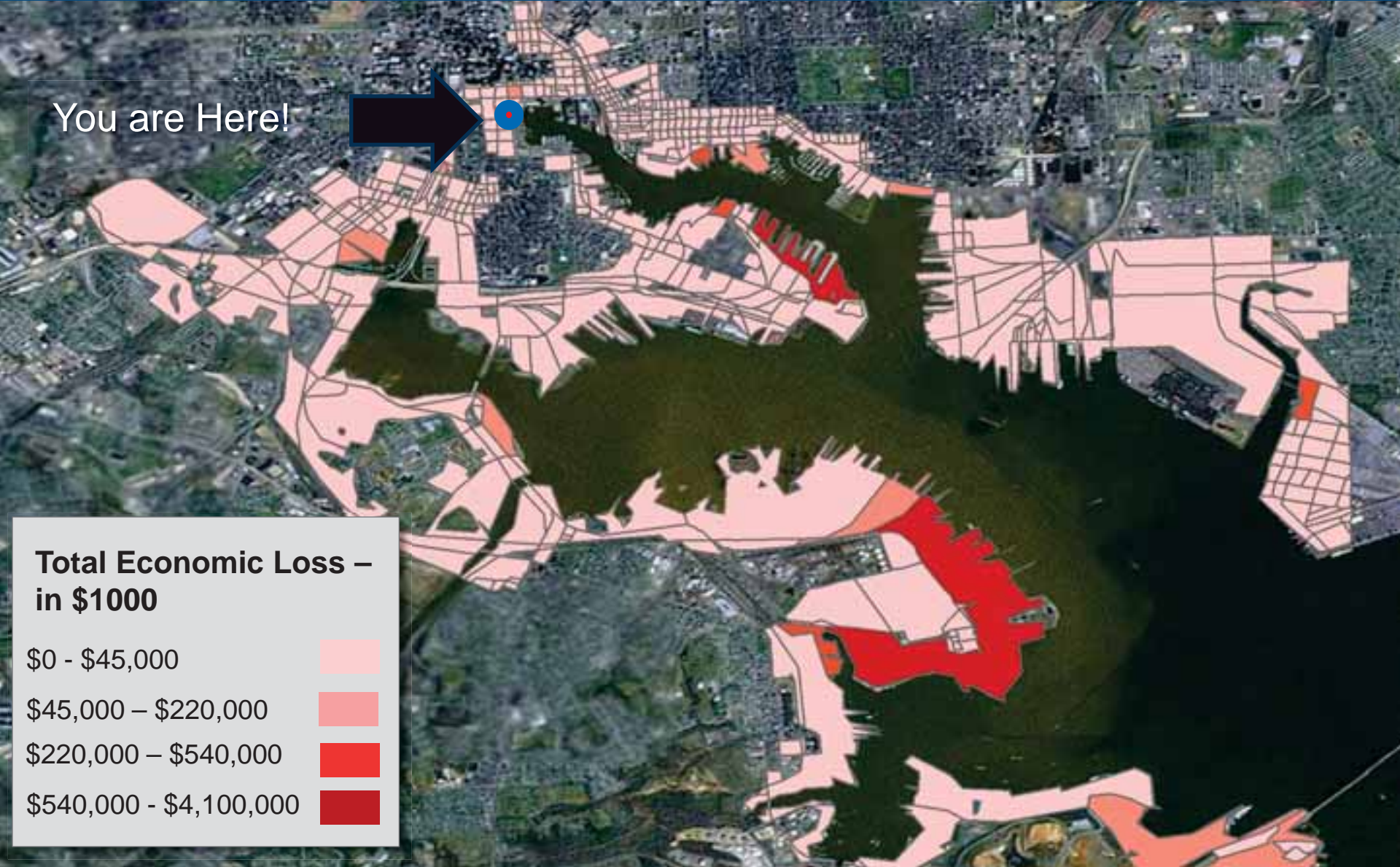
\$45,000 – \$220,000



\$220,000 – \$540,000



\$540,000 - \$4,100,000



Comparison of Coastal Losses – Isabel + 7ft

You are Here!



**Total Economic Loss –
in \$1000**

\$0 - \$45,000



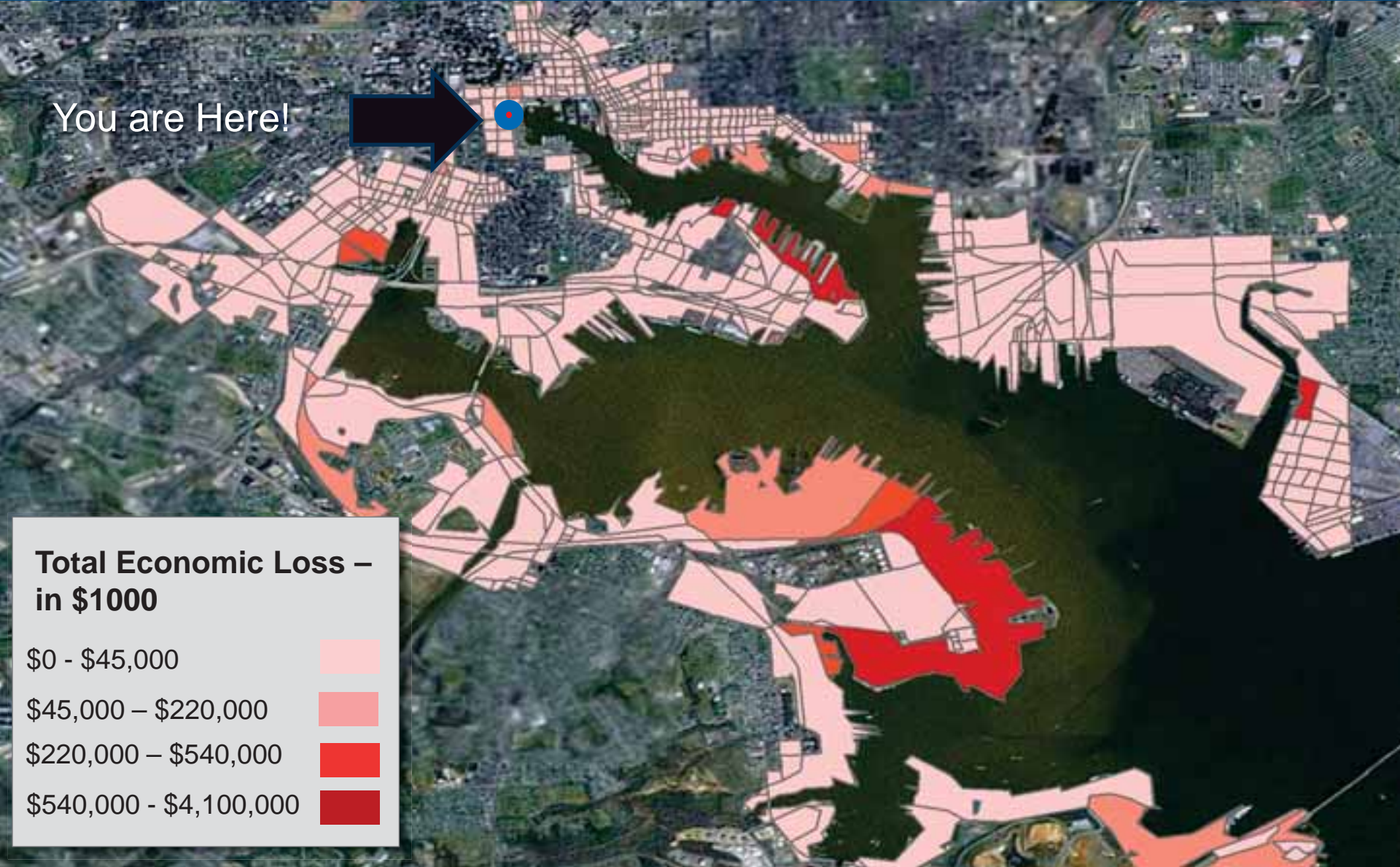
\$45,000 – \$220,000



\$220,000 – \$540,000



\$540,000 - \$4,100,000



Comparison of Coastal Losses – TS Sandy Forecast

You are Here!



**Total Economic Loss –
in \$1000**

\$0 - \$45,000



\$45,000 – \$220,000



\$220,000 – \$540,000








\$540,000 - \$4,100,000

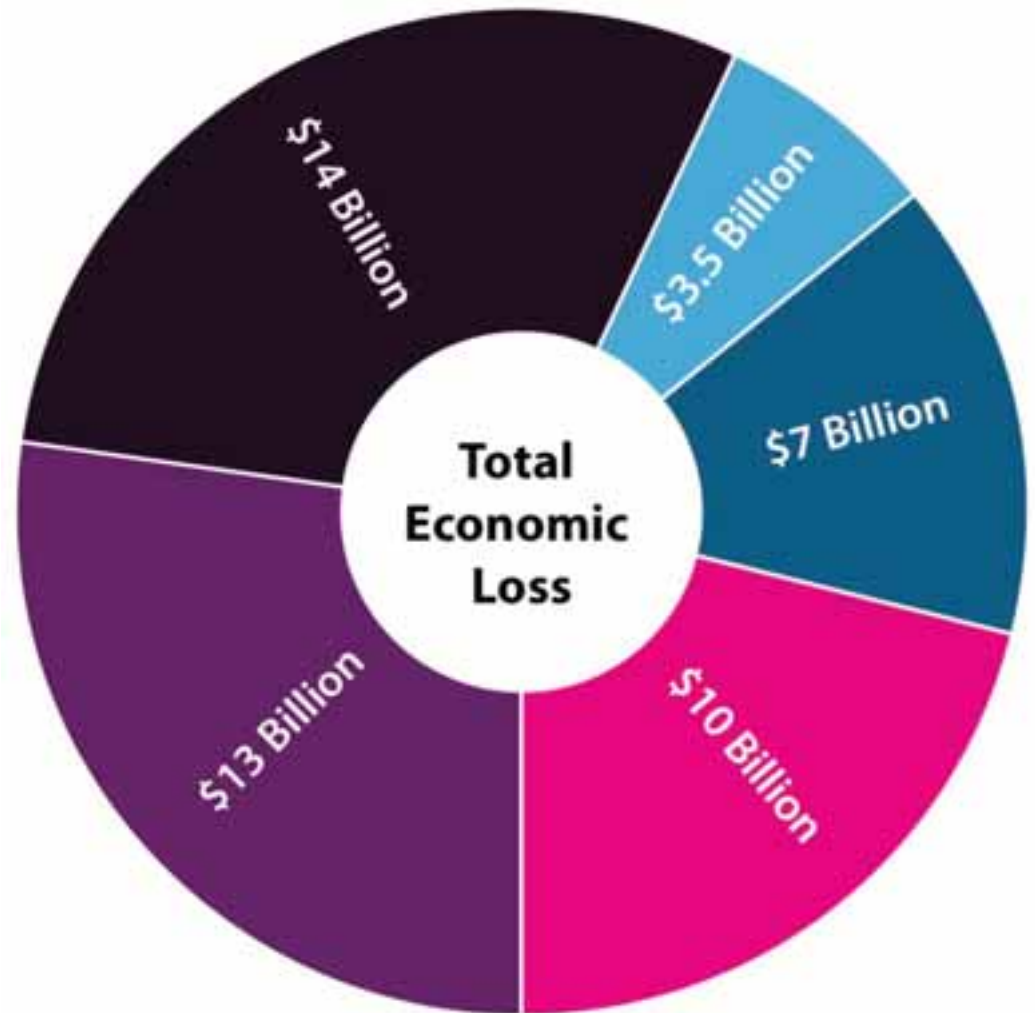


Coastal Flood Results

- **Comparison of Flood Losses from Coastal events**

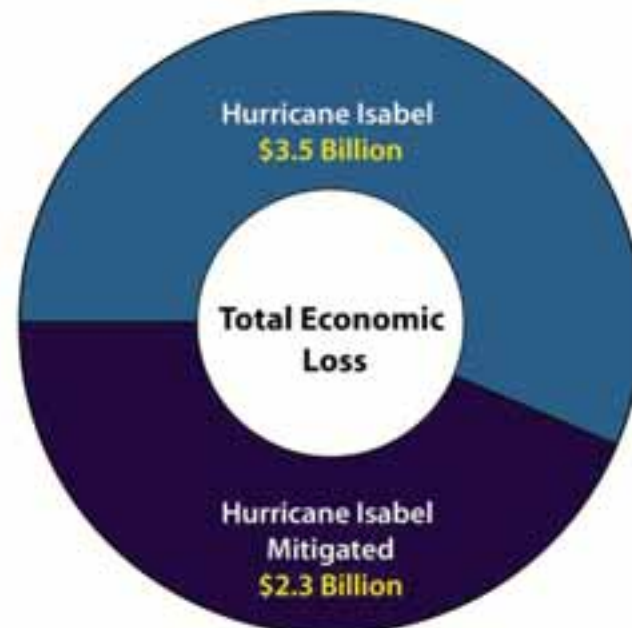
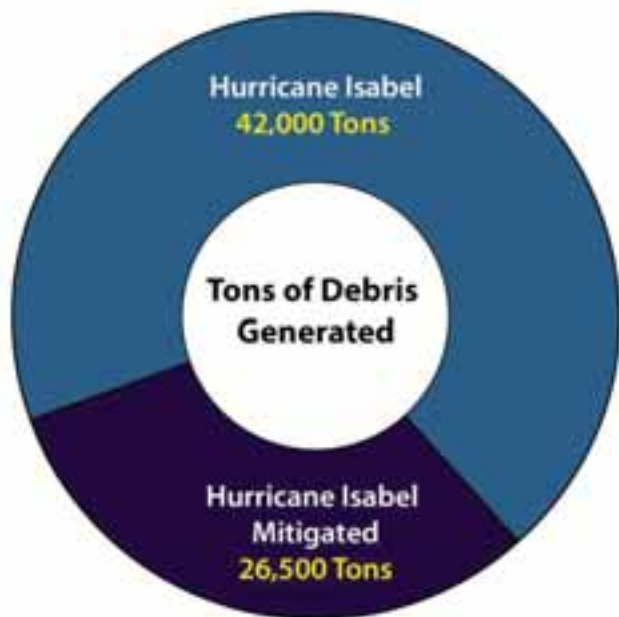
- Total Economic Loss
 - Direct - Building Loss
 - Indirect - Business Interruption

Hurricane Isabel	
Hurricane Isabel + 3ft	
Hurricane Isabel + 5ft	
Hurricane Isabel + 7ft	
Sandy Forecast	



Potential Reduced Losses from Mitigation Actions

- **Flood proofing: Elevate first floor and utilities in the .2% flood zone**
 - Coastal Structures – FFE elevated to 8 Ft
 - Riverine Structures – FFE elevated to 4 Ft – 8Ft
- **These mitigation measures potentially reduce economic losses caused by coastal flooding by more than \$1.2 Billion**



Utilizing the Results

- **Updated All-Hazard Mitigation Plan – Climate Change Adaptation**
 - Policy & Mitigation & Actions & Strategies
 - Infrastructure
 - Buildings
 - Natural Systems
 - Public Health
 - Continuity of Operations Planning
 - Defining and preparing for disaster response
 - Regulate to .2% Annual Flood Extent
 - Update Floodplain Ordinance with enhanced HAZUS analysis
 - Analyzing reduced losses from multiple mitigation strategies

Opportunities for Resilience & Mitigation – All-Hazard Mitigation Plan

- **Transportation**

- Integrate Climate change into transportation design, building and maintenance
- Alter transportation systems in flood-prone areas in order to effectively manage storm water

- **Waterfront**

- Enhance the resiliency of the City's waterfront to better adapt to impacts from hazard events and sea-level rise

- **Policy & Government Decision Making**

- Encourage the integration of climate change and natural hazards into private and State planning systems
- Develop City policy which requires new City government capital improvement projects to incorporate hazard mitigation principles

- **Buildings**

- Enhance building codes that regulate development within a floodplain or near a waterfront
- Update list of flood prone and repetitive loss buildings to consider for acquisition

Opportunities for Resilience & Mitigation – Continuity of Operations Planning

- **HAZUS analyses will define the potential impact from sea-level rise and inform:**
 - Public Outreach + Build Public Support
 - Communicate impacts of the preliminary Flood Insurance Rate Map (FIRM) and the economic impact to the business community
 - Apply for Community Rating System (CRS) Credit
 - 330 Outreach Projects – 350 Points
 - 410 Floodplain Mapping – 752 Points
 - 510 Floodplain Management Planning – 622 Points
 - Improve emergency planning with first responders
 - **Regulate to .2% Flood extent – Hurricane Isabel**
 - **More Restrictive Floodplain Regulations**
 - Update local floodplain ordinance beyond the NFIP requirements to capture potential impacts from sea-level rise
 - Put restrictions on Land Development Incentives in at risk areas - .2% flood extent















Questions?



FEMA

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