

What Works: The Cost Savings of Flood Mitigation Techniques

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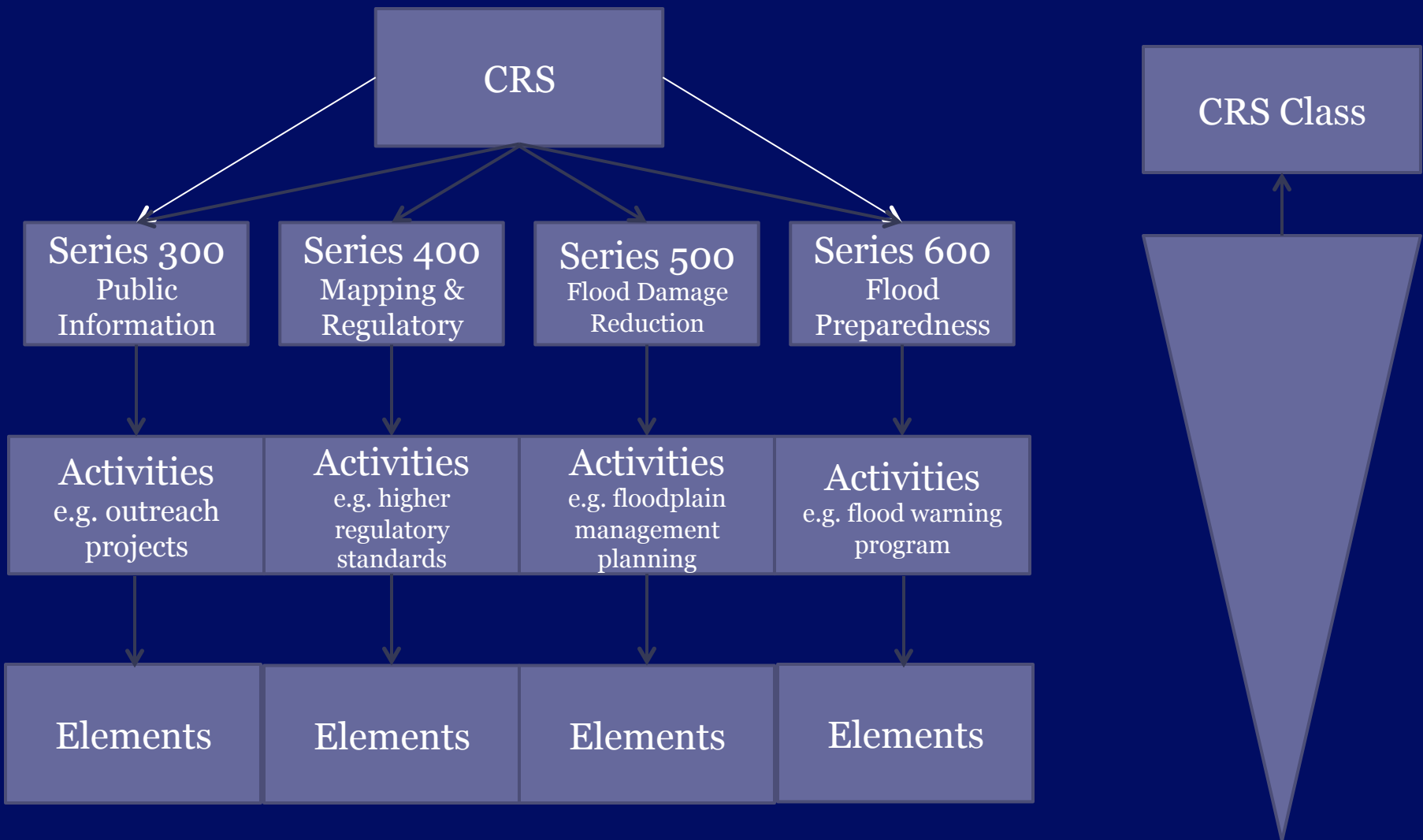


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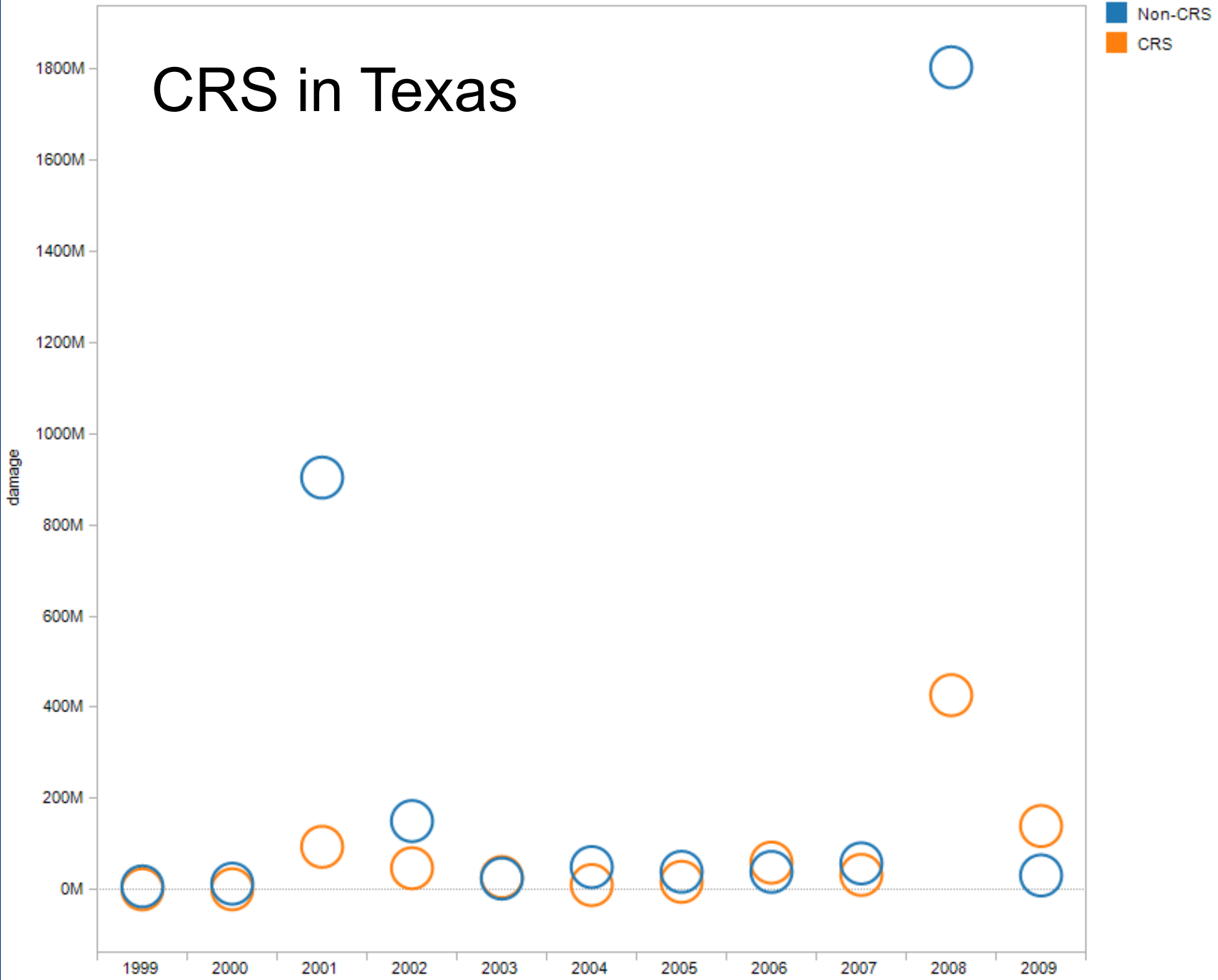
FEMA Community Rating System



Summary of CRS Activity Points

Activity	Maximum Possible Points	Average Points Earned	Maximum Points Earned	Percentage of Communities Credited
300 Public Information Activities				
310 Elevation Certificates	162	69	142	100%
320 Map Information Service	140	138	140	95%
330 Outreach Projects	380	90	290	86%
340 Hazard Disclosure	81	19	81	61%
350 Flood Protection Information	102	24	66	87%
360 Flood Protection Assistance	71	53	71	48%
400 Mapping & Regulatory Activities				
410 Additional Flood Data	1,346	86	521	29%
420 Open Space Preservation	900	191	734	83%
430 Higher Regulatory Standards	2,740	166	1,041	85%
440 Flood Data Maintenance	239	79	218	68%
450 Storm-water Management	670	98	490	74%
500 Flood Damage Reduction Activities				
510 Floodplain Management Planning	359	115	270	20%
520 Acquisition and Relocation	3,200	213	2,084	13%
530 Flood Protection	2,800	93	813	6%
540 Drainage System Maintenance	330	232	330	69%
600 Flood Preparedness Activities				
610 Flood Warning Program	255	93	200	30%
620 Levee Safety	900	198	198	1%
630 Dam Safety	175	66	87	81%

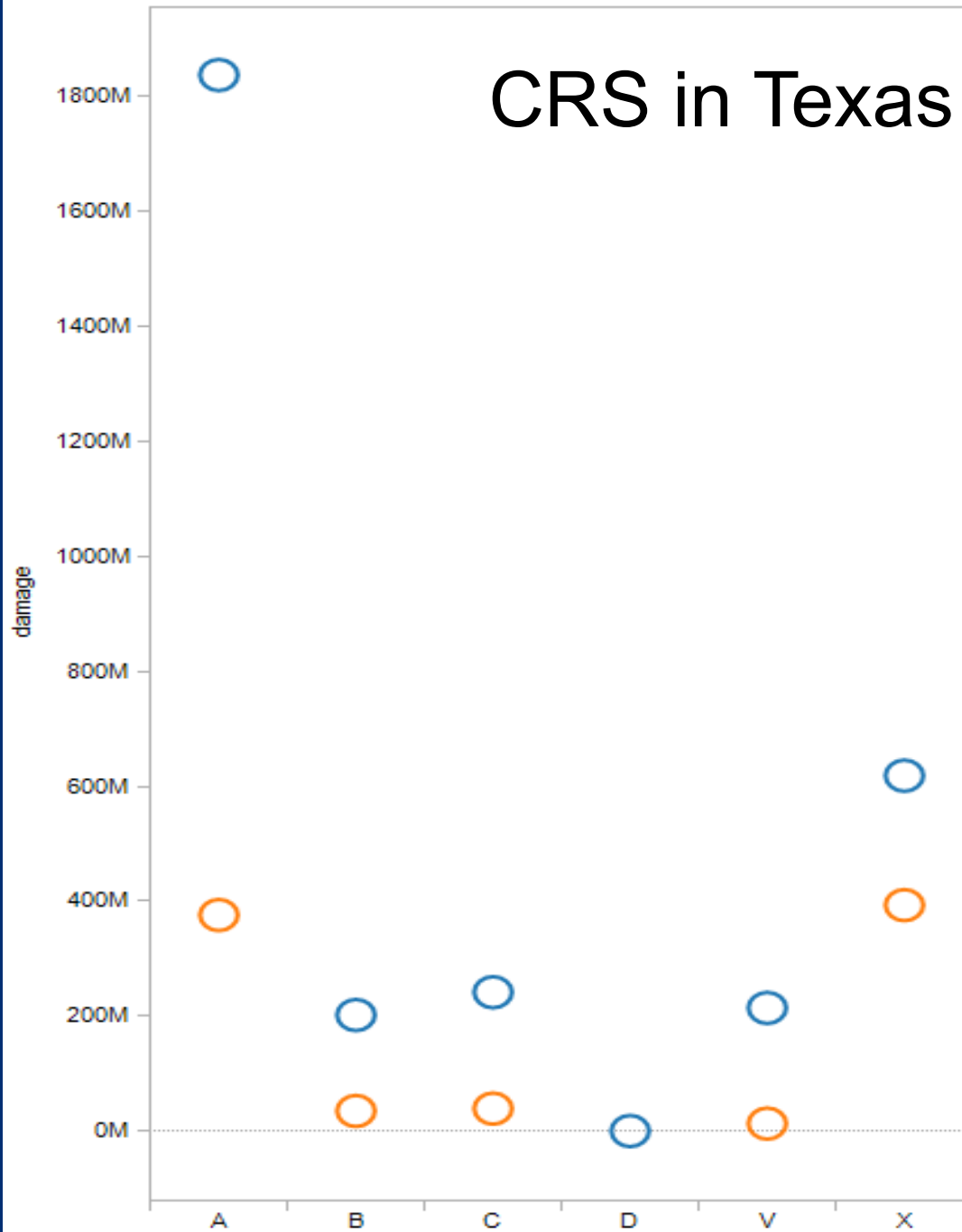
CRS in Texas



zone

CRS in Texas

CRS_in
■ Non-CRS
■ CRS



Single-State Studies

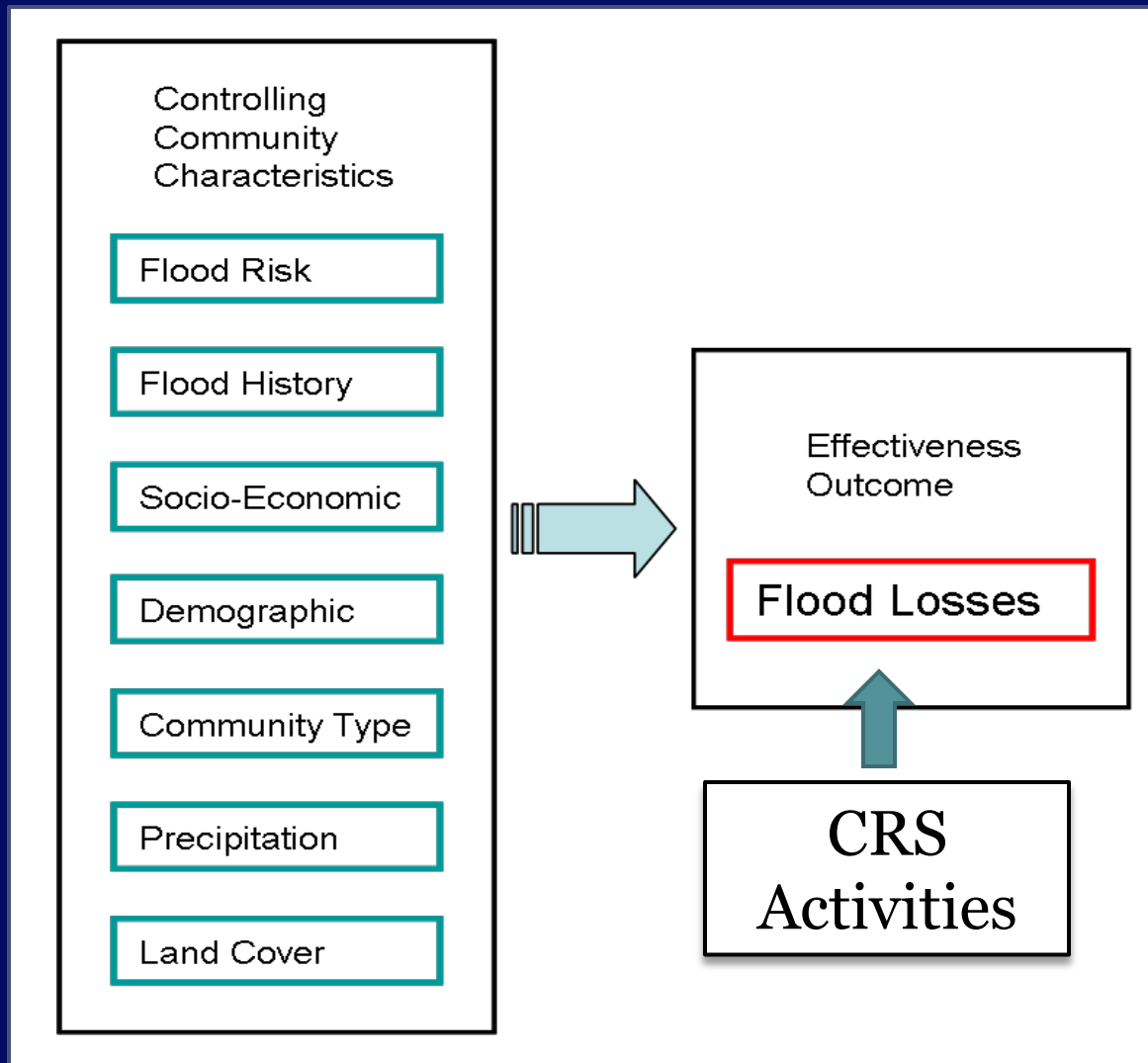
In Coastal Texas:

- A unit increase in the Community Rating System (CRS) equals **\$38,989** reduction in the average property damage per flood.

In Florida:

- A unit change in CRS rating equals **\$303,525** decrease in average amount of damage.

Conceptual Approach



A Representative National Study

- Tracked 450 CRS communities over a 11-year period: 1999-2009.
- Multiple measurements for each CRS community on a yearly basis—panel model.
- Isolate the effect of each selected CRS activity by controlling for other pertinent variables that differentiate participating CRS communities.
- 4,800 observations, \$11 billion in insured loss.

Summary of Damage Estimates

Damage Category	Mean	Std. Dev.	Min	Max
Total Damage	2,247,526	97,900,000	0	6,720,000,000
A-V Zone	1,853,905	84,800,000	0	5,840,000,000
B-C-D-X	387,395	13,100,000	0	869,000,000
Total Contents	421,932	17,200,000	0	1,170,000,000
A-V Zone Contents	324,610	13,900,000	0	949,000,000
B-C-D-X Contents	93,713	3,227,415	0	212,000,000
Total Building	1,825,594	80,700,000	0	5,550,000,000
A-V Zone Building	1,529,295	70,900,000	0	4,890,000,000
B-C-D-X Building	293,682	9,858,951	0	658,000,000

n=4848

Contextual Controls

Variable	Measurement
Flood Risk	
Floodplain	Proportion of jurisdiction containing 100-yr floodplain
Soil Permeability	Average soil permeability in inches per hour
Slope	Average percent slope
Inundation	
Precipitation	Hundredths of millimeters per year
Surge Event	Number of storm surge events per jurisdiction during the study period
Socioeconomic/Built Environment	
Housing Units	Number of housing units
Population	Number of people
Income	Median household income level
Impervious Surface	Proportion of jurisdiction covered by impervious surfaces based on summing 30 sq. meter pixels from remote sensing imagery.
Other	
Area of Jurisdiction	Number of square miles
Coastal Location	Distance from coastline in meters
Year Built	Year structure was built
NFIP Policies	Total count of insurance policies within a FEMA flood zone

National Findings - Freeboard

- The dollar savings of a one-point increase in the Freeboard element is equivalent to, on average, **\$10,114** per community per year.
- Based on average amount of points accrued for Freeboard, the total savings per year is equivalent to, on average, **\$960, 817**.

Avoidance

Vertical Avoidance, Elevated Structures



Avoidance

Vertical Avoidance, Elevated Structures



National Findings - Open Space

- The dollar savings of a one-point increase in activity 420 is equivalent to, on average, **\$3,147** per community per year.
- Based on average amount of points accrued for open space protection, the total savings per year for this activity is equivalent to, on average, **\$547,497**.

Avoidance

Horizontal Avoidance, Open Space Protection



Avoidance

Horizontal Avoidance, Setbacks and Buffers



Resistance

Multi-functional Barriers



Resistance

Multi-functional Barriers



Resistance

Single-functional Barriers



The Ike Dike strategy is to keep the ocean surge out of Galveston Bay by using a gated coastal barrier



Houston Ship Channel

Bolivar Peninsula

High Island

Bolivar Roads

Galveston Island

Existing Seawall

Coastal Spine

Intracoastal Waterway

• San Luis Pass

Passive Recreation Opportunities



Residential Connection Options



Protecting Open Space



Path of Synthetic Storm

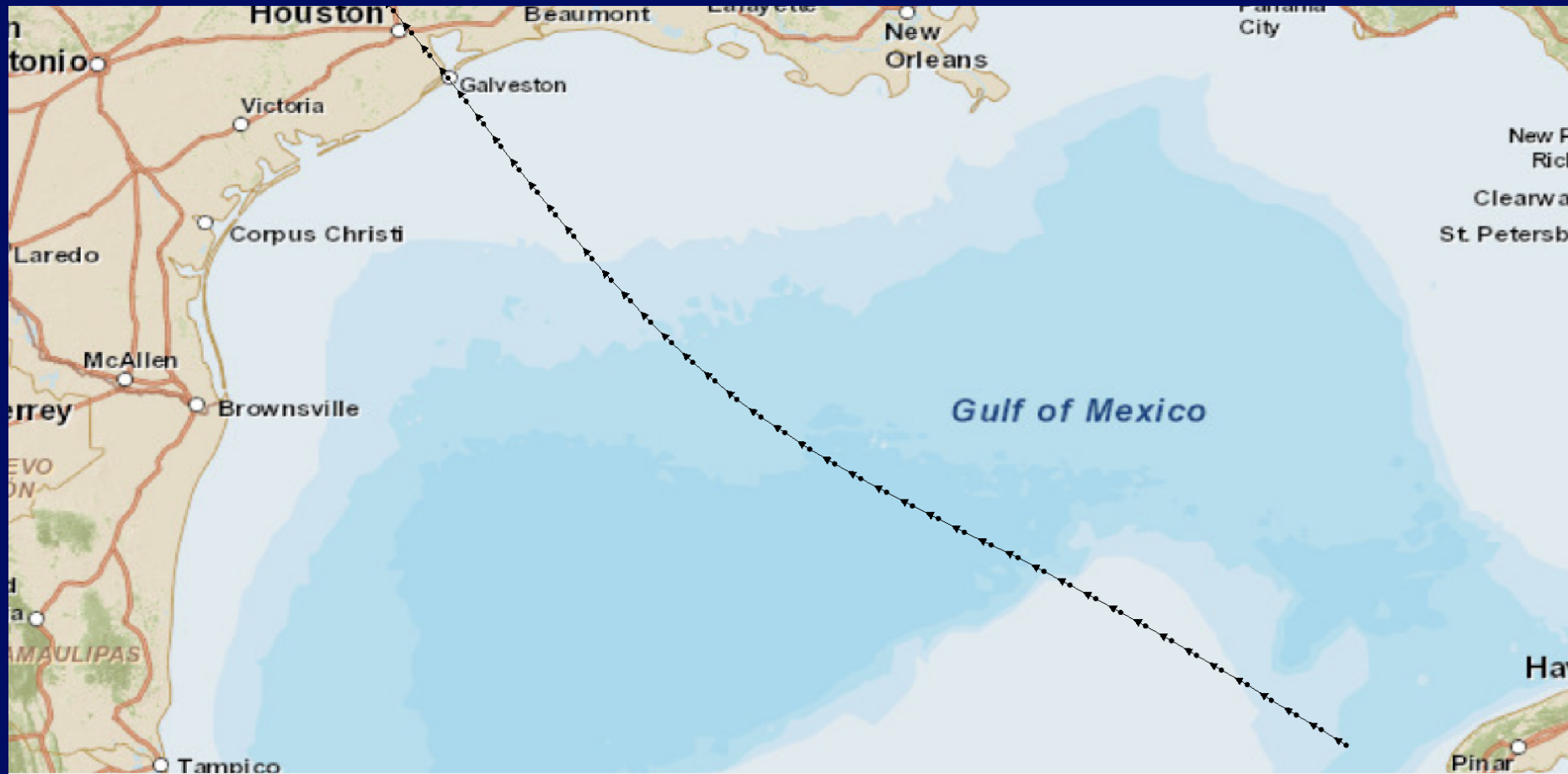


Figure 1: Inundation with Existing Conditions (Storm 122)

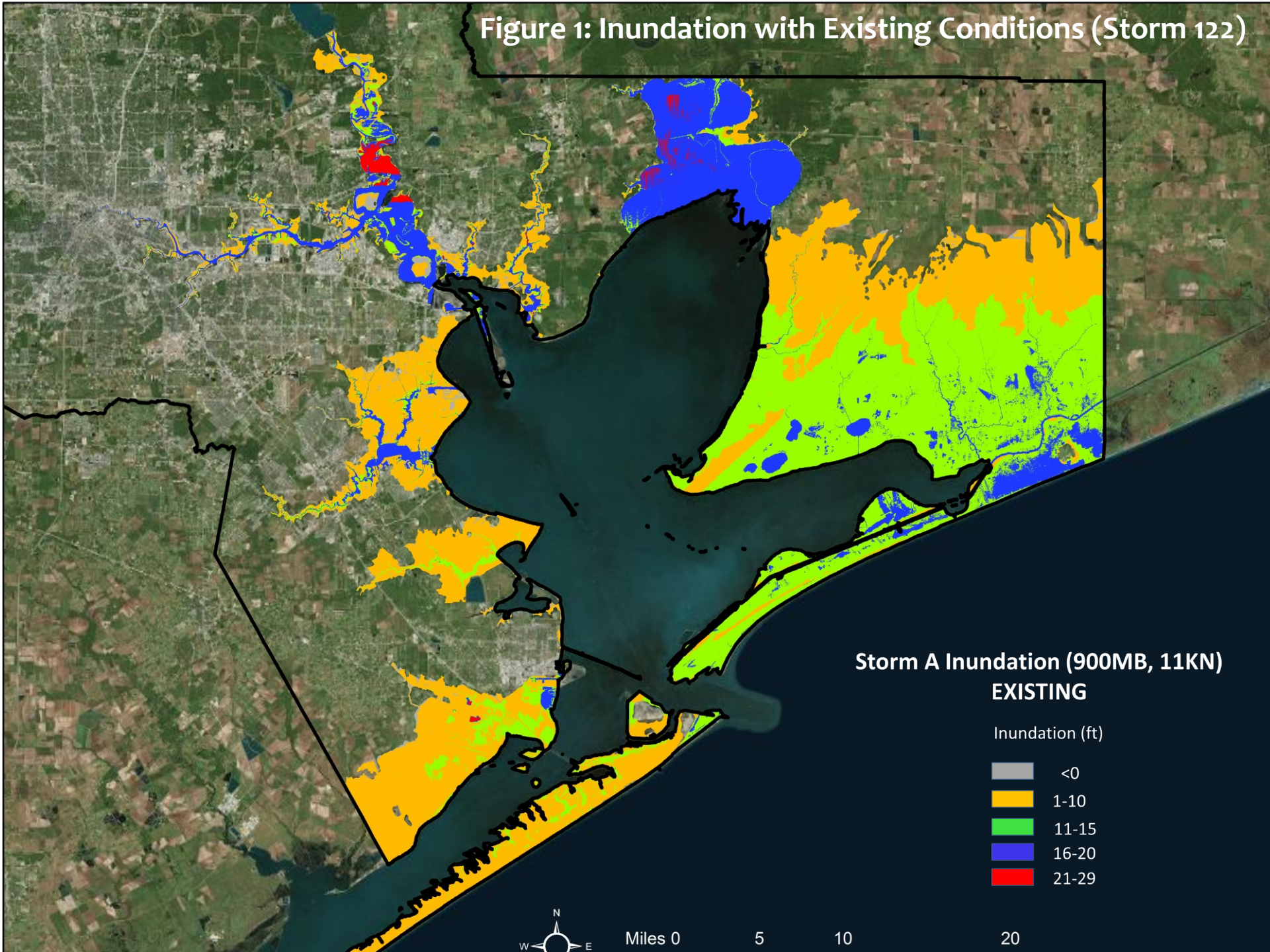
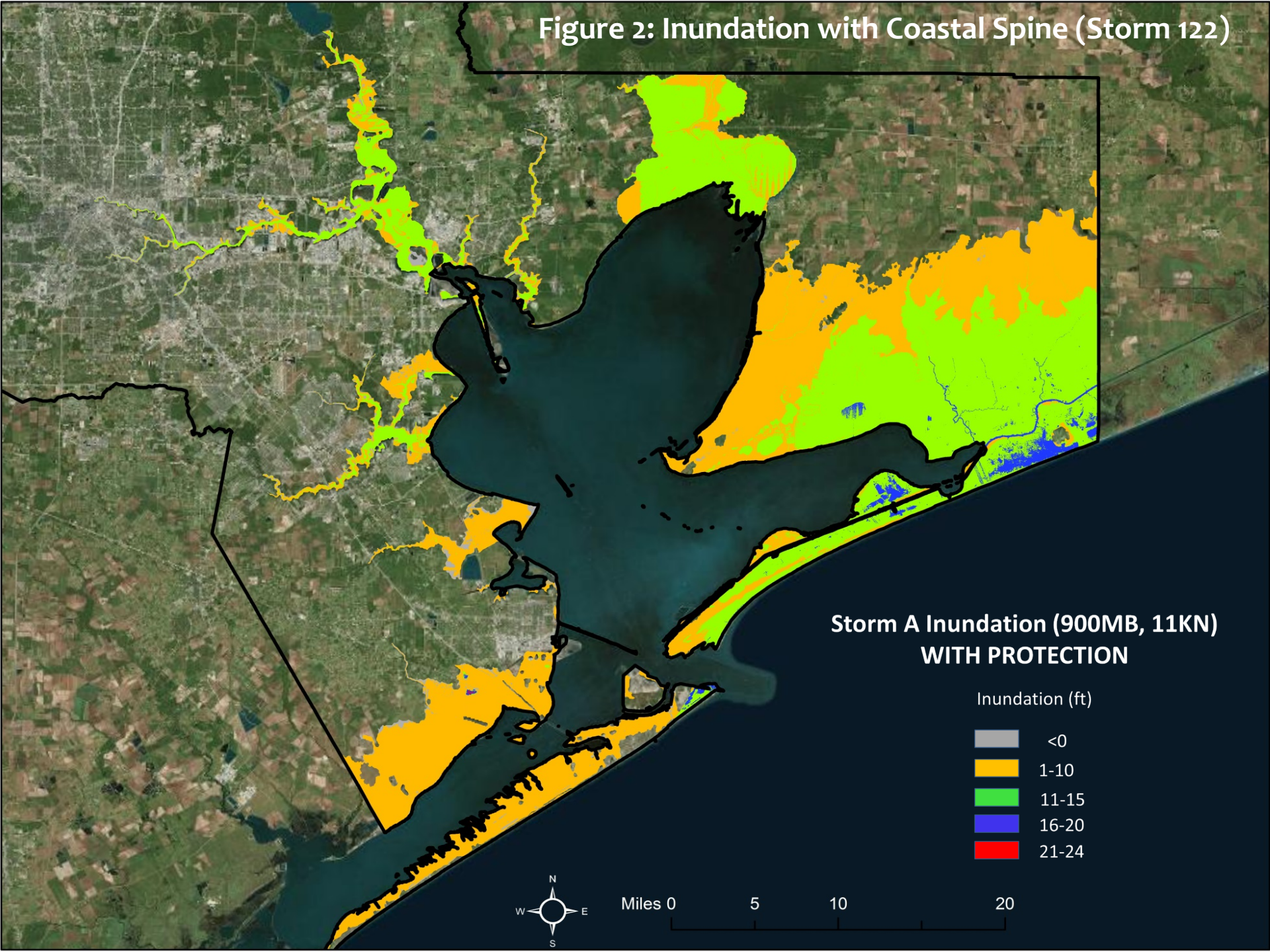


Figure 2: Inundation with Coastal Spine (Storm 122)



**Storm A Inundation (900MB, 11KN)
WITH PROTECTION**

Inundation (ft)

- <0
- 1-10
- 11-15
- 16-20
- 21-24



Miles 0 5 10 20

Figure 3: Total Building Loss from Storm 122 (Existing)

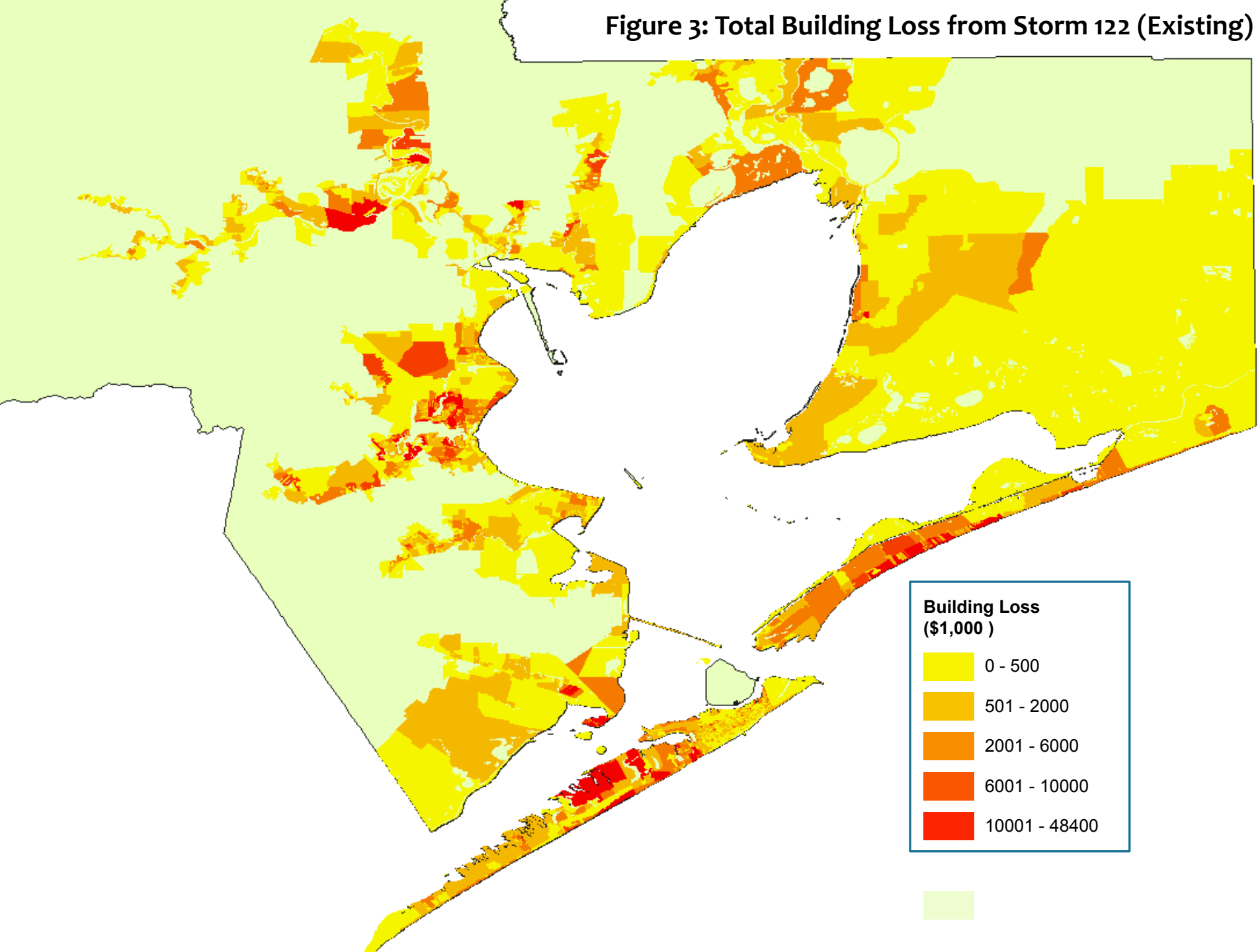
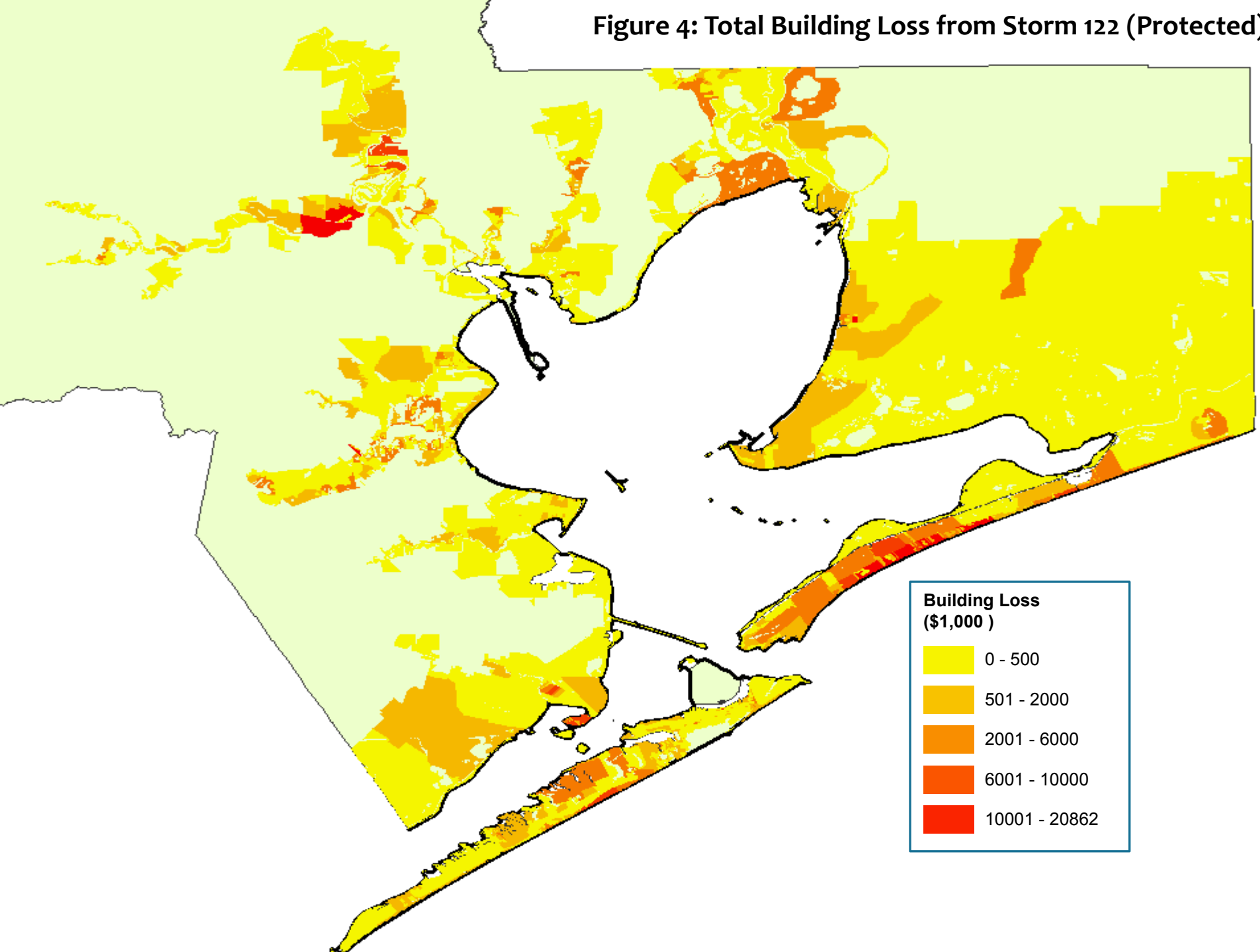


Figure 4: Total Building Loss from Storm 122 (Protected)

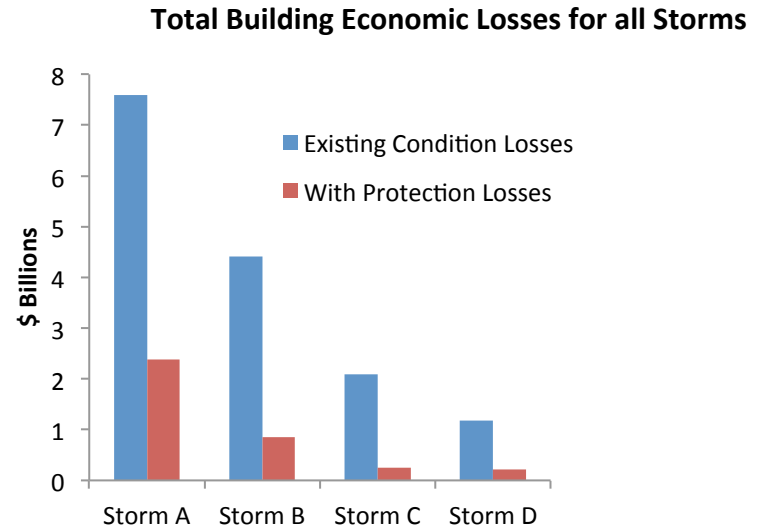
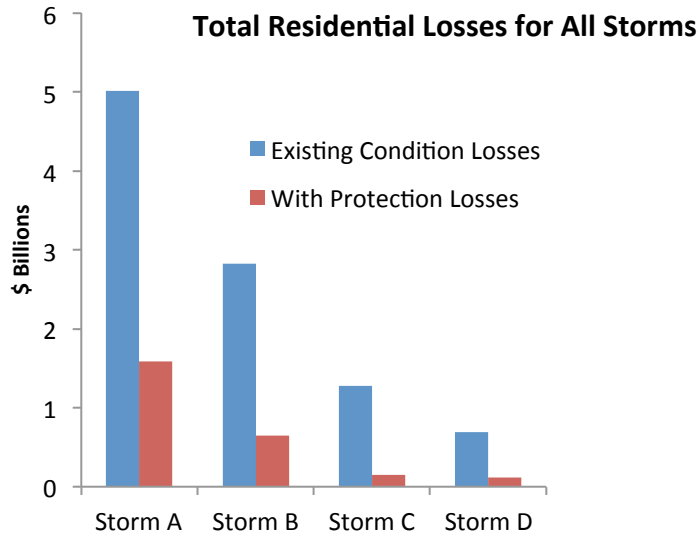


Total Residential Losses for All Storms (\$Billion)

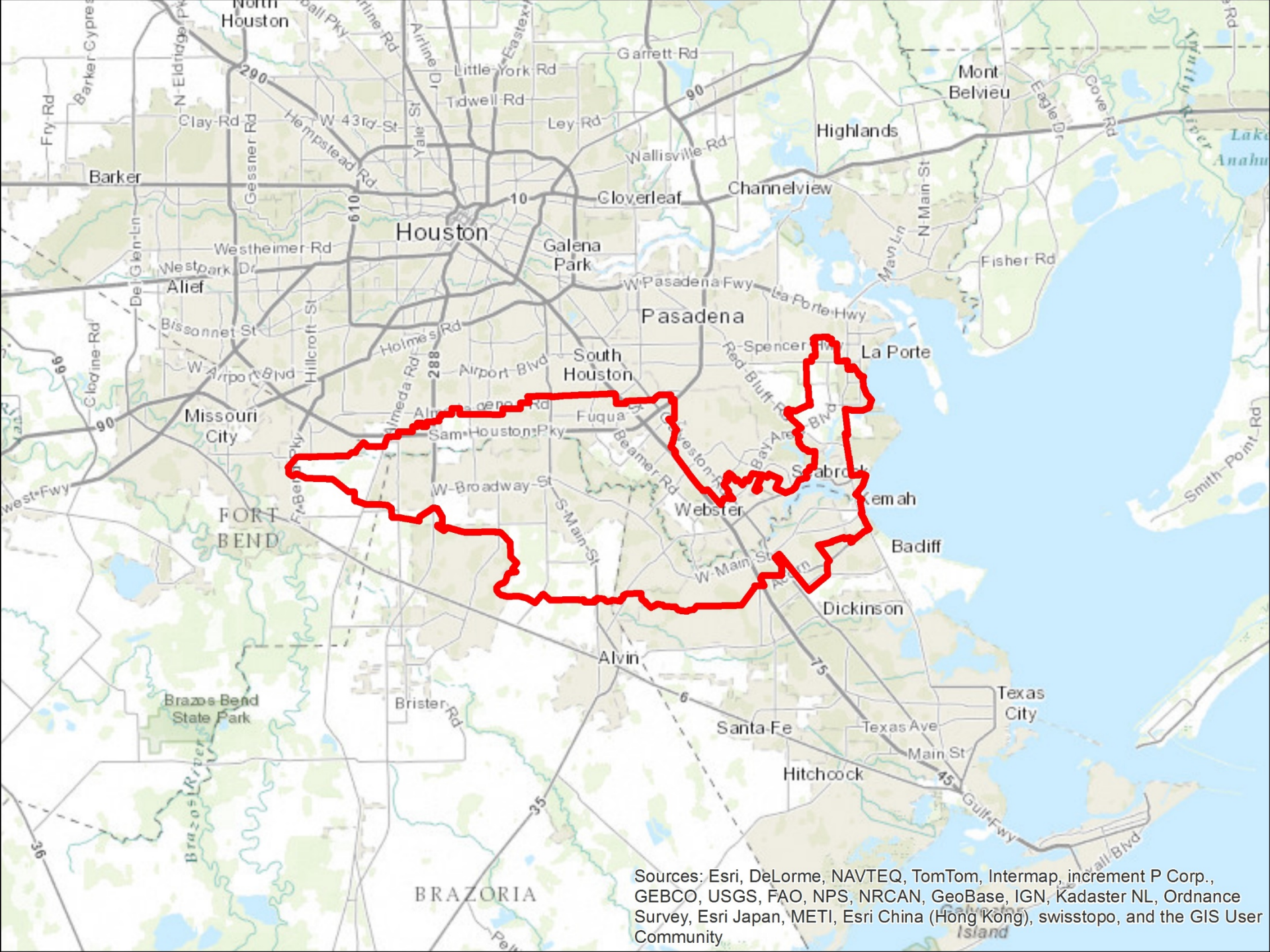
Storm	Existing Condition Losses	With Protection Losses
Storm A	5.01	1.59
Storm B	2.82	0.65
Storm C	1.28	0.15
Storm D	0.69	0.12

Total Building Economic Losses for All Storms (\$Billion)

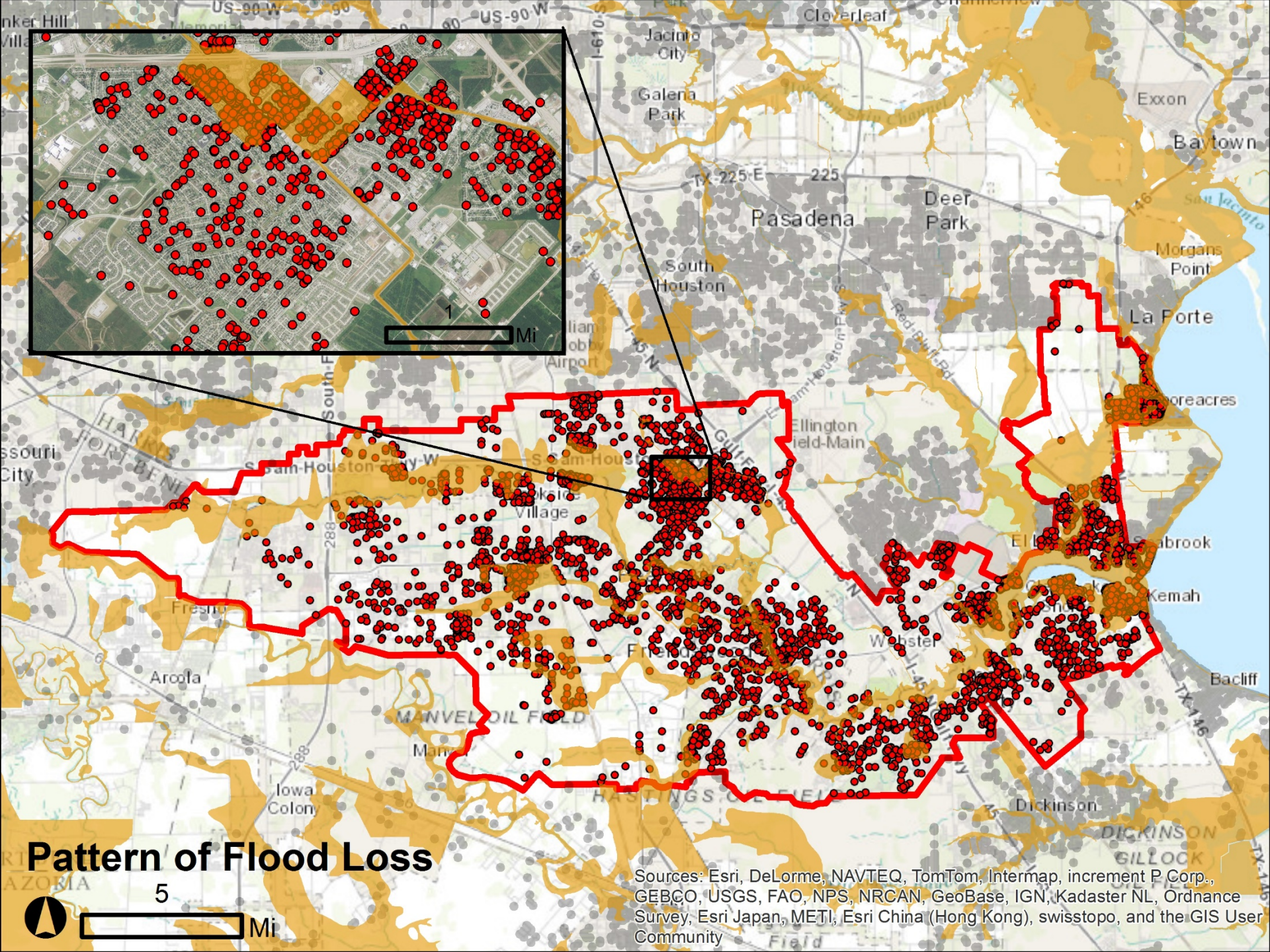
Storm	Existing Condition Losses	With Protection Losses
Storm A	7.6	2.39
Storm B	4.42	0.85
Storm C	2.09	0.25
Storm D	1.19	0.21



Clear Creek Watershed Case Study



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community



Pattern of Flood Loss



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Characteristics of Flood Loss

- Total loss (1999-2009) = \$356 million (9,800 claims)
- Average claim = \$36,585
 - 43% from Hurricane Ike
- **55% claims outside floodplain (40% of damage)**
 - Average distance from boundary = 1,378 ft
- Average distance from stream = 3,178 ft
 - Losses from Ike significantly closer.
- Average distance from coastline = 30,177 ft
 - Losses from Ike closer; Allison further inland.

Importance of Proximity

- Properties further away from floodplain experience less damage
 - 1 foot = \$23.20 decrease in reported damage
- ...BUT...
- Living a quarter mile outside the floodplain still leaves an expected loss of **\$12,972.**

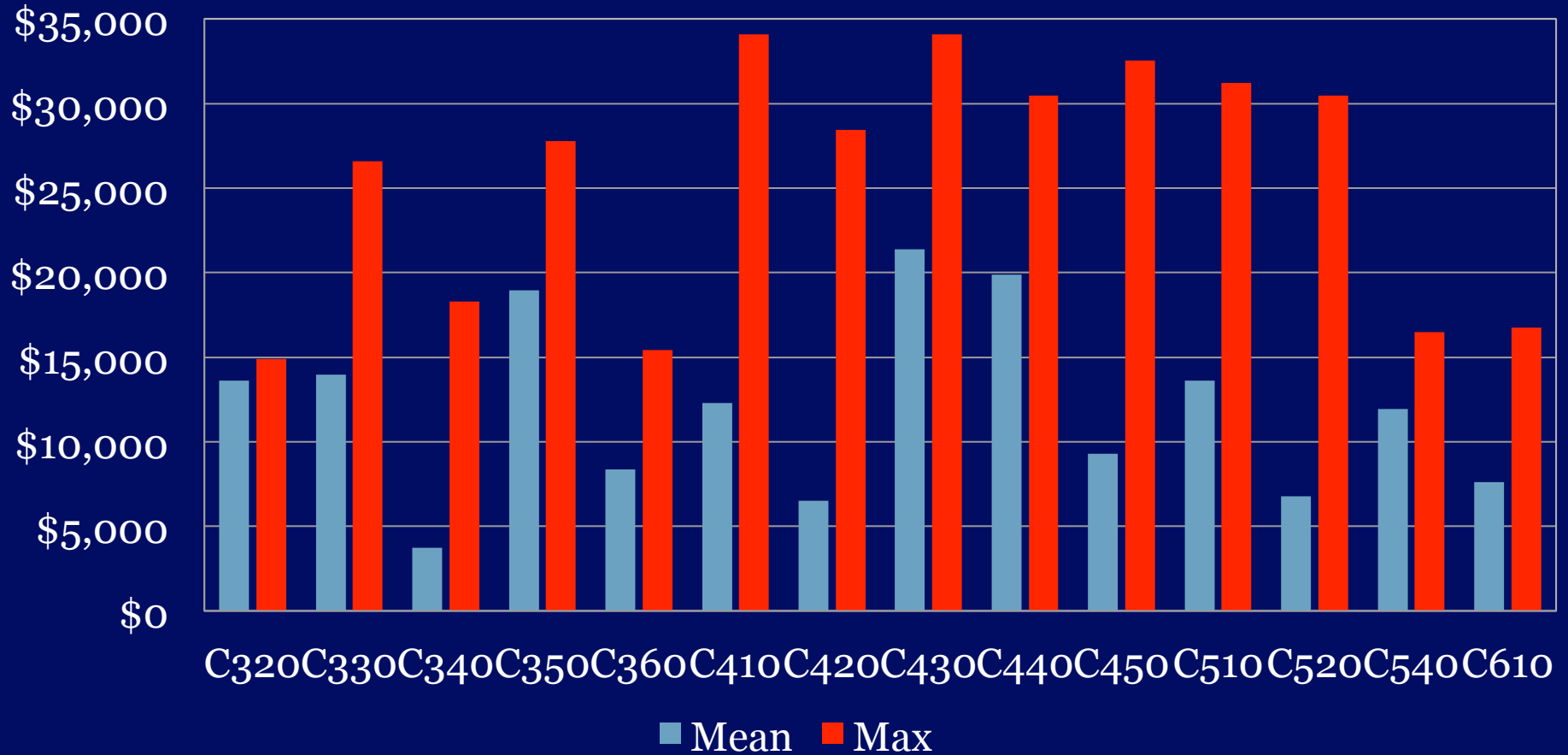
Implication of Location

- The 100-year floodplain boundary is a **poor predictor** of actual flood loss.
- Risk changes gradually but floodplain boundaries are dichotomous.
- The type of flood event is important in determining where losses will occur.
- Delineating flood risk based on **actual loss** may better capture/communicate risk.
 - More responsive to population density, land use, and home value.

Savings from Mitigation Activities

Activity	Mitigation Activity	Mean Points	Maximum Possible	Per Point	Total Mean Savings
320	Map Information	124	140	-\$140	-\$13,622
330	Outreach Projects	110	315	-\$164	-\$13,972
340	Hazard Disclosure	12	81	-\$324	-\$3,737
350	Flood Protection Info.	32	66	-\$873	-\$18,933
360	Flood Protection Assistance	33	71	-\$290	-\$8,386
410	Floodplain Mapping	29	1373	-\$518	-\$12,299
420	Open Space Protection	106	900	-\$68	-\$6,524
430	Higher Reg. Stds.	259	2720	-\$130	-\$21,358
440	Flood Data Maint.	90	231	-\$331	-\$19,895
450	Storm water Management	69	670	-\$157	-\$9,270
510	Floodplain Planning	64	309	-\$273	-\$13,622
520	Acquisition/Relocation	317	3200	-\$24	-\$6,788
540	Drainage System Maint.	216	330	-\$68	-\$11,937

Clear Creek CRS Savings



Applying National Data to Escambia County

Research Objectives

- Collect and analyze insured flood losses for unincorporated Escambia County.
- Leverage a national dataset to “down-scale” the effects of the most significant CRS activities.
- Estimate the percent reduction in insured flood losses based on the implementation of certain CRS activities.
- Conduct “what if scenarios” based on changing contextual conditions within the County to estimate future flood losses.

Mean Values for Escambia County, FL

Variable	Mean 2009
Year Built	1987.32
Percent SFHA	0.18
Population (1K)	289.50
Soil Permeability	4.93
Slope	32.13
Precipitation	80.18
Surge Event	0
Policies in SFHA	3860
CRS 420	232
CRS Freeboard	0

Community Scenarios

1. What if Escambia County received the national average (55.5) of CRS points for Freeboard in 2009 (it had 0 at the time)?
2. How much does open space protection in the floodplain (Activity 420) reduce insured flood losses?
3. What if there were 2 coastal surge events before the year 2040 impacting Escambia County?
4. What if Escambia County reached its projected population for the year 2040 of 386,800 people?
5. What if Escambia County increased the number of NFIP policies within the SFHA from 3,869 to 5,000?

Percent Change in Flood Losses

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Total Damage	-20.02%	-38.93%	756.12%	38.05%	---
SFHA Damage	-17.35%	-40.43%	804.10%	23.09%	29%
non-SFHA Damage	-5.44%	-29.62%	470.15%	30.06%	---

Lessons Learned for Resiliency

- Take a systems approach
- Plan for a multi-hazard setting
- Work with natural functions
- Avoidance preferred approach before new development in floodplain occurs
- Structural modifications effective with existing development
- Consider urban form and development patterns



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