Coastal Hazards and Social Vulnerability: The Texas Coast

Presentation to the Gulf Coast Ecosystem Restoration Task Force
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Natural Disasters are too often treated as acute problems

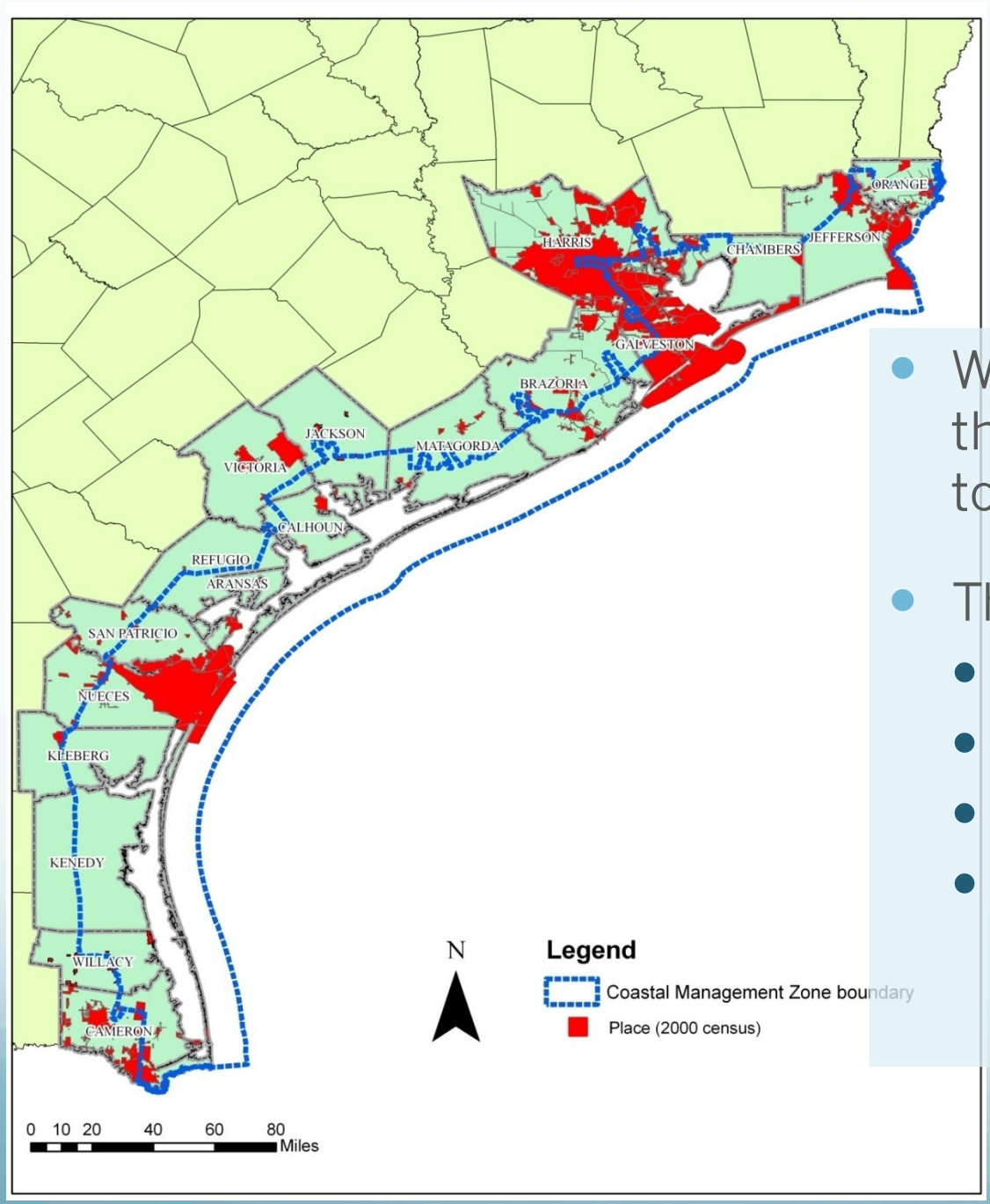
- The scientific consensus is that natural disasters are not simply “natural” events…
  - They are an outcome of the interaction between biophysical systems, human systems, and their built environment
- Human action (or inaction) is in large measure driving these events:
  - We continue to develop and expand into high hazard areas with the consequences of…
    - Increasing hazard exposure
    - and destroying or compromising natural resources and the potential services they are providing. A prime example is the destruction of our nation’s wetlands.

Ecosystem Restoration/Preservation & Coastal Hazards

- Ecosystem restoration/preservation **and** coastal hazards are inextricably related to each other
  - Destruction and compromising of ecosystems, such as wetlands, can increase the severity of hazard impacts through…
    - a loss of ecosystem services
      - Increases flooding losses as well as causalities can result
    - increasing exposure to coastal hazards such as surge and flooding
    - Unfortunately, as we shall see there has been extensive destruction and disruption of wetlands along the Texas coast.
  - Preservation and restoration of ecosystems can and should be an important element of hazard mitigation policies and programs
    - Unfortunately, as we will see, these are neglected elements within hazard mitigation planning, particularly in Texas.

For detailed discussions and analysis of wetland alteration, its consequences and an extensive focus on the Texas coast see: Brody, Highfield, and Kang 2011; Brody and Zahran 2008; Brody, Davis, Highfield, and Bernhardt 2008, Brody, Zahran, Highfield, Grover, and Vedlitz 2007; Brody, Highfield, Ryu, and Spanel-Weber 2007; and Zahran, Brody, Peacock, Grover and Vedlitz. 2008.

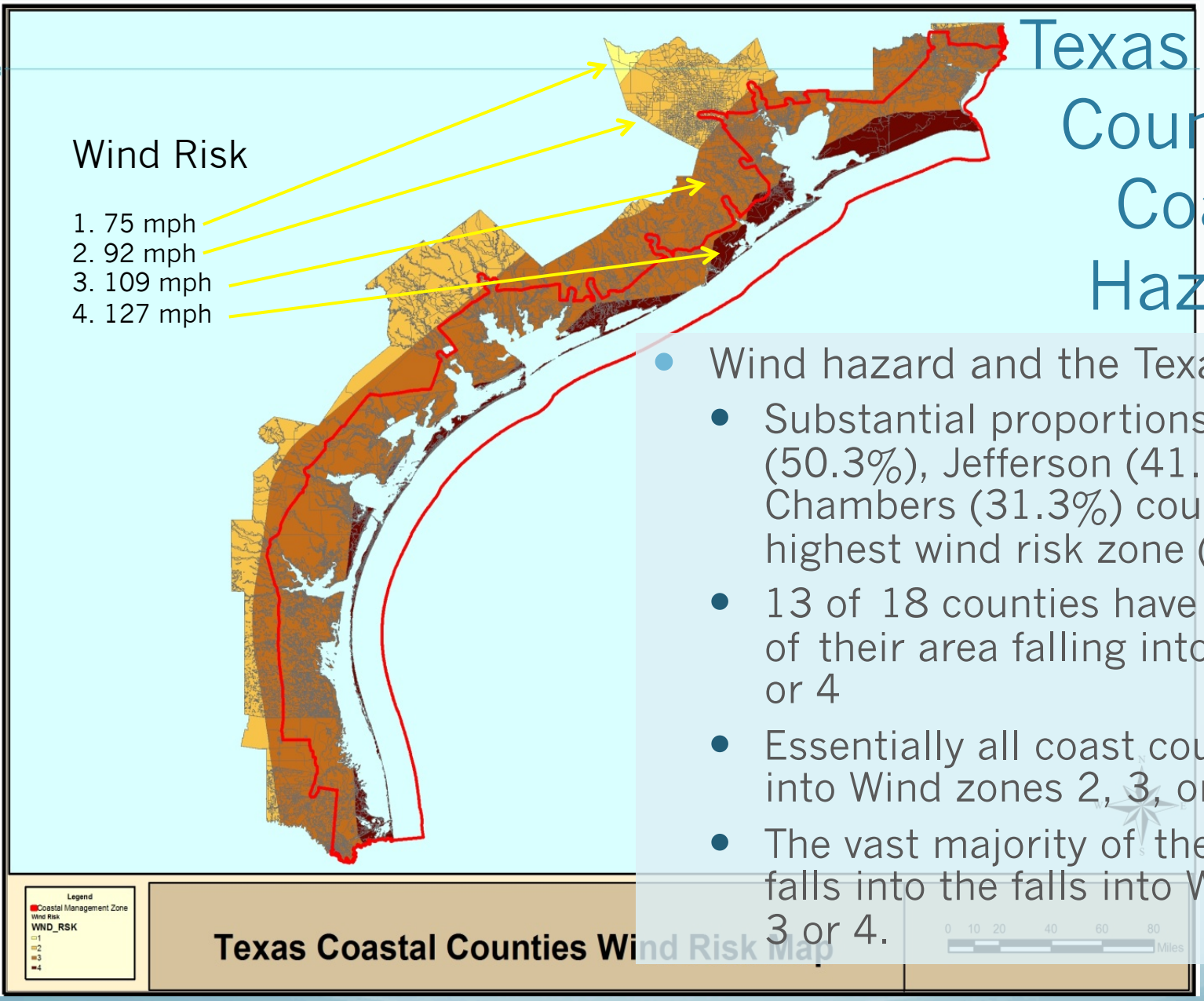
Texas Coastal Counties & Coastal Hazards



- We will begin by exploring the Texas coast's exposure to coastal hazards*
- The Texas Coast:
  - 18 coastal counties
  - 228 coastal municipalities
  - 39,546 sq. kilometers
  - 47.6% of this area is located in our Coastal Management Zone (CMZ)

* A more complete discussion of Texas coastal county hazard exposure, with particular reference to the Coastal Management Zone can be found in Peacock, Kang, Lin, Grover, Husein, and Burns. 2009.

Texas Coastal Counties & Coastal Hazards*



- Wind hazard and the Texas Coast:
  - Substantial proportions of Galveston (50.3%), Jefferson (41.7%) and Chambers (31.3%) counties are in the highest wind risk zone (4)
  - 13 of 18 counties have 80% or more of their area falling into risk zones 3 or 4
  - Essentially all coast county areas fall into Wind zones 2, 3, or 4.
  - The vast majority of the entire CMZ falls into the falls into Wind risk zones 3 or 4.

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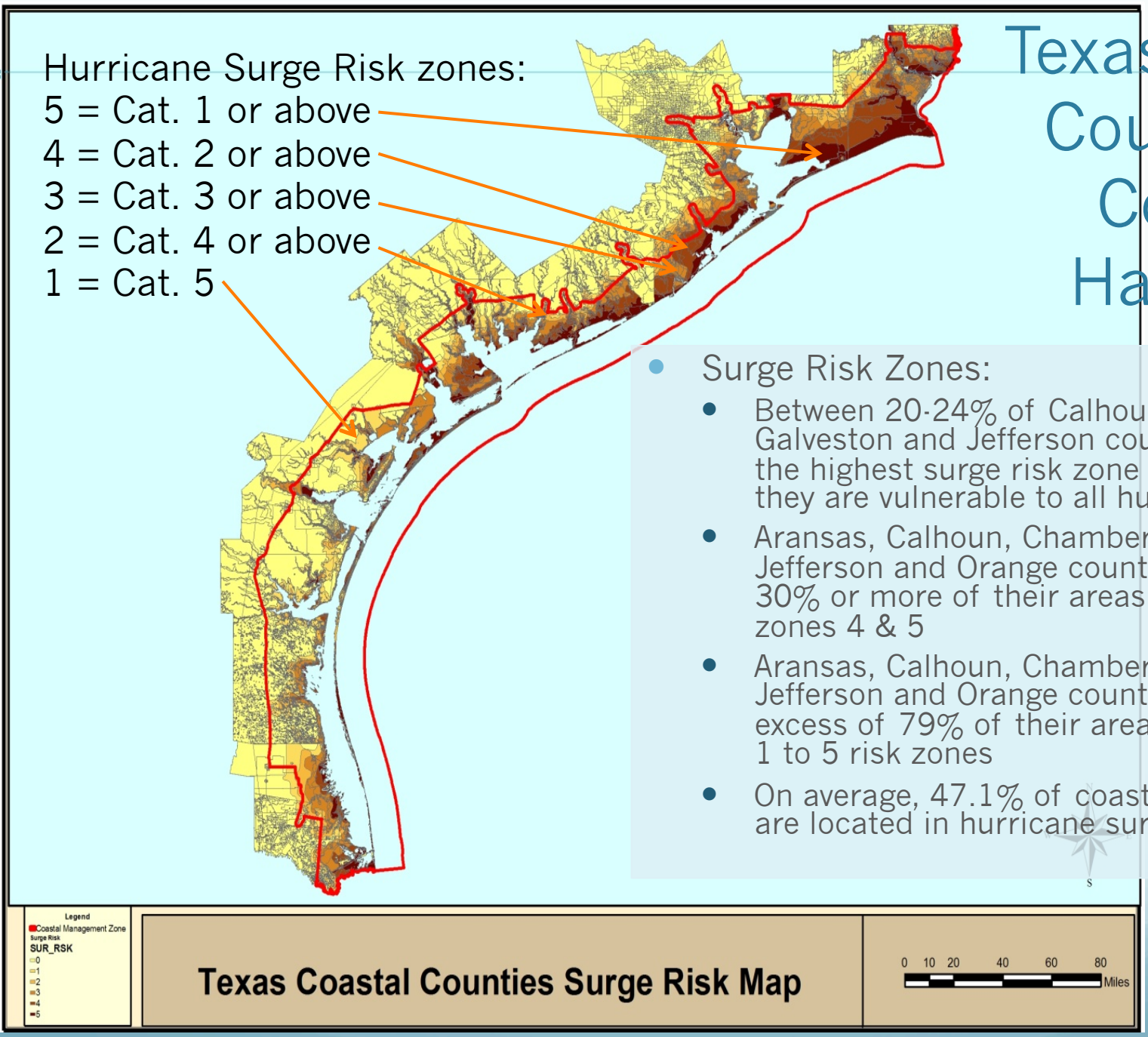
Texas Coastal Counties & Coastal Hazards*



- Surge Risk Zones:
  - Between 20-24% of Calhoun, Chambers, Galveston and Jefferson counties fall into the highest surge risk zone (5) (meaning they are vulnerable to all hurricanes).
  - Aransas, Calhoun, Chambers, Galveston, Jefferson and Orange counties all have 30% or more of their areas located in zones 4 & 5
  - Aransas, Calhoun, Chambers, Galveston, Jefferson and Orange counties all have in excess of 79% of their areas located in Cat 1 to 5 risk zones
  - On average, 47.1% of coastal county areas are located in hurricane surge risk zones.

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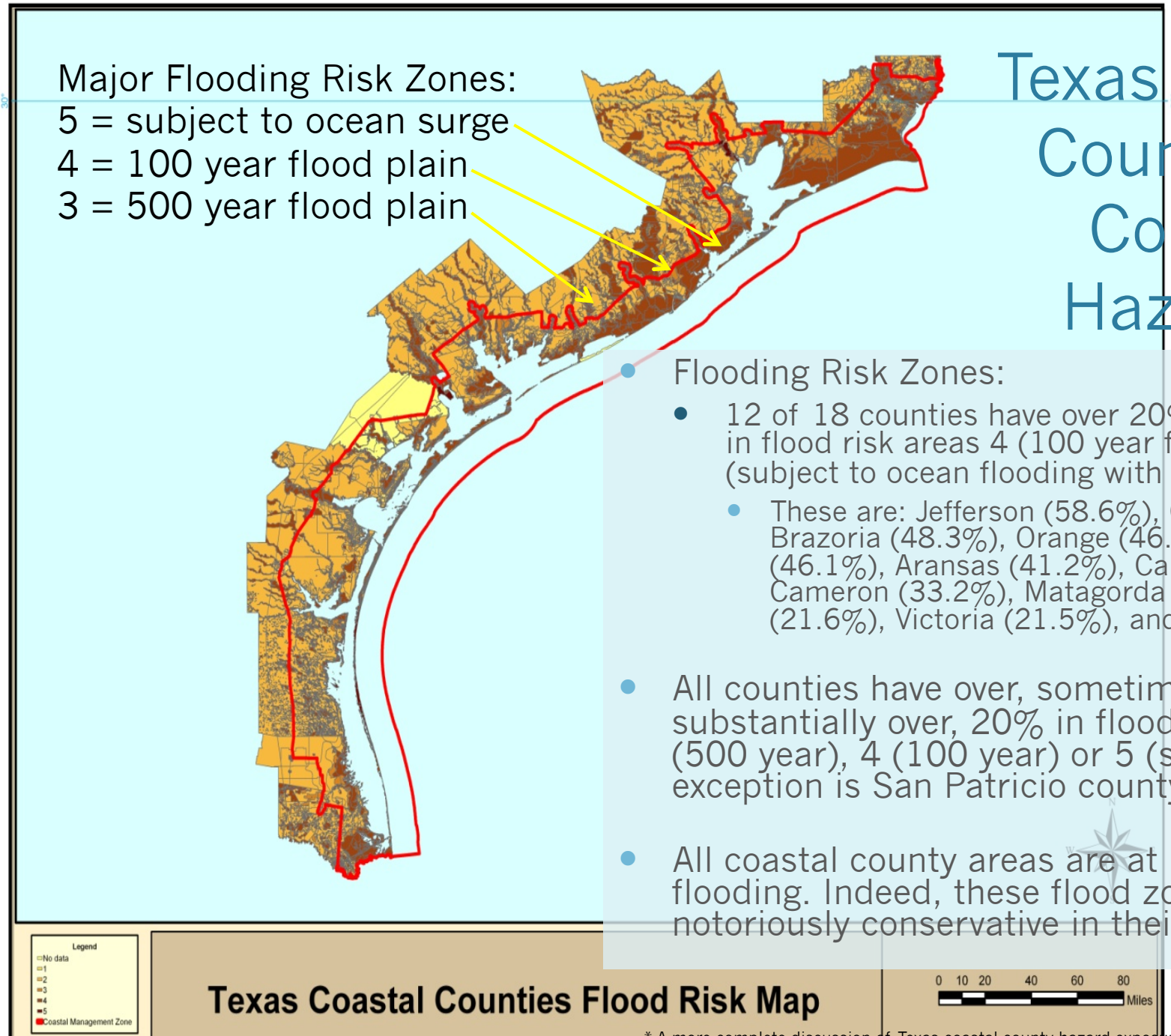
Texas Coastal Counties & Coastal Hazards*



- Flooding Risk Zones:
  - 12 of 18 counties have over 20% of their areas in flood risk areas 4 (100 year flood plain) or 5 (subject to ocean flooding with wave action)
    - These are: Jefferson (58.6%), Chambers (50%) Brazoria (48.3%), Orange (46.6%), Galveston (46.1%), Aransas (41.2%), Calhoun (33.9%), Cameron (33.2%), Matagorda (27.2%), Harris (21.6%), Victoria (21.5%), and Kenedy (20.9%).
- All counties have over, sometimes substantially over, 20% in flood risk zones 3 (500 year), 4 (100 year) or 5 (surge). The only exception is San Patricio county at 18.4%.
- All coastal county areas are at risk of flooding. Indeed, these flood zones are notoriously conservative in their assessments.

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Coastal Hazard Impacts 1960-2007*

Dates	Injuries	Deaths	Damage ($)
1960 - 1969	274	43	485,138,177
1970 - 1979	201	55	1,320,582,653
1980 - 1989	1072	48	1,381,191,030
1990 - 1999	102	15	393,932,143
2000 - 2007	69	19	2,648,787,945
Totals	**1718**	**180**	**6,229,631,948**

* Data are from the Hazards & Vulnerability Research Institute (2010). The Spatial Hazard Events and Losses Database for the United States, Version 8.0 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org . Damage are transformed into constant 2007 dollars.
NOTE: does not include Hurricane Ike, with its estimated 19.3 billion in losses and estimates that 20 people died directly due to storm, 64 for indirect reasons, and ~34 missing.

Coastal Hazard Impacts 1960-2008*

** Including Ike's estimates, interpret with caution **

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1990 - 1999	102	15	393,932,143
2000 - 2008	69	103	21,948,787,945
Totals	**1718**	**264**	**25,529,631,948**

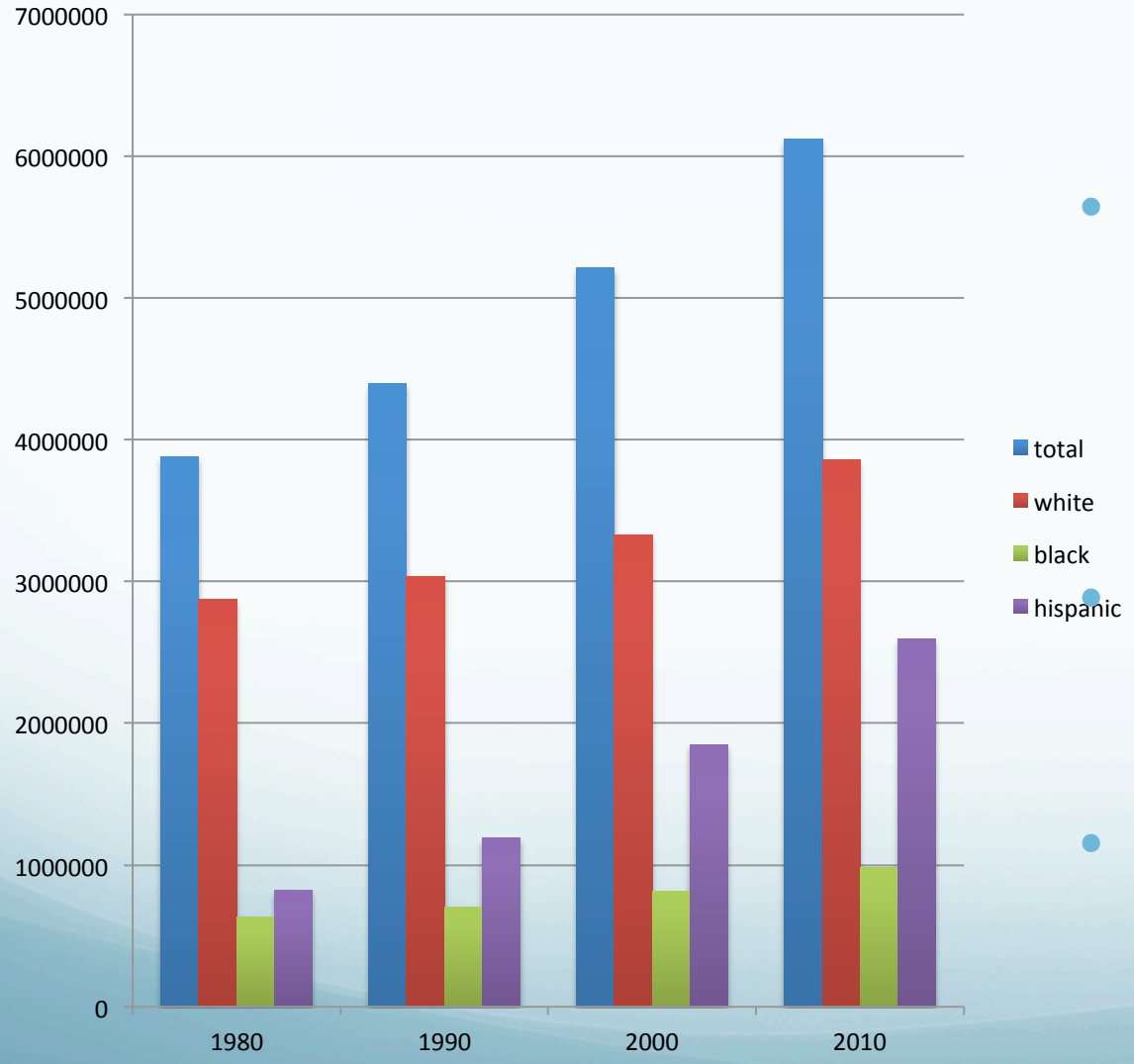
* Most data are from the Hazards & Vulnerability Research Institute (2010). The Spatial Hazard Events and Losses Database for the United States, Version 8.0 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org . Damage in constant 2007 dollars. However, the 2008 estimate losses due to Ike have been added to the final two rows – this is just for illustrative purposes.

NOTE: does not include Hurricane Ike, with its estimated 19.3 billion in losses and estimates that 20 people died directly due to storm, 64 for indirect reasons, and ~34 missing.

Texas Coastal Counties & Coastal Hazards

- Clearly we see substantial hazard exposure when considering wind, surge, and flooding to Texas coastal counties.
- And, we also see substantial losses, particularly when we factor in Hurricane Ike.
- Coastal counties have also experience considerable
  - population growth
  - and increasing demographic diversity.

Coastal County Population Trends*

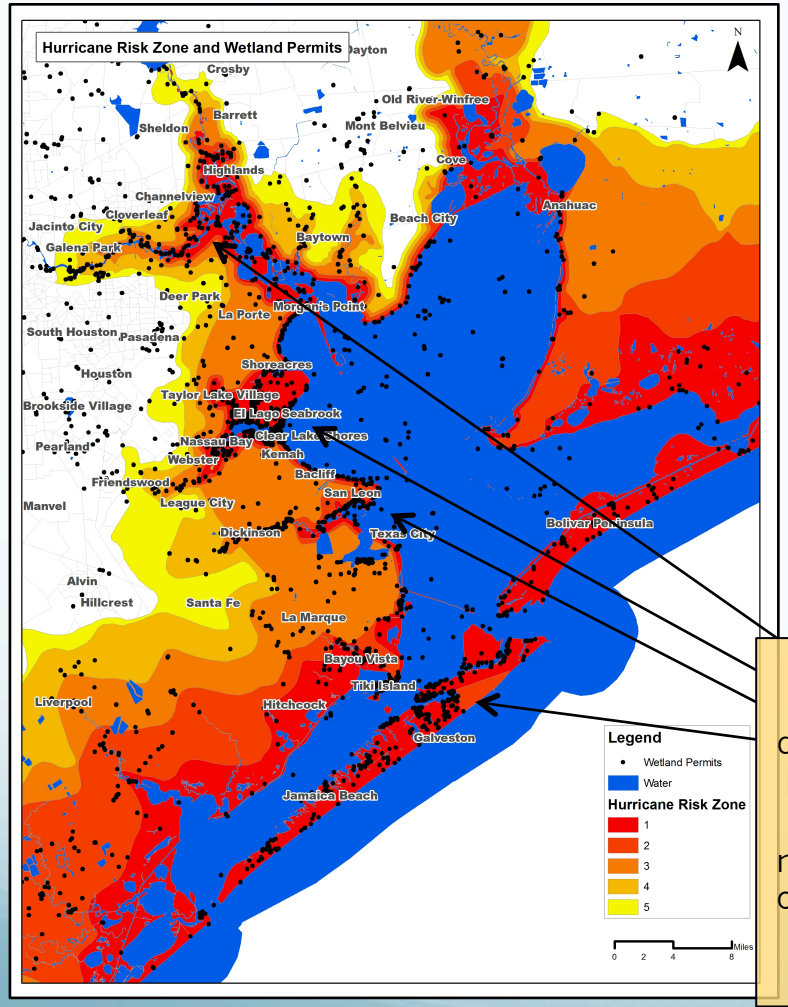


- Significant overall population growth:
  - 3.8 to 6.1 million people by 2010
  - 57.8% increase in population
- Increased diversity
  - White: 2.87 m. to 3.86 m.
    - 34.3% increase
  - Black: 630K to 979K
    - 55.3% increase
  - Hispanic: 824K to 2.6 m.
    - 214.7% increase
- NET RESULT: high concentrations of an increasingly diverse population in coastal counties that have high exposure to coastal hazards.
- These levels of population growth have not come without "developmental" consequences to coastal ecosystems, particularly wetlands…

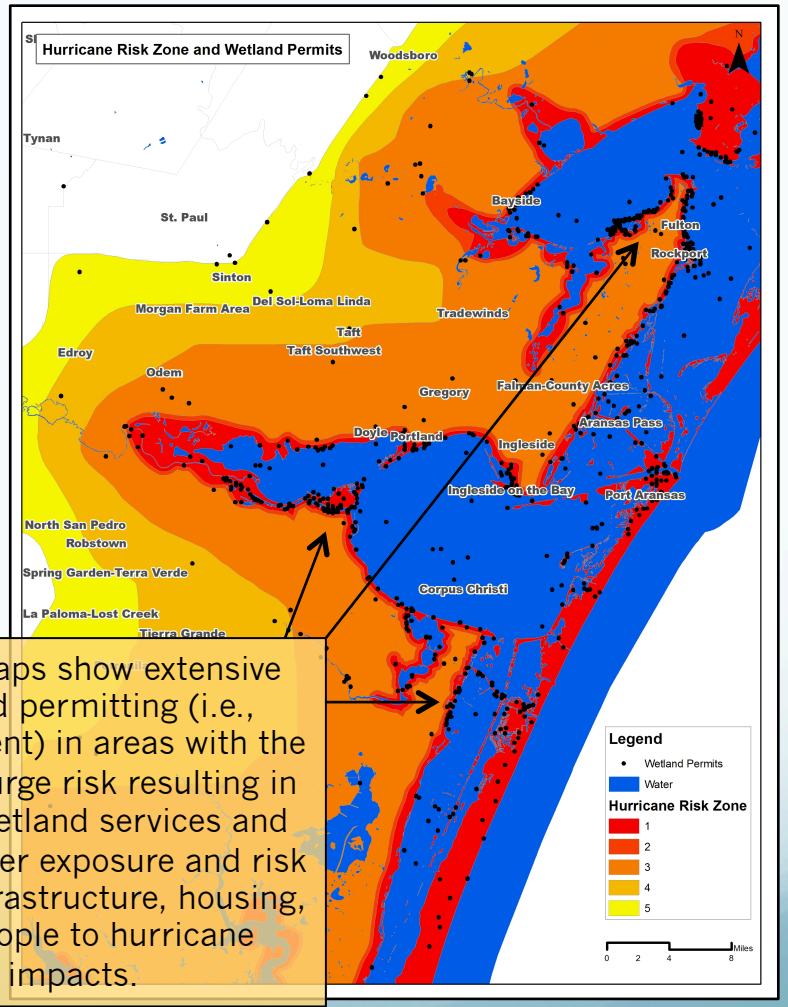
Population Size and Composition: Texas Coastal Counties

*Data from the U. S. Census

Associated ecosystem disruption/compromise



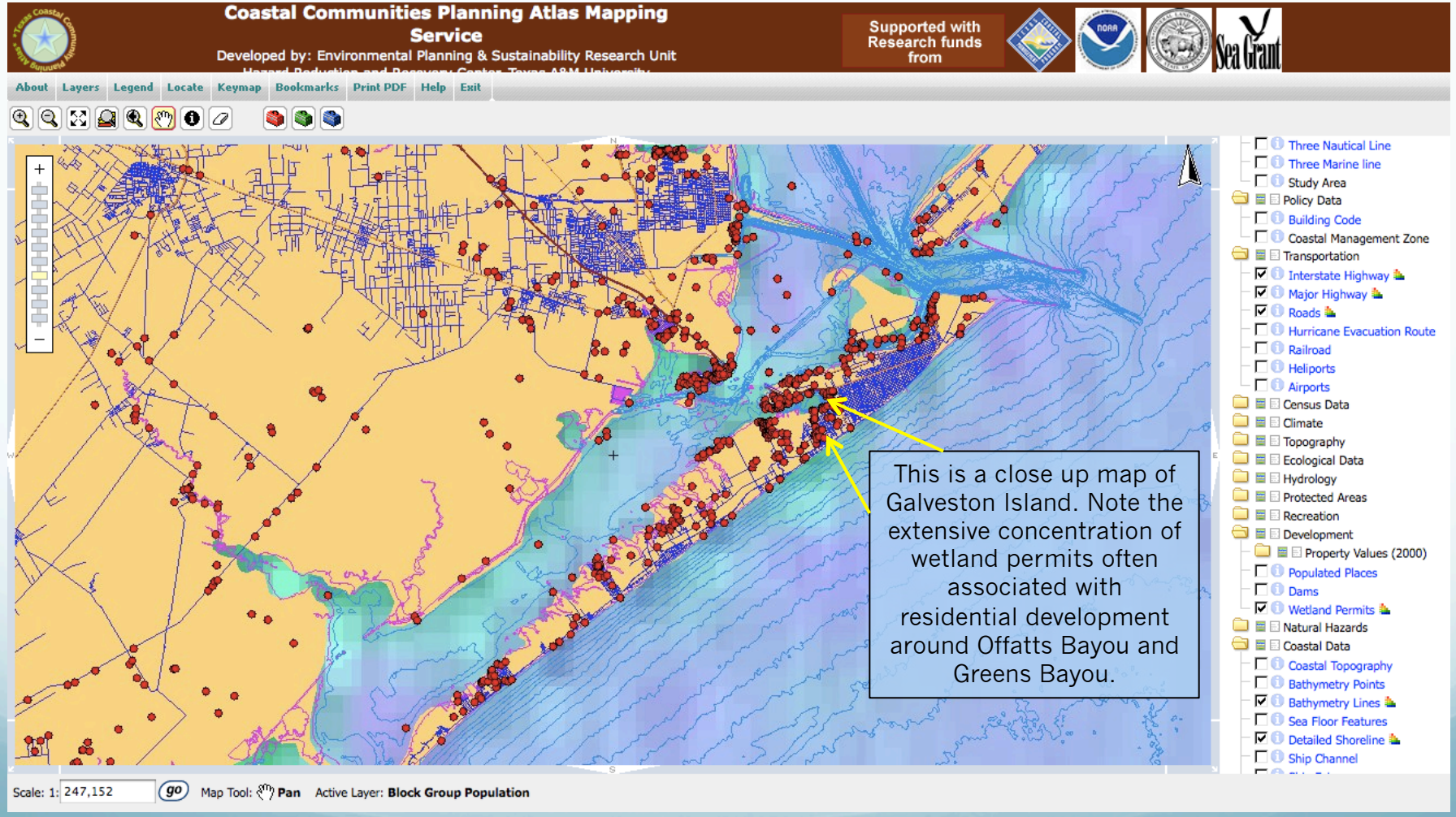
Wetland Permits 1990-2004: Galveston Bay



Wetland Permits 1990-2004: Corpus Christi, Aransas, and Copano Bays

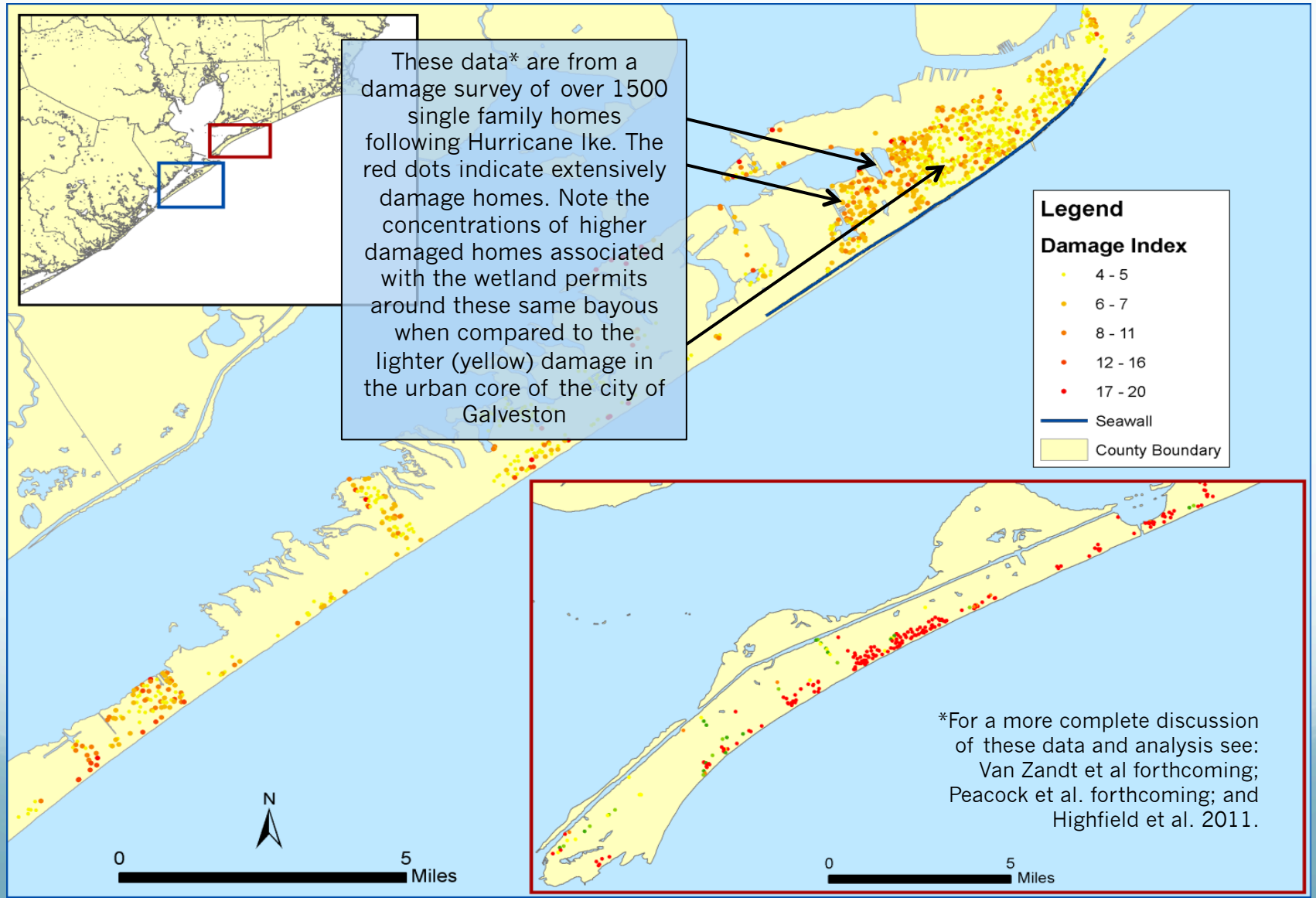
These maps show extensive wetland permitting (i.e., development) in areas with the highest surge risk resulting in loss of wetland services and much higher exposure and risk of new infrastructure, housing, and people to hurricane impacts.

Development in higher hazard areas can have consequences

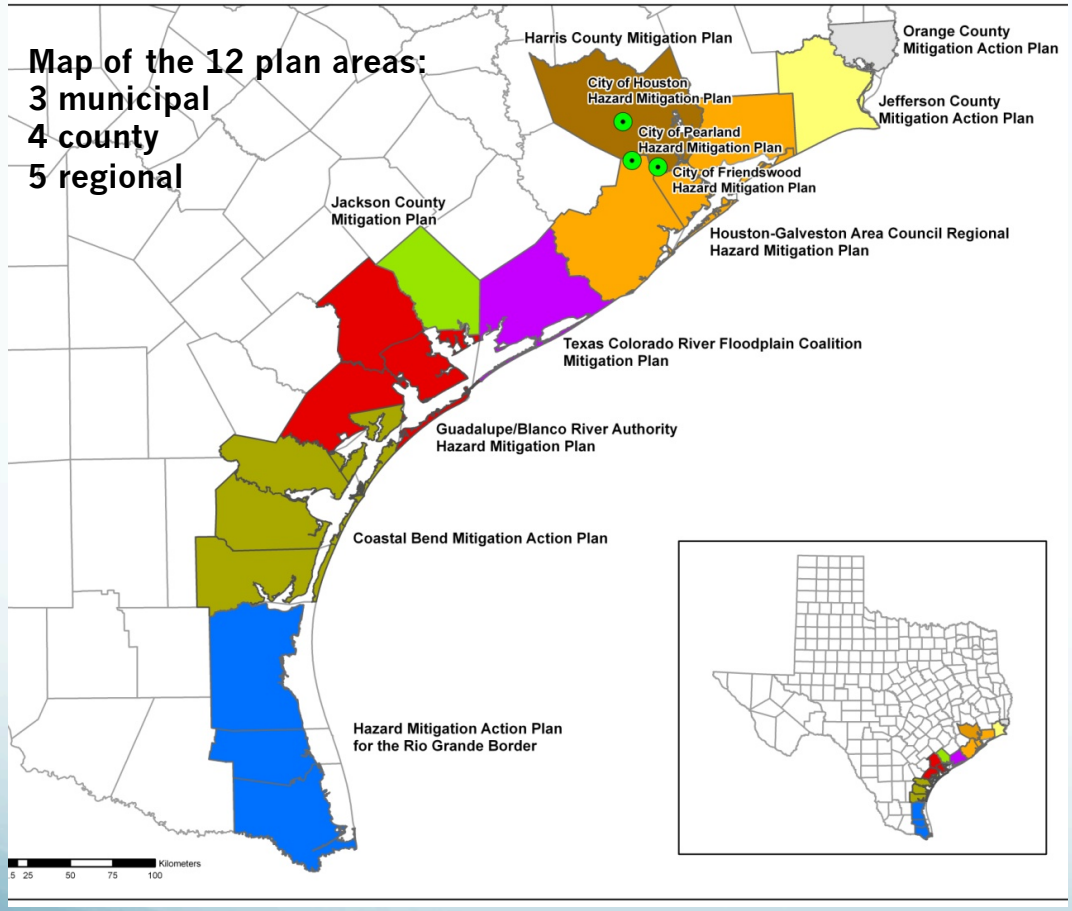


This map is from the coastal planning atlas, a web based planning tool developed and hosted by the Center for Texas Beaches and Shores at Texas A&M Galveston and the Hazard Reduction and Recovery Center at Texas A&M College Station. See coastalatlas.tamu.edu or coastalatlas.tamug.edu

Development in higher hazard areas can have consequences



Disconnect between hazard mitigation and ecosystem protection/restoration*



- Along the coast there are
  - 12 FEMA approved Hazard Mitigation Plans
  - Types of plans: 3 municipal, 4 county, & 5 regional
  - Covering 18 counties and 112 municipalities
- Only one plan discussed wetland/ ecosystem restoration
- Of the 836 mitigation actions proposed by these plans, very few touch on ecosystem preservation/restoration:
  - Structural: 34.4%
  - Emergency management: 24.1%
  - Regulatory/planning: 25.8%
  - Education/Awareness: 14.4%
  - Natural resource protection/ restoration: 1.4%

* For a more complete discussion of these findings and data collection see: Kang, Peacock and Husein 2010 and Peacock et al. 2009.

Disconnect between hazard mitigation and ecosystem protection/restoration

Local officials were asked: To what does your jurisdiction use in the following for natural resource protection?

	Not At All	Small Extent	Some Extent	Very Great Extent	Total
Wetland protection	67	11	18	24	120
	55.8%	9.2%	15.0%	20.0%	100.0%
Coastal Vegetation protection	93	5	10	12	120
	77.5%	4.2%	8.3%	10.0%	100.0%
Habitat protection/ restoration	81	12	18	9	120
	67.5%	10.0%	15.0%	7.5%	100.0%
Protected areas	76	17	14	13	120
	63.3%	14.2%	11.7%	10.8%	100.0%

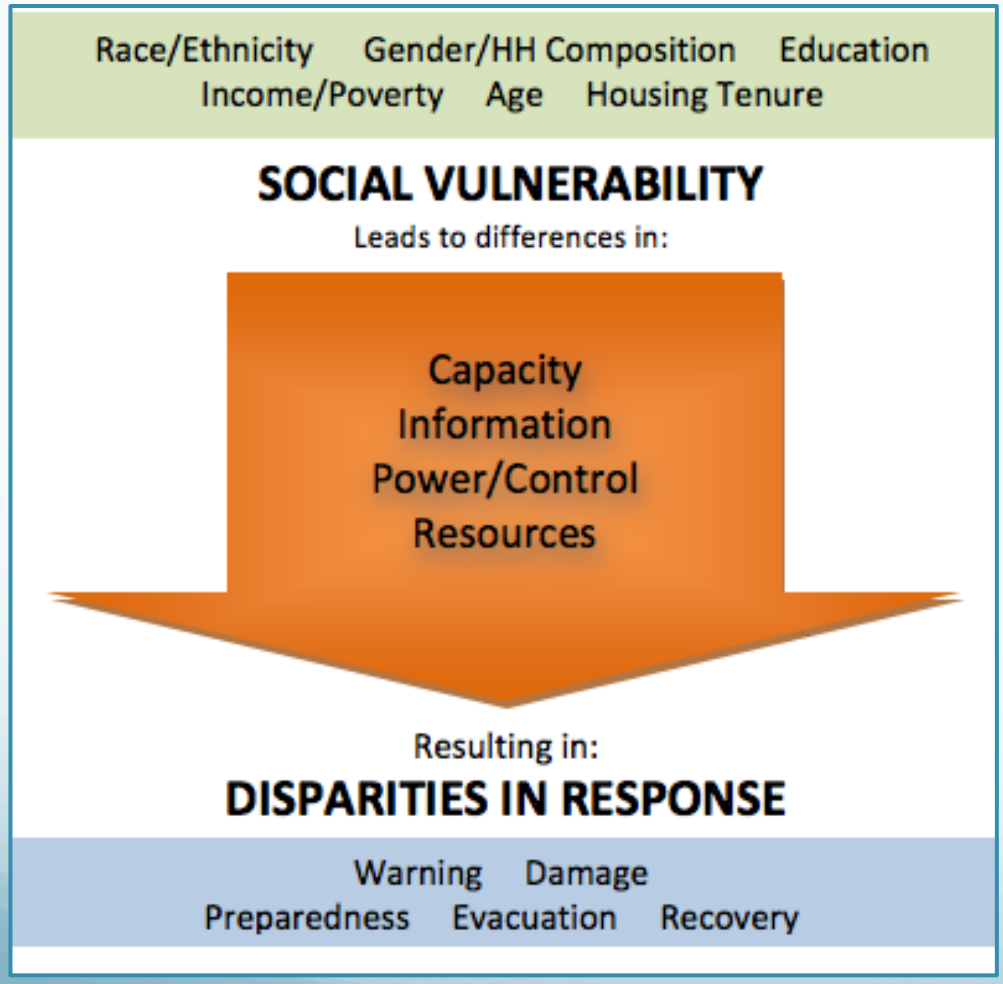
- Preliminary results from a new survey of coastal jurisdictions:
  - Counties and Municipalities
  - Preliminary results from 120 Jurisdictions
- Findings:
  - The bad: Most jurisdictions **do not use any of these ecosystem preservation/ restoration approaches** to facilitate natural resource protection
  - The good:
    - 35% employ wetland protection to some or a very great extent.
    - 22.5% employ protected areas to some or a very great extent.

* These are preliminary data findings. A full report on this survey will be available on the HRRC website by November 2011

Recommendation 1

- We must do a better job of linking ecosystem restoration and preservation with hazard mitigation policies and planning activities:
  - This might be accomplished through:
    - Education programs related to hazard mitigation training
    - Incentives to enhance ecosystem restoration/ preservation as a part of effective hazard mitigation planning
    - Guidelines: modify FEMA and State hazard mitigation guidelines
    - Mandates for ecosystem preservation/restoration to obtain hazard mitigation funding from the federal and state government.

Social vulnerability, coastal hazards, and ecosystem restoration



- Much like physical vulnerability except focused on social units
- Focus is on social factors and processes that generate vulnerability in terms of a person's or group's capacity to anticipate, cope with, resist and recover from the impact of a natural hazard
  - These factors include:
    - Race/ethnicity, gender, education, poverty, age, and housing tenure
- Social vulnerability will rarely be uniformly distributed among the individuals, groups, or various populations comprising social systems
  - As a consequence we can develop mapping tools to identify areas with higher concentrations of socially vulnerable populations

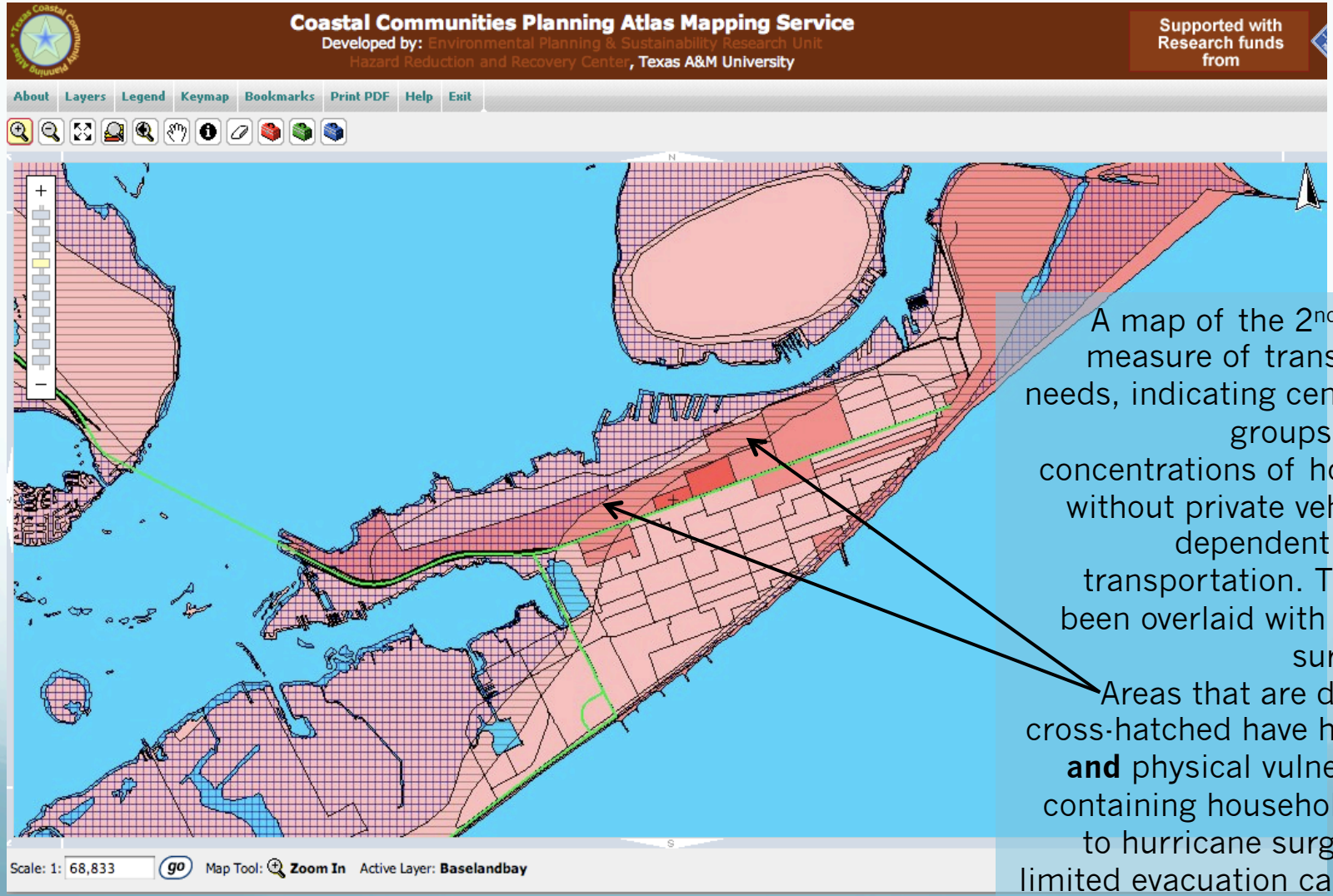
*For a more complete discussion of this approach and perspective see: Van Zandt et al forthcoming, Peacock et al. forthcoming; Highfield et al. 2011, and Peacock et al 2011.

Social vulnerability mapping strategy

Base Social Vulnerability Indicators (percentages)	2nd Order	3rd Order
1. Single parent households with children/Total Households 2. Population 5 or below/Total Population	Child care Needs	Socially Vulnerable Hotspot
3. Population 65 or above/Total Population 4. Population 65 or above & below poverty/Pop. 65 or above	Elder Care Needs	
5. Workers using public transportation/Civilian pop. 16+ and employed 6. Occupied housing units without a vehicle/Occupied housing units (HUs)	Transportation needs	
7. Occupied Housing units/Total housing units 8. Persons in renter occupied housing units/Total occupied housing units 9. Non-white population/Total population 10. Population in group quarters/Total population 11. Housing units built 20 years ago/Total housing Units 12. Mobile Homes/Total housing units 13. Persons in poverty/Total population	Temporary Shelter and housing recovery needs	
14. Occupied housing units without a telephone/Total occupied HU 15. Population above 25 with less than high school/Total pop above 25 16. Population 16+ in labor force and unemployed/Pop in Labor force 16+ 17. Population above 5 that speak English not well or not at all/Pop > 5	Civic Capacity needs	

This table displays 1st order (base indicators) and 2nd and 3rd order composite social vulnerability measures that can be mapped using the Texas Coastal Planning Atlas: coastalatlas.tamu.edu or coastalatlas.tamug.edu

Area with high levels of transportation dependence and hazard exposure

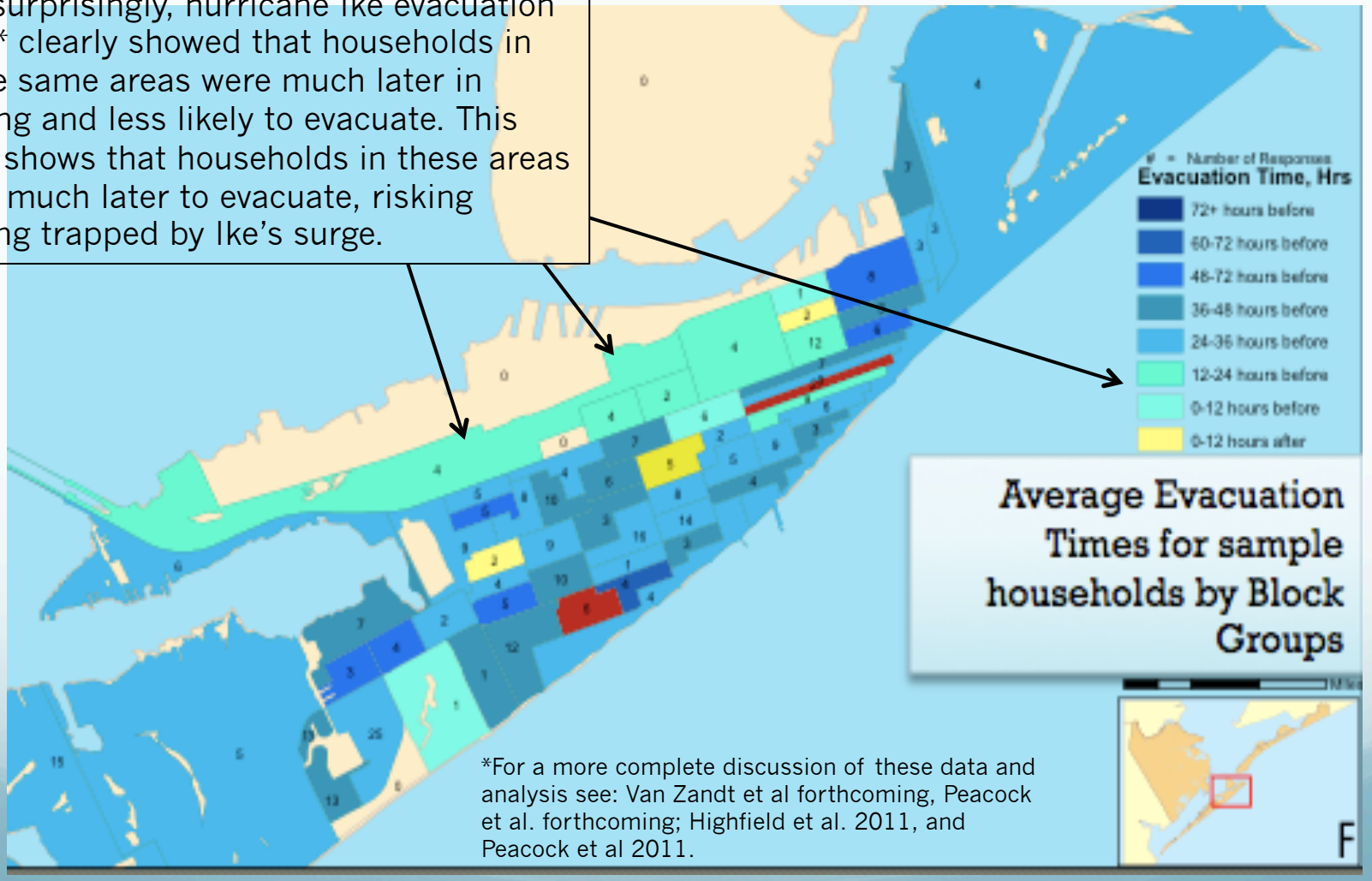


A map of the 2nd order SV measure of transportation needs, indicating census block groups with high concentrations of households without private vehicles and dependent on public transportation. These have been overlaid with hurricane surge zones.

Areas that are darker and cross-hatched have high social **and** physical vulnerabilities, containing households at risk to hurricane surge yet with limited evacuation capabilities.

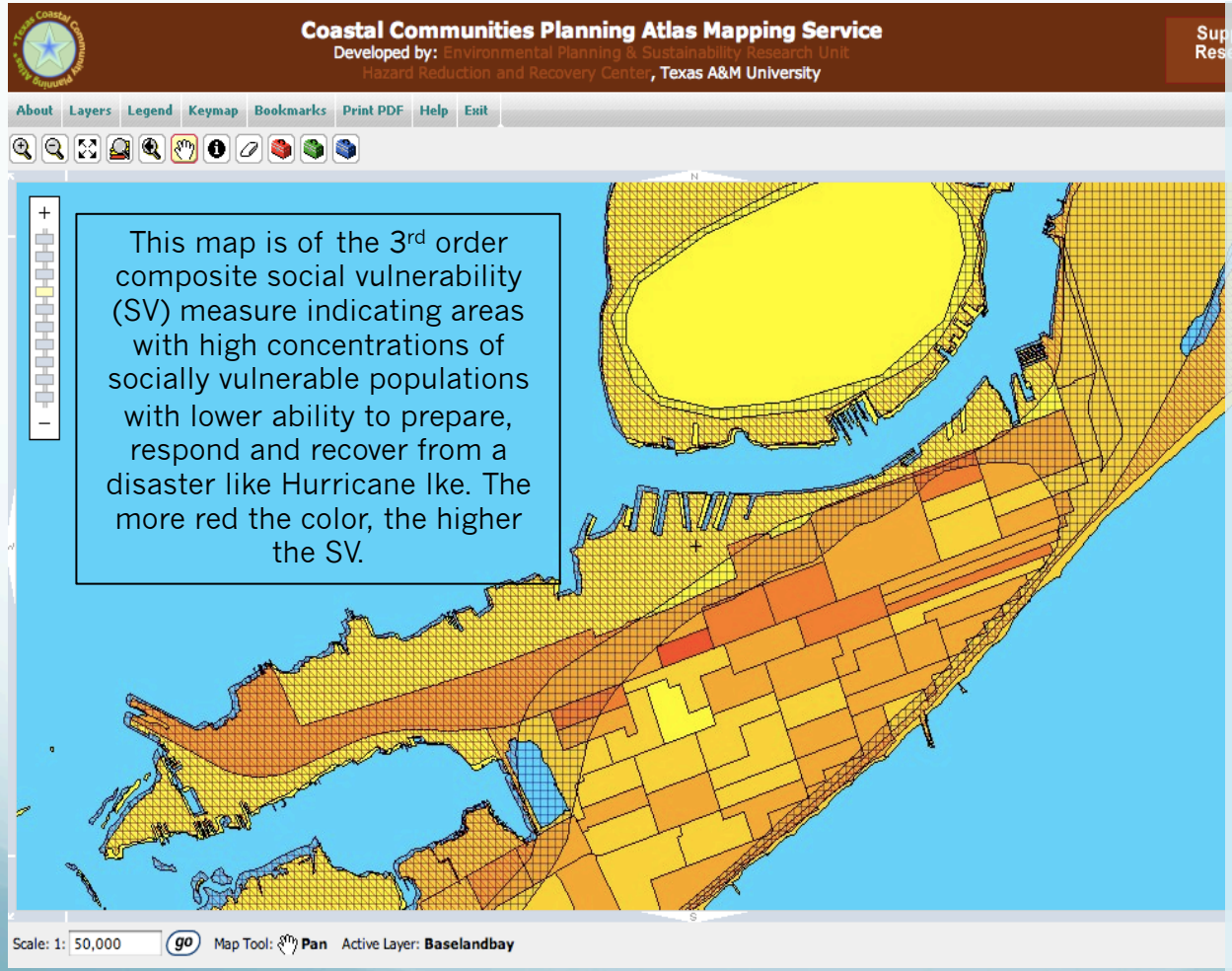
Area with high levels of transportation Dependence and hazard exposure

Not surprisingly, hurricane Ike evacuation data* clearly showed that households in these same areas were much later in leaving and less likely to evacuate. This map shows that households in these areas were much later to evacuate, risking getting trapped by Ike's surge.



*For a more complete discussion of these data and analysis see: Van Zandt et al forthcoming, Peacock et al. forthcoming; Highfield et al. 2011, and Peacock et al 2011.

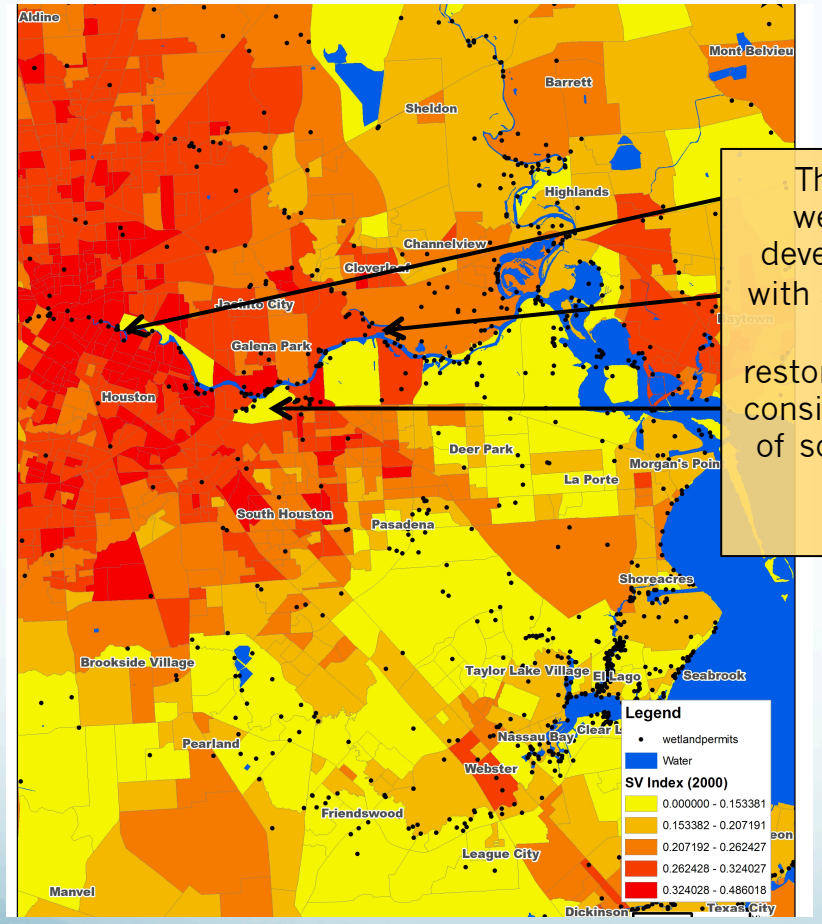
Area with high levels of SV and hazard exposure



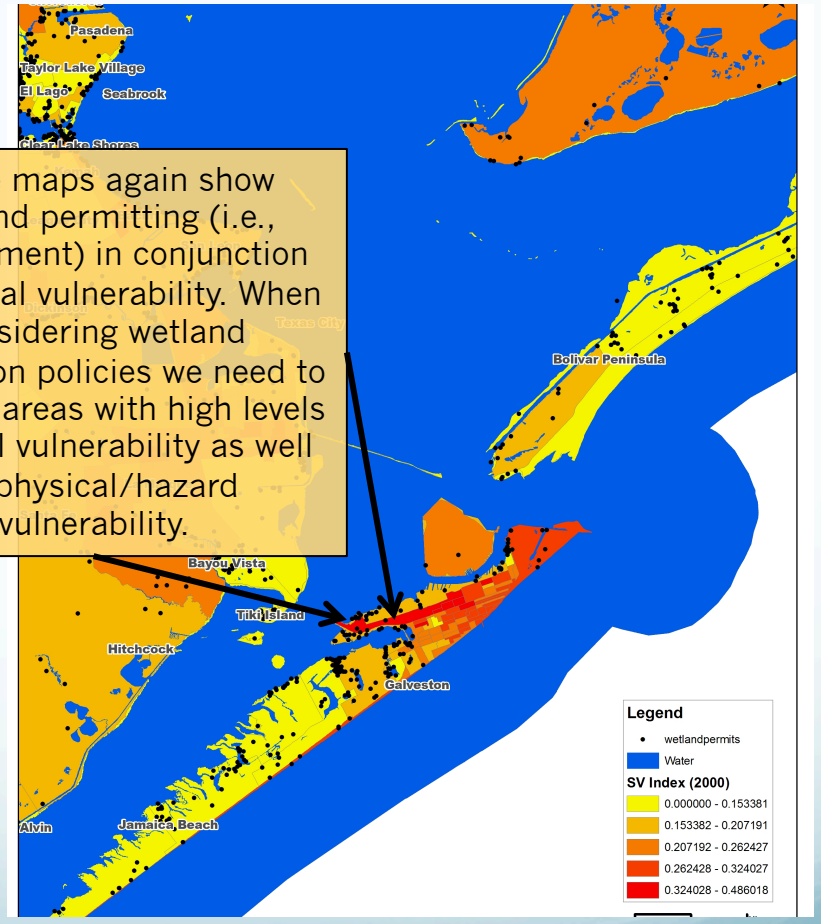
- Post Hurricane Ike research* has shown that areas with higher SV:
  - Suffered greater levels of relative damage
  - Were less likely to have homeowners and renters insurance
  - Were more likely to have applied for FEMA assistance, but less likely to apply for SBA loans
  - Have been slower to be able to undertake significant repairs to their homes
  - Have been slower to receive permits for repairs
  - and, on the whole have been slower to recover.

*For a more complete discussion of these data, analysis and findings see:
Van Zandt et al forthcoming, Peacock et al. forthcoming; Highfield et al. 2011, and Peacock et al 2011.

As we consider restoration efforts, we should also consider SV



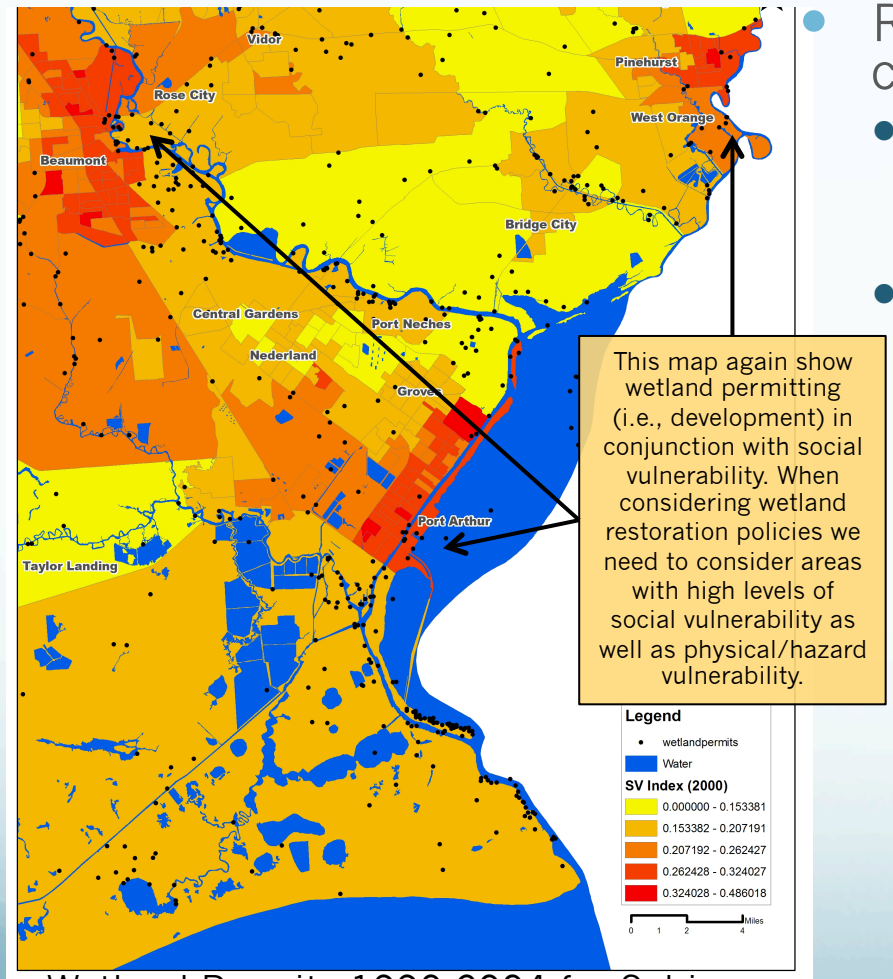
Wetland Permits 1990-2004 in Harris County overlaid on SV Map



These maps again show wetland permitting (i.e., development) in conjunction with social vulnerability. When considering wetland restoration policies we need to consider areas with high levels of social vulnerability as well as physical/hazard vulnerability.

Wetland Permits 1990-2004 for Galveston and Galveston Bay overlaid on SV Map

As we consider restoration efforts, we should also consider SV



Wetland Permits 1990-2004 for Sabine Lake, Port Arthur and Beaumont Texas overlaid on SV Map

- Recommendation 2: When considering restoration efforts
  - Consider hazard vulnerability reduction
    - Targeting ecosystem restoration in high hazard areas
  - However, also consider social vulnerability issues as well
    - Try to obtain a *double payoff*
      - Reducing both physical **and** social vulnerability through ecosystem restoration/ preservation
    - Be concerned about environmental justice issues
      - If ecosystem restoration always means displacement of socially vulnerable/less powerful citizens – this is a problem
      - If ecosystem restoration always benefits the powerful and rich -- this too is a problem.

Coastal hazards, social vulnerability, and ecosystem restoration/preservation

- Texas coastal counties are highly vulnerable to a variety of coastal hazards (wind, surge, and flooding).
- The population of these counties has grown substantially from 1980 to 2010 and has become highly diverse.
- That population growth has been coupled with substantial development of fragile wetland ecosystems
  - Resulting in
    - Loss of ecosystem services
    - Increased hazard exposure
- There is a marked disconnect between hazard mitigation **and** ecosystem restoration/ preservation.
- Recommendations:
  - Link hazard mitigation to ecosystem restoration/ preservation
    - particularly with respect to wetlands and habitat
  - When targeting ecosystem restoration/preservation two issues should drive decisions:
    - Consider hazard reduction issues **and**
    - Consider social vulnerability issues

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