Toward Sustainable Urban Systems: natural hazards, vulnerability, and resiliency

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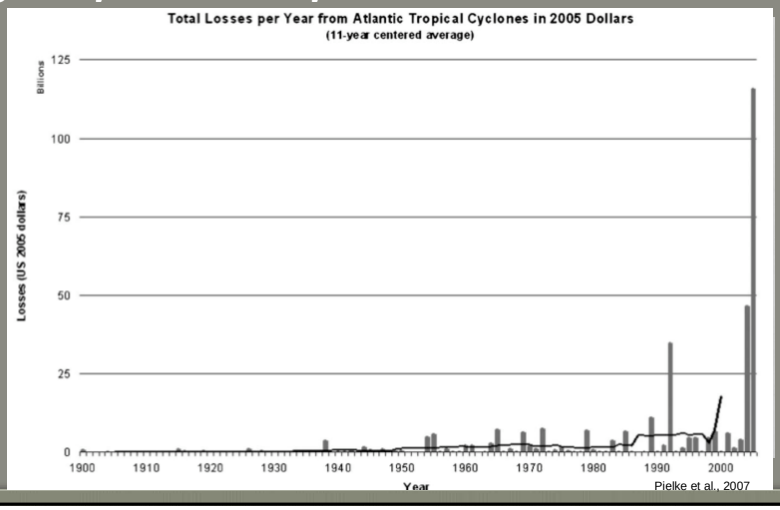
We have entered a "New Era of Catastrophes"

Kunreuther and Michel-Kerjan, 2009

- Extraordinary growth in losses due to natural disasters globally and nationally



Pielke et al., 2007

We have entered a "New Era of Catastrophes"

- Multi-billion dollar hurricane disasters have become the new norm*
  - Katrina (2005) 84.6, Andrew (1992) 48, Wilma (2005) 21.5, Ike (2008) 19.3; Charley (2004) 16.3; Ivan (2004) 15.5; Rita (2005) 11.8; Frances (2004) 9.7
- also, the trend for loss of life has been broken: Katrina 1,836
- The notion of a mega-catastrophe is clearly in the realm of possibility

* In constant 2006 dollars. From Blake, Rappaport, and Landsea 2007

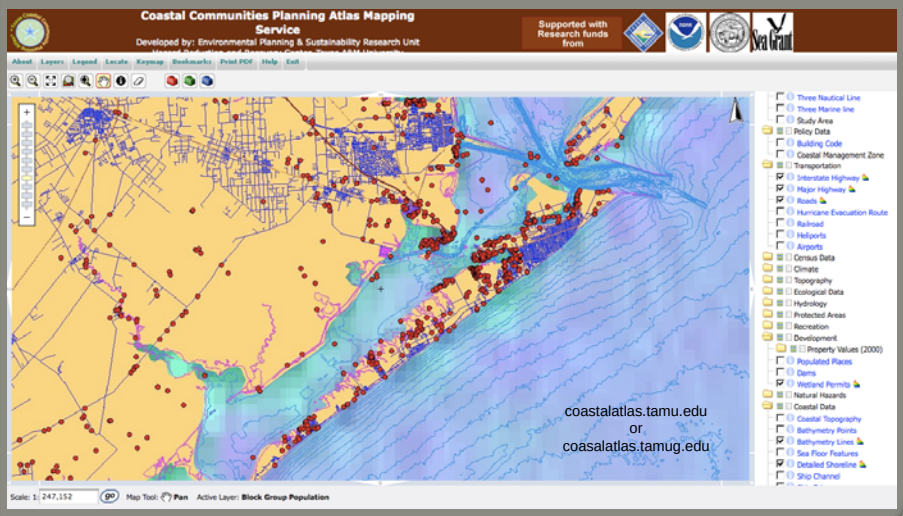
Disasters are still treated as acute not chronic issues

- The scientific consensus is that natural disasters, are not simply natural events….
  - They are an outcome of an interaction between biophysical systems, human systems and their built environment.
- Human action (or inaction) is in large measure driving these trends:
  - We continue to develop and expand into high hazard areas
    - Increasing hazard exposure
    - Destroying natural resources such as wetlands

Disasters are still treated as acute not chronic issues

- Since 1950 population concentrations in coastal areas have grown by 106% compare to 75.8% in non-coastal areas
- Net results:
  - In 2000: 48.9% of population within 50 miles of coastline
  - In 2000: 47.8% of housing units within 50 miles of coast
  - In 2005: population density for coastal counties was 304.6 person per square mile, 5 times the density of non-coastal counties

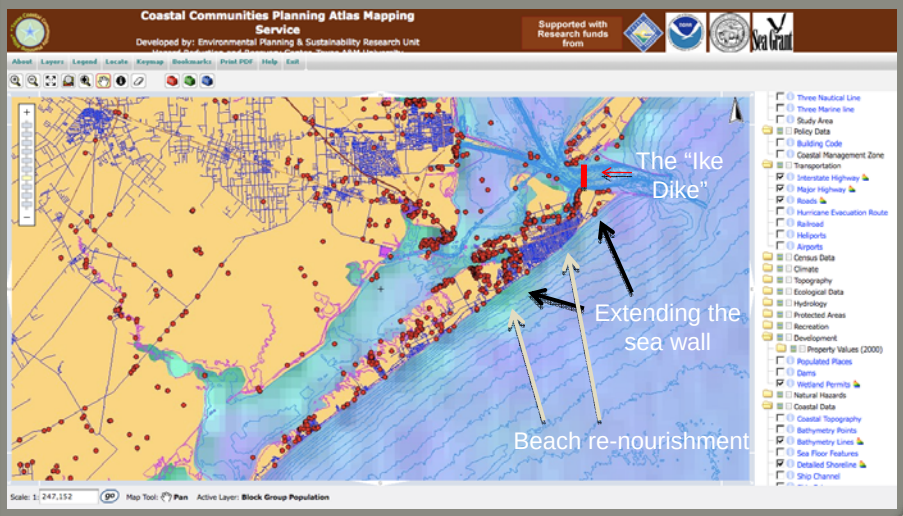
Wetland permits Galveston and Brazoria counties



…still counting on old solutions.

- And when disasters occur:
  - recovery requires massive infusions of external public and private resources,
  - is highly uneven, and
  - is likely to reproduce many preexisting vulnerabilities
- When vulnerabilities are addressed:
  - solutions focus on short term technological fixes such as levees, sea walls, and beach re-nourishment programs that can also have detrimental environmental consequences and promote increased and often unsustainable development.

The Solution: to Galveston's Hurricane Vulnerability



In Short…

- …many of our communities are becoming more vulnerable and less resilient.
- Tend to focus on short term technical solutions and not long term solutions that promote sustainable development:
  - development in low hazard areas
  - environmental resource preservation and restoration
  - appropriate development patterns and construction practices that are consistent with hazard vulnerabilities and risks
  - address equity and access issues
- Enhancing resiliency and reducing vulnerability should be the goals

Advancing Coastal Community Resilience Project Goals

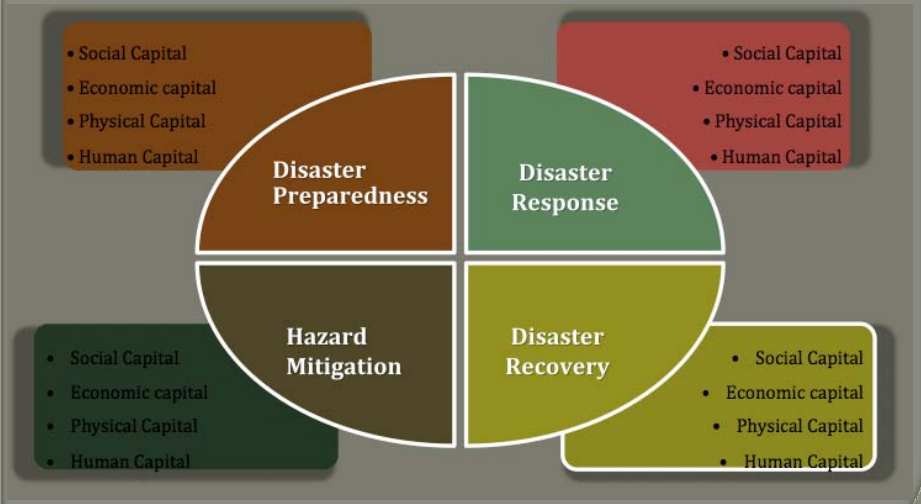
- Develop a suite of Community Disaster Resilience Indicators for:
  - Coastal counties/parishes along the Gulf Coast
    - Using broad-based indicators that are readily available from secondary data sources
    - Use the results to inform local community CDRI
  - Working with Local communities and municipalities like Galveston

Defining 'DISASTER RESILIENCE'

- Three common elements emerged from the literature suggesting that disaster resilience should be defined as the ability of a community to:

1. absorb, deflect or resist disaster impacts
2. bounce back after being impacted, and
3. learn from experience and modify its behavior and structure to adapt to future threats

COMMUNITY DISASTER RESILIENCE FRAMEWORK (CDRF)



Framework Matrix For Indicator Selection

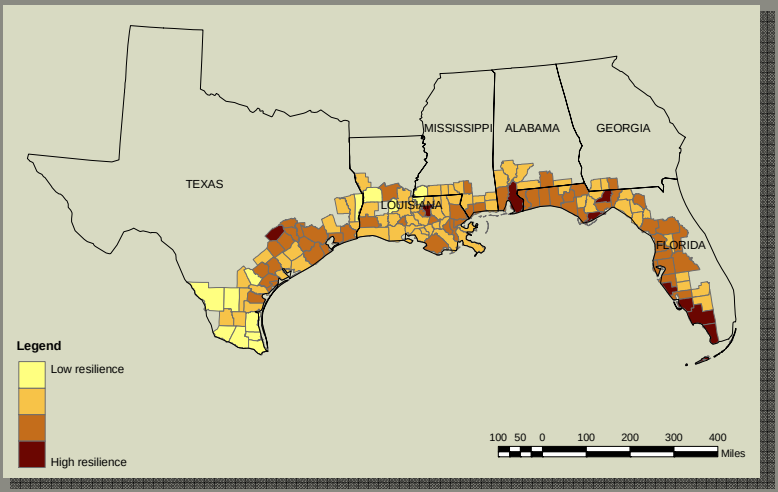
DISASTER PHASES' ACTIVITIES	CAPITAL DOMAIN'S INDICATORS			
I: HAZARD MITIGATION	**Social Capital**	**Economic Capital**	**Physical Capital**	**Human Capital**
Example of activities: ✓Building dams, levees, dikes, and floodwalls. ✓Land use planning to prevent development in hazardous areas ✓Strengthening buildings through building codes and building standards. ✓Protecting the natural environment and environmental resources (e.g., wetlands)	*Indicator 1* 1 *Indicator 2* … *Indicator k*	*Indicator 1* 2 *Indicator 2* … *Indicator k*	*Indicator 1* 3 *Indicator 2* … *Indicator k*	*Indicator 1* 4 *Indicator 2* … *Indicator k*
II: DISASTER PREPAREDNESS				
Example of activities: ✓Developing response procedures ✓Design and installation of warning systems, ✓Developing plans for evacuation ✓Emergency preparations (Exercise & Drills) ✓Training of emergency personnel ✓Stockpiling of resources e.g., medical supplies	*Indicator 1* 5 *Indicator 2* … *Indicator k*	*Indicator 1* 6 *Indicator 2* … *Indicator k*	*Indicator 1* 7 *Indicator 2* … *Indicator k*	*Indicator 1* 8 *Indicator 2* … *Indicator k*

Framework Matrix For Indicator Selection

DISASTER PHASES' ACTIVITIES	CAPITAL DOMAIN'S INDICATORS			
III: DISASTER RESPONSE	**Social Capital**	**Economic Capital**	**Physical Capital**	**Human Capital**
Example of activities: ✓Securing impacted area ✓Warning ✓Evacuation ✓Search & Rescue ✓Provision of medical care ✓Sheltering evacuees	*Indicator 1* 9 *Indicator 2* … *Indicator k*	*Indicator 1* 10 *Indicator 2* … *Indicator k*	*Indicator 1* 11 *Indicator 2* … *Indicator k*	*Indicator 1* 15 *Indicator 2* … *Indicator k*
IV: DISASTER RECOVERY				
Example of activities: (i) Relief & rehabilitation ✓Re-establishment of economic activities ✓Provision of housing, clothing, and food ✓Restoration of critical facilities ✓Restoration of essential community services (ii) Reconstruction ✓Rebuilding of major structure e.g. public buildings, roads, bridges, and dams ✓Revitalizing the economic system ✓Reconstruction of housing	*Indicator 1* 13 *Indicator 2* … *Indicator k*	*Indicator 1* 14 *Indicator 2* … *Indicator k*	*Indicator 1* 15 *Indicator 2* … *Indicator k*	*Indicator 1* 16 *Indicator 2* … *Indicator k*

Mapping Coastal County Resiliency

Spatial Distribution of CDRI Scores



The resulting measure appears to perform as expected:

VALIDITY MEASURE	CDRI-1
(1) Deaths due to flooding	-.420***
(2) Total flood property damage	-.239**
(4) Uninsured flood property damage	-.223**
(5) Social vulnerability index	-.308**
(6) Wind risk	.291**
(7) Flood risk	.270**
(8) Surge risk	.141
(9) Total risk (wind, flood, and surge)	.266**

Note: ** = prob (r) .05; *** = prob (r) .01;

Additional Findings

- The picture is highly uneven with respect to States: Florida counties had the highest average CDRI scores, followed, not so closely, by Alabama, Georgia, Mississippi, and Louisiana, with Texas counties, on average, at the bottom.

State	CDRI	
	Mean Score	Rank
Florida	.2539	1
Alabama	.0067	2
Georgia	-.0479	3
Mississippi	-.0860	4
Louisiana	-.0981	5
Texas	-.1418	6

Additional Findings

- In general, counties with comprehensive planning, that adopt hazard relevant building codes and zoning regulations, that participate in FEMA CRS rating, and implement other similar policies, were more disaster resilient.

TOP 10 LIST			
Rank	County	State	Score
1	Monroe	Florida	1.44
2	Leon	Florida	1.12
3	Collier	Florida	1.03
4	Sarasota	Florida	1.02
5	Franklin	Florida	0.90
6	Lee	Florida	0.72
7	East Baton Rouge	Louisiana	0.69
8	Baldwin	Alabama	0.68
9	Fayette	Texas	0.68
10	Okaloosa	Florida	0.67

BOTTOM 10 LIST			
Rank	County	State	Score
135	West Feliciana	Louisiana	-0.61
136	Kenedy	Texas	-0.61
137	Vernon	Louisiana	-0.67
138	Webb	Texas	-0.68
139	Cameron	Texas	-0.72
140	Bee	Texas	-0.73
141	Hidalgo	Texas	-0.81
142	Duval	Texas	-0.92
143	Willacy	Texas	-0.98
144	Starr	Texas	-1.32

Additional Findings

- The Situation among urban areas in Texas Coastal Counties

Summary of Municipalities and Population Percentages Adopting or Engaging in Specific Form of Mitigation Planning or Management

	All Municipalities		CMZ Municipalities		Partial-CMZ Municipalities	
	Num.	Pop %	Num.	Pop %	Num.	Pop %
Comp. Plan	36	19.1	19	59.8	3	1.6
Floodplain	53	30.0	32	66.0	7	13.7
Storm water	34	24.6	19	65.6	4	7.9
Zoning	39	18.6	25	60.8	1	1.1
Subdivision	44	24.2	26	79.9	5	0.4
CRS	13	69.4	9	49.8	2	86.0
IRC/IBC 03-06	47	86.5	28	70.8	7	97.2
Municipalities	**112**		**59**		**15**	
Population	**3,626,348**		**964,465**		**2,305,348**	

obstacles and constraints to promoting vulnerability reduction and resiliency:

- Policy inconsistencies and disconnects
  - Failure to recognize the very different socio-political environments in which decisions are made
- Lack of resources and information
- Failure to capitalize on potential synergies and commonalities among stakeholders as well as windows of opportunity
- Development and powerful economic interests tend to win out
- failure to incorporate or heed current research particularly with respect to land-use planning and mitigation policy development and implementation
- weaknesses in current scientific research

obstacles and constraints to vulnerability and resiliency science:

- Current funding mechanisms almost exclusively **support one-shot case studies of** limited duration
  - preclude the ability to monitor change in resiliency and vulnerability thereby hindering the development of models that explain change over time.
- Independent studies too often **fail to replicate measurement protocols** of common concepts
  - limit comparability across data collection efforts.
- Most studies only offer **partial views of place**
  - fail to capture the full complexity of coupled socio-ecological systems.
- Many independent data collection programs in the public and private sectors **are poorly coordinated**
  - constraining data sharing among researchers and use by practitioners

The very nature of vulnerability and resiliency research calls for establishing observatory

- NSF has undertaken major investments in establishing environmental observatories
  - focus on the structure and dynamics of the biophysical environment and its systems related to resiliency and sustainability issues
    - Long Term Ecological Research Network (LTER)
    - National Environmental Observatory Network (NEON)
- What is lacking is an observatory that focuses on the nature and dynamics of the social systems and their built environments
  - Resiliency and Vulnerability Observatory Network (***RAVON***)

Call for RAVON consistent with:

1) The ***Second Assessment*** and its accompanying volumes which directly assessed the state of hazard and disaster research and research needs for addressing vulnerability and resiliency (Mileti 1999);

2) The **National Research Council's** assessment of social science research efforts funded by the NSF as part of NEHRP and future needs (NRC 2006);

3) The National Science Board's efforts addressing hurricane science research needs and the development of a new **National Hurricane Research Initiative** (NSB 2007);

4) The recent ***Rising to the Challenge*** report that focused on the critical failures to integrate social science research into the existing national environmental observatories (Vjajjhala, Krupnick, McCormick, Grove, McDowell, Redman, Shabman, Small 2007);

5) **NOAA's** efforts seeking to develop a social science research agenda related to hurricane forecast and warning (Gladwin, Lazo, Morrow, Peacock and Willoughby 2007); and

6) **USGS's efforts** to highlight national needs related to natural hazard risk reduction and management (Shapiro, Bernknopf, and Wachter 2007).

Why RAVON?

- This observatory would address current obstacles by:
  - supporting development of **long term longitudinal data sets;**
  - Invest in the development of **data collection protocols to ensure comparable measurement** in multiple socio-political environmental settings and across multiple hazards;
  - **build on and complement existing data collection efforts and activities** in the public and private sectors; and
  - **Enhance the sharing of data** throughout research and practice communities

Thank you!

Doug Spenser, USGS

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