“Coastal Habitats: Risks, Resiliency and Restoration” NSB Workshop: Task Force on Hurricane Science and Engineering, April 18, 2006

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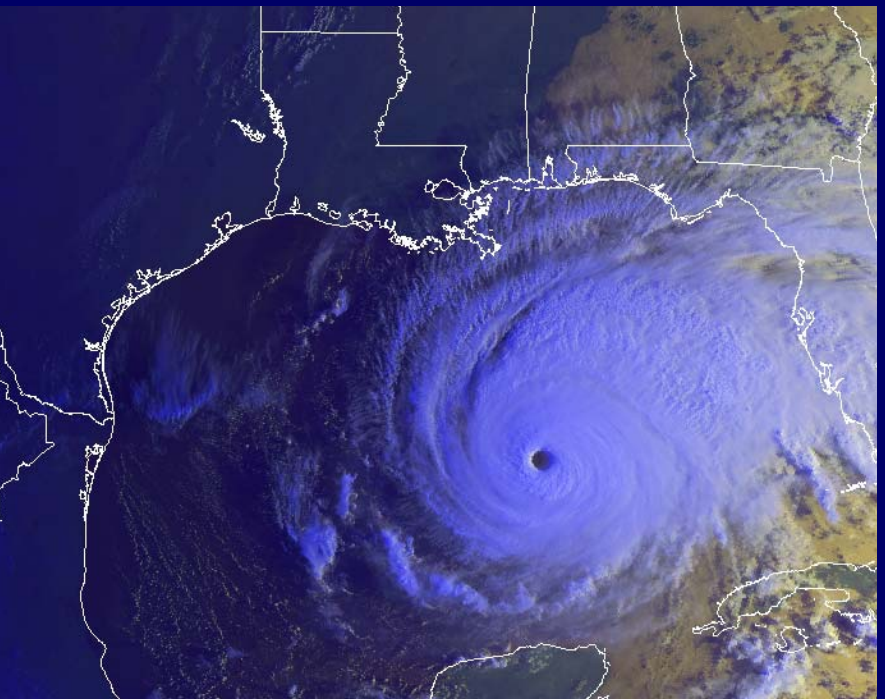
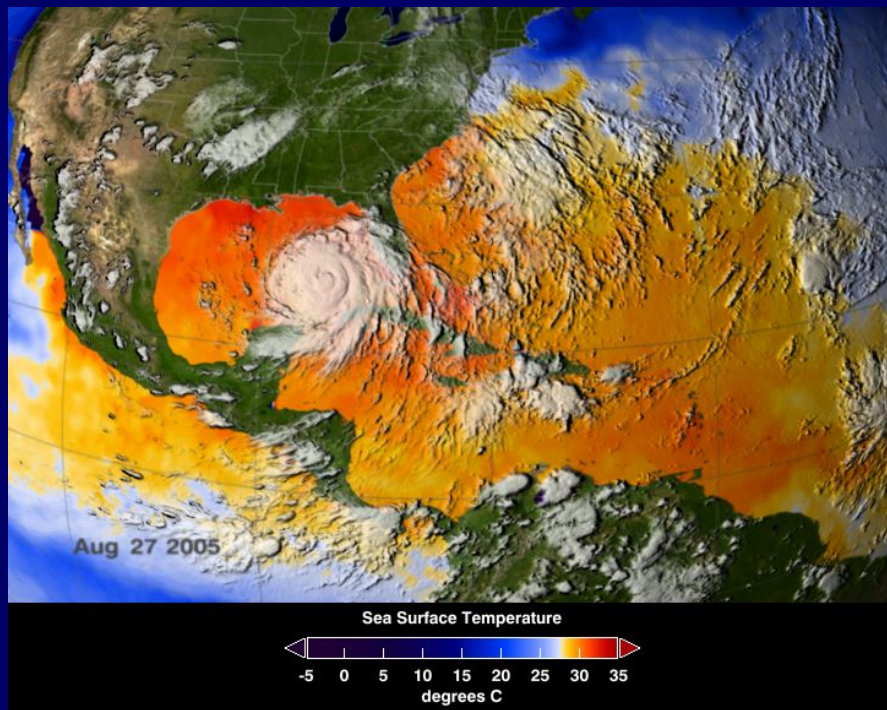
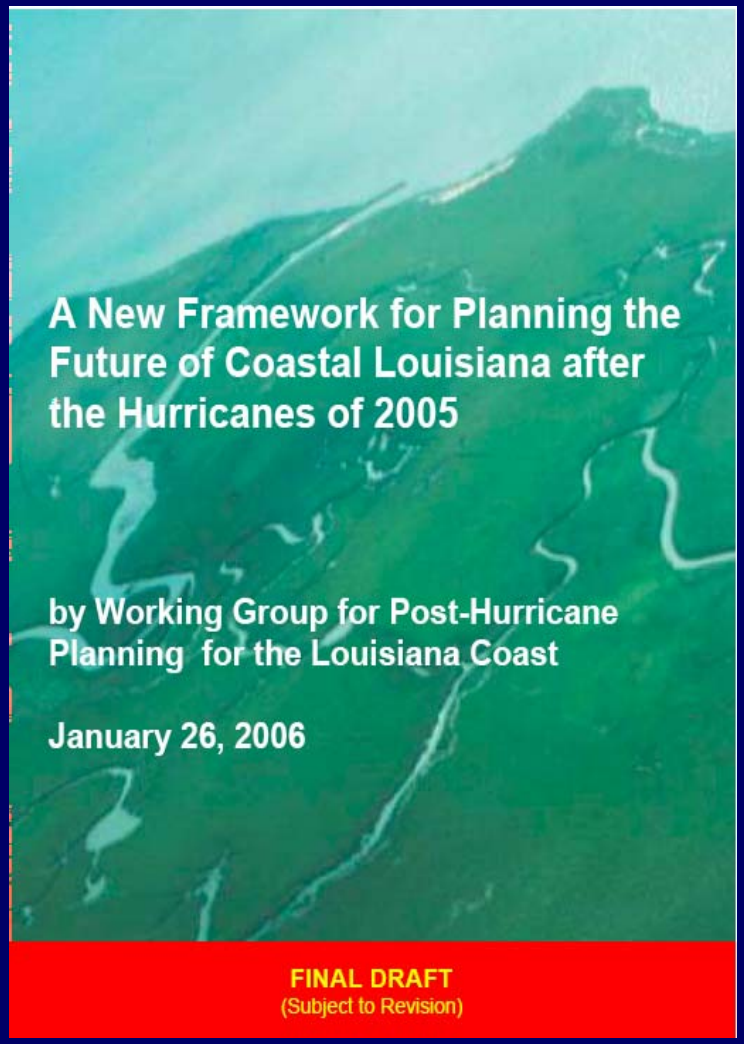
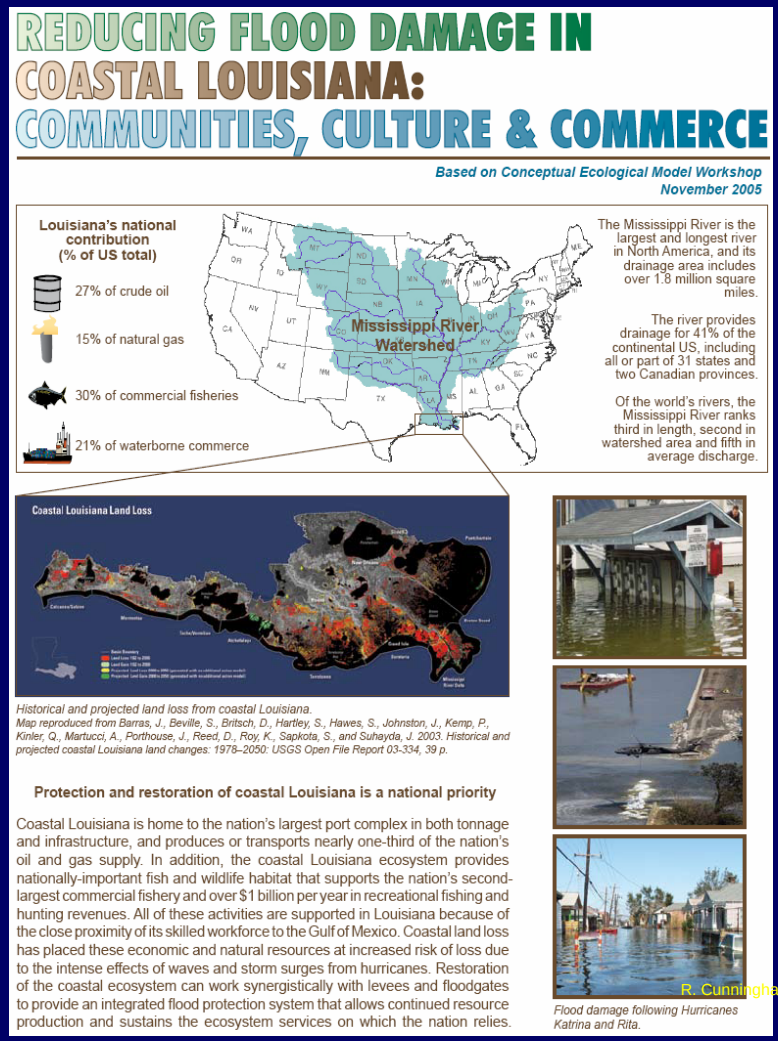








REDUCING FLOOD DAMAGE IN COASTAL LOUISIANA: COMMUNITIES, CULTURE & COMMERCE

Based on Conceptual Ecological Model Workshop
November 2005

Louisiana's national contribution (% of US total)

- 27% of crude oil
- 15% of natural gas
- 30% of commercial fisheries
- 21% of waterborne commerce

Mississippi River Watershed

The Mississippi River is the largest and longest river in North America, and its drainage area includes over 1.8 million square miles.

The river provides drainage for 41% of the continental US, including all or part of 31 states and two Canadian provinces.

Of the world's rivers, the Mississippi River ranks third in length, second in watershed area and fifth in average discharge.

Coastal Louisiana Land Loss

Historical and projected land loss from coastal Louisiana.
Map reproduced from Barras, J., Beville, S., Britsch, D., Hartley, S., Hawes, S., Johnston, J., Kemp, P., Kinler, Q., Martucci, A., Porthouse, J., Reed, D., Roy, K., Sapkota, S., and Suhayda, J. 2003. Historical and projected coastal Louisiana land changes: 1978–2050: USGS Open File Report 03-334, 39 p.

Protection and restoration of coastal Louisiana is a national priority

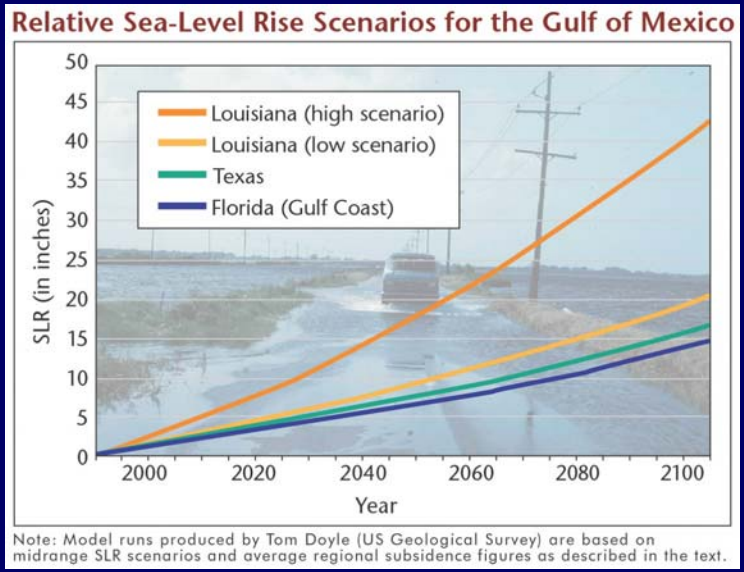
Coastal Louisiana is home to the nation's largest port complex in both tonnage and infrastructure, and produces or transports nearly one-third of the nation's oil and gas supply. In addition, the coastal Louisiana ecosystem provides nationally-important fish and wildlife habitat that supports the nation's second-largest commercial fishery and over $1 billion per year in recreational fishing and hunting revenues. All of these activities are supported in Louisiana because of the close proximity of its skilled workforce to the Gulf of Mexico. Coastal land loss has placed these economic and natural resources at increased risk of loss due to the intense effects of waves and storm surges from hurricanes. Restoration of the coastal ecosystem can work synergistically with levees and floodgates to provide an integrated flood protection system that allows continued resource production and sustains the ecosystem services on which the nation relies.

R. Cunningham

Flood damage following Hurricanes Katrina and Rita.

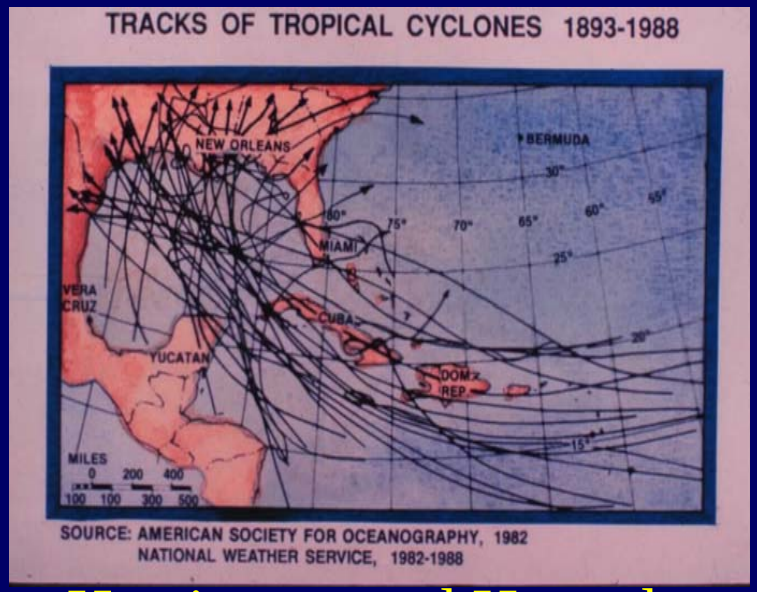
Ecosystem Science:
Natural Systems in Highly Engineered Landscapes

Environmental Issues Requiring Strong National Agenda



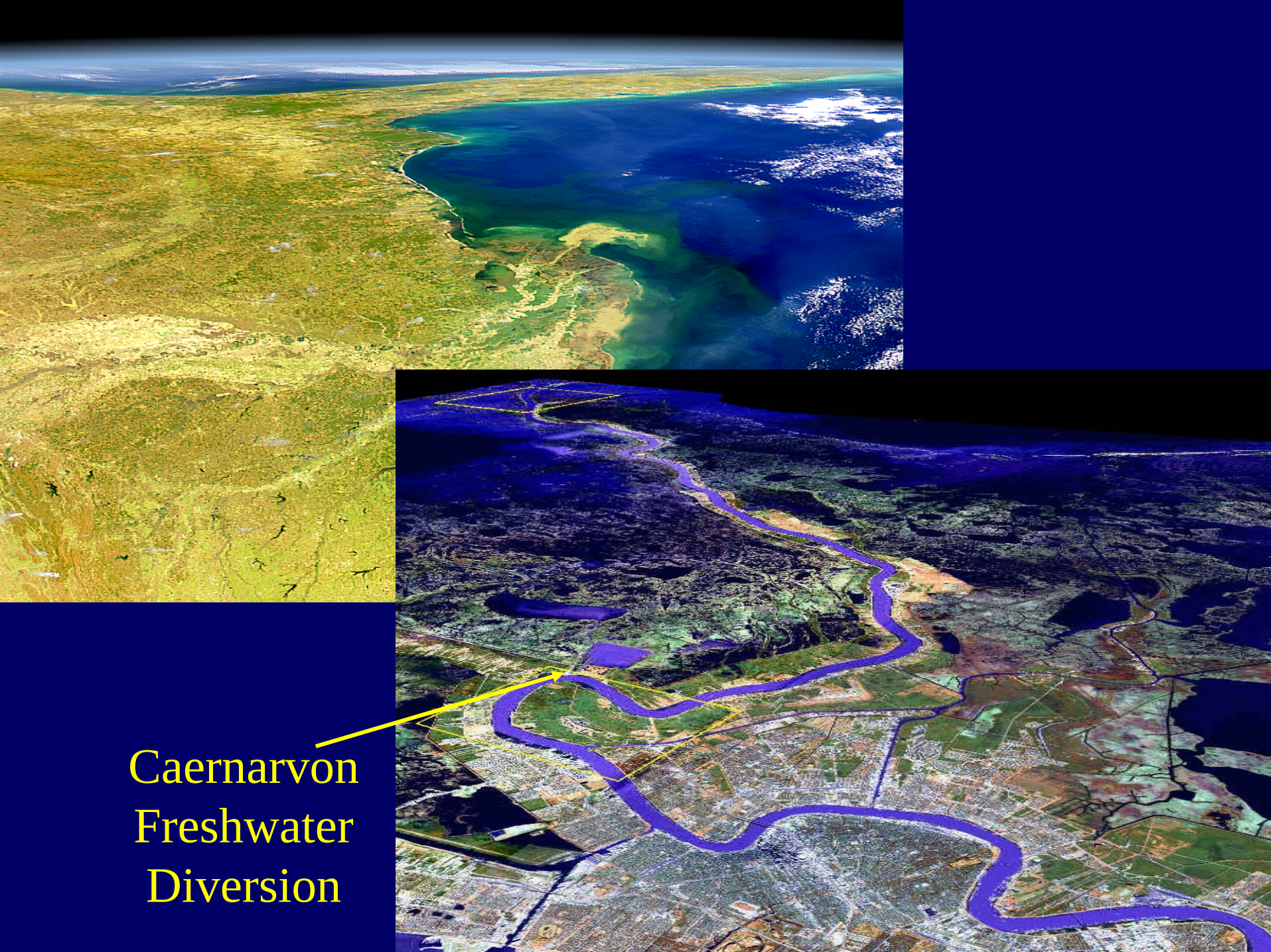
Sea Level Rise

Wetland (habitat) Loss



Hurricanes and Hazards

Eutrophication


Caernarvon
Freshwater
Diversion

Natural Ecosystems

- Wetland/Floodplain
- Shoreline
- Upland

Managed Ecosystems

- Agriculture
- Forestry
- Fisheries
- Restored Ecosystems

Built/Urban Ecosystems

- New Orleans
- Rural Communities
- Navigation
- Energy Related

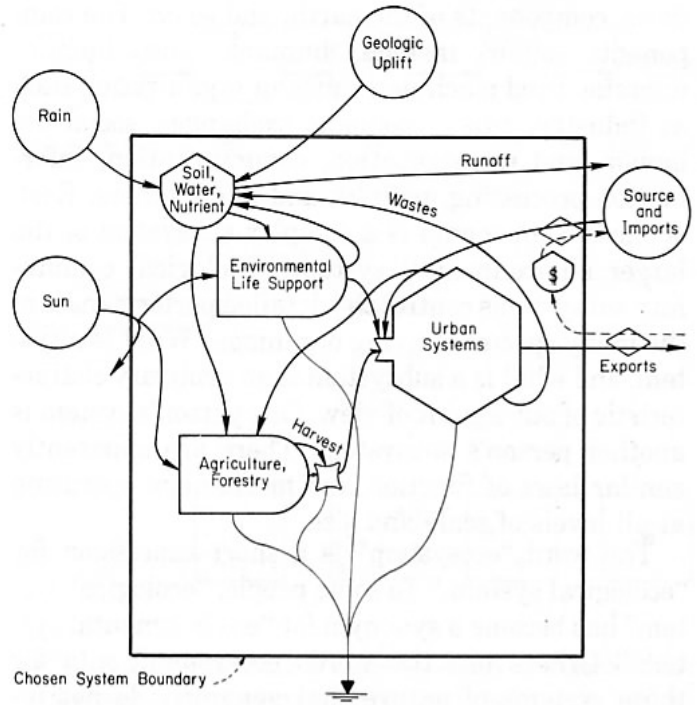
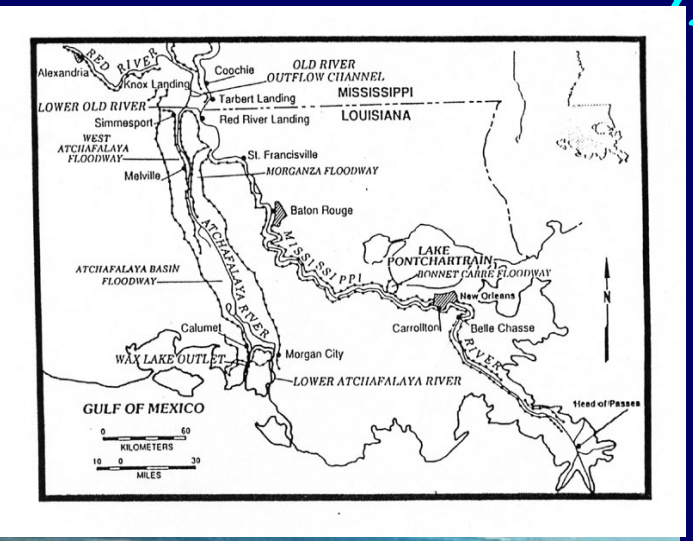


FIGURE 2-4. Diagram of an environmental system with use of symbols of the energy circuit language.

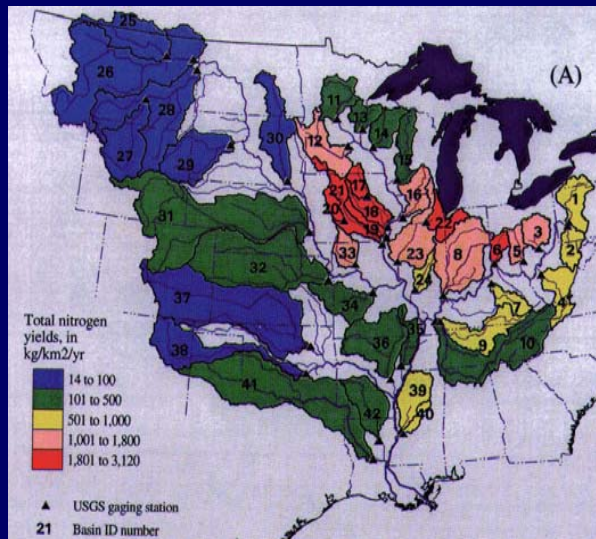
Federal Projects with purpose to Protect and Serve the Public Good; With Long-term Unintended Consequences



Flood Control (1927 - 1965 - to present)

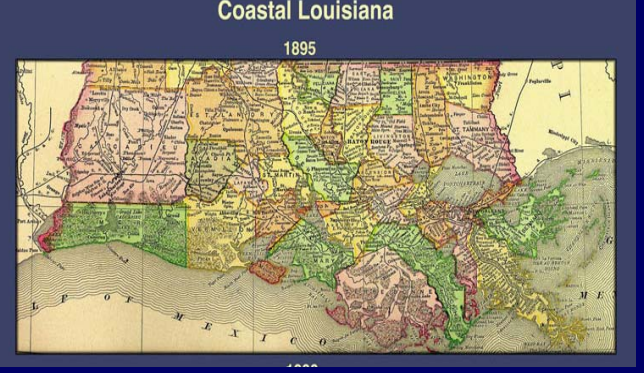
Coastal Oil and Gas Exploration (1930-1970)

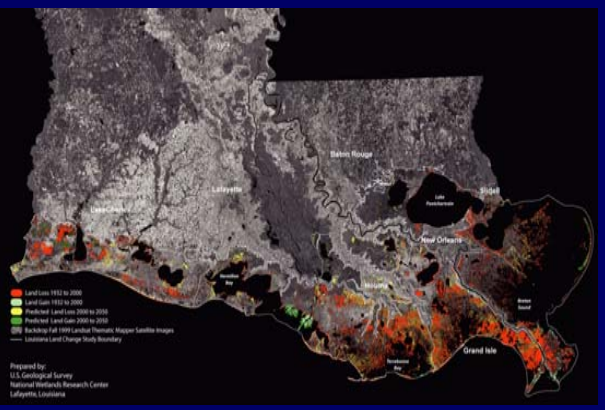
Navigation (1850-1970)

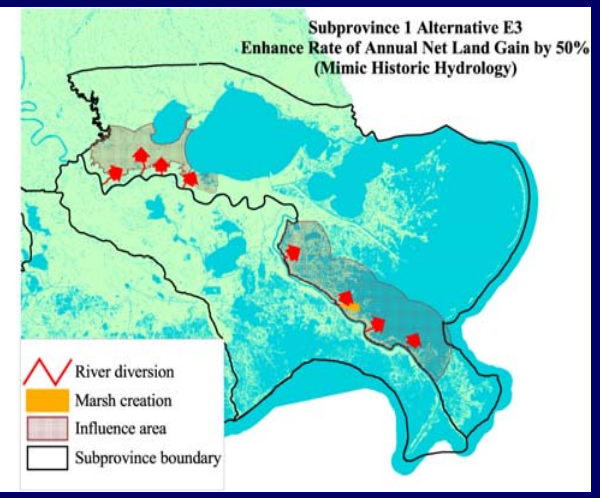


Agriculture (1850-1960)

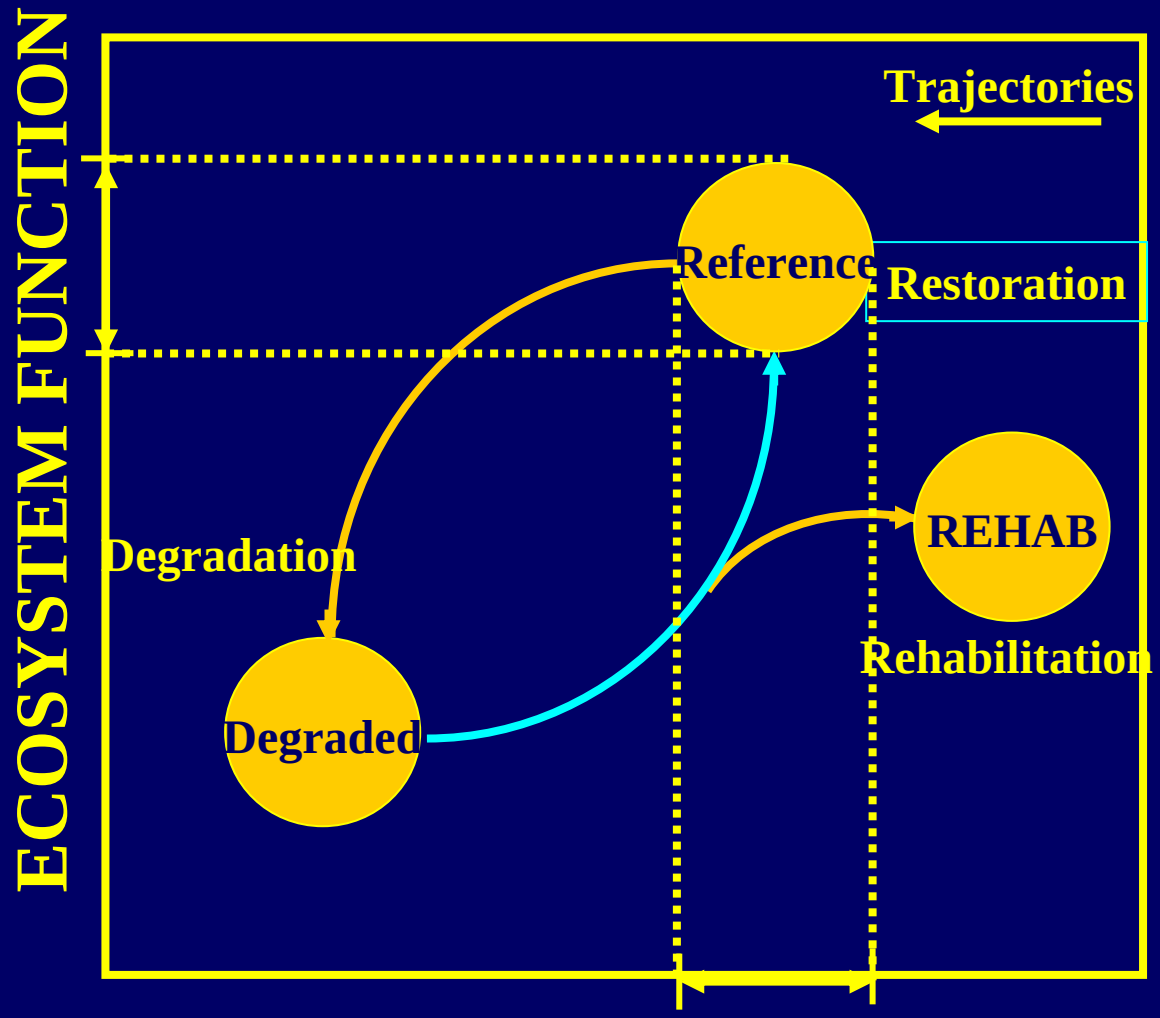
Ecosystem Forecasting:
Risks, Restoration, Resiliency







ECOSYSTEM REHABILITATION



Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Program

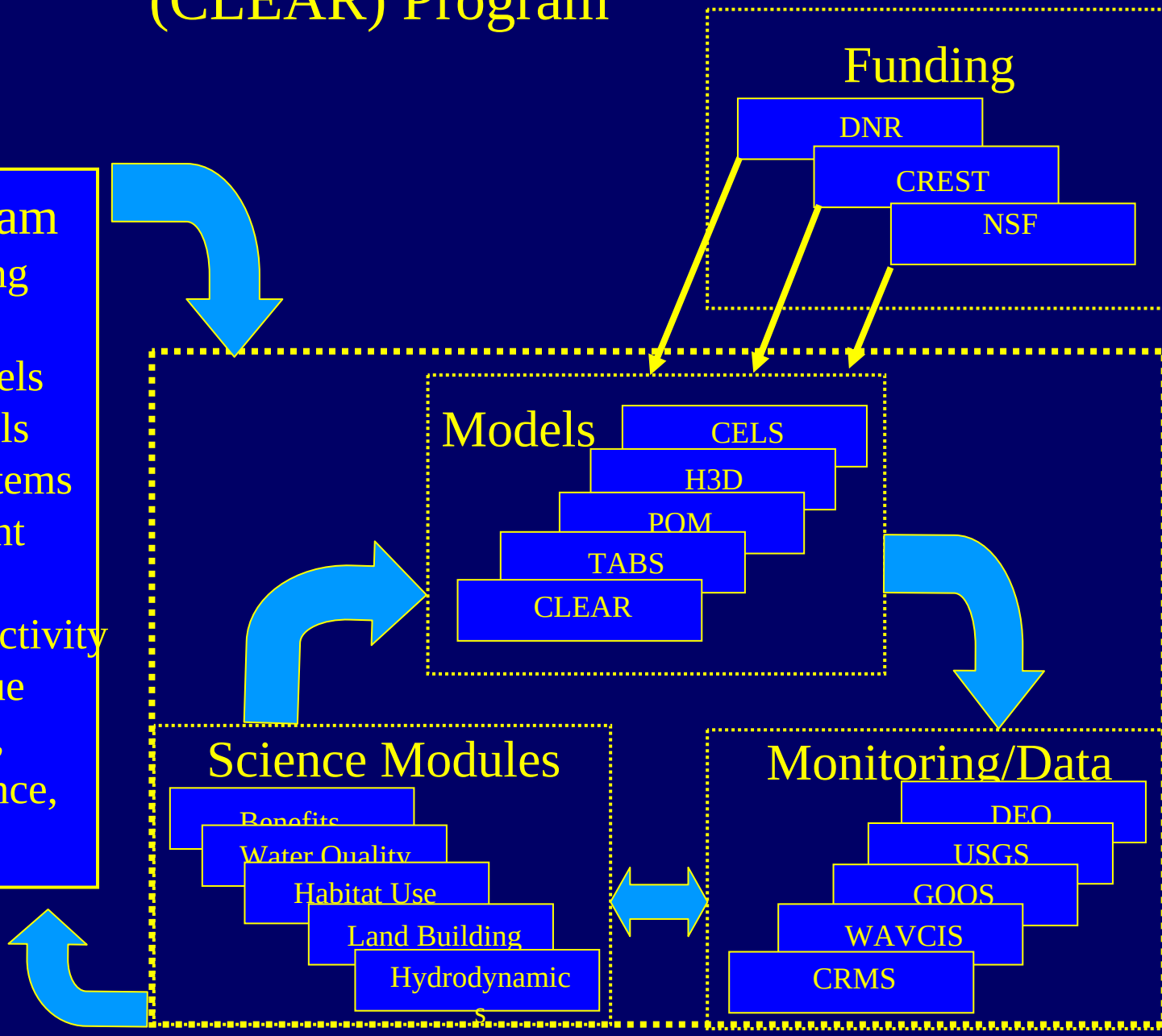
CLEAR Program

Ecosystem Forecasting Systems:

1) Conceptual Models
2) Numerical Models
3) Observation Systems
4) Data Management Systems

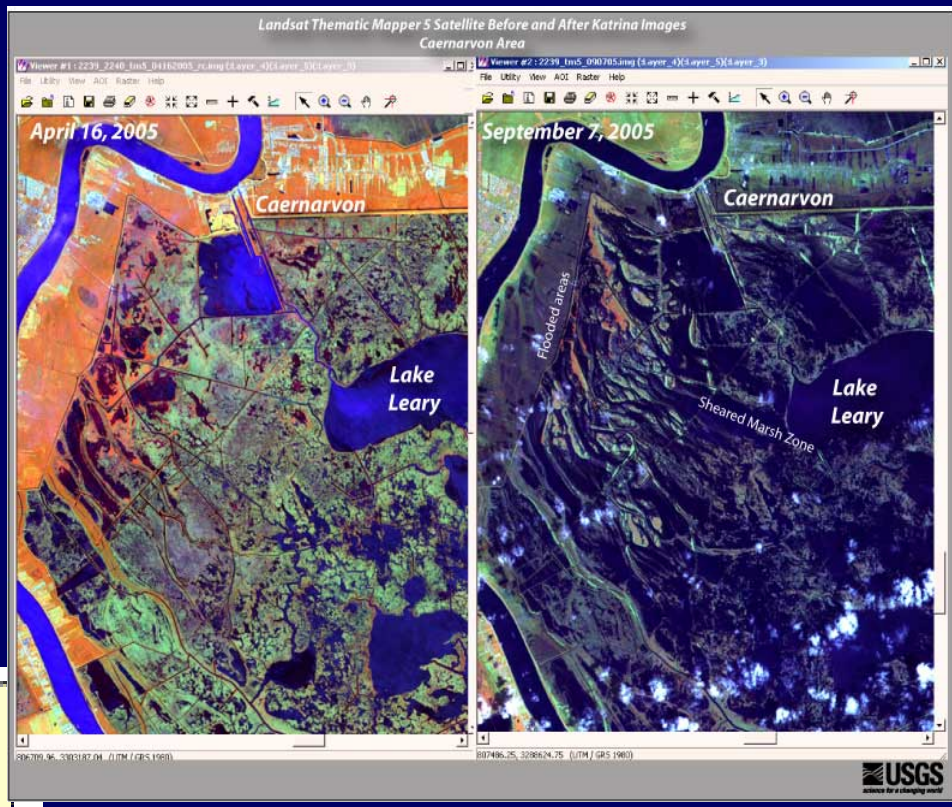
Performance - Connectivity

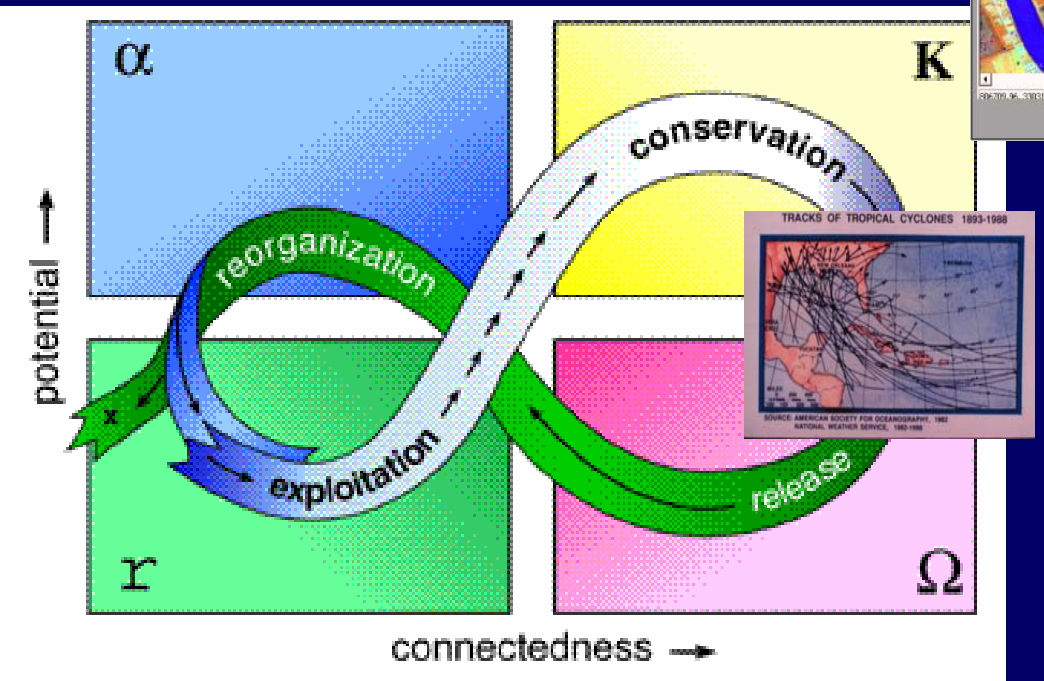
- Lack of dialogue among modelers, monitoring, science, and agencies



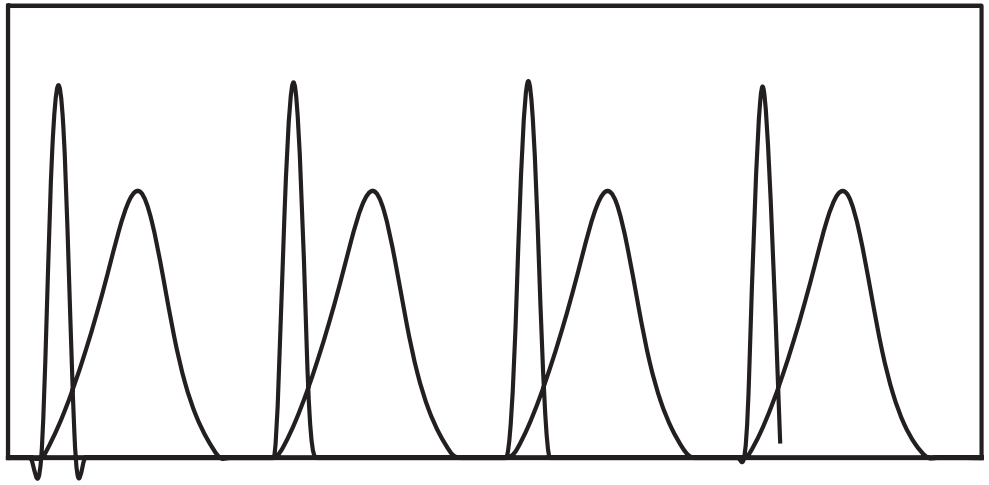
Concepts of Ecosystem Resiliency - National Agenda

- Metrics to test hypothesis; forecast ecosystem state change; establish ecosystem report cards; establish critical threshold conditions





Increasingly studies in ecology and other fields are showing... (that systems) maximize performance by pulsing… Pulsing can maximize long-range performance.
[*from H.T. Odum 1988 Science 242:1132-1139*]



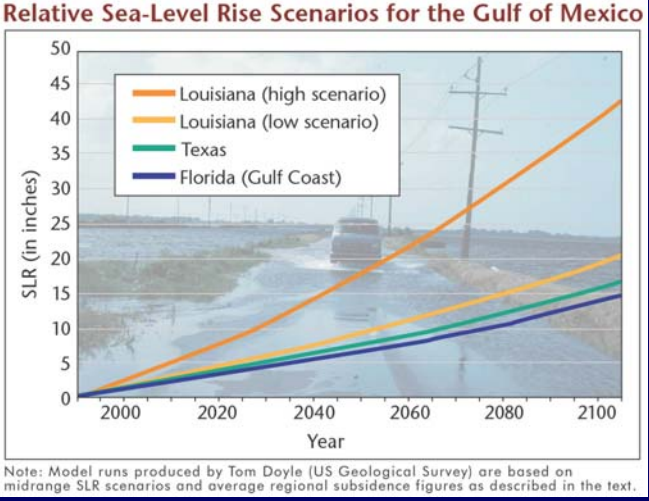
Uncertainty Assessment of Ecosystem Forecasting:

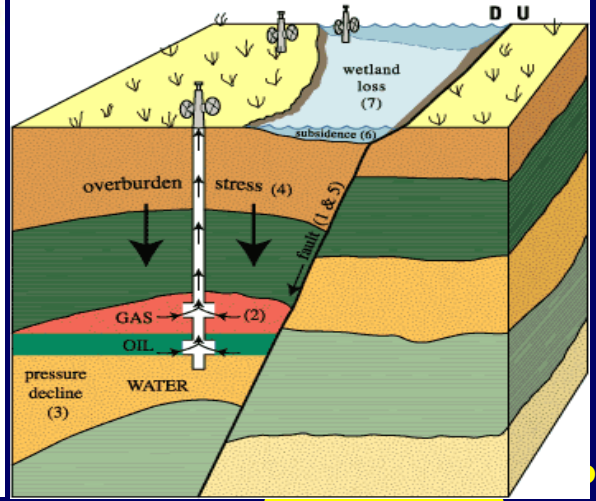
Land Surface Dynamics (storm surge);

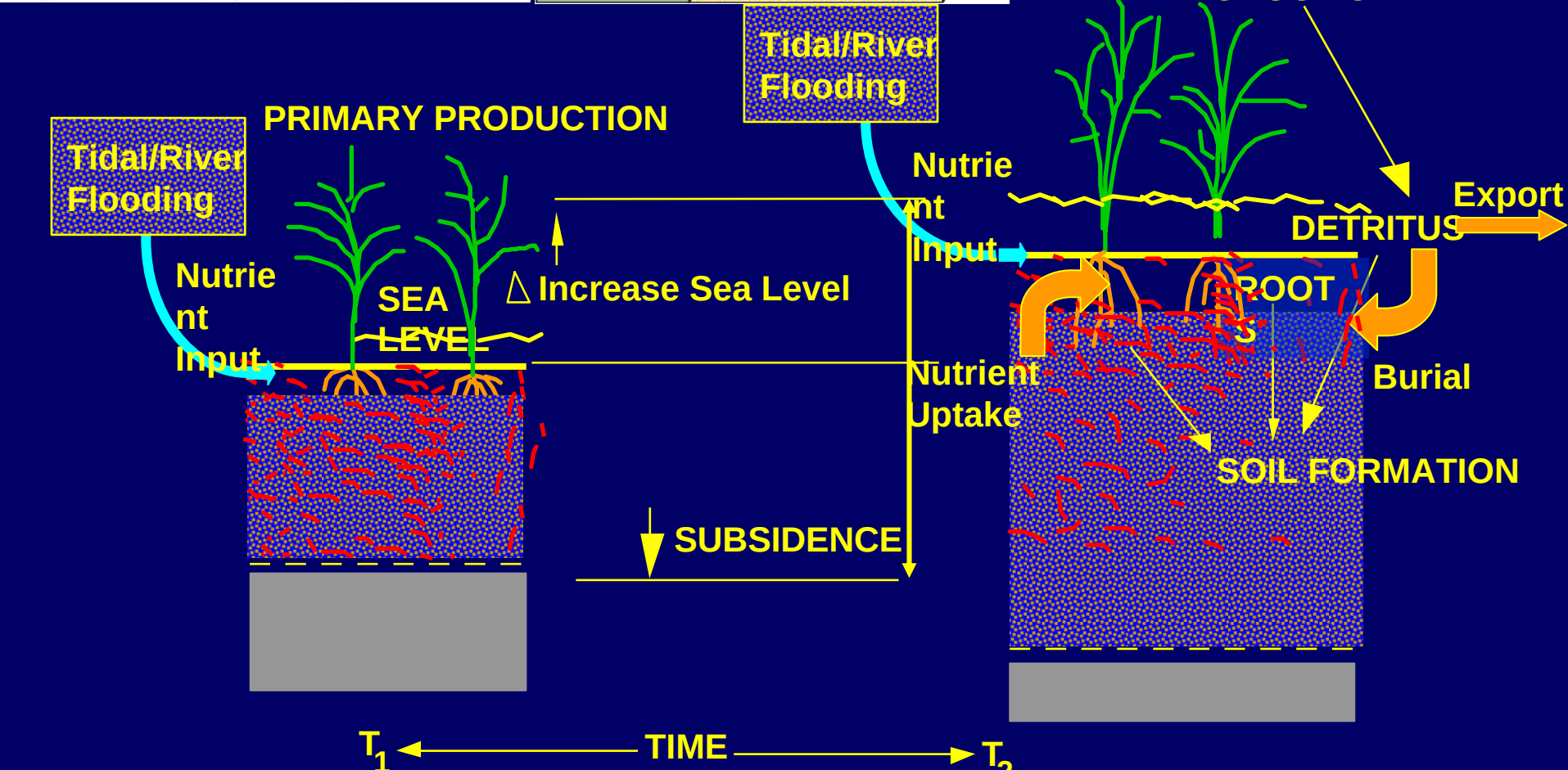
Climate Change;

Ecosystem Thresholds;

Model Validation


Relative Sea-Level Rise Scenarios for the Gulf of Mexico
Louisiana (high scenario)
Louisiana (low scenario)
Texas
Florida (Gulf Coast)
SLR (in inches)
0
5
10
15
20
25
30
35
40
45
50
2000
2020
2040
2060
2080
2100
Year
Note: Model runs produced by Tom Doyle (US Geological Survey) are based on midrange SLR scenarios and average regional subsidence figures as described in the text.

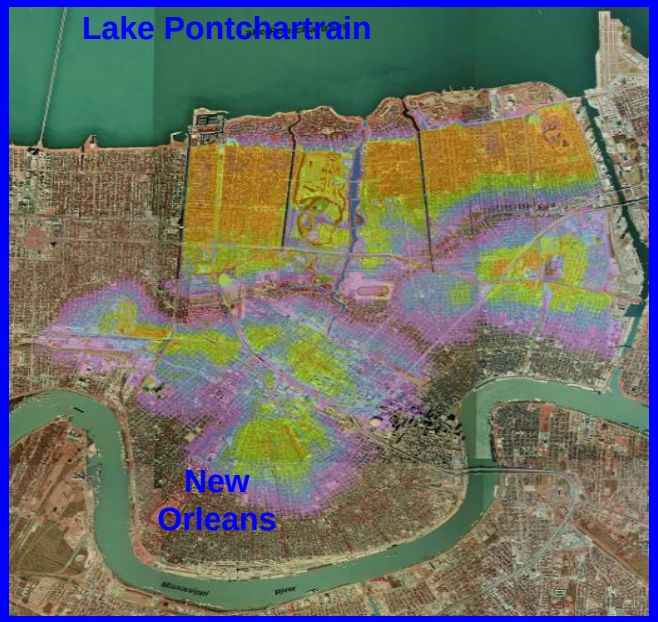

D
U
wetland loss (7)
subsidence (6)
overburden
stress (4)
fault (1 & 5)
GAS
(2)
OIL
WATER
pressure decline (3)


ORGANIC SEDIMENT
MINERAL SEDIMENT
DEEPER SUBSTRATE
Tidal/River Flooding
PRIMARY PRODUCTION
Nutrient Input
SEA LEVEL
Δ Increase Sea Level
SUBSIDENCE
Tidal/River Flooding
PRIMARY PRODUCTION
Nutrient Input
Export
DETRITUS
ROOTS
Nutrient Uptake
Burial
SOIL FORMATION
T_1
TIME
T_2

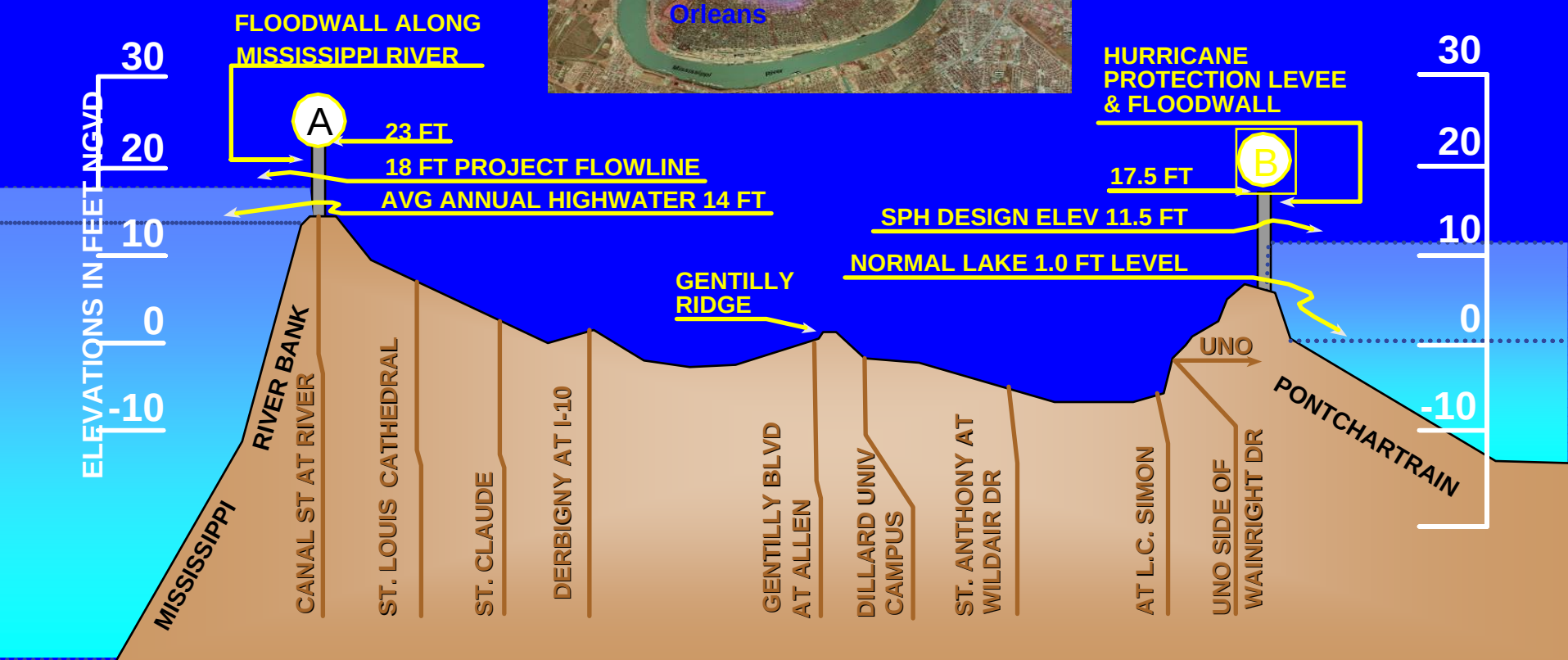
Ecosystem Science and Hurricanes: Natural Systems as Part of the Protection Strategy

The problem in urban areas is clear

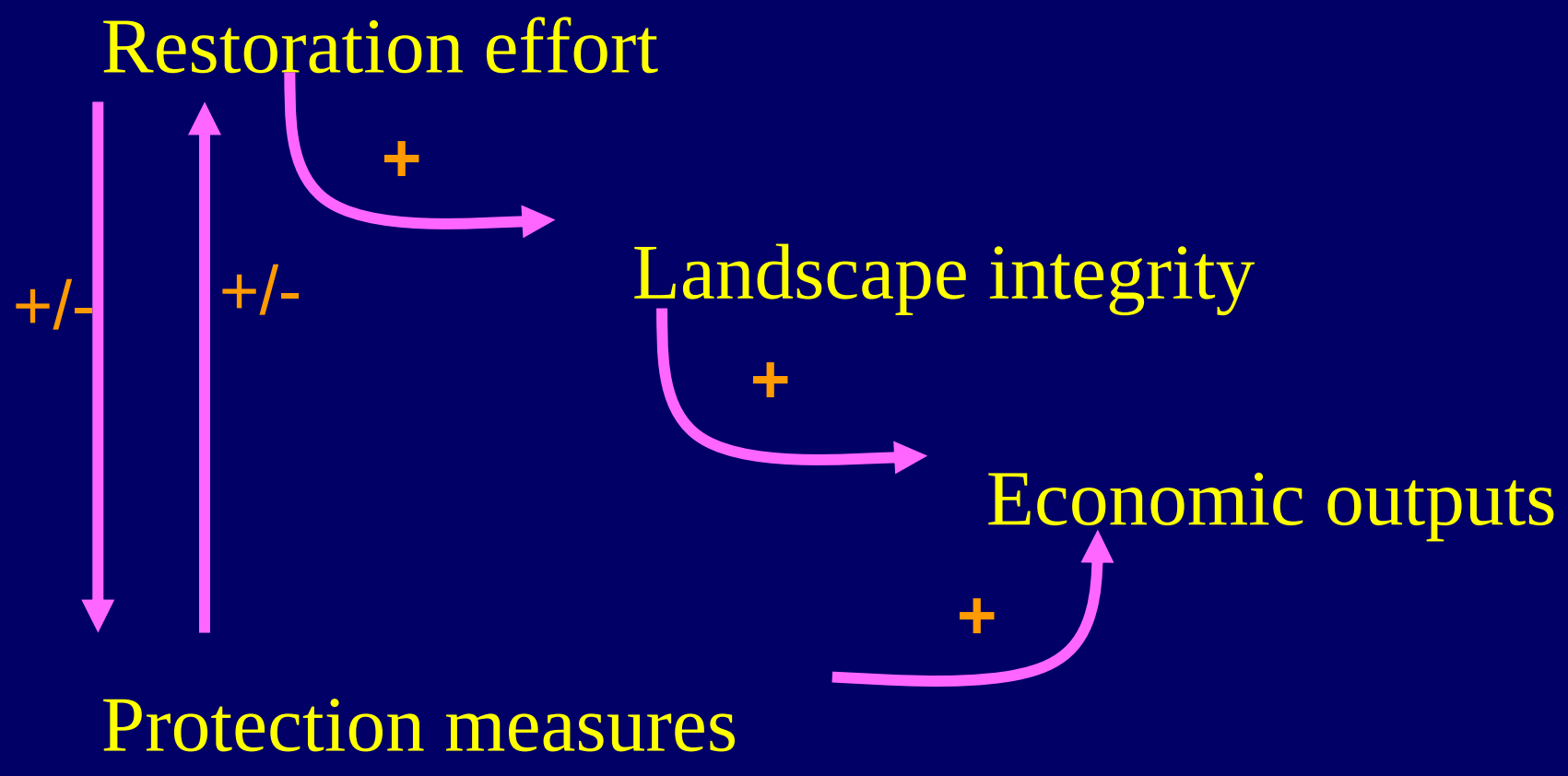
City of New Orleans Ground Elevations



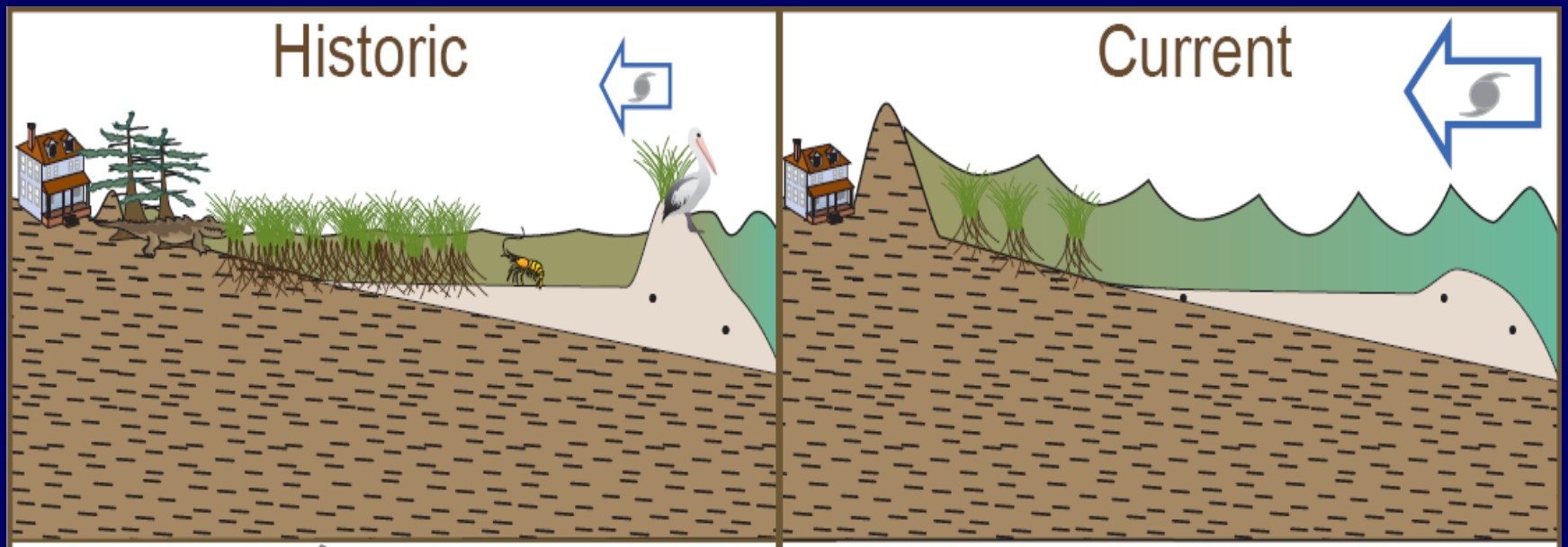
From Canal St. at Mississippi River to the Lakefront at U.N.O.



Strategies for Developing Scenarios



Storm Protection



Barrier islands & continuous marsh act as buffers to reduce storm surge penetration & wave impacts along the coast. With the presence of healthy, intact barrier islands & extensive wetlands, only small flood protection levees are required.

As barrier islands erode, their buffering capacity is lost. Storm surges & wave impacts penetrate farther inland with increased magnitude and frequency. This results in the need to build and maintain larger levees & more complex pumping systems to protect communities & commercial infrastructure.

VIEWPOINT

Social-Ecological Resilience to Coastal Disasters

W. Neil Adger,[1*] Terry P. Hughes,[2] Carl Folke,[3] Stephen R. Carpenter,[4] Johan Rockström[5]

Social and ecological vulnerability to disasters and outcomes of any particular extreme event are influenced by buildup or erosion of resilience both before and after disasters occur. Resilient social-ecological systems incorporate diverse mechanisms for living with, and learning from, change and unexpected shocks. Disaster management requires multilevel governance systems that can enhance the capacity to cope with uncertainty and surprise by mobilizing diverse sources of resilience.

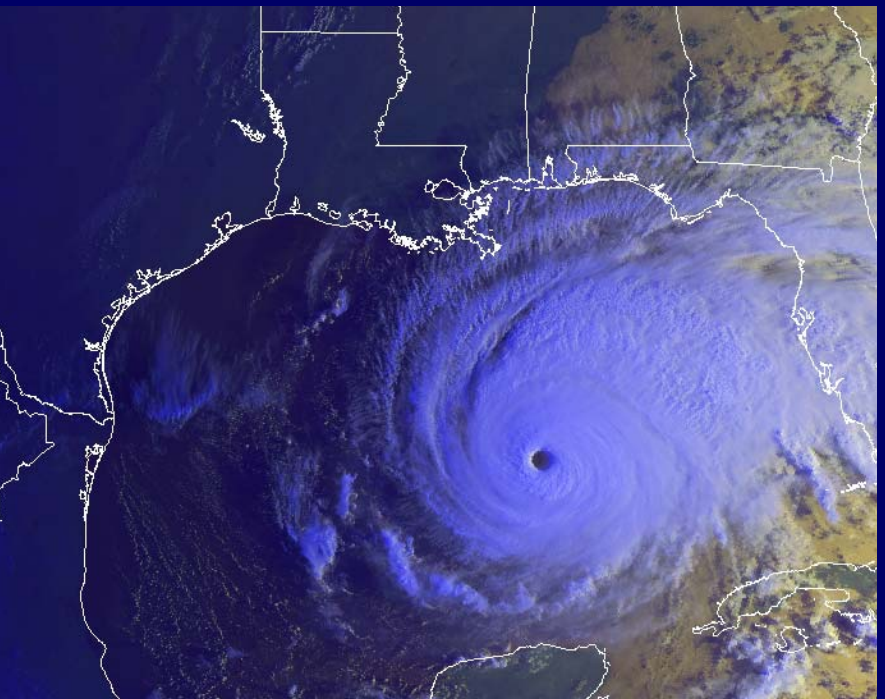
stable, to a more realistic viewpoint aimed at sustaining and enhancing the capacity of social-ecological systems to adapt to uncertainty and surprise.

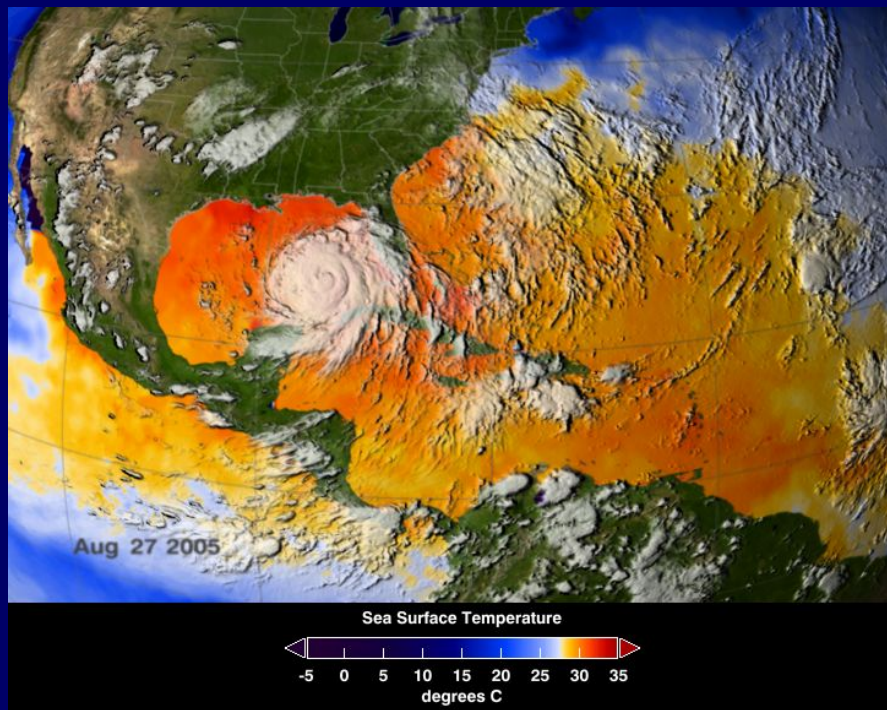
Coastal Hazards and Resilience

Table 1. Examples of local- and regional-scale actions to enhance resilience in social-ecological systems exposed to abrupt change.

Elements of vulnerability	Local action	National and international action
Exposure and sensitivity to hazard	Maintenance and enhancement of ecosystem functions through sustainable use Maintenance of local memory of resource use, learning processes for responding to environmental feedback and social cohesion	Mitigation of human-induced causes of hazard Avoidance of perverse incentives for ecosystem degradation that increase sensitivity to hazards Promotion of early warning networks and structures Enhancement of disaster recovery through appropriate donor response
Adaptive capacity	Diversity in ecological systems Diversity in economic livelihood portfolio Legitimate and inclusive governance structures and social capital	Bridging organizations for integrative responses Horizontal networks in civil society for social learning

Recommendations





(1) Ecosystem Forecasting: Risks, Resiliency, and Restoration

(2) Ecosystem Forecasting: Thresholds for wetland stability under different scenarios of sediment supply, tidal amplitude, sea level rise, subsidence, and hurricane disturbance?

(3) Uncertainty Assessment: Land Surface Dynamics; Ecosystem Thresholds; Pulses as Part of System Stability;

(4) Environmental Observation Systems; Questions associated with large-scale disturbances (hurricanes); Data acquisition and model verification (data archives);

BoR Post Hurricane Forum 2006
‘Science Recovery and Discovery: Role of Higher Education in Securing a Sustainable Future’

Goal of Forum 2006

- Rebuilding of Science
- Science of Rebuilding

(5) Ecosystem Science and Engineering: Role of natural coastal systems to protection strategies; Coastal Engineering and Science

Science for Rebuilding Coastal Louisiana

<u>Natural Science</u>

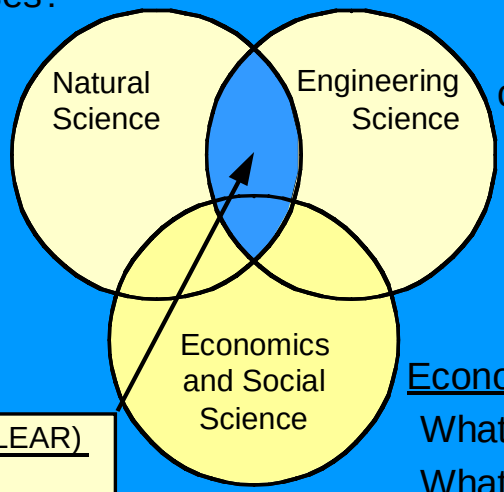
Driving processes?

What is status, trends in natural systems?

<u>Engineering</u>

What can we do?

How and at what cost?



<u>Applied Science (CLEAR)</u>

What is feasible?

How is/will it perform?

<u>Economic Analysis</u>

What is at stake?

What opportunities exist (risks/benefits)?