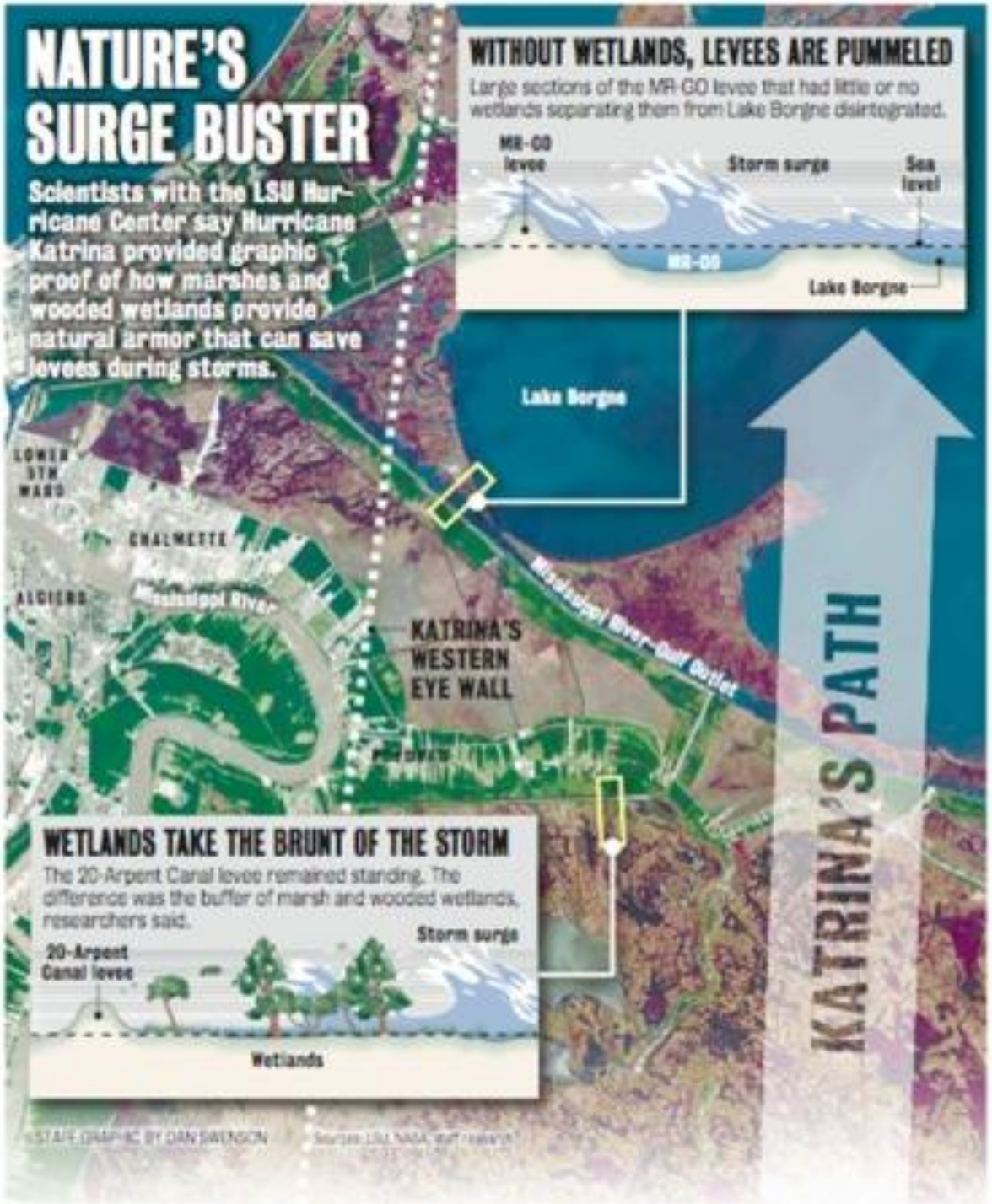
Wetland Assimilation for Climate Change Adaptation: A Decision Analytic Approach

Sarah K. Mack, PhD, CFM

Climate Change Adaptation and Restoration in New Orleans

- Wetland Assimilation Project
- Decision Model Development
- Trade-offs results
- Applications


10 M SPOT Satellite Image: 2 Sept 2005
UNO
Lake Borgne
Treatment Plant
Miss River
Gulf Outlet
Destroyed
Wetlands
Potential
Restoration
Area
Tulane
French
Quarter
NATURAL SYSTEMS MODELING GROUP
at LOUISIANA STATE UNIVERSITY
DeWitt Braud and Rob Cunningham


NATURE'S SURGE BUSTER
Scientists with the LSU Hurricane Center say Hurricane Katrina provided graphic proof of how marshes and wooded wetlands provide natural armor that can save levees during storms.
WITHOUT WETLANDS, LEVEES ARE PUMMELED
Large sections of the MR-GO levee that had little or no wetlands separating them from Lake Borgne disintegrated.
MR-GO levee
Storm surge
Sea level
MR-GO
Lake Borgne
Lake Borgne
LOWER 9TH WARD
CHALMETTE
ALGIERS
Mississippi River
KATRINA'S WESTERN EYE WALL
Mississippi River-Gulf Outlet
KATRINA'S PATH
WETLANDS TAKE THE BRUNT OF THE STORM
The 20-Arpent Canal levee remained standing. The difference was the buffer of marsh and wooded wetlands, researchers said.
Storm surge
20-Arpent Canal levee
Wetlands
STAFF GRAPHIC BY DAN SWINSON

PEARL RIVER – (EYE OF KATRINA)

INTACT CYPRESS

FALLEN OAKS

Increasing Adaptive Capacity

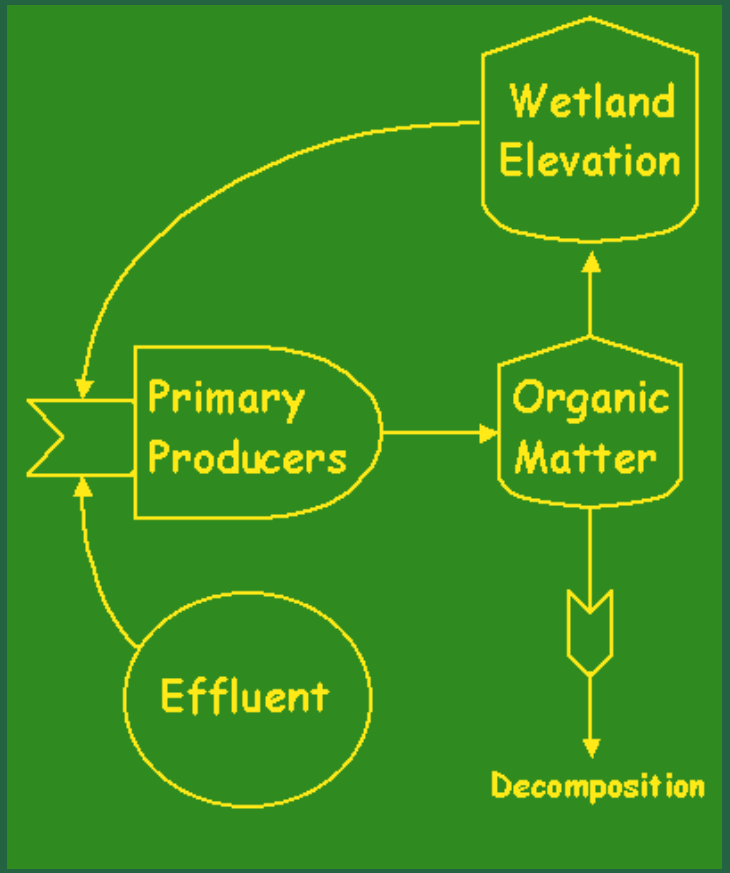
- Adaptation of vulnerable human and ecological systems.
- Need to adapt to an already-changing climate
  - Hurricane protection
  - Off-set relative sea level rise (RSLR)
    - Increase vertical accretion

Key adaptation technique is restoration of coastal wetlands

Wetland Assimilation

Effluent discharged into wetlands:

- Increases accretion to offset RSLR
- Carbon sequestration mitigates climate change
- Hurricane surge protection and floodwater retention increases resiliency of the built environment
- Freshwater in effluent protects against drought and buffers saltwater intrusion
- Numerous social and economic benefits



Enhanced Accretion

(Rybczyk et al. 2002)

Cypress Restoration of Bayou Bienvenue Central Wetland Unit

What we need is a tool?

- Engage local stakeholders
- Incorporate local knowledge
- Determine trade-offs
- Build consensus
- Transparent holistic framework
- Guide implementation and the development of new policies

The first decision model to evaluate wetland assimilation for climate change adaptation

Multi-Criteria Decision Analysis (MCDA)

- Analytical approach to address complex problems
  - Multiple conflicting objectives
  - Multiple stakeholders
  - Assess trade-offs
- Scientific framework to organize information
- Systematically evaluate multiple criteria
- Evaluate and choose among alternatives
- Formulate strategies for decision making and informing policy

Purpose of the study

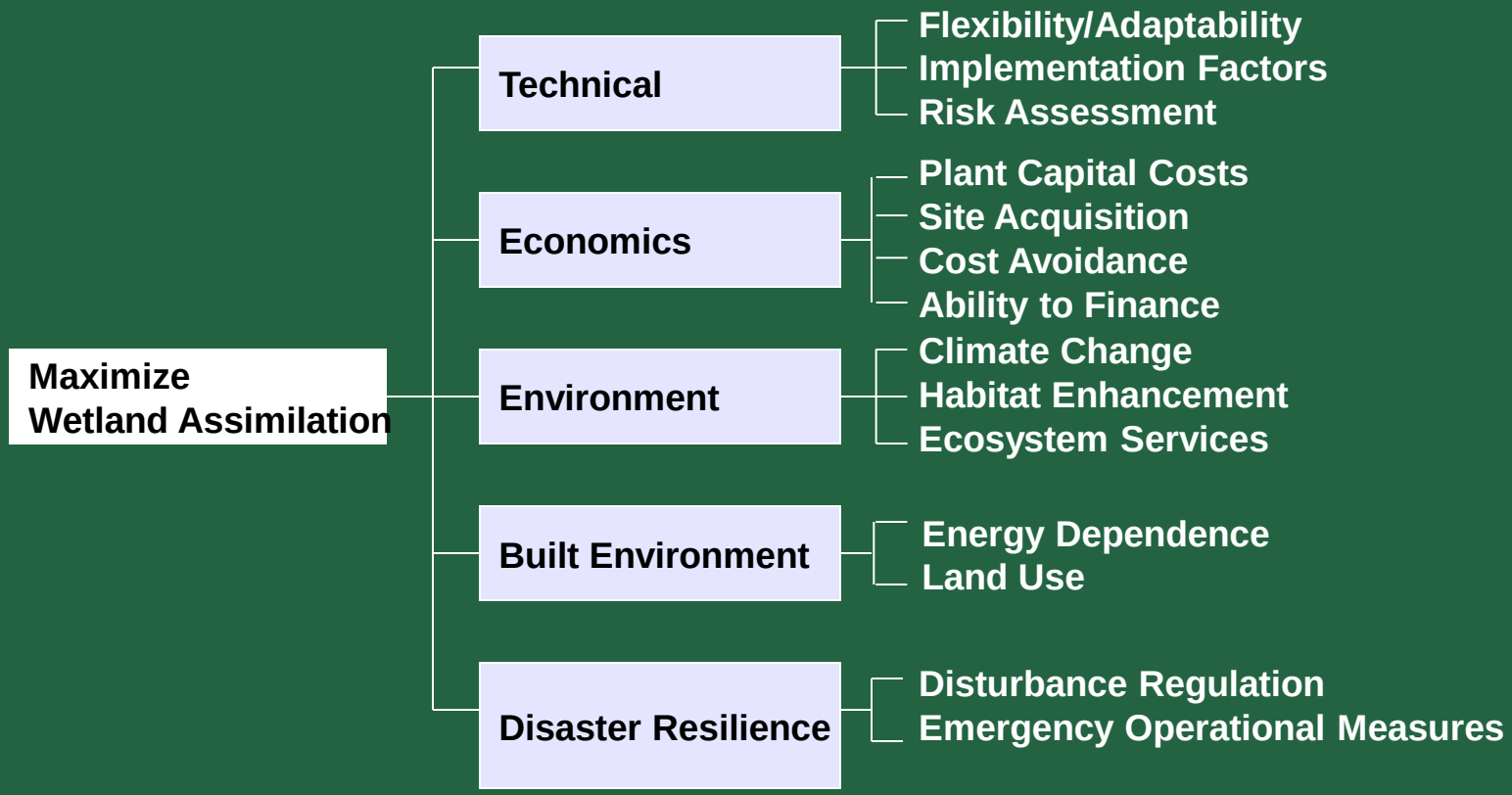
- **Goal**: To systematically evaluate wetland assimilation and propose policy by integrating wetland assimilation ecological and engineering design with sustainable development, urban planning, public health, and disaster management.

- **Objectives**:
  - Create a multi-criteria decision model for wetland assimilation.
  - Apply the model to the New Orleans regional wetland assimilation plans.
  - Evaluate the stakeholder trade-offs for implementation.
  - Propose new policy.

Defining Criteria

- Identify all major objectives and sub objectives for evaluation and sound decision-making
  - 5 Objectives
  - 30 Sub objectives
- Expert Input and Literature Review
  - Public Health -- Ecology
  - Wetland Assimilation -- Sustainable Development
  - Climate Change Adaptation -- Engineering
  - Emergency Management -- Hazard Mitigation

Structuring the Decision Problem



Built Environment

- To investigate the impact of community design and land-use choices on public health, social well-being, and the environment.
- Ecosystem-mediated impacts
  - *Property Damage and Value*
  - Enhanced wetlands, unsafe housing, and general quality of life.
  - Relationship of health, risk and urban environments.

Trade-offs Analysis

- Simple Multi-Attribute Rating Technique (SMART)
- Scoring system based on two parameters
  - Values
  - Weights
- Experts rank and rate weights via a questionnaire
- Weights reflect value judgments of stakeholders

Identification of Experts

- Acceptable trade-offs were determined using expert representation of six stakeholder groups
  - Appointed and elected officials
  - Science and technical experts
  - Citizen stakeholders
  - Environmental advocates
  - Government regulatory groups
  - Business or industry stakeholders

Stakeholder Group Trade-Offs

- Technical - Priority on community design for climate change adaptation
- Regulatory - Highest priority on direct public health impacts
- Environmental - Community design should focus on natural environment
- Industry - Highest priority on *Disaster Resilience*
- Citizens - Priority on protecting their community
- Appointed – Need to educate appointed and elected officials to think holistically

Technical Major Objective

- *Implementation Factors*
  - Institutional barriers, proven treatment technology, regulatory and legal complexity, and siting.
  - Citizen and Appointed stakeholders in 10 least important variables.
- Direct and indirect public health aspects not valued.
  - Priority of Regulatory and Environmental stakeholders
  - Require health impact assessments
  - Optimize direct and indirect health impacts of urban environments

Economics Major Objective

- *Ability to Finance*
  - Technical and Regulatory stakeholders aware.
  - Appointed, Citizen, Industry, and Environmental stakeholders unaware:
    - Financial and technical capacity needs
    - Greater transparency
- *Operation and Maintenance & Site Acquirement*
  - Industry stakeholders brought to light hidden costs
  - Are Regulatory and Technical stakeholders providing all the information to decision-makers?

Environment Major Objective

- *Climate Change*
  - Technical-2nd and Citizens-7th.
  - Appointed-17th and Environmental 15th.
  - Industry and Regulatory in 10 least important variables.
    - Technical and Citizens have little influence.
    - Business as usual decision-making leaves us where?
- *Ecosystem Services*
  - Benefits to human societies by natural ecosystems-not a priority.
  - *Disturbance Regulation* valued by all groups.
  - Quantify locally important ecosystem services
  - Educate – Appointed and Regulatory

Built Environment Major Objective

- Land Use Planning
  - Well designed community favors health and quality of life.
  - Characteristics of Built Environment on Vulnerability
    - Flooded areas converted to green space or hazard mitigated.
  - Climate change and disturbance regulation on land use and property damage.
    - Appointed <4%.
    - Have Regulatory and Technical stakeholders tried to persuade appointed officials?
    - Citizens- *Property Damage and Value-6th* but *Land Use* less.
    - ECONOMICS!
  - Assist decision-makers to make hard decisions
    - Hazard Mitigation Grant Program (HMGP)
    - Refine policies

Built Environment Major Objective

- *Energy Dependence*
  - Will the region be prepared for an energy crisis?
    - NO!
    - Only a priority of citizens
- *Equity*
  - Listed in the 10 least important variables for all stakeholder groups but citizens
  - Indicative of the region
  - Essential for implementation

Disaster Resilience Major Objective

- Most valued for improving physical, mental, and social well-being of the public
- *Disturbance Regulation*
  - Ecosystems valued for adaptive capacity
- *Hazardous Source*
  - Potential to release hazardous products
  - Respond to a spill
- *Resilience*
  - Resistance to storm surge
  - Time required to restore operation

Consensus of All Stakeholders

Integrated all values into a decision set of structured consensus trade-offs

- Priority on community design for climate change adaptation

  Disturbance Regulation, Climate Change, Land Use, and *Property Damage*

- Environmental parameters for design

  Ecosystem Integrity, Habitat Enhancement, Water Quality,Compatibility

- System will be disaster resilient

  Disturbance Regulation, Resiliency, Reliability

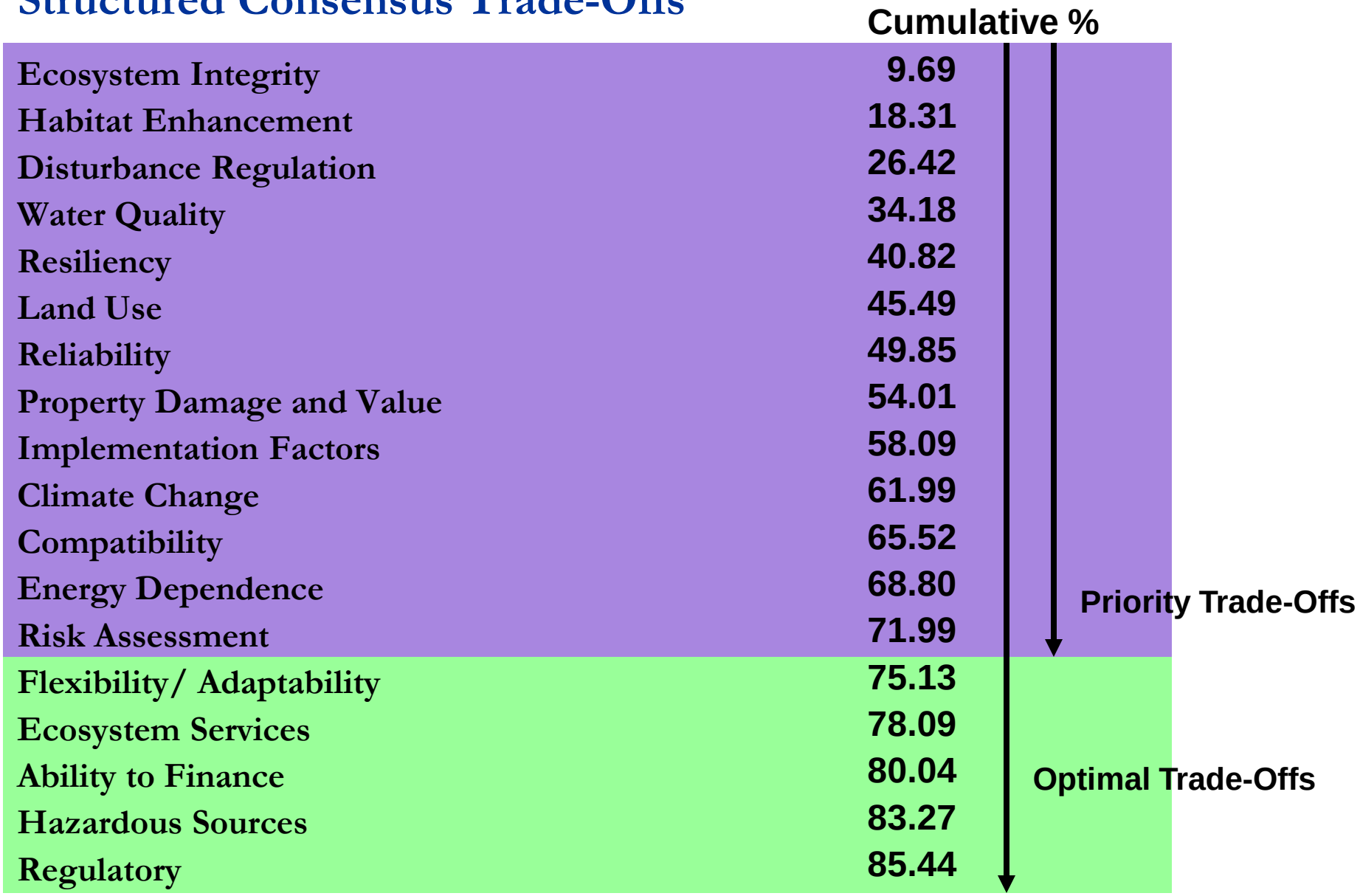
- Citizens priority on *Energy Dependence* is included

- *Implementation Factors* address institutional barriers

- *Risk Assessment* addresses direct public health impacts

Decision Set

Structured Consensus Trade-Offs



The Reality: consequences of poor policy

- Lack of technical and financial capacity
  - Devastated infrastructure
  - Billions of dollars of deficits
  - Limited tax base
  - Overwhelmed staff
- Biggest obstacles
  - *Ability to Finance*
  - *Site Acquirement*
  - *Equity*

Applications of the Model

- Wetland Assimilation Performance Scores
  - Identify areas for improvement that would have greatest impact
    - resilience/score/$
  - Evaluate improvement over time (monitoring)
  - Calculate in advance to provide goals for improvement or benchmarks
  - Relative performance scores of various scenarios

Acknowledgements

Environmental Defense Fund

WASTE IS A RESOURCE OUT OF PLACE