Water and Biodiversity:
Sustainability Science to Inform Resource Management

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Enduring Need for Sustainability

USGS Organic Act (1879)

"…classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain."

USGS Mission

To serve the Nation by providing reliable scientific information to:

- Describe and understand the Earth
- Minimize loss of life and property from natural disasters
- Manage water, biological, energy, and mineral resources
- Enhance and protect our quality of life

USGS' Evolving Role

National Research Council Review of USGS (2001)

Major Recommendation

"USGS should shift from a more passive role of study and analysis to one that seeks to convey information actively in ways that are responsive to social, political, and economic needs"

From science as problem description to science as a critical input to problem solving

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Water, Biodiversity, and Humans

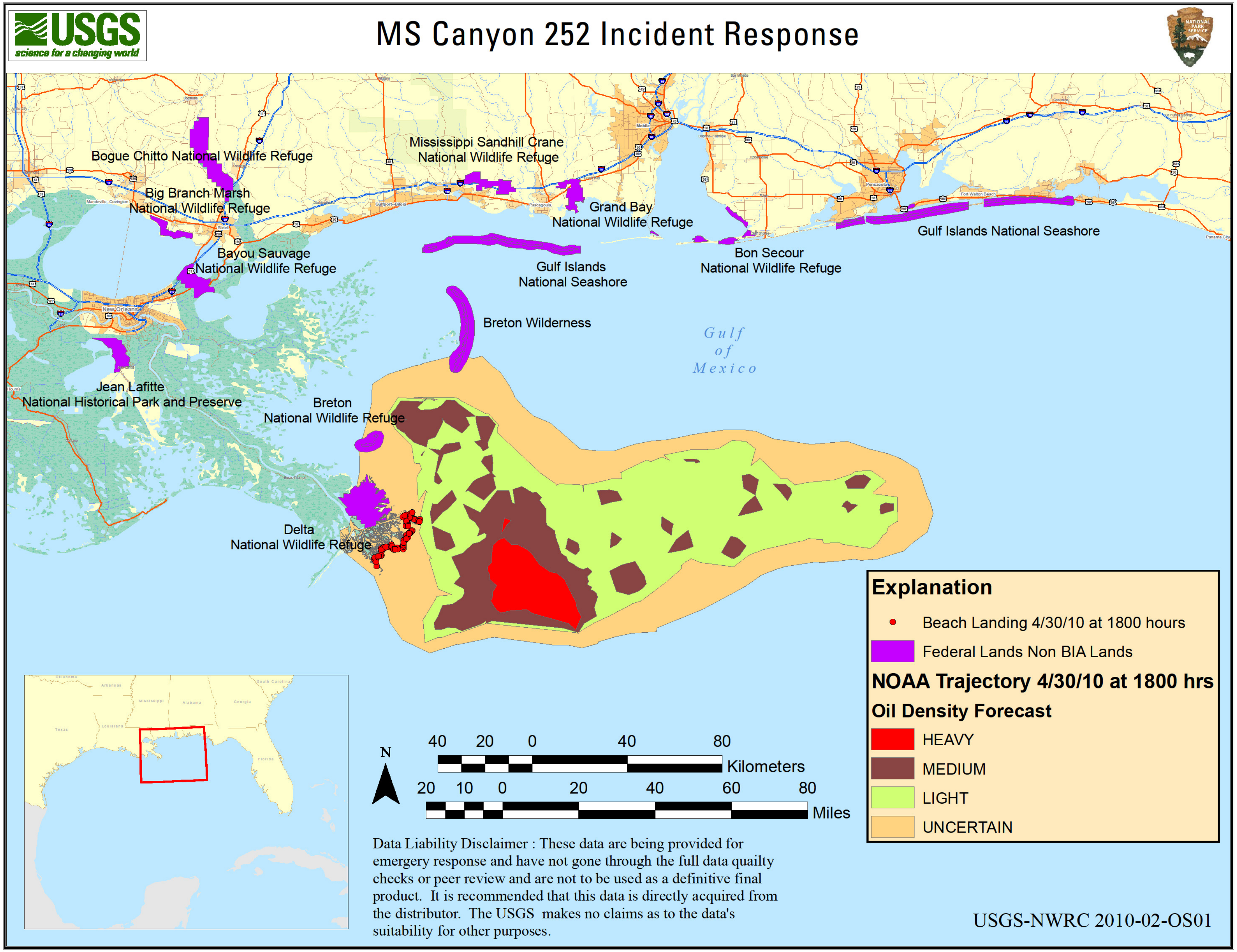
Long-term maintenance of basic ecosystem processes and functions is essential to support biodiversity.

Water is a fundamental component of any ecosystem and the species that it supports.

Our nation's coastlines, including the Great Lakes, are home to more than 50 percent of the US population, living in approximately 17 percent of the coterminous US land area.

Devastation caused by recent natural and human-induced disasters have heightened awareness of the effects of human development and the storm buffering capacity of wetlands, and coastal awareness and subsidence.

Source: USGS Ecosystem Science Council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science for a changing world
MS Canyon 252 Incident Response
Bogue Chitto National Wildlife Refuge
Mississippi Sandhill Crane
National Wildlife Refuge
Big Branch Marsh
National Wildlife Refuge
Grand Bay
National Wildlife Refuge
Gulf Islands National Seashore
Bayou Sauvage
National Wildlife Refuge
Gulf Islands
National Seashore
Bon Secour
National Wildlife Refuge
Breton Wilderness
Gulf of Mexico
Jean Lafitte
National Historical Park and Preserve
Breton
National Wildlife Refuge
Delta
National Wildlife Refuge
Explanation
Beach Landing 4/30/10 at 1800 hours
Federal Lands Non BIA Lands
NOAA Trajectory 4/30/10 at 1800 hrs
Oil Density Forecast
HEAVY
MEDIUM
LIGHT
UNCERTAIN
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40 20 0 40 80
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Miles
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USGS-NWRC 2010-02-OS01

Science-Based Restoration

Developing a restoration strategy in response to the Gulf of Mexico oil spill requires a comprehensive effort that:

1. Explicitly links natural and human systems;

2. Addresses uncertainty both in the impacts of the spill and in the consequences of management responses;

3. Encompasses a structured decision process that is transparent so that the many stakeholders who are intimately involved with the outcome become part of the process; and

4. Considers the long-term consequences and sustainability of restoration efforts.

Historical Context

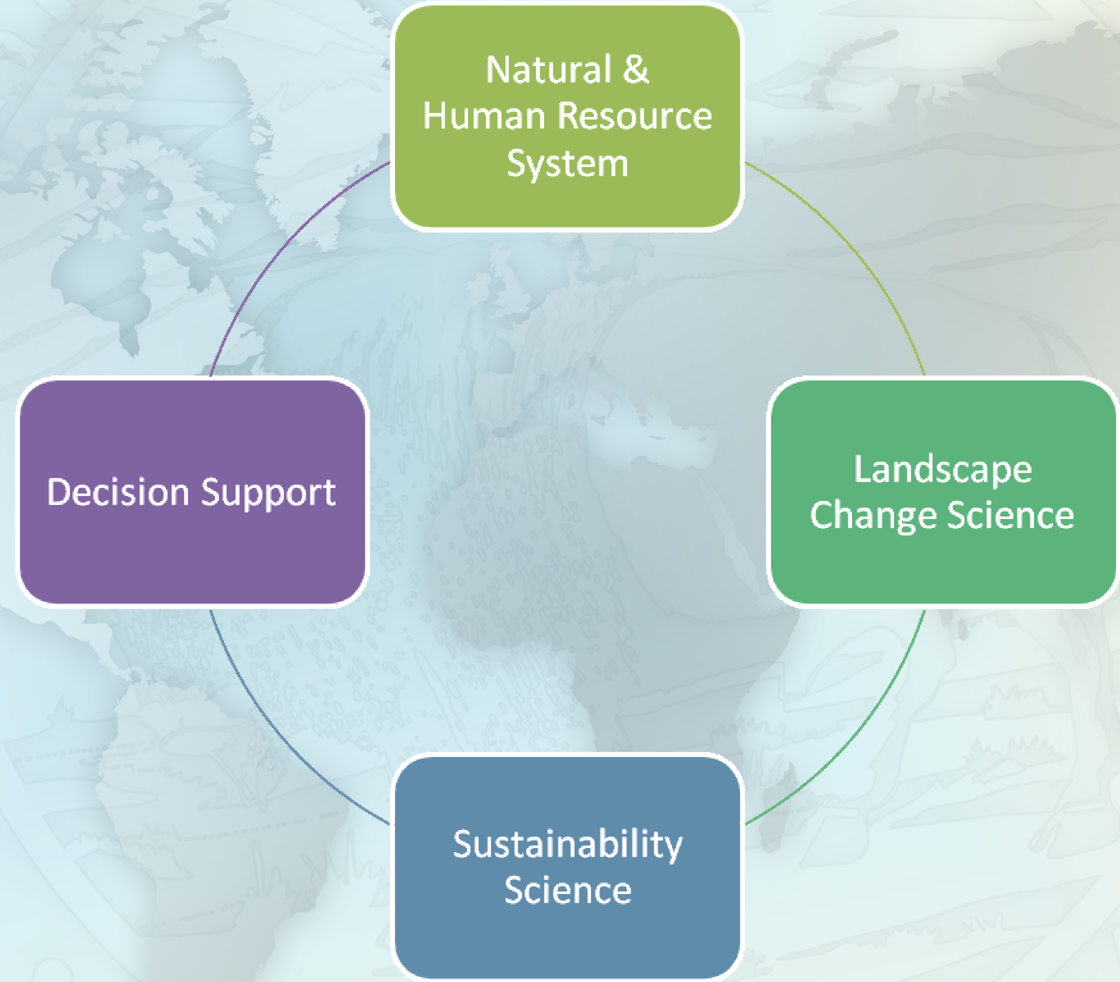
Post World War II Supply-Side Model

Science → Translation → Decision Making

Late 20th Century Demand-Side Model

Stakeholders → Science → Decision Making

Integrated Model



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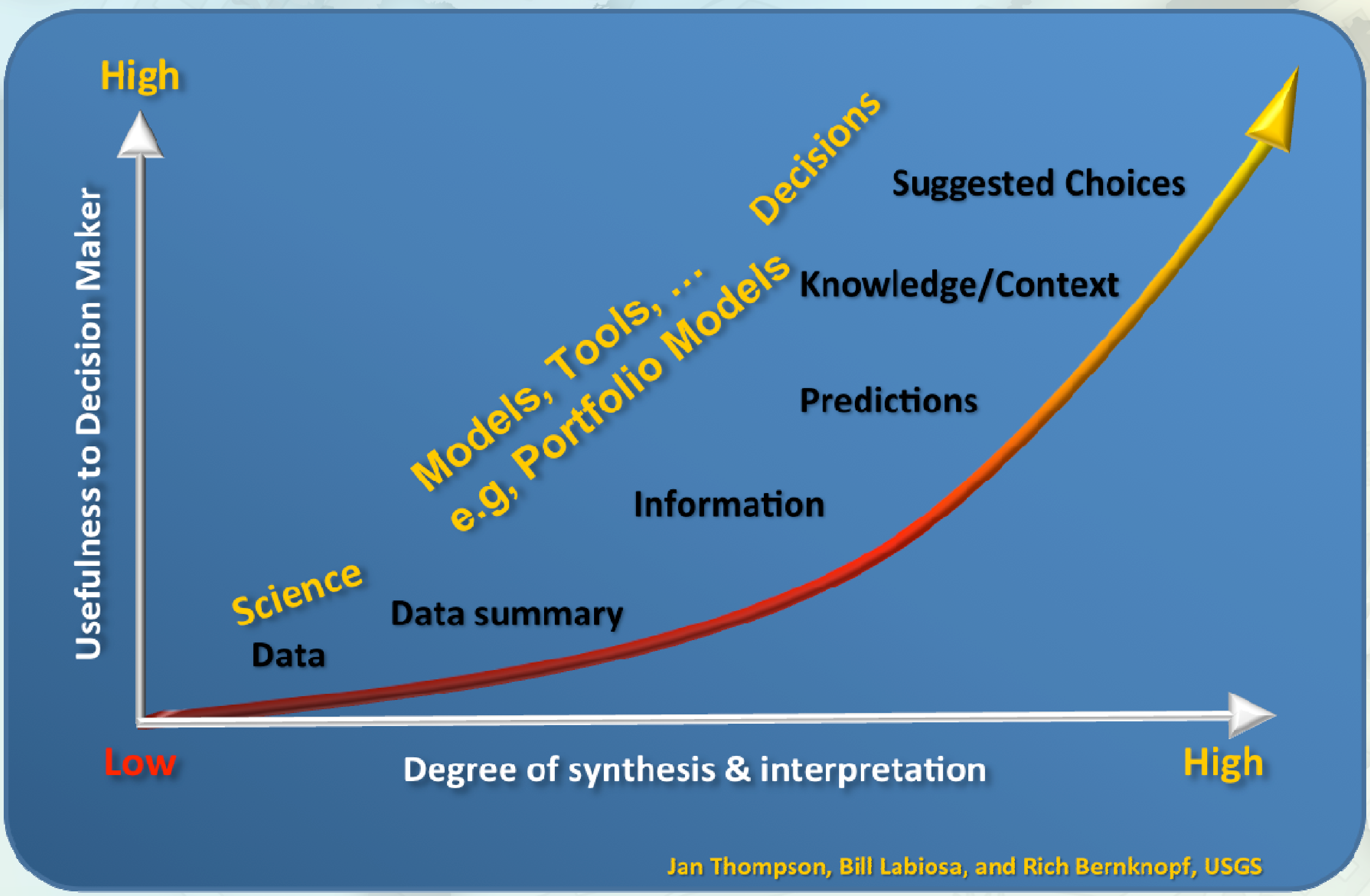
Bridging the Gap Between Scientists and Decision-makers



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Sustainability Science

The study of managing natural and urban systems so that human quality of life and a healthy environment can be maintained and improved over space and time.

1. Ecosystem Services
2. Adaptive Management
3. Resiliency, Vulnerability, and Risk

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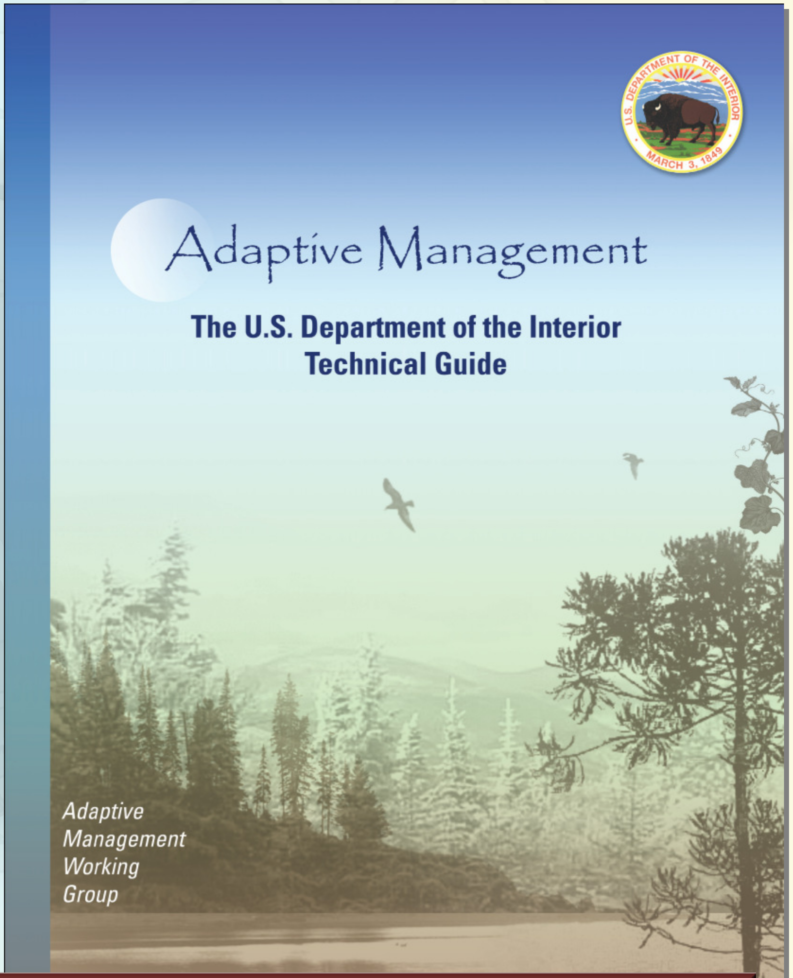
Adaptive Management

AM provides a structured decision process for iterative decision making when scientific uncertainty exists.

AM facilitates near-term decision making even when there is imperfect information about longer-term consequences.

The integrated conceptual framework provided by ES can be important to an AM decision process by contributing to the articulation of objectives, the assessment of potential management strategies, and evaluation of management consequences.



http://www.doi.gov/initiatives/AdaptiveManagement/index.html

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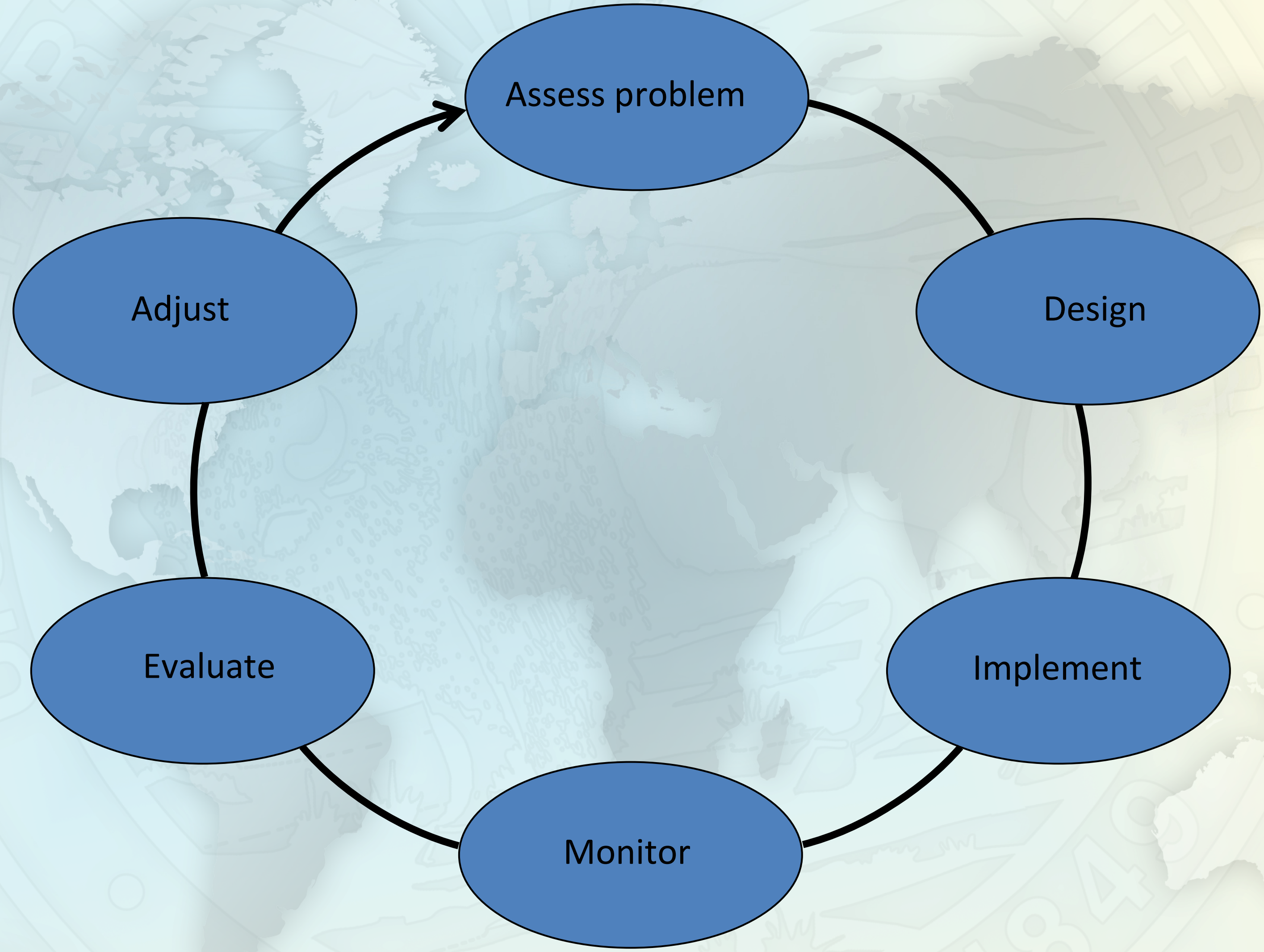
The Adaptive Management Process



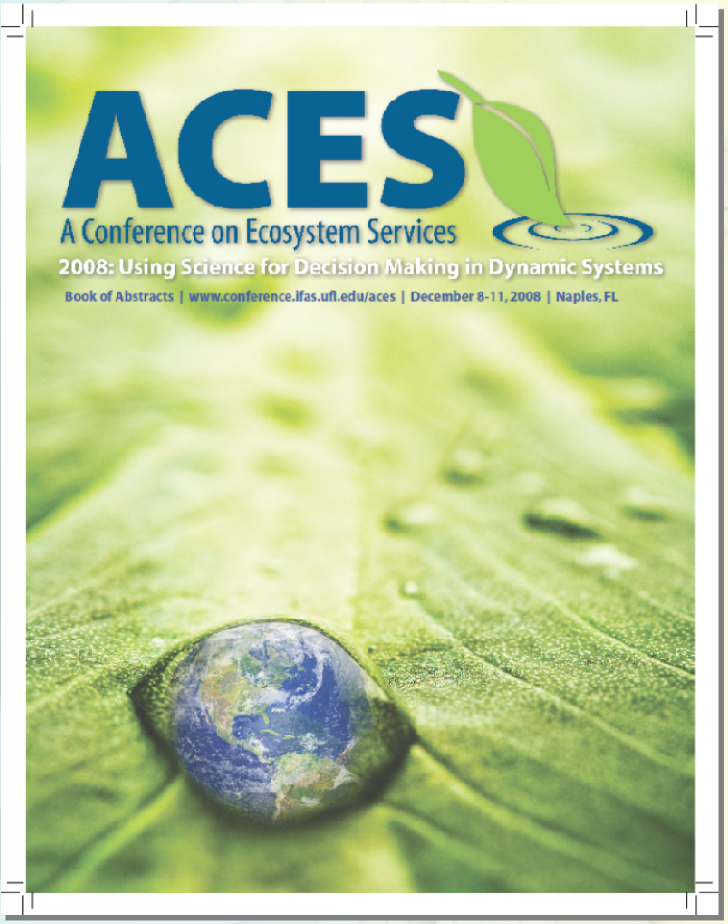
Ecosystem Services

Goods and services produced by natural systems are not always considered in resource management decisions.

Ecological, geographic, economic, and institutional information needs to be combined to facilitate informed decisions.

Ecosystem services provide an integrated framework for assessing the consequences of resource management decisions and for evaluating tradeoffs among resource management, conservation, restoration, and development alternatives.

This framework is especially important when assessing the impacts of dynamic systems caused by climate change, human settlement, and other drivers.



http://www.conference.ifas.ufl.edu/aces/

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What are ecosystem services?

Ecosystem services are the goods and services provided by nature and include commodities such as food and fresh water and services such as biodiversity, climate resilience, and storm protection.

Ecosystem services typology

Provisioning Services	Regulating Services	Cultural Services
Products obtained from ecosystems	*Benefits obtained from regulation of ecosystem processes*	*Nonmaterial benefits obtained from ecosystems*
■ Food	■ Climate regulation	■ Spiritual and religious
■ Fresh water	■ Disease regulation	■ Recreation and ecotourism
■ Fuelwood	■ Water regulation	■ Aesthetic
■ Fiber	■ Water purification	■ Inspirational
■ Biochemicals	■ Pollination	■ Educational
■ Genetic resources		■ Sense of place
		■ Cultural heritage

Supporting Services

Services necessary for the production of all other ecosystem services

■ Soil formation ■ Nutrient cycling ■ Primary production

Source: Millennium Ecosystem Assessment, 2003. Ecosystems and Human Well-Being: A Framework for Assessment. Island Press, Washington, DC

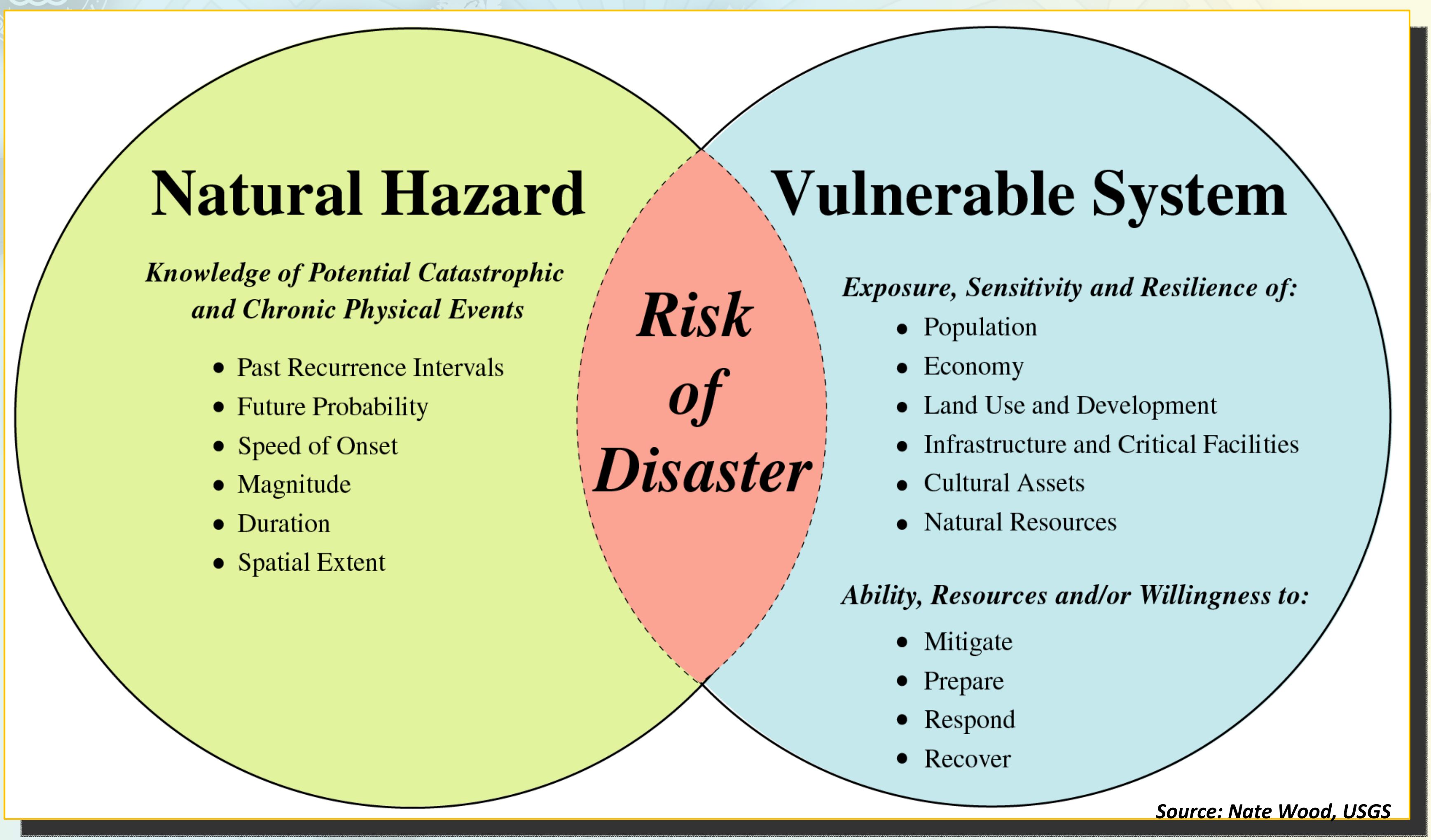
Resilience, Vulnerability, and Risk

Resilience, vulnerability, and risk provide measures of a natural, managed, or human system's sustainability.

These elements can help frame the process of decision making, and play an important role in assessing the potential consequences of management strategies.

In this context they are directly connected to both AM and ES and are used to describe and define sustainability.

Hazards, Vulnerable Systems, and Risk



Key Issues

1.How can science most effectively be used to inform sustainable resource management decisions?

2.How can the natural and social sciences collaborate and communicate to develop integrated understanding of the consequences and tradeoffs expected to result from alternative management choices and decisions?

3.How can the concepts of ecosystem services and resilience be incorporated into an adaptive decision process that facilitates the synthesis of learning and management?

4.How can the value of ecosystem services be routinely incorporated into resource management decisions when valuation methods are complex and uncertain?

5.How can adaptive management methods be used most effectively when dealing with non-stationary systems caused by climate change and human development?

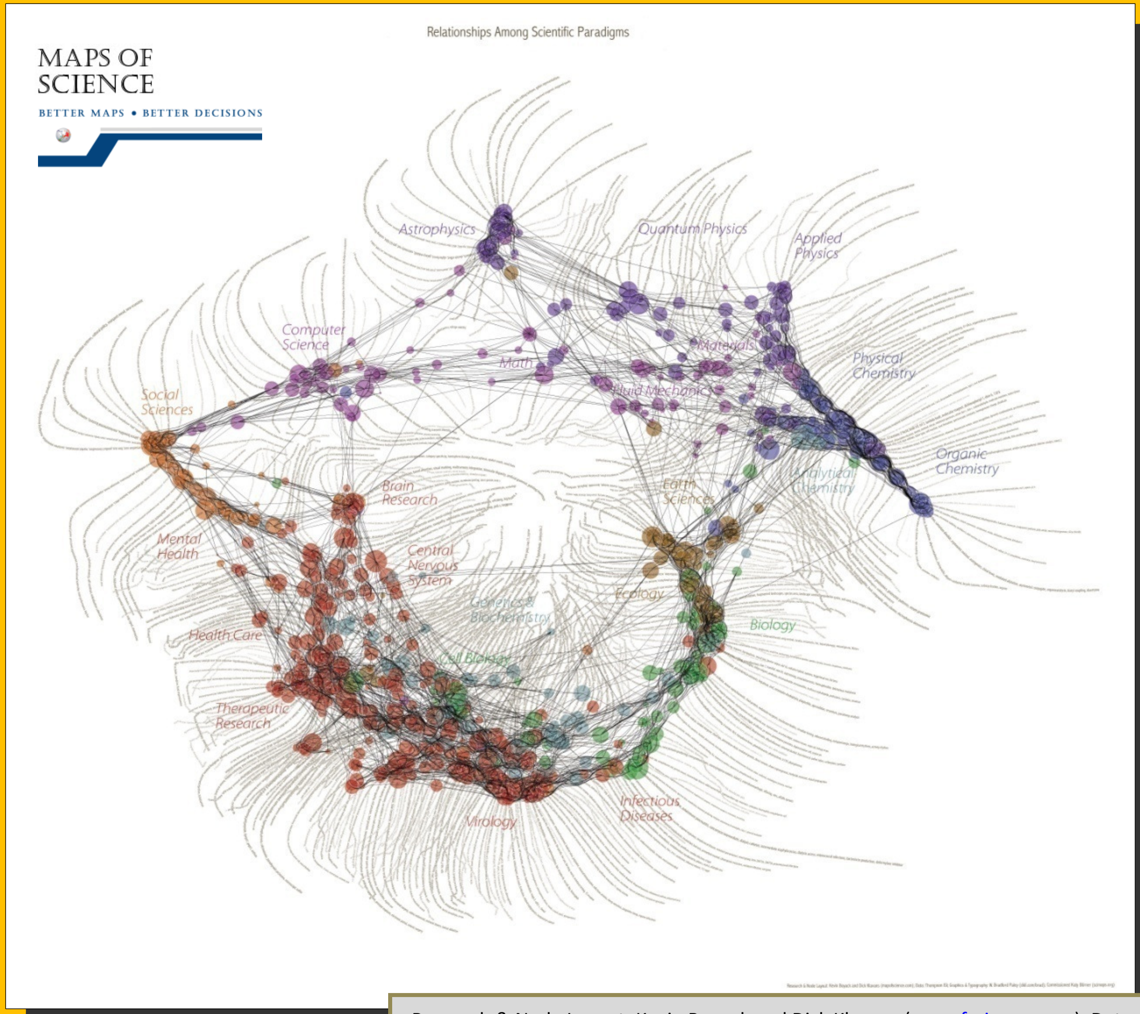
6.How can an understanding of and metrics for resiliency be developed so that natural and human systems' response to change can be incorporated into sustainable decision making?

Relationships Among Scientific Paradigms

March 2007

This map was constructed by sorting roughly 800,000 published papers into 776 different scientific paradigms (shown as pale circular nodes) based on how often the papers were cited together by authors of other papers. Links (curved black lines) were made between the paradigms that shared papers, then treated as rubber bands, holding similar paradigms nearer one another when a physical simulation forced every paradigm to repel every other; thus the layout derives directly from the data. Larger paradigms have more papers; node proximity and darker links indicate how many papers are shared between two paradigms. Flowing labels list common words unique to each paradigm, large labels general areas of scientific inquiry.

Ie Information Esthetics



Research & Node Layout: Kevin Boyack and Dick Klavans (mapofscience.com); Data: Thompson ISI; Graphics & Typography: W. Bradford Paley (didi.com/brad); Commissioned Katy Börner (scimaps.org)

Thank you

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