

WORLD DELTAS: FINDING COMMON GROUND

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NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS

A NATIONAL SCIENCE FOUNDATION SCIENCE & TECHNOLOGY CENTER

Climate Change

Vulnerability
Sustainability
Resilience

Safety
Prosperity
Biodiversity

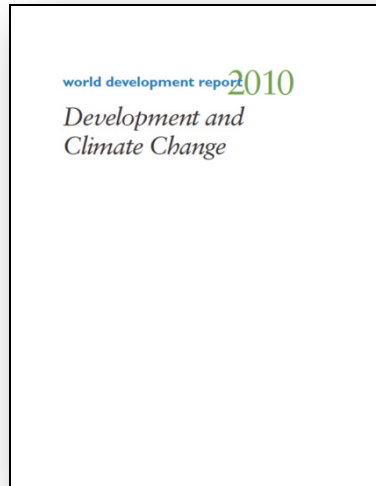
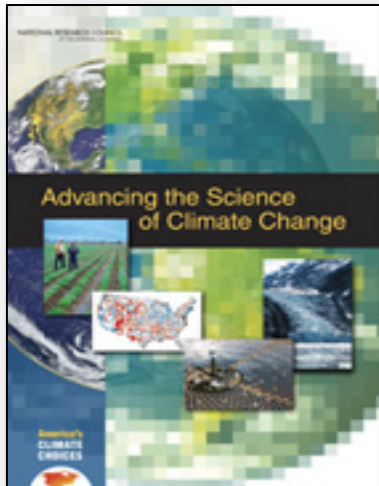
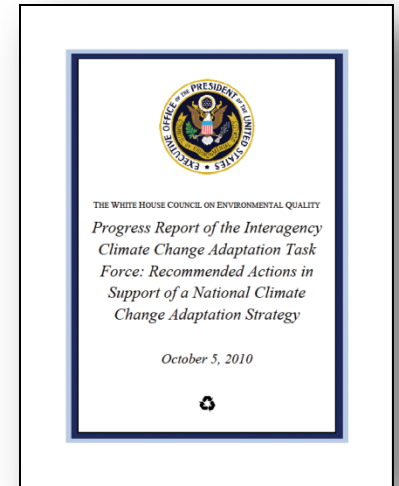
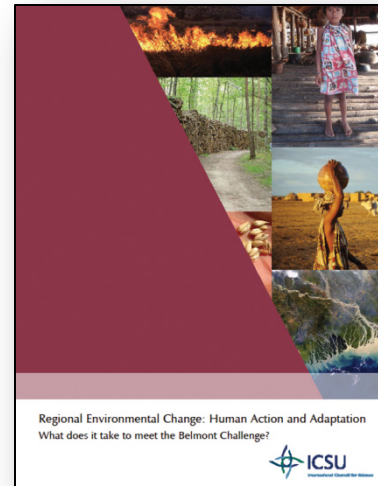
Increased capacity for
monitoring Earth:
smart sensors and
from space



Interagency Cooperation
International Collaboration

Scientific challenges
Tipping points
Complex, coupled systems
Abrupt changes

The concerns increase ... so do the reports and special task forces





Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade (June 2010)

SCOPE

- Mobilize the international global change scientific community.
- Focus and intensity of a global “Apollo Project” towards global sustainability

CHALLENGES

Forecasting: Improve the usefulness of forecasts of future environmental conditions and their consequences for people

Observations: Develop the observation systems needed to manage global and regional environmental change

Thresholds: Determine how to anticipate, recognize, avoid, and adapt to abrupt global environmental change

Responses: Determine what institutional, economic, and behavioral changes can enable effective steps towards global sustainability

Innovation: Encourage innovation in developing technology, policy, and social responses to achieve global sustainability.



Regional Environmental Change: Human Action and Adaptation

What does it take to meet the Belmont Challenge?
(August 2010)

Develop and deliver knowledge in support of national and international government action to mitigate and adapt to global and regional environmental change and its associated regional hazards.

Near- to Mid-term Foci

1. Coastal zones in the 21st century: ecosystems, people, commerce and security;
2. Water quality and water resources: availability and distribution;
3. Sustainable carbon-based economy, including ocean acidification, deforestation, land use and soils; and
4. The most vulnerable societies, with low-response capacity and with high societal vulnerability to environmental changes.



Geovision Report (October 2009)

CHALLENGES

Understanding and predicting the behavior of a complex and evolving system

Reducing vulnerability and sustaining life

Applying geoscience research to real-world problems

The Grand Challenge: Over the next decade, developing a framework to understand and predict responses of the Earth as a system—from the space-atmosphere boundary to the core, including the influences of humans and ecosystems—constitutes the Grand Challenge for the geosciences community.





Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy (October 2010)

VISION

...a resilient, healthy, and prosperous Nation in the face of a changing climate.

GOALS

Goal 1: Encourage and Mainstream Adaptation Planning Across the Federal Government

Goal 2: Improve Integration of Science into Decision Making

Goal 3: Address Key Cross-Cutting Issues

Goal 4: Enhance Efforts to Lead and Support International Adaptation

Goal 5: Coordinate Capabilities of the Federal Government to Support Adaptation



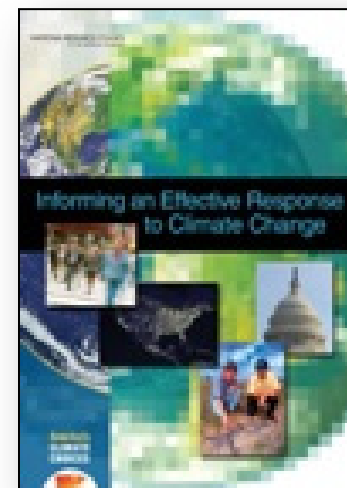
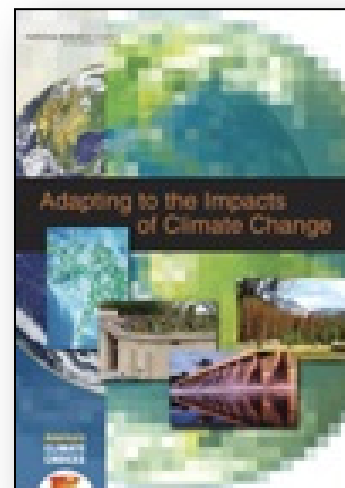
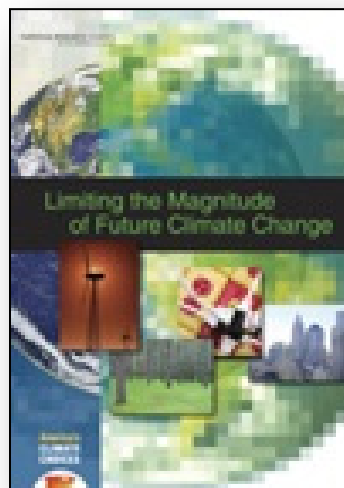
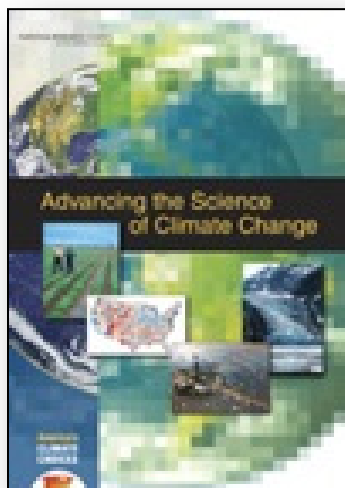
“Coastal areas will need to prepare for rising sea levels and increased flooding.”

- Progress Report on Work of Climate Change Adaptation Task Force

“Ecosystem-based adaptation strategies, such as protecting coastal wetlands to reduce damages from flooding, can improve resilience to climate change.”



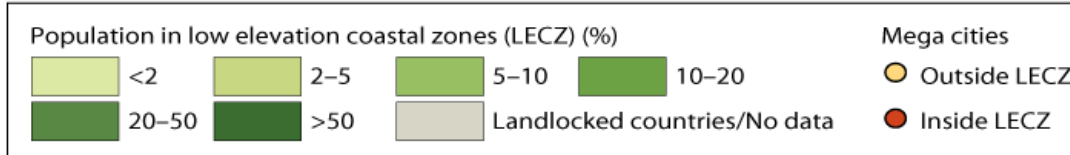
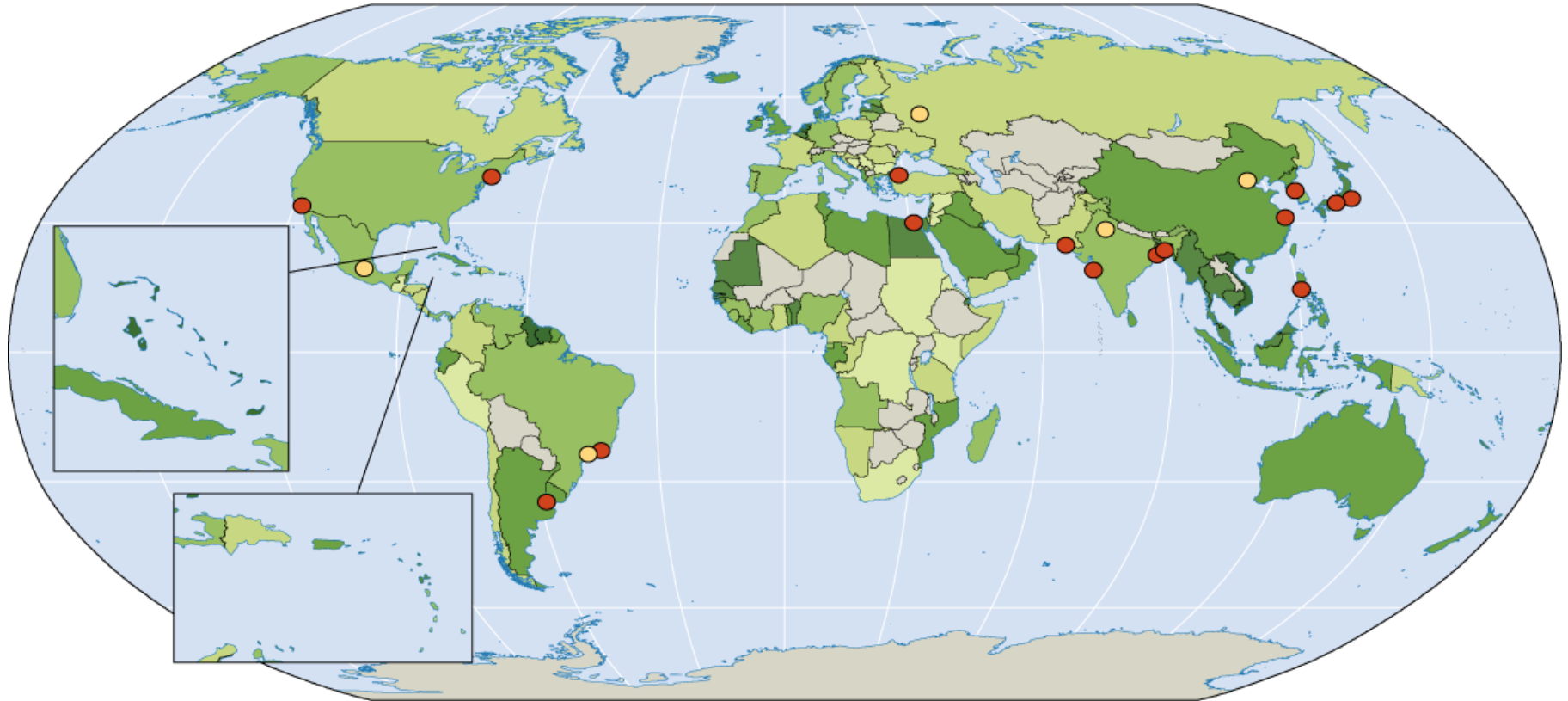
America's Climate Choices



America's Climate Choices is a congressionally requested suite of studies from the National Research Council designed to inform and guide the nation's response to climate change.

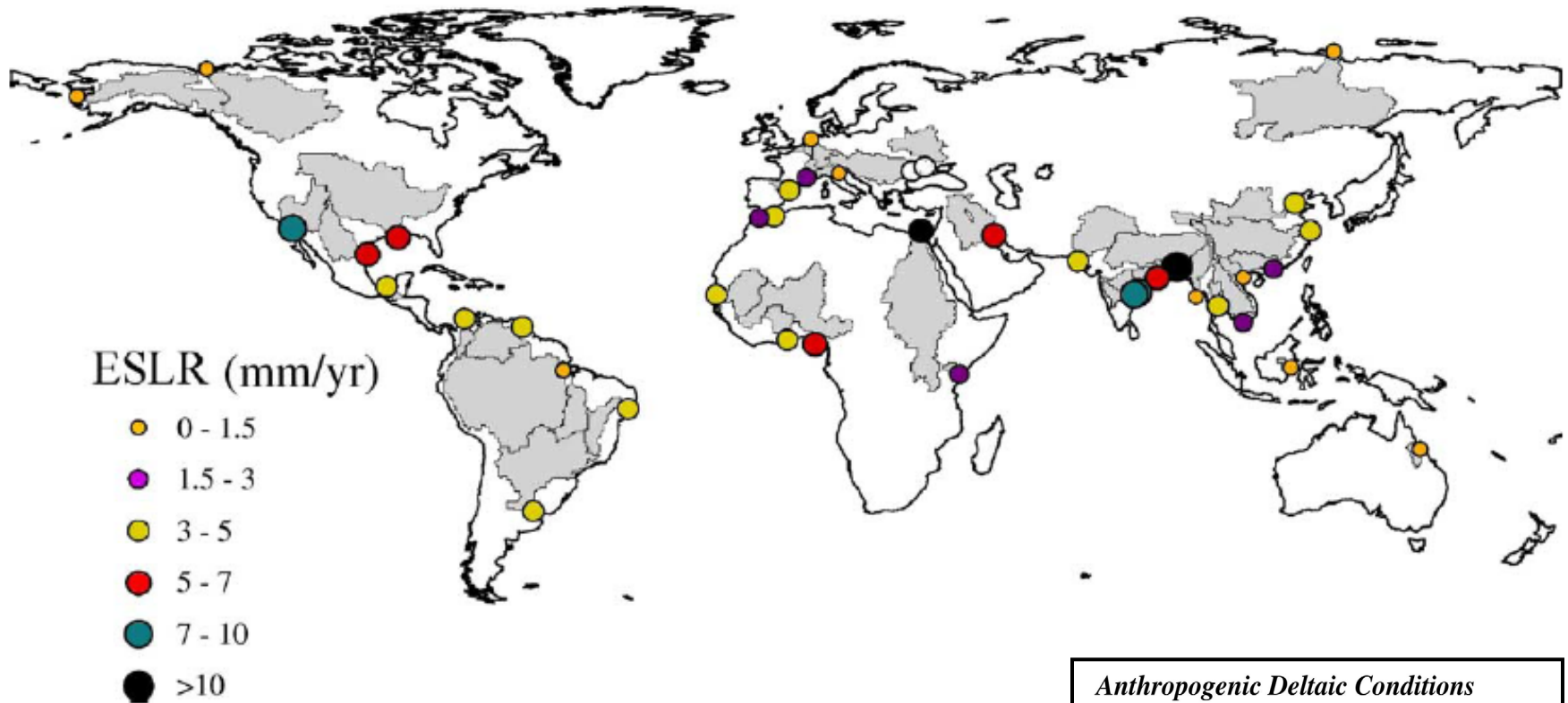
To provide advice on limiting the magnitude of climate change, adapting to the impacts of climate change, advancing the science of climate change, and informing effective decisions related to climate change.

World Development Report: Development and Climate Change (2010)



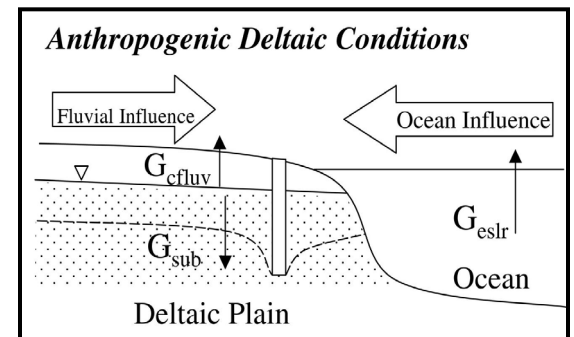
POPULATIONS AT RISK

>100 MILLION PEOPLE LIVE WITHIN 1 m OF SEA LEVEL

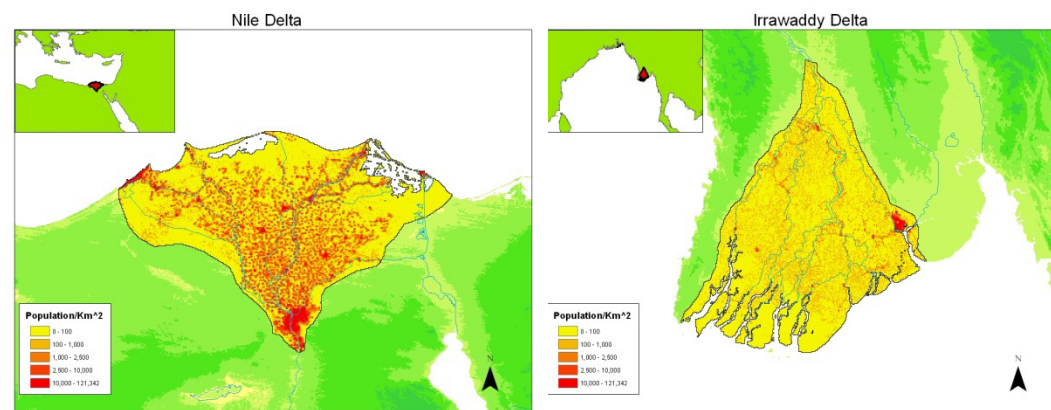


40 deltas draining 30% of globe; contemporary conditions.

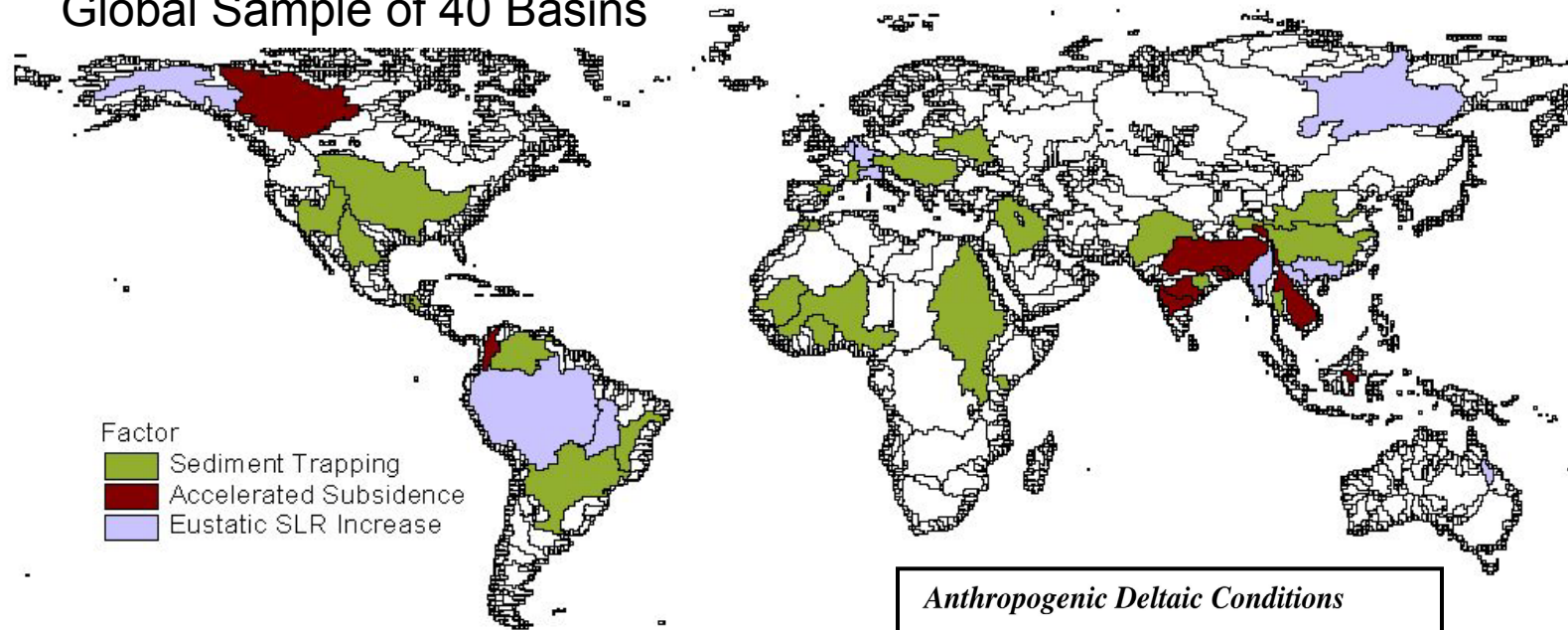
ESLR= Effective Sea Level Rise (Gross Eustatic SLR + Gross total subsidence – Gross accretion of fluvial sediment)



Sediment-starved Deltas



Global Sample of 40 Basins

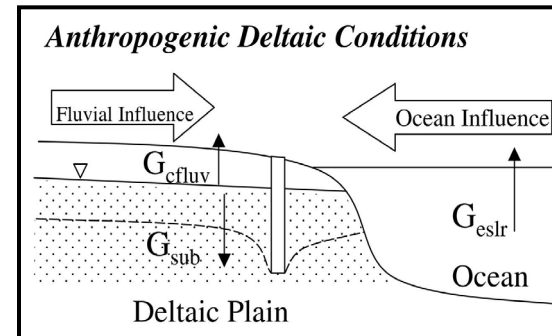


- Factor
- Sediment Trapping
 - Accelerated Subsidence
 - Eustatic SLR Increase

Sources of Change:

- 5 Eustatic Sea Level Rise
- 8 Groundwater/petroleum extraction
- **27 Upstream sediment trapping & diversion**

Ericson et al., 2006, *Global and Planetary Change*

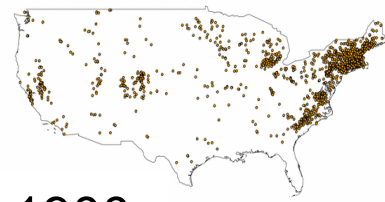


Slide courtesy of C. Vorosmarty

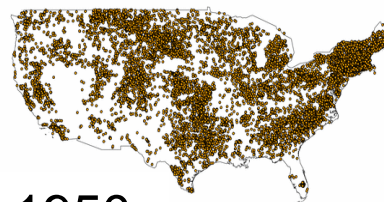
History of US Dam & Reservoir Construction



1800



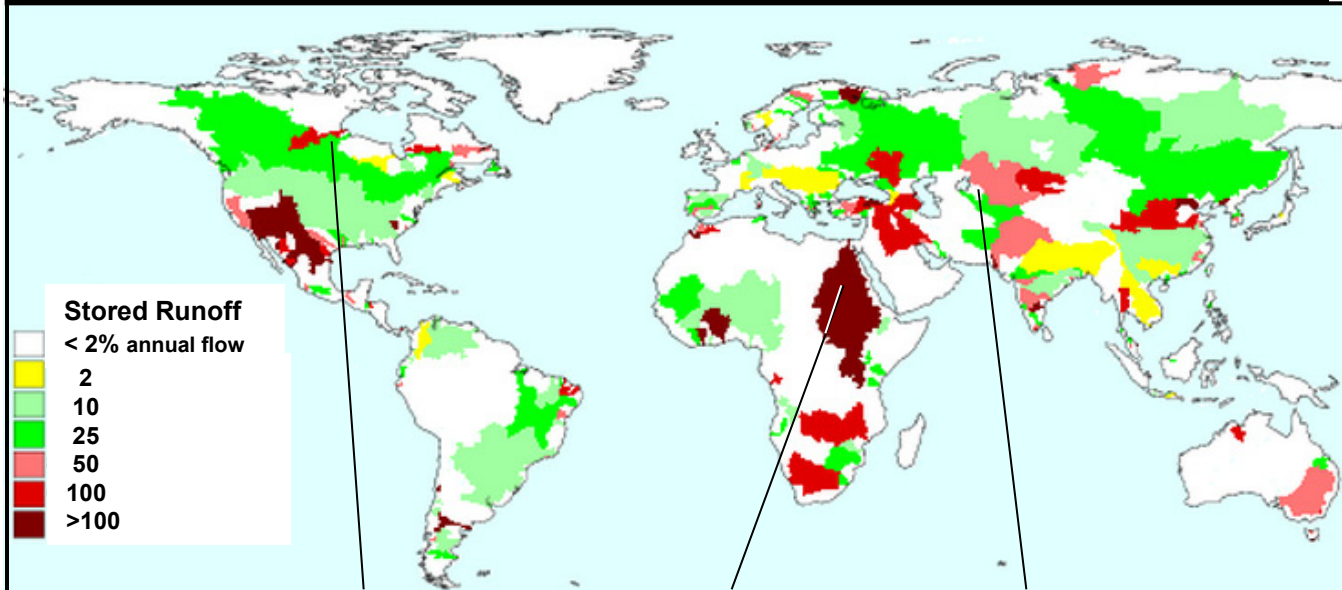
1900



1950

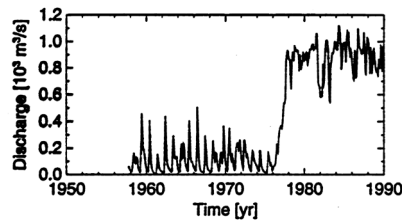


2000

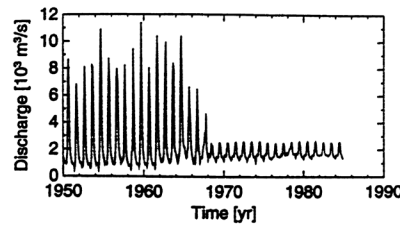


- 700% increase in water held by river systems
- Several years of residence time change in many basins
- Tripling of river runoff travel times globally (from 20 up to 60 days)
- Substantial impact on aquatic biodiversity
- Interception of 30% of continental TSS flux

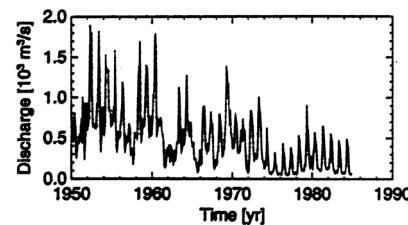
Burntwood River near Thomson



Nile River at the Aswan Dam

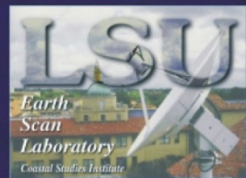


Syr-Darya River at Tyumen Aryk





Mississippi
"Bird Foot"
Delta

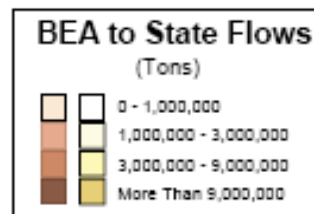
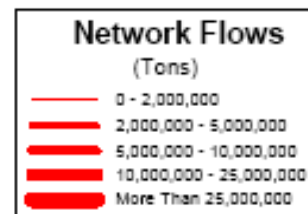


GULF OF MEXICO



Total Combined Truck Flows
(1998)

NEW ORLEANS



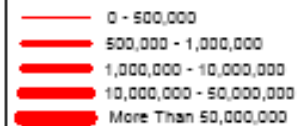
U.S. Department of Transportation
Federal Highway Administration
Office of Freight Management and Operations
Freight Analysis Framework



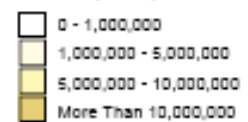
Total Combined Truck Flows
(1998)

LOUISIANA

Network Flows (Tons)



State to State Flows (Tons)

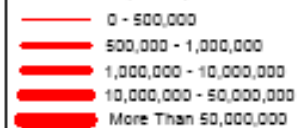




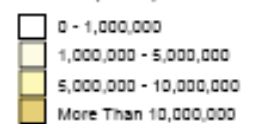
Total Combined Truck Flows
(1998)

LOUISIANA

Network Flows (Tons)



State to State Flows (Tons)



THE WAX LAKE DELTA AS ANALOGUE OF HOW TO REBUILD A DELTA

Wonsuck Kim, Gary Parker,
David Mohrig, Robert Twilley,
EOS 2009

$$\left(\dot{H} + \sigma \right) A_{top} = f_r Q_s + r_{org} A_{top}$$



Developing a Self-Maintaining Coast is Possible

Base Case: SEA-LEVEL RISE = 2 mm/yr, SUBSIDENCE = 5 mm/yr (980 km²)

Worse Case: SEA-LEVEL RISE = 4 mm/yr, SUBSIDENCE = 10 mm/yr (701 km²)

Solid line: variant case
Dotted line: base case

Base Case
Sea-Level Rise: 2 mm/yr
Subsidence: 5 mm/yr

"Worst case":
still 701 km² of new land

And extra land-building
due to organics is not yet
included

2110

	Shoreline	Fan Area
Barataria Bay:	14.1 km	311.1 km ²
Breton Sound:	15.7 km	389.5 km ²
Sea-Level Rise:	4 mm/yr	
Subsidence:	10 mm/yr	
Fraction of Water Diverted:	0.45	
Guide channels:	5 km each	

10 km

Vulnerable systems require a coordinated international action



This iceberg, 50 feet high, is located in the Ross Sea, Antarctica. The hole in the center is believed to have been formed by wave action as the iceberg rolls and breaks up in the sea.
Source: Michael Van Woert, NOAA.

International Polar Year 2007-2008

- An intense, internationally coordinated campaign of observations, research and analysis in the polar regions.
- Think beyond traditional borders (national or disciplinary)
- Towards a new level of integrated cooperative science
- NSF, NASA, USGS, US Coastal Guard, Dept. of State, NOAA





INTERNATIONAL 2011 2012
YEAR OF DELTAS

An aerial photograph of a river delta, showing a wide river branching into several smaller channels that flow into a larger body of water. The land is green and brown, and the water is a mix of blue and green. The text is overlaid in the center of the image.

A VISION FOR INTERNATIONAL YEAR OF DELTAS 2011-2012

A coordinated campaign on deltas around the world for shared observations, research and strategies for adaptive management. An effort that is multidisciplinary in scope and international in participation.

PROPOSED FRAMEWORK FOR ORGANIZING IYD

IYD 2011-2012 will provide the opportunity to focus on the local, national and global significance of deltas and establish solutions for sustainable restoration.

Four broad challenges can provide a framework for organizing IDY activities:

- Sharing data, knowledge, and culture in deltas around the world and raise local and global awareness
- Understanding human-environmental dynamics in regions where the connections are intimate and the impacts of change catastrophic
- Creating the capacity to model and value trade-offs for decision making and adoptive management
- Creating new connections between science, decision making, and the public as stakeholders in a sustainable future

There is no alternative but to act now!

Year - 2009



Year - 2100



Map: Blum, M.D., and H.H. Roberts (2009), Drowning of the Mississippi delta due to insufficient sediment supply and global sea-level rise, *Nat. Geosci.*, 2, 488-491.

Action should not be incremental but transformative!



not



Year - 2009



Year - 2100



Map: Blum, M.D., and H.H. Roberts (2009), Drowning of the Mississippi delta due to insufficient sediment supply and global sea-level rise, *Nat. Geosci.*, 2, 488-491.