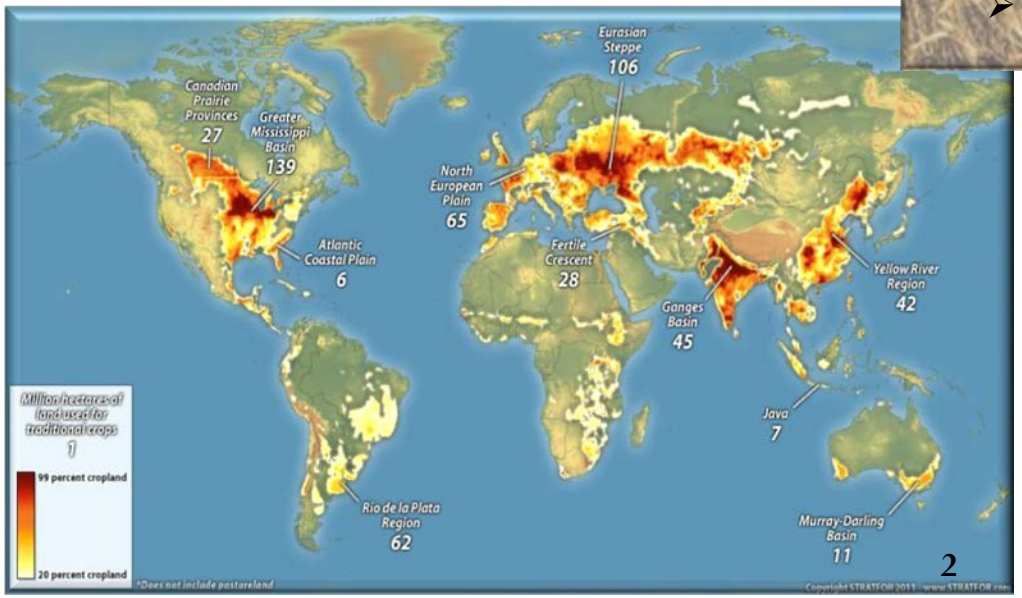
America's Watershed Initiative: 50 Years After the 4 Revolutions With No Action?

BG Ret. Duke DeLuca
Sapper, Builder, Educator, Water Resources Steward and Developer

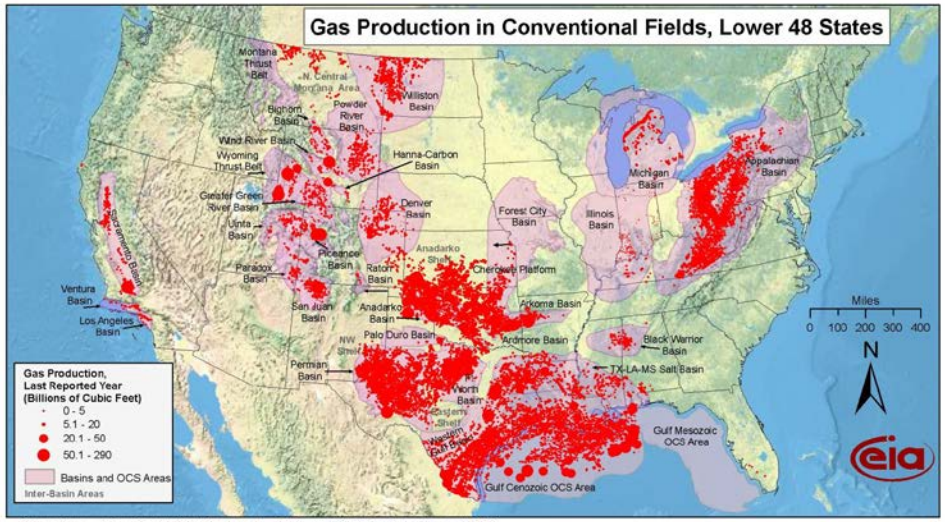
Revolution #1: Explosive Growth in US Agricultural Productivity

- 15-25 bushels per acre growing to 100 bushels per acre
  - Wheat, rice, soybeans, cotton
- Growing to 200 bushel per acre – corn
  - Some cases 300 bushels per acre
- Second "Green Revolution" now
  - First – 1970s "Borlaug" Revolution

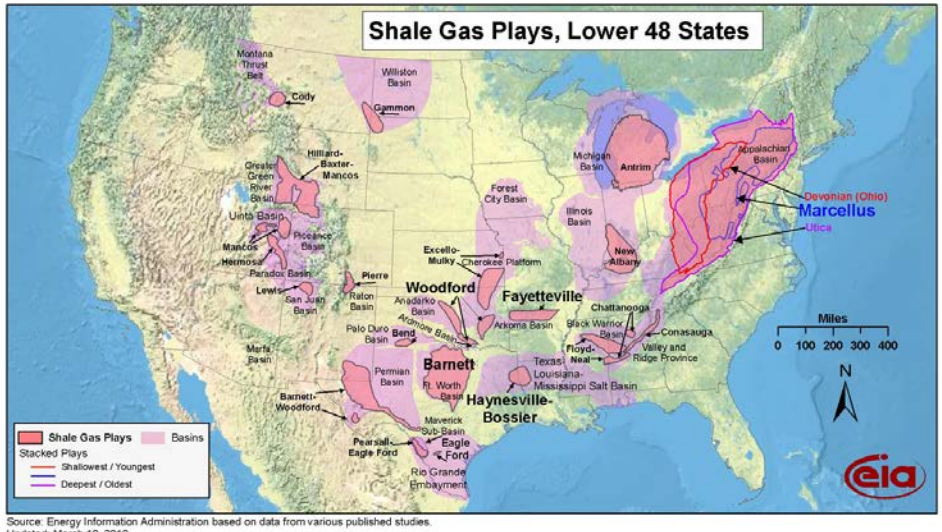


Revolution #2: Hydrocarbon Production Revolution

- **United States oil production:**
  - **Grew 18% in last year alone**
  - ~~**US will be world #1 producer in 2015 (more than KSA)**~~ **US is #1 producer July 2014**
- **United States natural gas production:**
  - **United States is world's #1 producer as of 2013 (more than Russia)**
- **Affects many other industries including chemical, plastics and all manufacturing**



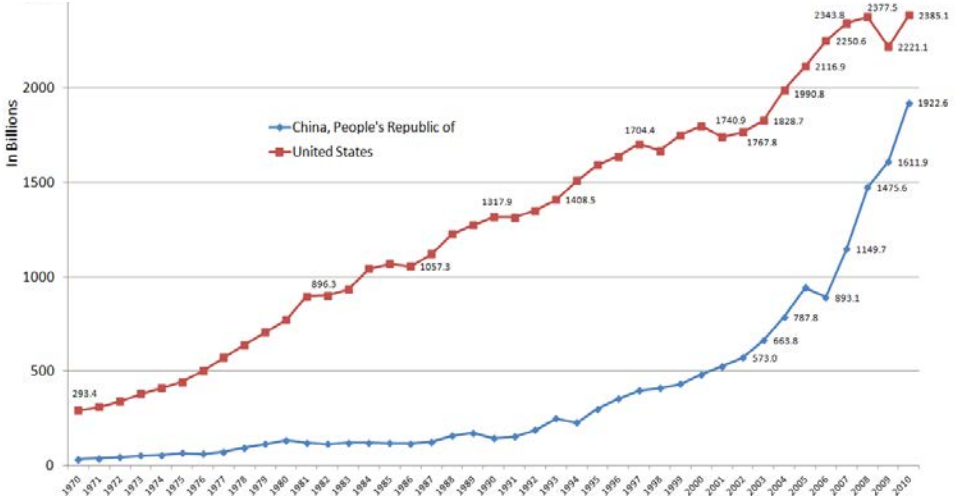
Source: Energy Information Administration based on data from HPDI, IN Geological Survey, USGS
Updated: April 8, 2009



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

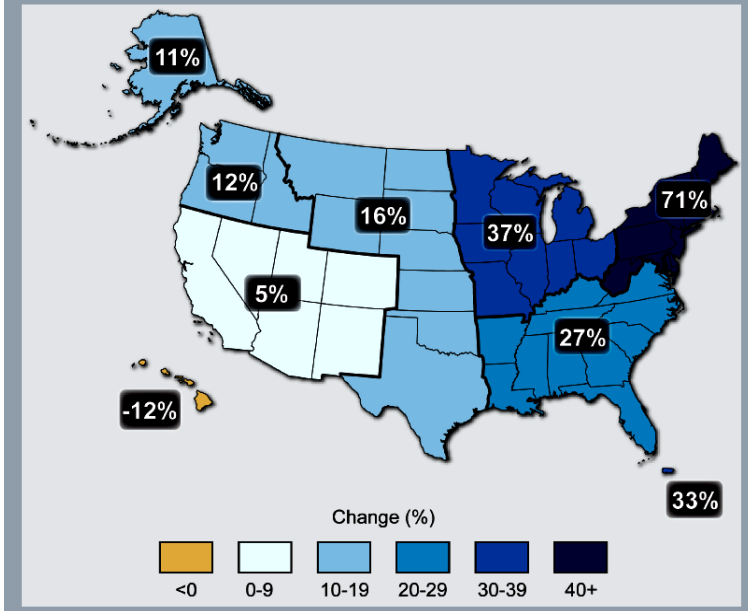
Revolution #3: Return of Manufacturing to the US and the Mississippi Valley

US Manufacturing Output vs China Manufacturing Output 1970 - 2009

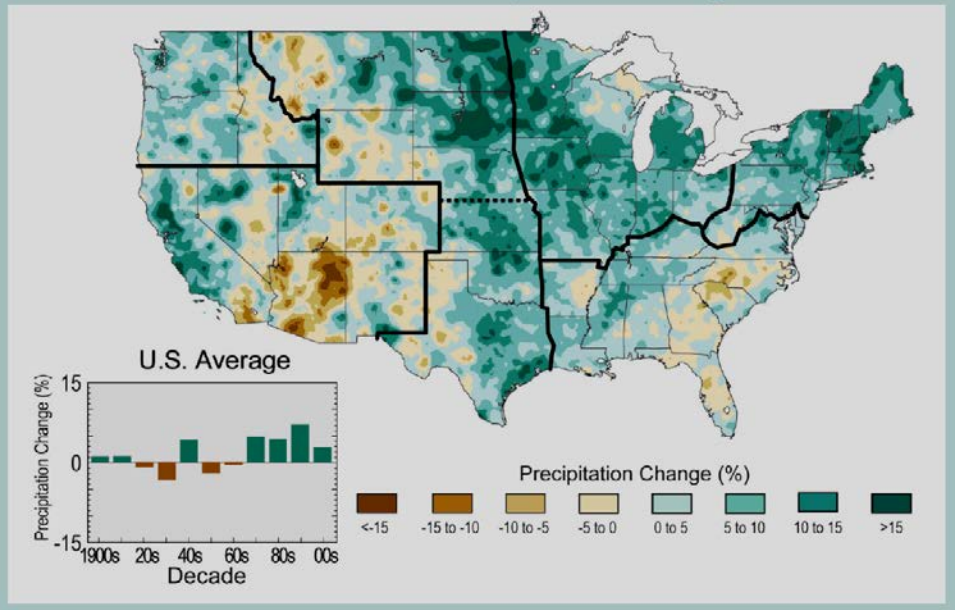


Revolution #4: Accelerating Impacts of Climate Change

- **Changes to weather**
  - **Precipitation more intense – more volume in less time**
  - **Increased runoff from this and development**
  - **Significant storm events of high intensity**
    - **Record number of > $1 billion events in 2013 (41 - 7 in United States)**
    - **Increasing high damage weather events - 151 since 1980**

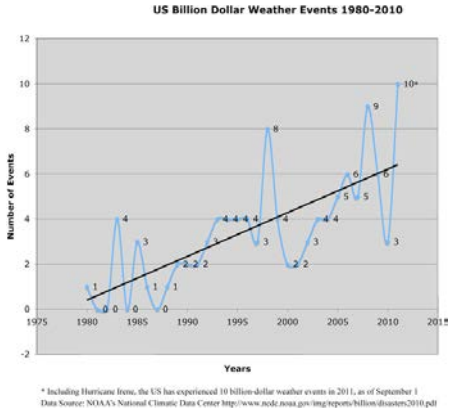


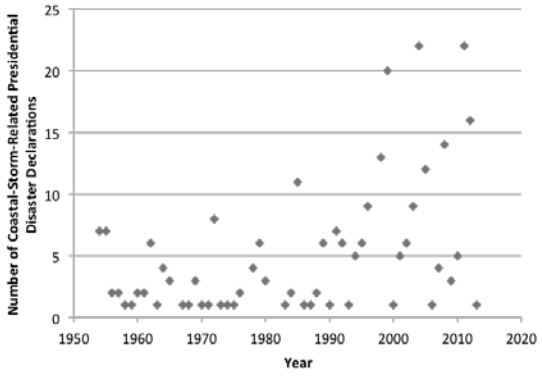
Percent changes in the amount of precipitation falling in very heavy events (the heaviest 1%) from 1958 to 2012 for each region. There is a clear national trend toward a greater amount of precipitation being concentrated in very heavy events, particularly in the Northeast and Midwest. (Figure source: updated from Karl et al. 2009[c]).

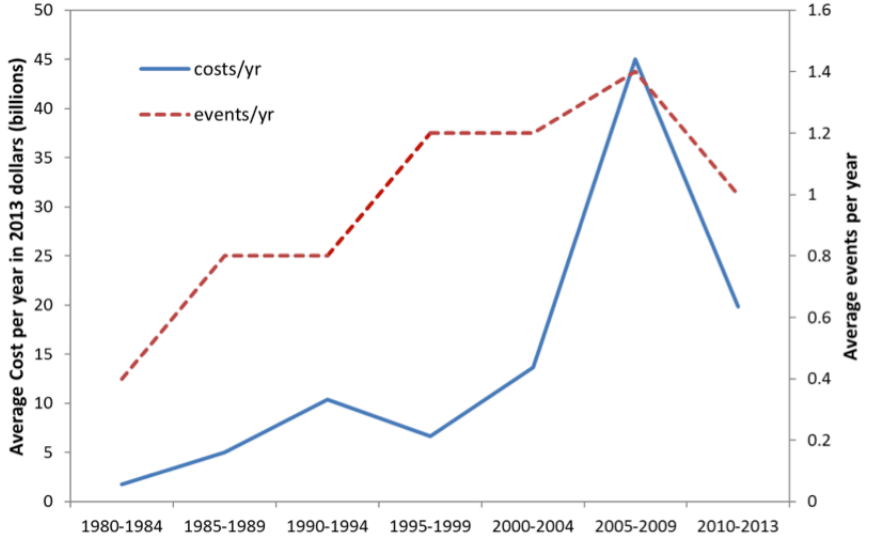


The colors on the map show annual total precipitation changes for 1991-2012 compared to the 1901-1960 average, and show wetter conditions in most areas. The bars on the graph show average precipitation differences by decade for 1901-2012 (relative to the 1901-1960 average). The far right bar is for 2001-2012. (Figure source: NOAA NCDC / CICS-NC).

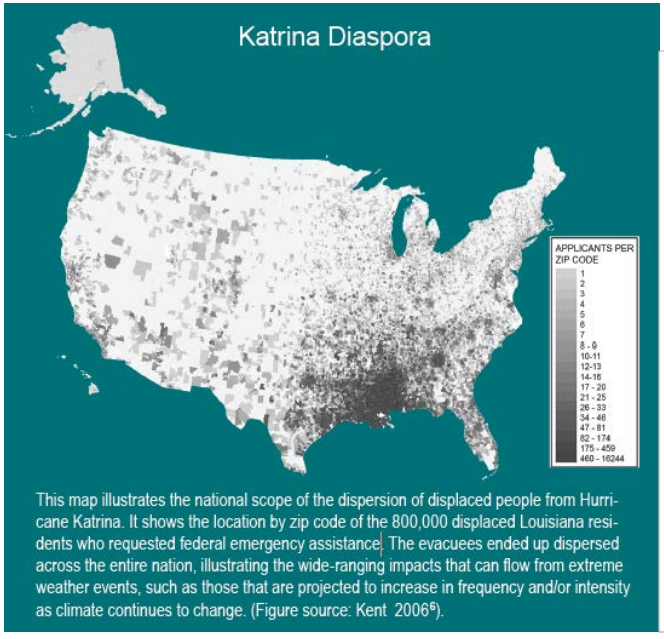
Accelerating Impacts from Climate Change - Damage Trends

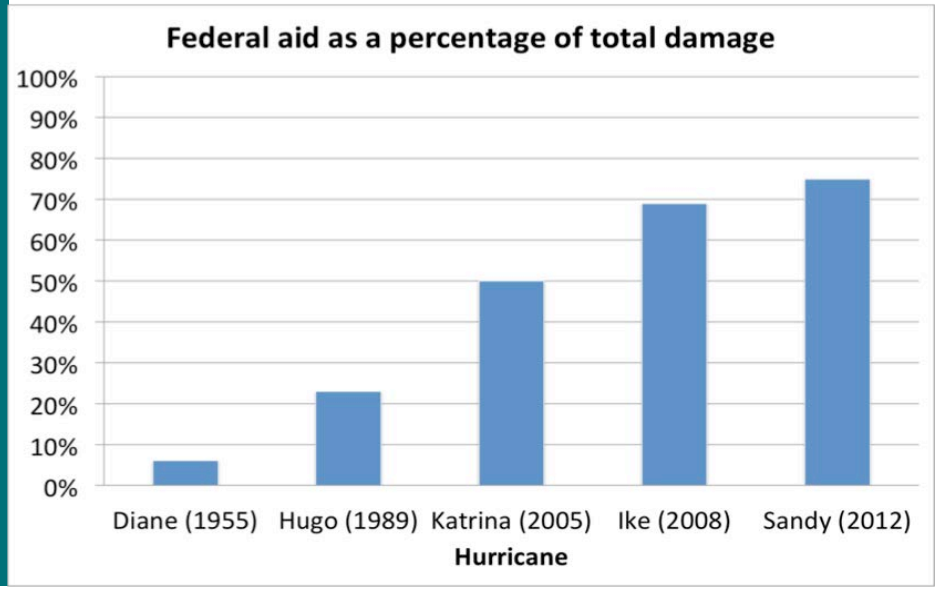






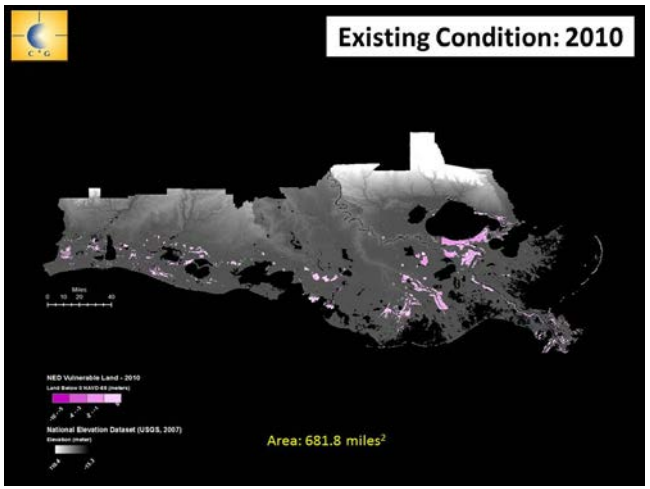
Climate Change Impacts in the United States: Highlights, U.S. Global Change Research Program, p. 32, http://nca2014.globalchange.gov/highlights

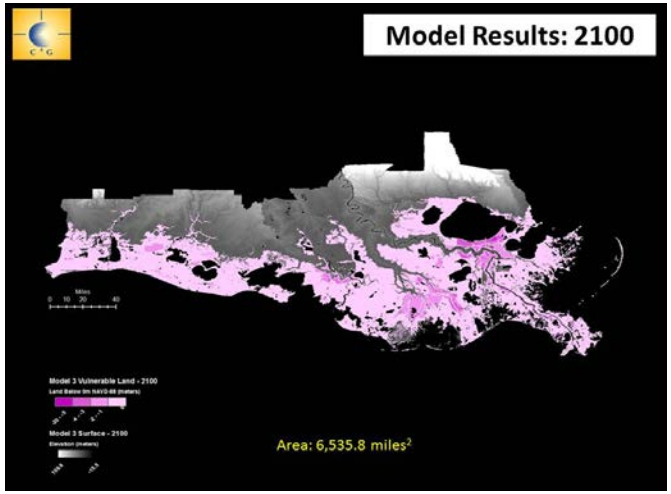


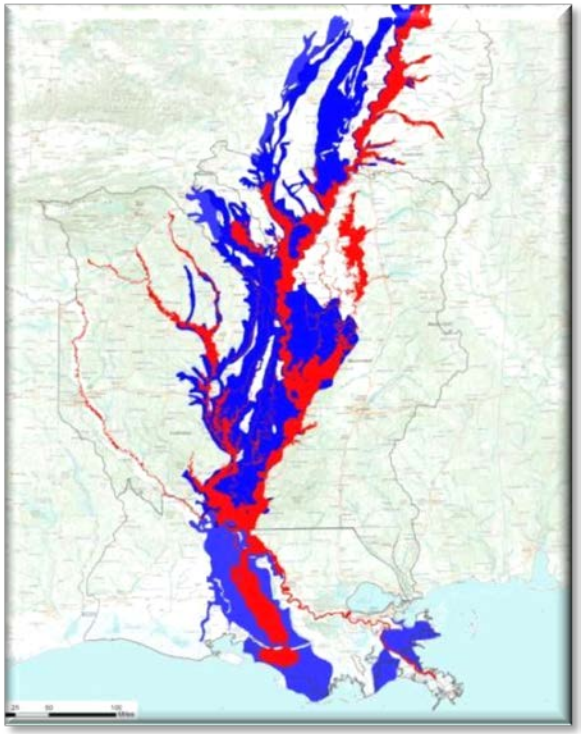


Accelerating Impacts from Climate Change – Adapt or Die

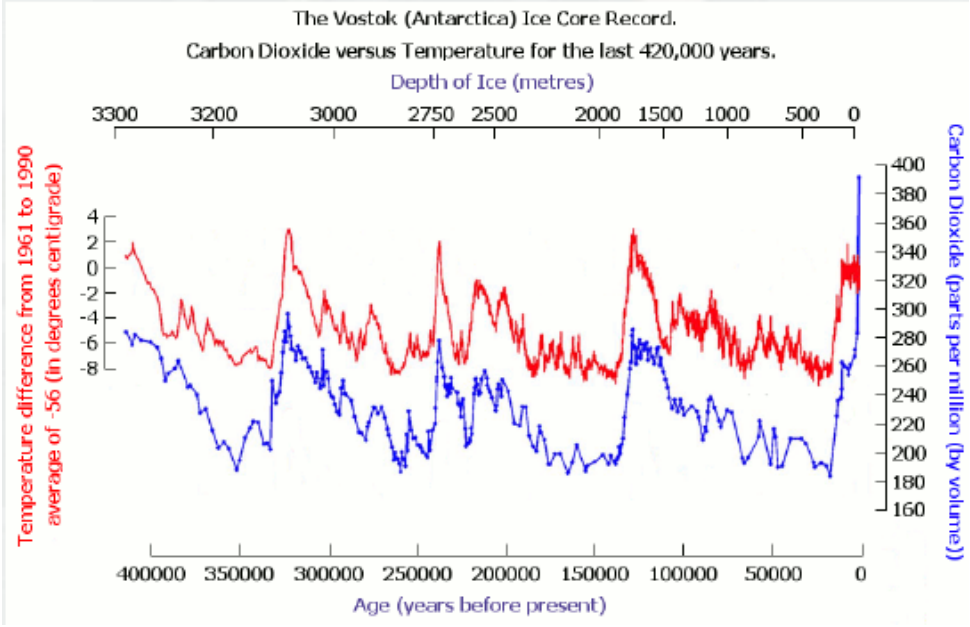
- **Changes to watershed functioning – part climate change**
  - **Higher stages with same or less flow as in the past (need new flow line for Mississippi River – underway)**
  - **Bottom changes (geomorphology study underway)**
    - **Accelerating sea level rise**
    - **Louisiana coastal land loss is relative SLR**



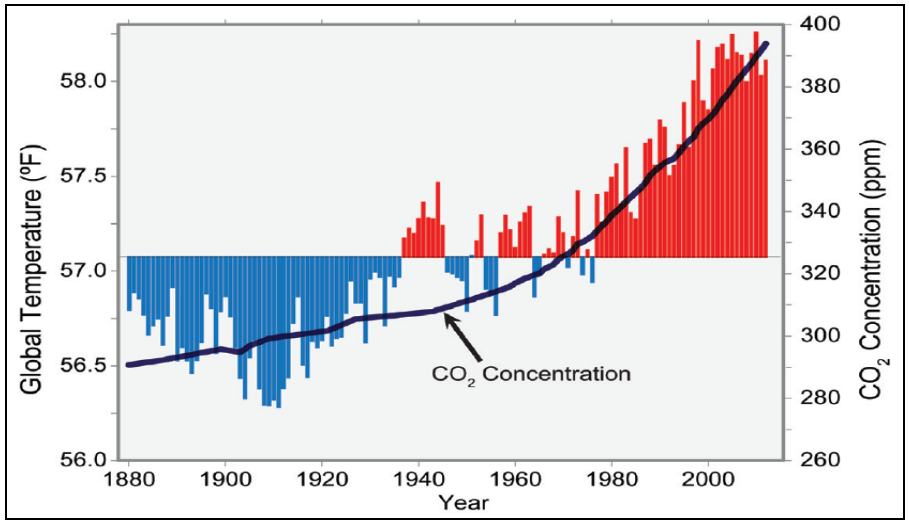




Global Temperature and Carbon Dioxide

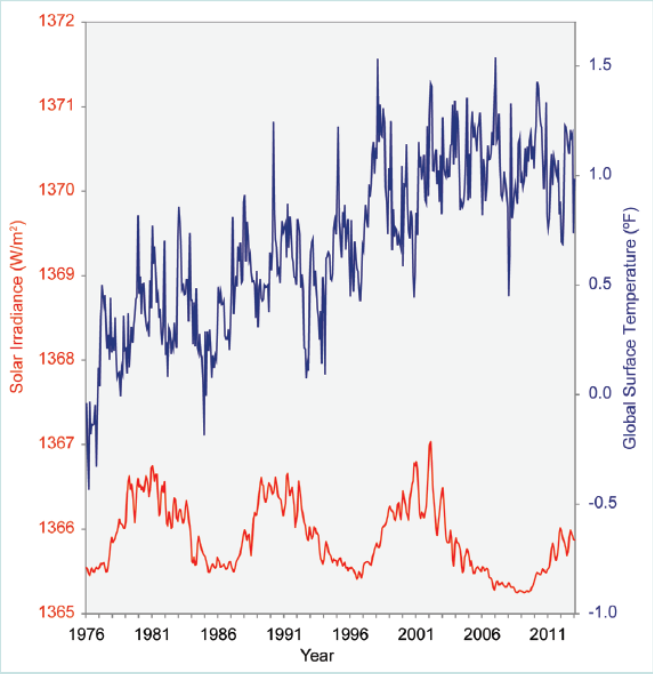


***Graphic courtesy of NOAA Paleoclimatology, National Climatic Data Center**



Climate Change Impacts in the United States: Highlights, U.S. Global Change Research Program, p. 18, http://nca2014.globalchange.gov/highlights

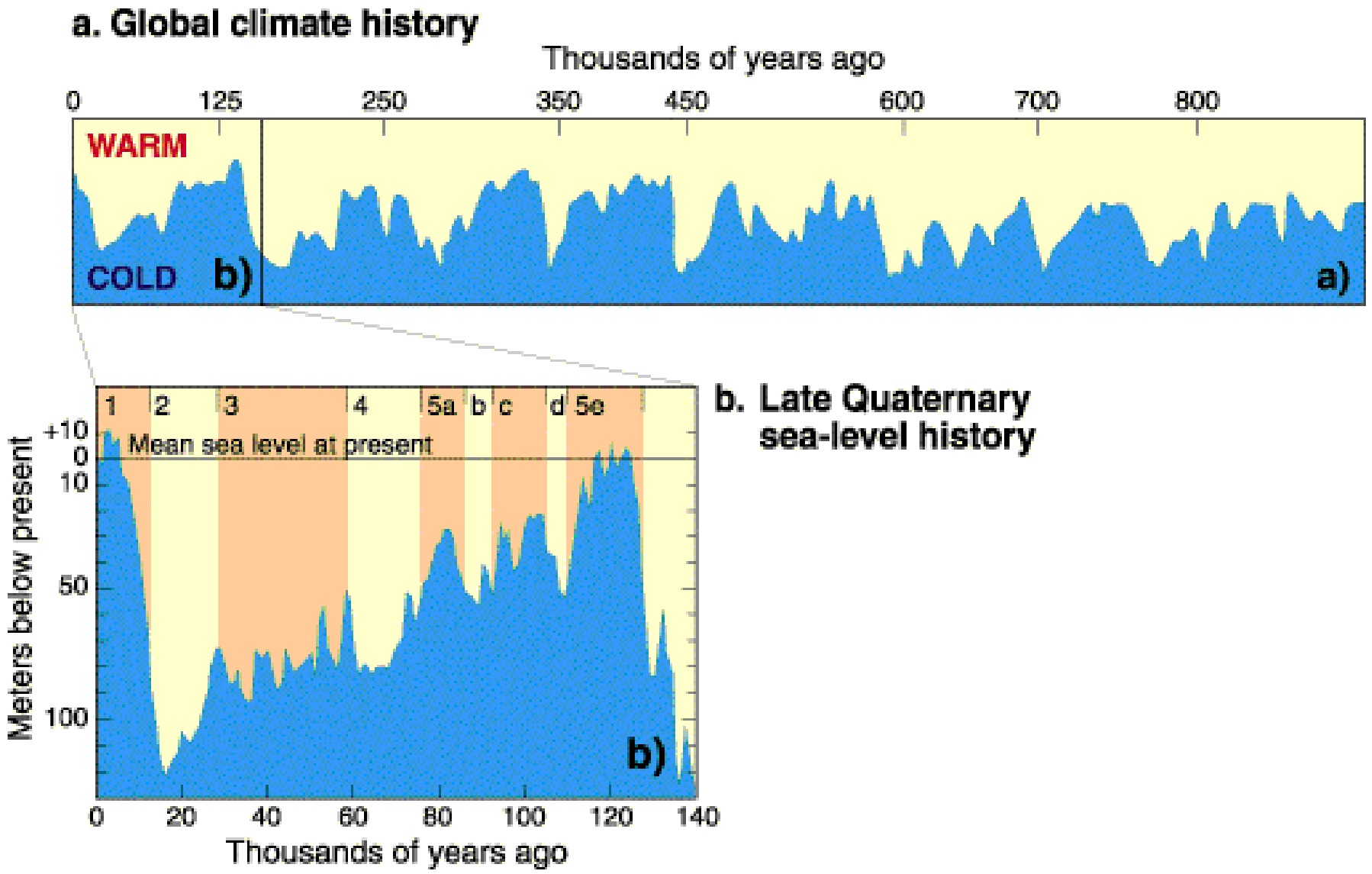
Measurements of Surface Temperature and Sun's Energy



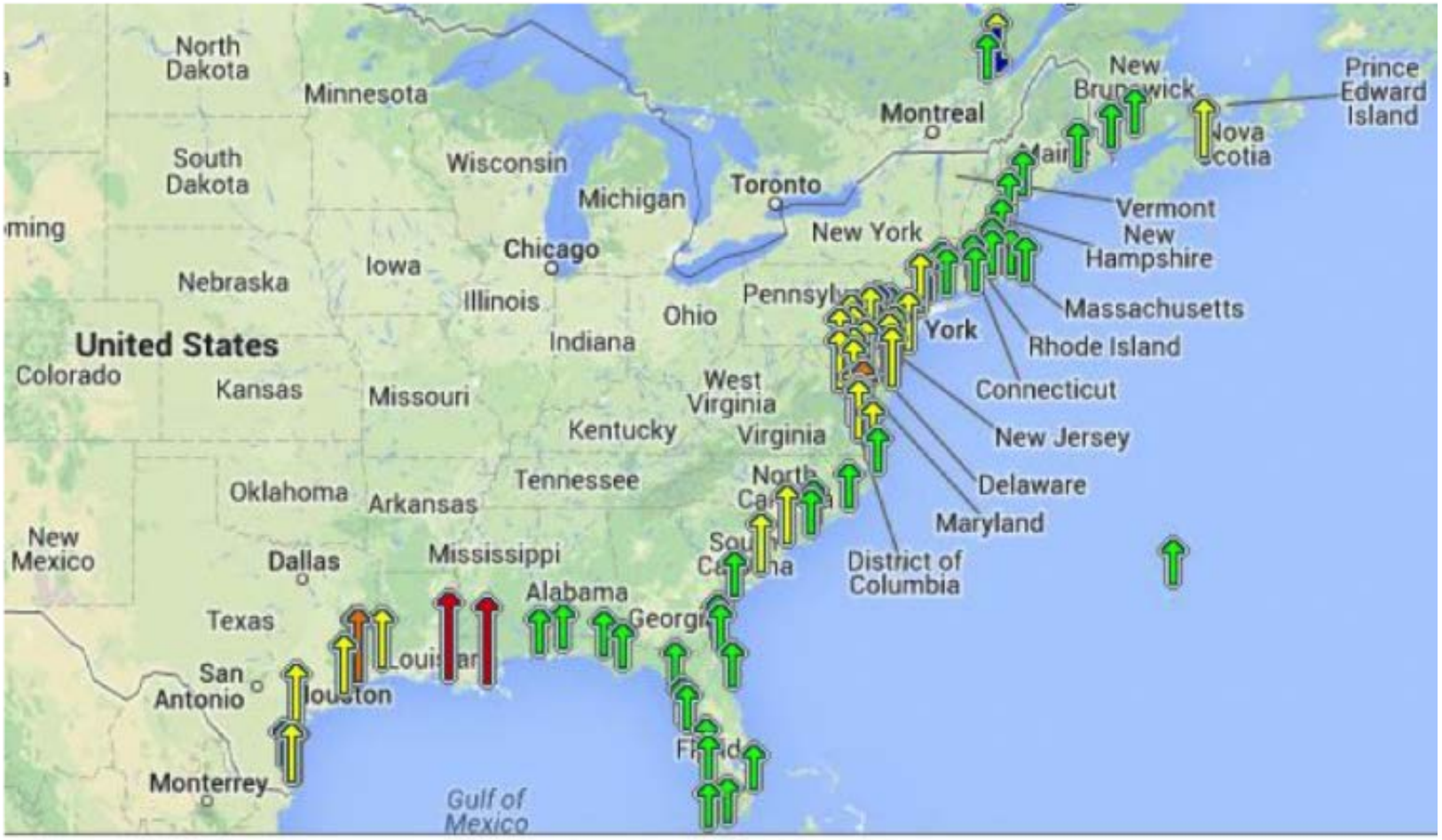
The full record of satellite measurements of the sun's energy received at the top of the Earth's atmosphere is shown in red, following its natural 11-year cycle of small ups and downs, without any net increase. Over the same period, global temperature relative to 1961-1990 average (shown in blue) has risen markedly. This is a clear indication that changes in the sun are not responsible for the observed warming over recent decades. (Figure source: NOAA NCDC / CICS-NC).

Climate Change Impacts in the United States: Highlights, U.S. Global Change Research Program, p. 23 http://nca2014.globalchange.gov/highlights

900,000-year History of Sea Level Change



Impacts from Climate Change - Coastal Risk

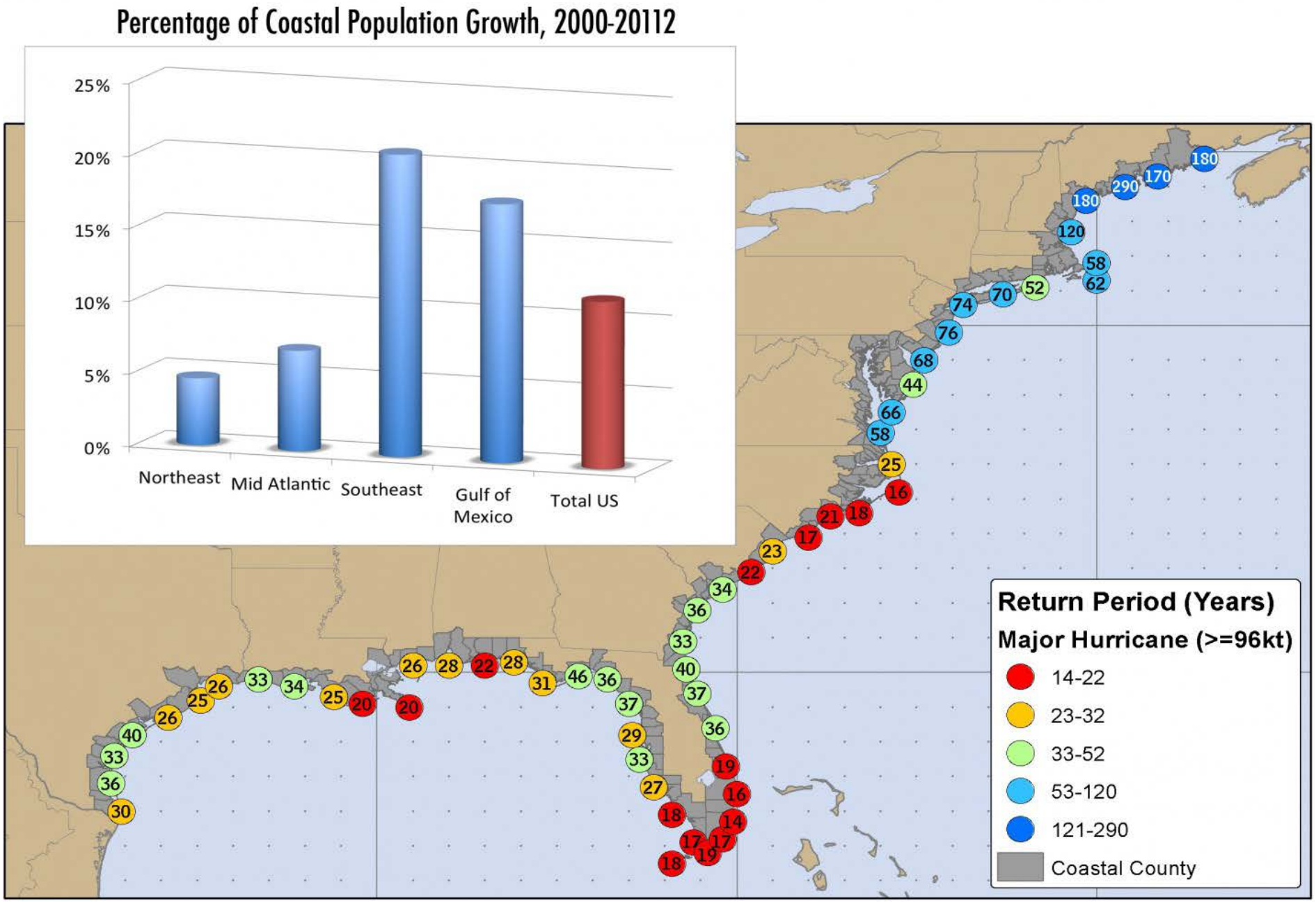


Sea Level Trends

mm/yr (feet/century)

15 to 21 (5 to 7)	6 to 9 (2 to 3)	-3 to 0 (-1 to 0)	-12 to -9 (-4 to -3)
12 to 15 (4 to 5)	3 to 6 (1 to 2)	-6 to -3 (-2 to -1)	-15 to -12 (-5 to -4)
9 to 12 (3 to 4)	0 to 3 (0 to 1)	-9 to -6 (-3 to -2)	-18 to -15 (-6 to -5)

Impacts from Climate Change – Risk Trend



AWI Preliminary Draft Report Card
Overall Mississippi Watershed

- Transport: Overall - No Grade
  - Stoppages – No Grade
  - Tonnage – C
  - Condition – B
  - Maintenance – No Grade

- Water Supply: Overall - B
  - Designated Use – D
  - Health-based Violations – A
  - Water Supply Stress – No Grade

- Economy: Overall – C
  - Employment – C
  - Income – C
  - Production – C

- Recreation: Overall – C
  - Participation – D
  - Licenses – C
  - Access – No Grade

- Eco-Systems: Overall - C
  - Nitrogen - C
  - Phosphorus – C
  - Benthic – D
  - Fish – C
  - Riparian – C
  - Woody Wetlands - C

- Flood Control: Overall - D
  - People at Risk – D
  - Levee Inspections – A
  - Preparedness - D

- Main Concerns
  - Nutrient Runoff – Hypoxia
  - Demand up for basin water
  - Altered Climate
  - Failure of Aged Infrastructure

No Action? Selected Funding Proposals from President's FY15 Budget Request ($ Millions)

	FY15 PROPOSED	FY14 ENACTED	% CHANGE
Highway obligation limit	$47,823	$40,256	+19
Federal Transit Administration	$17,649	$10,842	+63
FAA Airport grants	$2,900	$3,350	-13
DOD construction	$6,556	$10,186	-36
Corps civil works	$4,561	$5,468	-17
EPA water infrastructure	$3,005	$3,535	-15
DOE defense environmental cleanup	$4,865	$5,000	-3
GSA new construction	$745	$506	+47
GSA renovations	$1,257	$1,077	+17
VA major construction	$562	$342	+64

SOURCE: *Office of Management and Budget, Congressional Appropriations Committees* as published in *Engineering News-Record*, 10 March 2014, page 6.

Major Impacts of No Action

- Revolutions 1, 2 and 3:
  - Primary Impact Economic
  - Resulting Social and Political Impacts
- Revolution 4:
  - Mississippi Valley discussion focus so far:
    - Increased water loading, peak flows
    - Flooding – inland and coastal -- But.....
  - Drought is the main threat of accelerating accelerating climate change – globally and and historically (Maybe in the US too long-term)
- Global Vulnerability
  - 75% of World Pop lives in Tropics (5.25 Billion)
  - 2/3 depend on Agriculture to survive (3.5 Billion)
  - 1.3 Billion people live in poverty today
  - 600 Million people close to starvation today
  - 400 Million more live in marginal land in the Sahel

Revolutions 1-3 No Action
50 Year Future

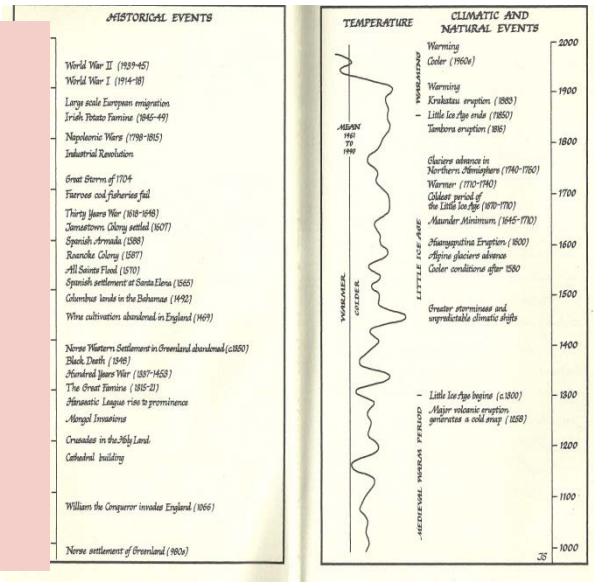
- Reality of American Good Fortune
  - Geography and Natural Resources – high margin for prolonged but not perennial error
  - Even with no action – muddling through……crises
  - Tempered success in spite of ourselves

- What will we lose with no action?
  - Great Depression – loss of Real GDP 1929-1935
    - Lost total of $1.8+ Billion in wealth
    - Lost Forever with a long tail – no growth from it
    - Result = $30.3 Trillion less wealth in America today!! (Ave GDP growth since 1940 of 3.67%)

  - Today we are growing wealth at least 1-2 % lower than potential due to reduced investments (all)
    - Lose $159 B to $318 Billion per year of wealth
    - 10 years No Action = $2.1 to $4.2 Trillion lost (min)
    - 50 years No Action = $22.9 to $45.8 Trillion lost (min)

Revolutions 1-3 No Action
50 Year Future

- Great Depression – Global Impacts
  - Social Breakdown
  - Economic Collapse
  - Famine
  - Decayed Infrastructure
  - National Breakdown
  - War and Social Disorder aggravate hunger



- Top 10% of IRS filers paid 68% of tax 2013

- Top 10% of IRS filers earned 50% of All Income and own 75% of All Wealth 2013

- Signs of early Social Breakdown today?
  - Extremely polarized politically
  - Tea Party + Middle Class Resentments
  - Working Class and Racial/Ethnic Resentments
  - New Gilded Age?
    - CEOs made 30 Times Worker pay 1960s
    - CEOs make 300 Times worker pay today
    - Top 25 Hedge Fund Mgrs = paid ~$1B each
    - Top 1% controlled 25% of wealth 1970s
    - Top 1% control 40% of wealth today (US)

Revolution 4 Climate Stress Historical Responses

- Migration / Movement – most common
- Social Collaboration
- Muddling from Crisis to Crisis
- Decisive Leadership by Central Small Group
- Innovations to Increase the Carrying Capacity of the Land

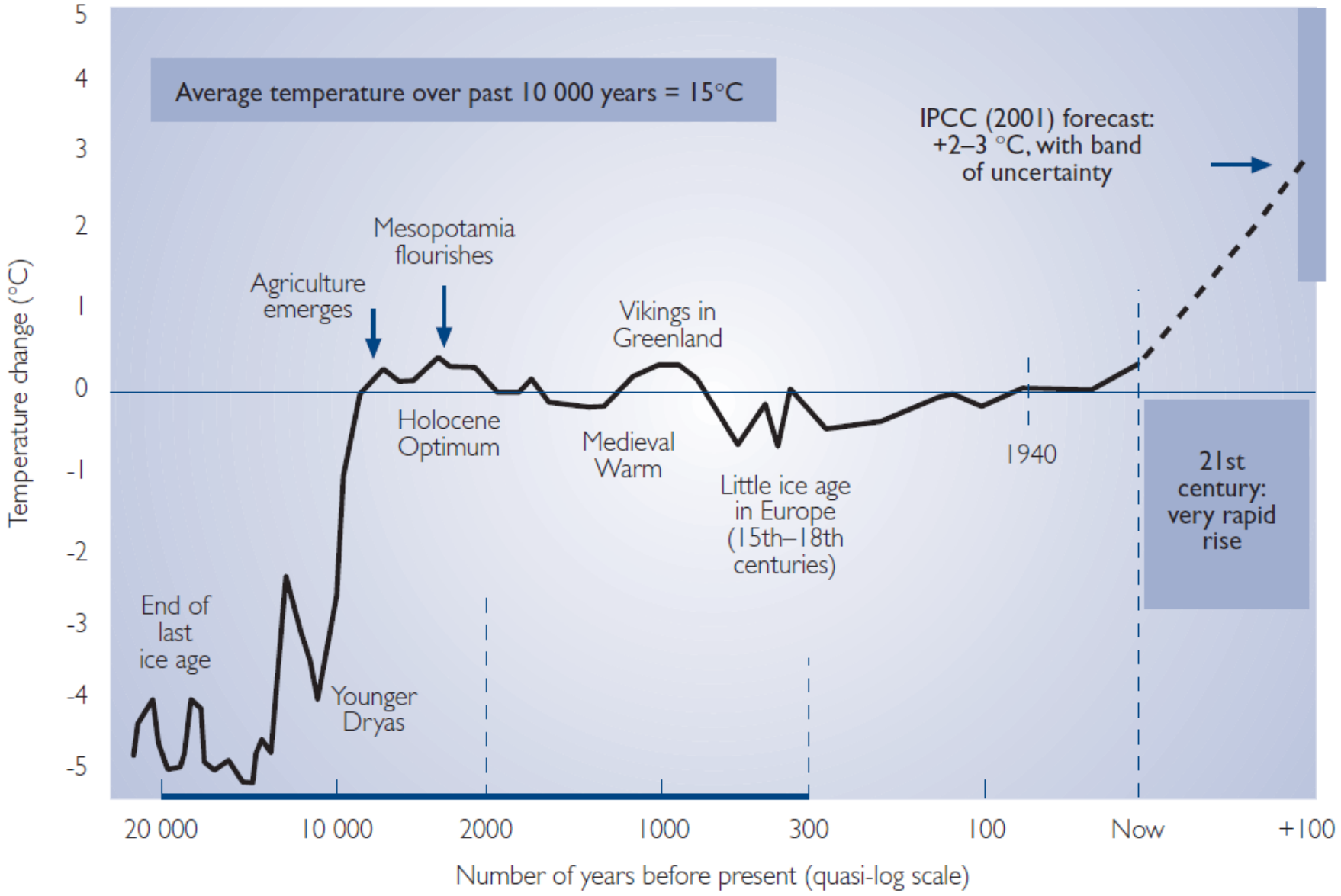
Migration Examples:
- US Dust Bowl 1931-40
- Ancient Sumeria
- Ancient Akkad
- Anasazi / Ancient Pueblo
- Early bands – hunter / gatherer

Collaboration Examples:
- Chumash (CA) intensify ag and new governance
- Egyptian state building and irrigation innovation

Not Always all bad effects - some Good Effects

- Stone Age Coping = Mobility and well-developed Social networks
- 8000 BCE = Development of Ag and Animal Husbandry
- 3000 BCE to today = population expansion!
- Ag led to State Formation
- Leaders and govts emerged, led cooperation + innovation
- New Agriculture in 14-1500s in Europe in "Little Ice Age"
  - Only France remained agriculturally backward in the deteriorating climate

Last Time We Were in a Warming Climate ?
Global Average Temperature



Medieval Warming Period Effects

Good Effects in Europe

- Population Growth
- Mild and Stable Weather
- Expansion of Ag
- State Formation
- Exploration
- High Middle Ages art, literature
- Golden age of Architects and Engineers 12-1300s
- Inter-civilizational trade – more wealth

Bad Effects in Europe

- Expansion into marginal lands – more vulnerability
- Conquest and Raiding
- Constant warfare
- Massive clear-cutting – more vulnerability
- Inter-civilizational Trade – more social risk

Medieval Warming Period Effects

Good Effects in Mexico - None

- Population exceeded carrying capacity of the land
- 5-8 Million people in 600 CE
- Migrated to small self-sustaining villages where they live to this day

Bad Effects in Central America

- Sustained El Nino cycles lead to drought in Maya peninsula and modern Mexico – 300 year Drought
- Resort to violence and extreme religious ideology (P, S, T!)
- Social rigidity limited innovation
- Collapse 900 CE due to ecological, social and political factors

Changes in the ENSO and NAO Cycles deliver extreme weather effects – not always warming

Medieval Warming Period Effects

Changes in the ENSO and NAO Cycles deliver extreme weather effects – not always warming

Today in Peru
-27% of pop lives in coastal area
- 2% of rainfall in Peru in the coastal area

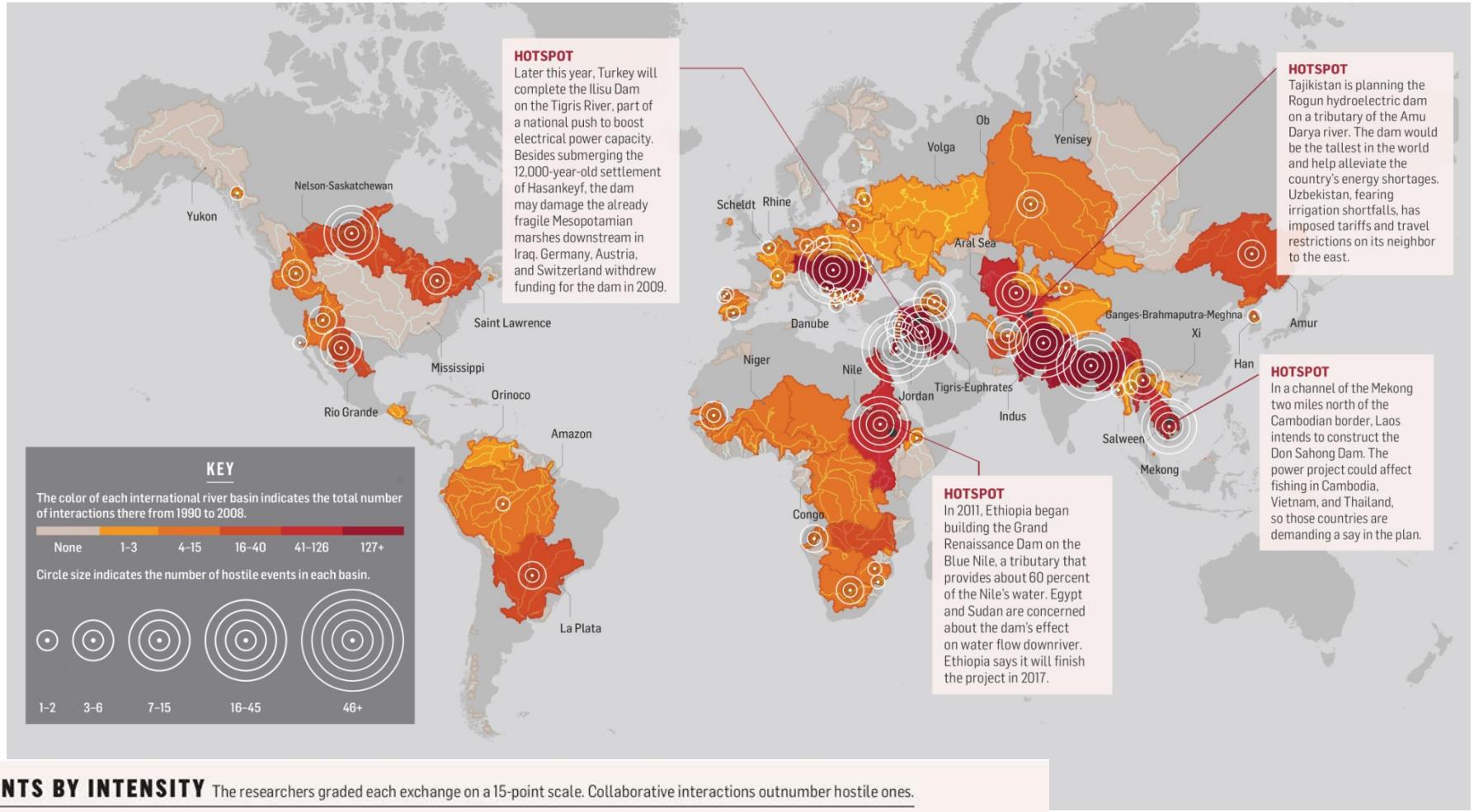
Good Effects in S. America

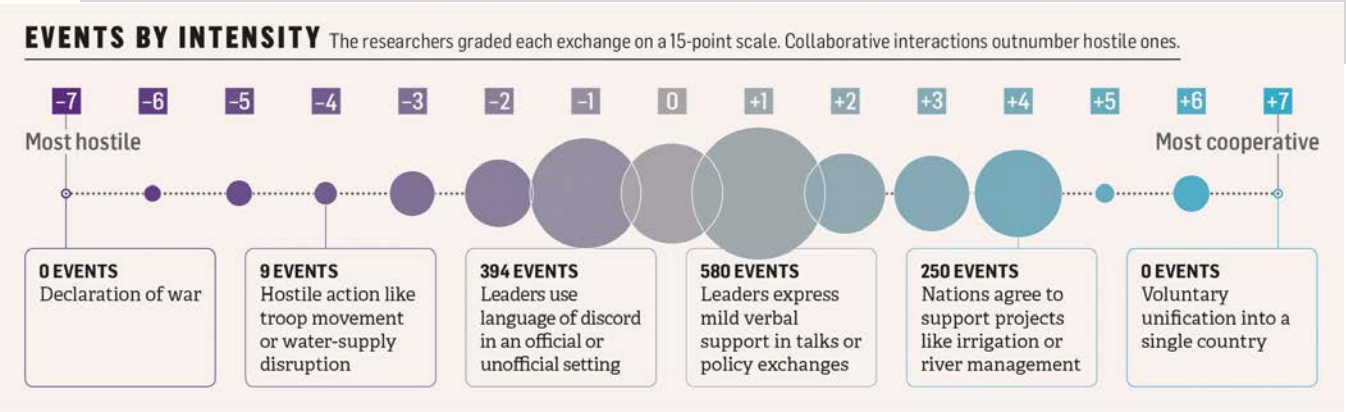
- Moche` society invested in hydrologic and irrigation innovation
- Limited migration

Bad Effects in South America – Moche`

- Sustained El Nino cycles lead to crushing storms and floods
- Reduced Aquaculture
- Resort to violence and extreme religious ideology (P,S, T!)
- Social rigidity limited innovation
- Collapse due to ecological, social and political factors

Where Will the World's Water Conflicts Erupt?





As published in Popular Science, June 2014, pp. 52-53, http://www.popsci.com/sites/popsci.com/files/water-lightbox.jpg

What Can We Conclude?

- 4 Revolutions are happening – increasing demands on America's Watershed

- US is not yet responding to the 4 revolutions in a systematic and coherent manner

- Climate is under stress globally unlike any era since the Medieval Warming Period and this stress will only increase
  - Relationship between Population – Carrying Capacity – and Legitimacy of Rulers is still active in human society

- Drought is the number 1 threat to the planet
  - Not necessarily in America's Watershed itself
  - In the West and SW USA yes – long-term period not short
  - In the Mid-West – especially groundwater aquifer depletion
  - Global and national drought will affect America's Watershed
    - Flows, allocations, conflicting demands
    - These influences and solutions cannot be effectively managed via the court system – EX: Missouri, Columbia

- Some Historic adaptation solutions are NOT open to us today
  - Mass migration and movement
  - Small centralized group exerting decisive leadership

What Can We Conclude?

- Some Historic adaptation solutions are open to us today and ARE strengths of American culture
  - Innovation to increase Carrying Capacity of the Land
    - US tends to believe on faith that this will save us absent other efforts
  - Social Collaboration – in a well-regulated market with rule of law

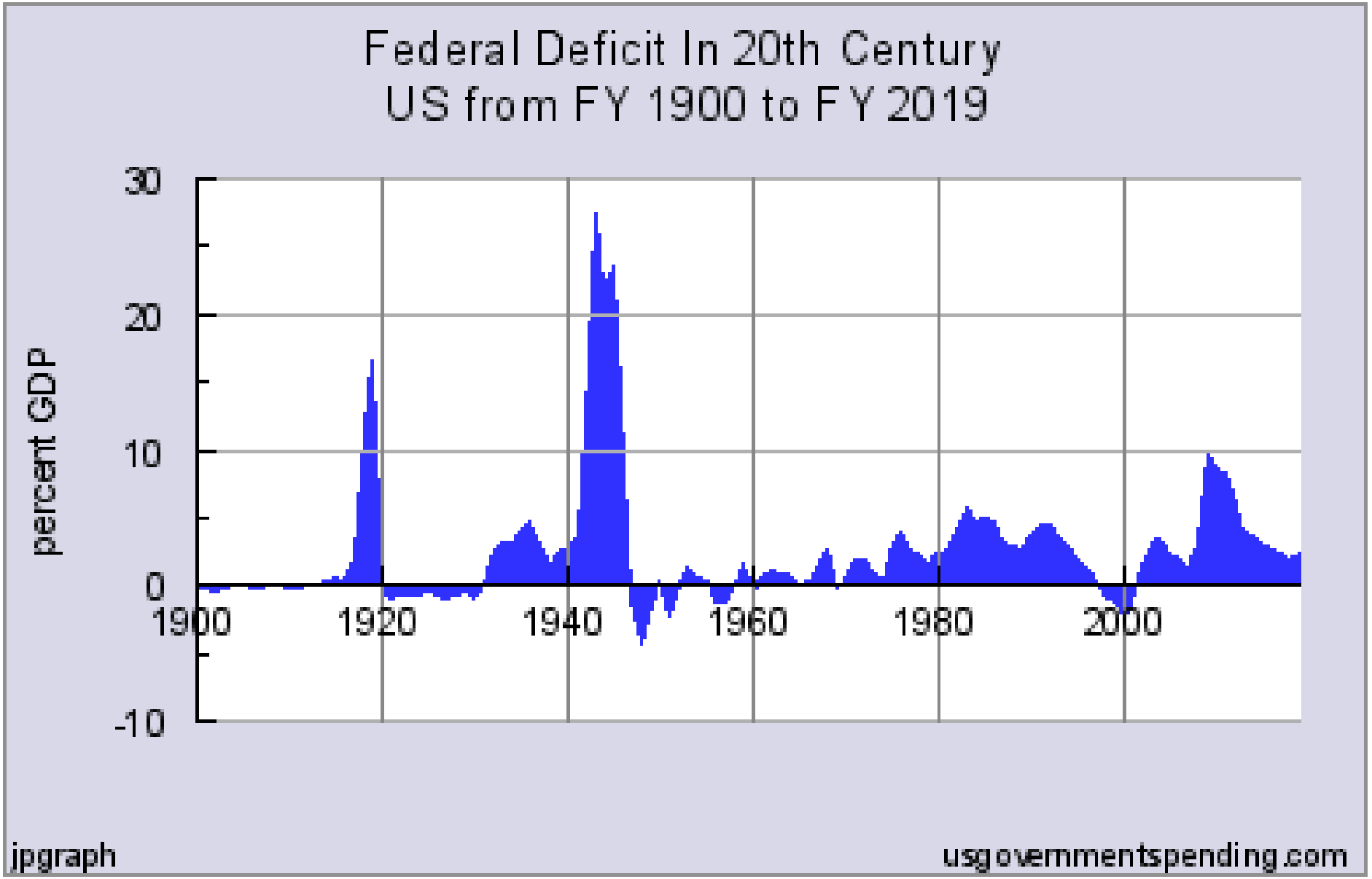
- Some Global Impacts last seen during the Great Depression are Already visible in US and global society
  - Social Breakdown (US, Africa, Middle East, Eurasia)
  - Decaying Infrastructure (US, Africa)
  - Famine (Africa)
  - National Breakdown (Africa, Middle East, Eurasia)
  - War and Social Disorder – only 15 nations conflict free

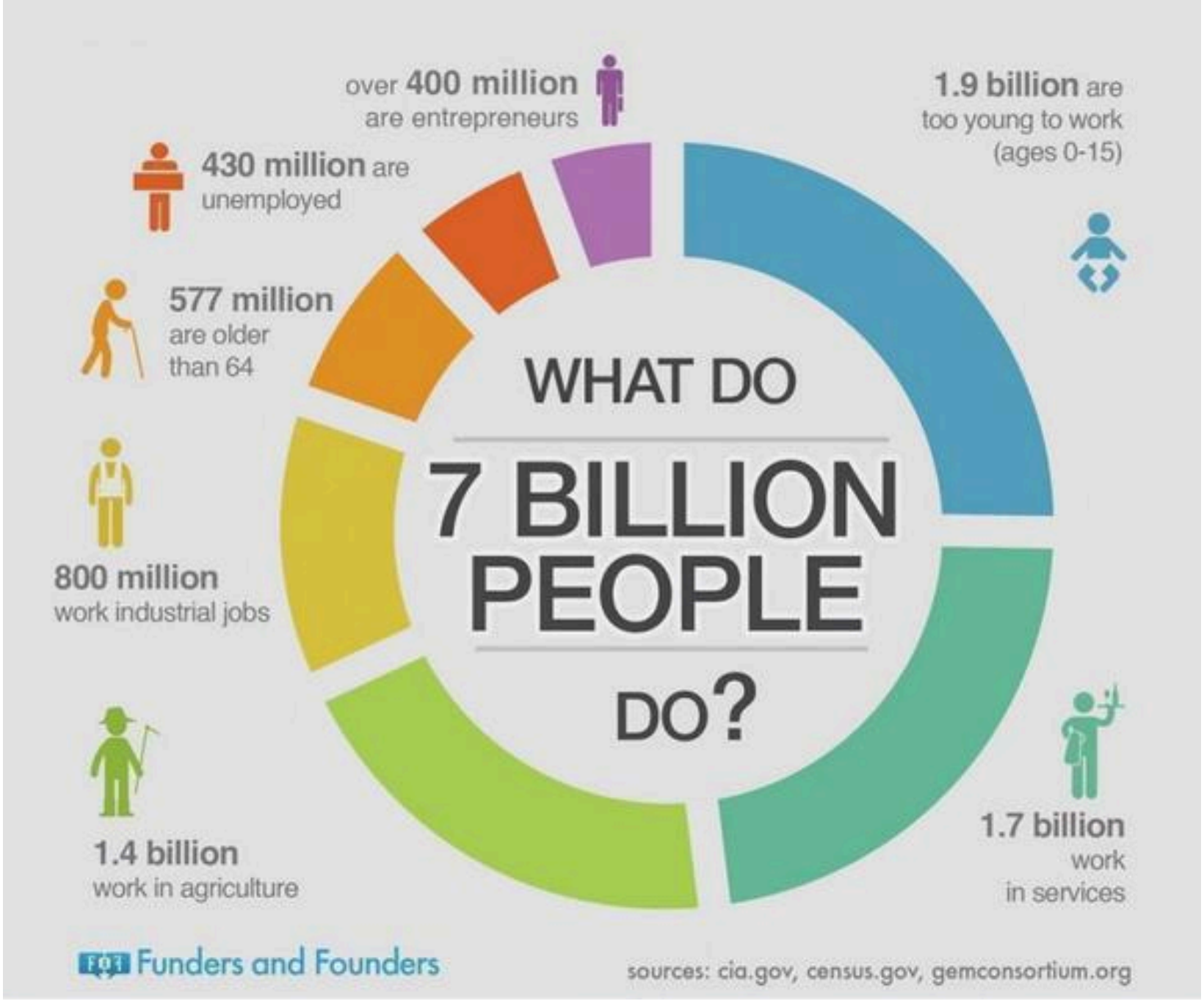
- Some historic unsuccessful responses to climate stress are present
  - Reliance on violence and extreme religious ideology P+S but no T
  - Denial or misunderstanding of the problems precludes the emergence of leadership on a scale needed to address

- US dominant mode (Democracies in general) is to choose the Adaptation method of Muddling Through from Crisis to Crisis
  - Will decisive but collaborative leadership emerge to address?

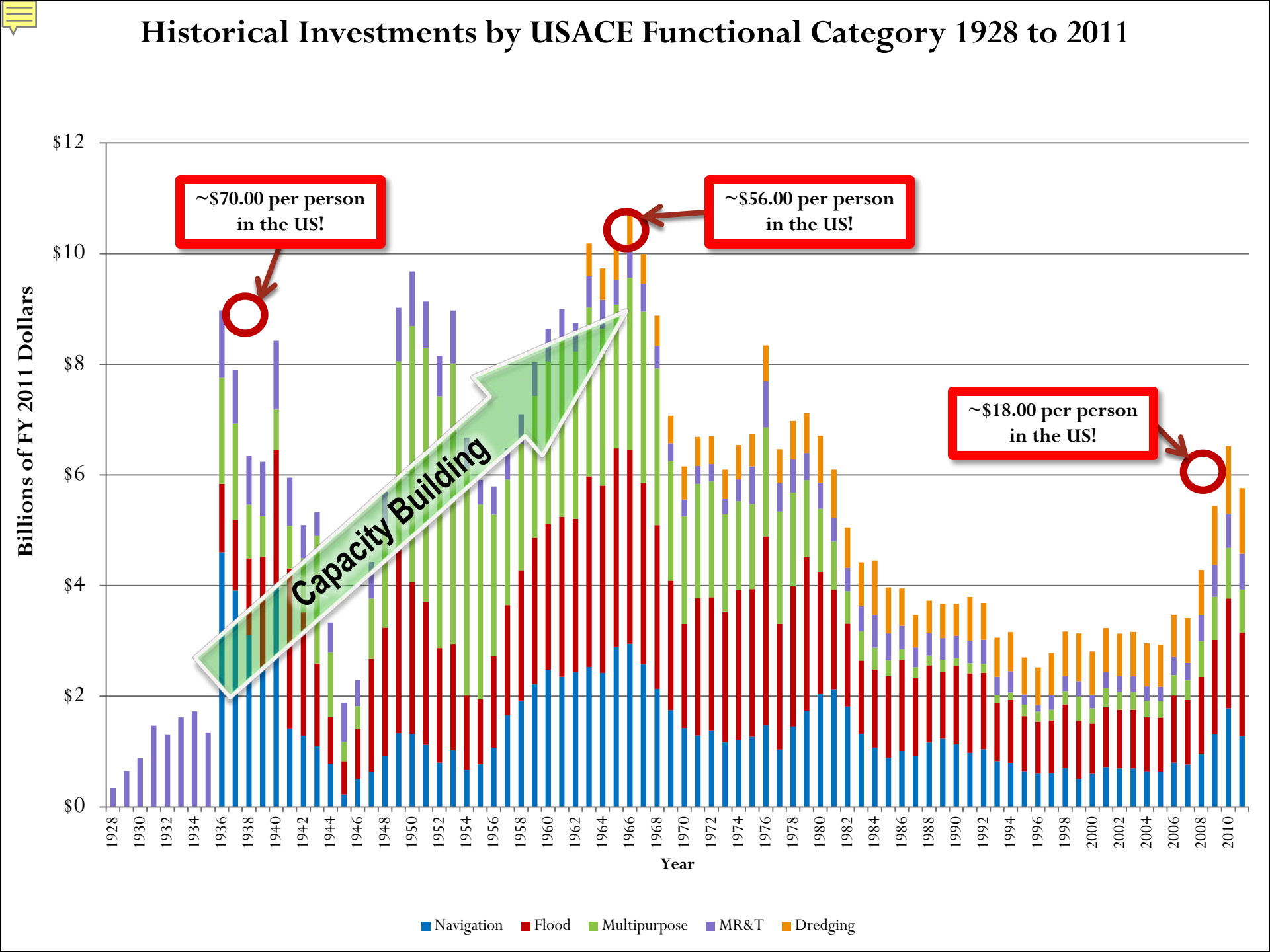
Nothing is as easy as it looks or sounds

Background

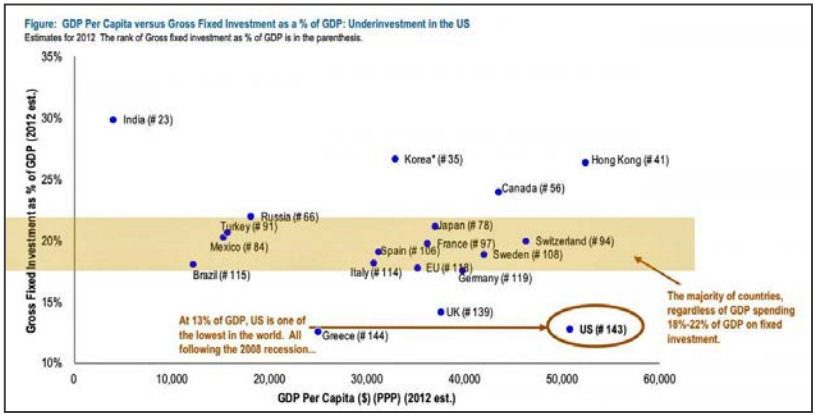

Federal Deficit In 20th Century
US from FY 1900 to FY 2019
percent GDP
30
20
10
0
-10
1900
1920
1940
1960
1980
2000
jpgraph
usgovernmentspending.com


over 400 million are entrepreneurs
1.9 billion are too young to work (ages 0-15)
430 million are unemployed
577 million are older than 64
WHAT DO
7 BILLION PEOPLE
DO?
800 million work industrial jobs
1.4 billion work in agriculture
1.7 billion work in services
FQ Funders and Founders
sources: cia.gov, census.gov, gemconsortium.org

Historical Investments by USACE Functional Category 1928 to 2011



United States relative to other nations



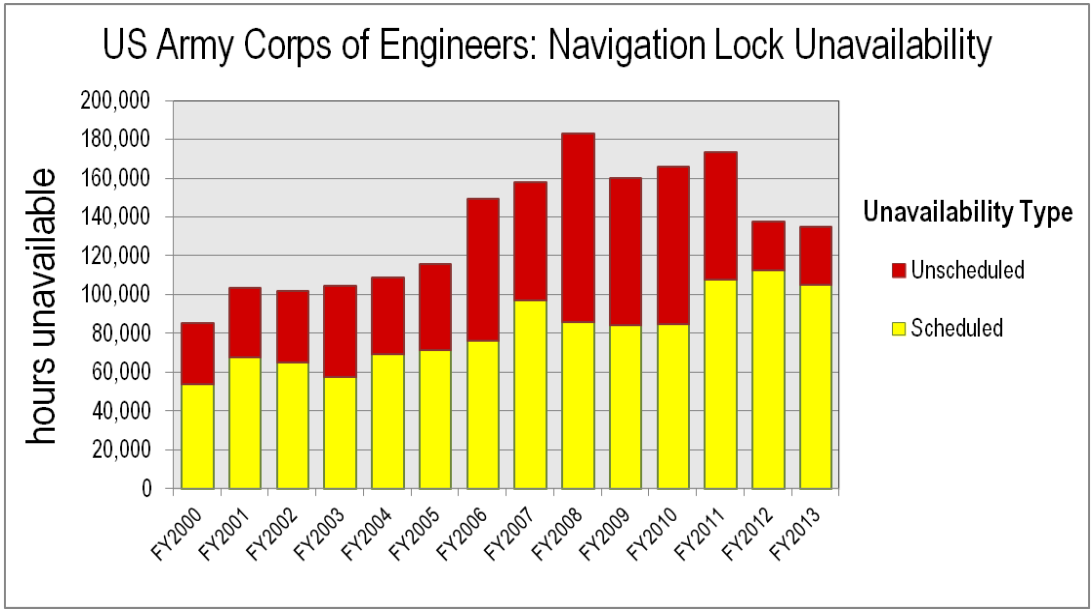
Low investment in infrastructure!

(equivalent to Greece #143 in world)

Since 2000: more than a doubling in delays!

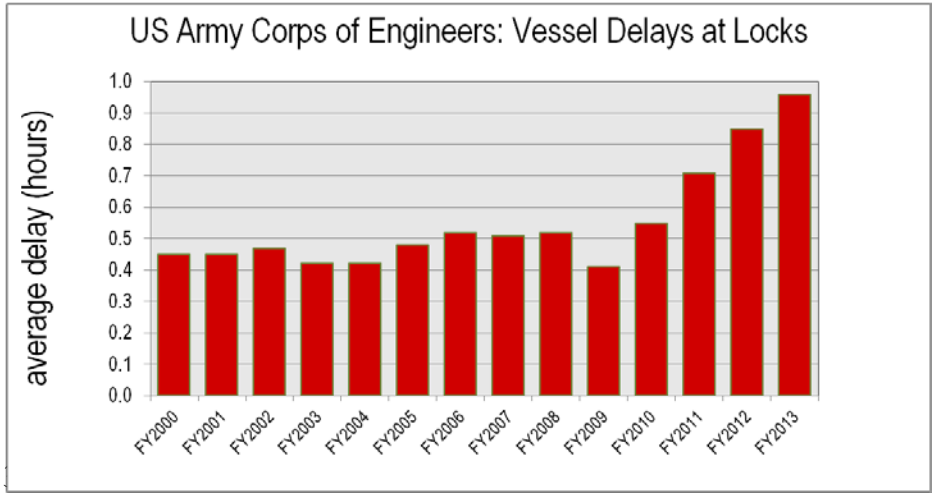
These are actual delays experienced by vessels!

Effects of decreased investment

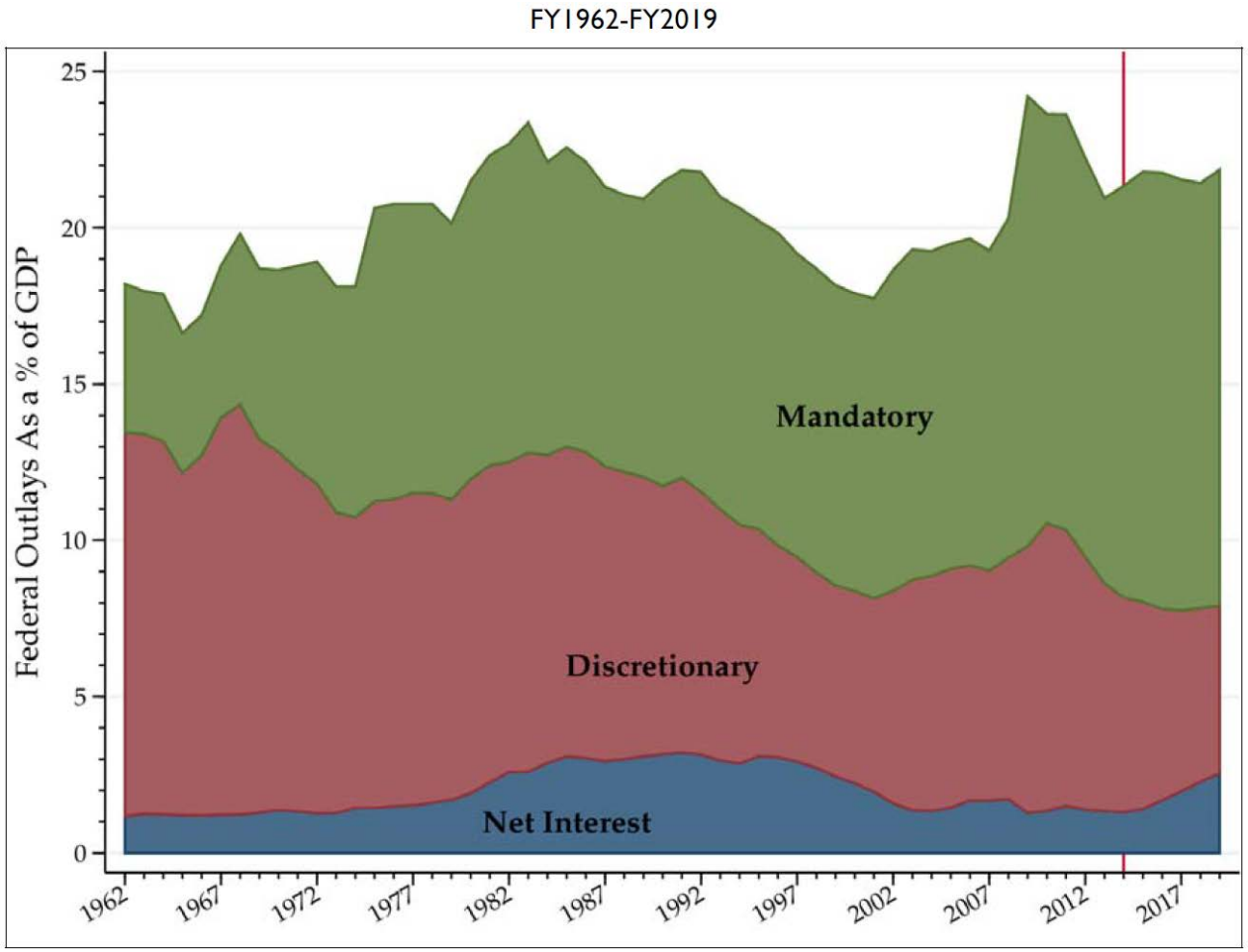


Since 2000:

- ~50% decrease in availability
- Twofold increase in scheduled outages!



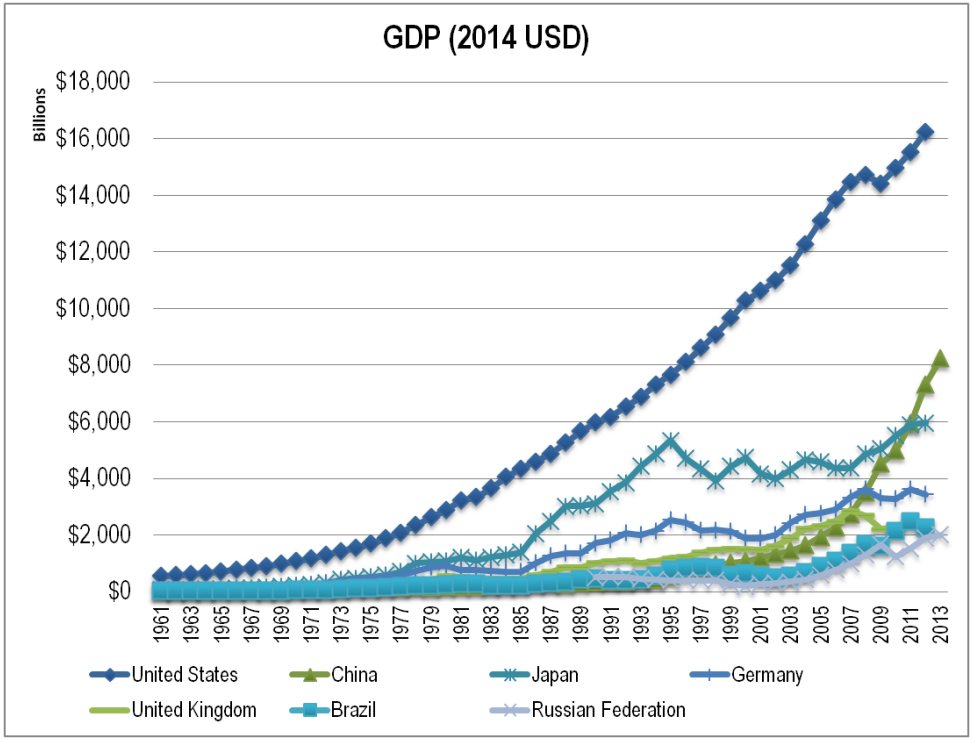
Components of Federal Spending: FY1962-FY2019



As published in "The Budget Control Act and Trends in Discretionary Spending," D. Andrew Austin, Congressional Research Service, 2 April 2014, p. 20.

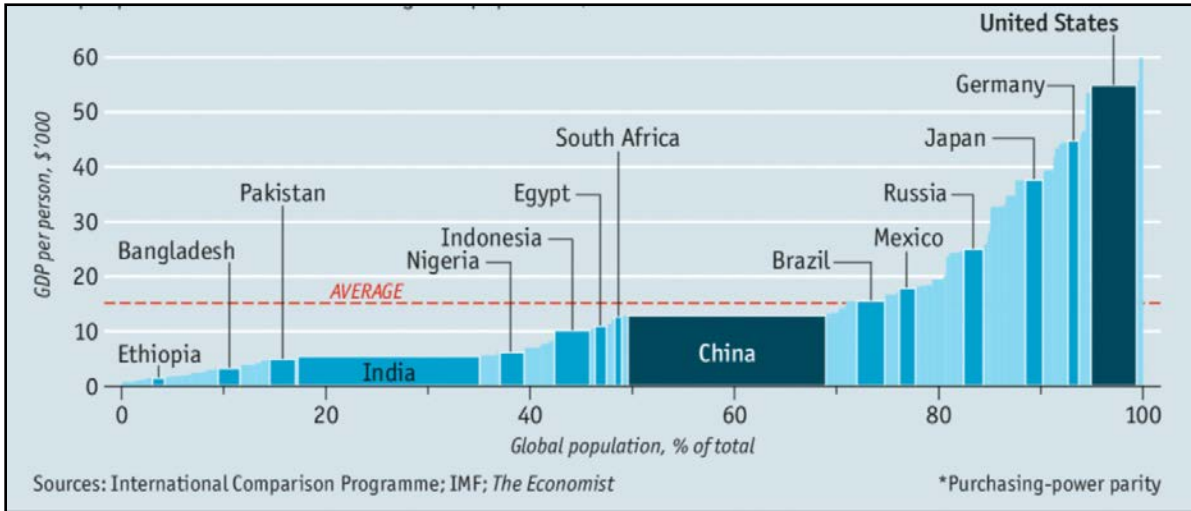
Source: CRS calculations based on data from the FY2015 OMB budget submission.

Comparison of gross domestic product



GDP per person at purchasing power parity and share of global population, 2014 forecast

As published in The Economist, “The Dragon takes wing”, May 3, 2014, p. 65.



Failure of Vision

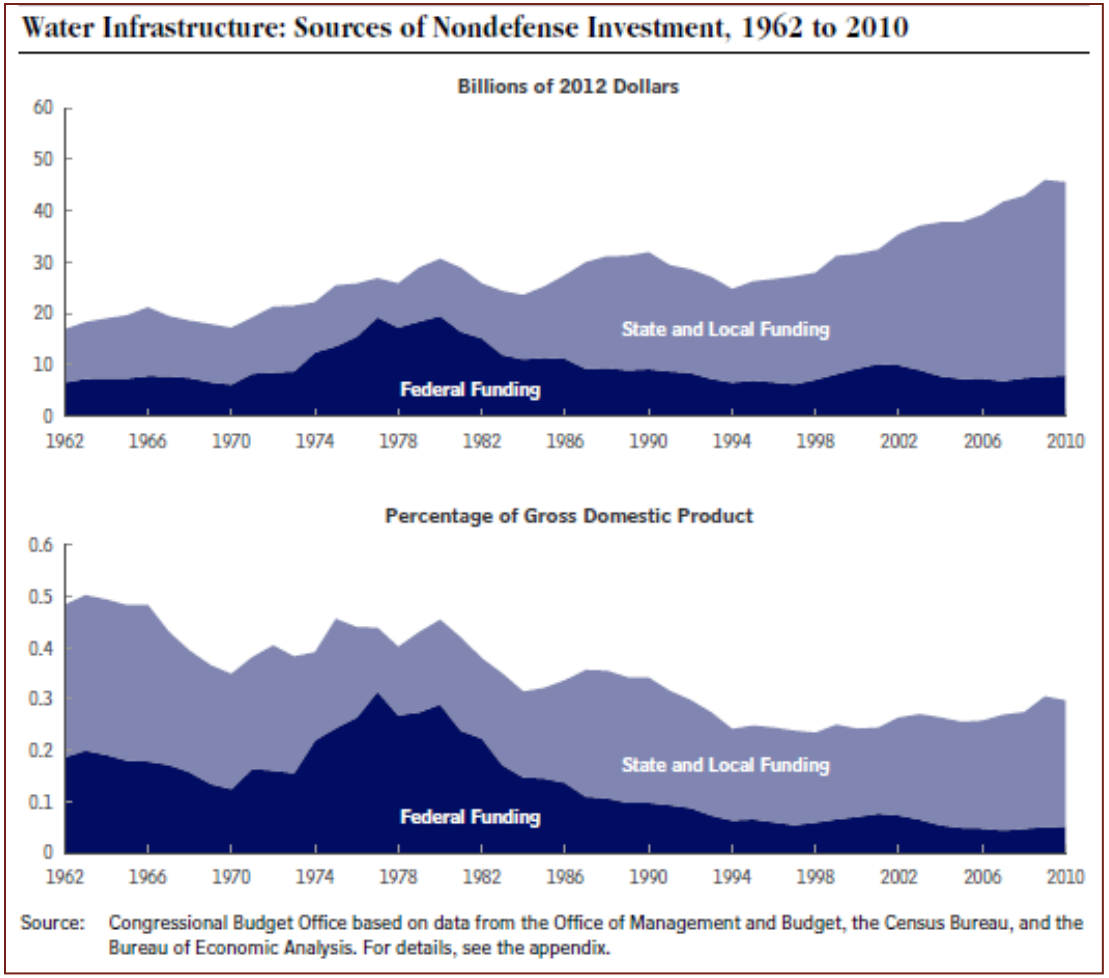
- "Nothing has been proposed during my twenty-two years in the United States Senate that would do more to wreck our fiscal budget system. As we spend and borrow and borrow, the least we can do for future generations – our children and grandchildren, on whom we would place astronomical burdens – is to keep an honest set of books so we'll know what debts we of this generation have incurred for them to pay."

--Sen. Harry Byrd: VA commenting on the proposed Clay Plan for the Eisenhower Interstate Highway System, 1955

Success of Vision

- United States GDP has grown 5.7 times larger today than in 1955 – due in large part to investments in inland waterways and the interstate highway system.
  - $ 2.78 trillion in 1955
  - $ 15.95 trillion in 2014

Water Infrastructure Spending



Between 1962 to 2010:

- **Total funding increased**
- **% GDP decreased**
- **Greater burden on state and local funding sources as infrastructure ages.**

What is Needed Now ?

- Renewed or return of understanding about federal investments
- Continue the democratization of water resource decisions and resourcing
- Evolution of USACE 3.0
- Creation of environmental movement 2.0
- Active involvement of producers (agriculture & manufacturers), shippers, transportation, re-creators, sportsmen, naturalists, secondary business owners, YOU!

2013 Report Card for America's Infrastructure

by the American Society of Civil Engineers

D+

America's Cumulative G.P.A.

Aviation	**D**	**Ports**	**C**
Bridges	**C+**	**Public Parks & Recreation**	**C-**
Dams	**D**	**Rail**	**C+**
Drinking Water	**D**	**Roads**	**D**
Energy	**D+**	**Schools**	**D**
Hazardous Waste	**D**	**Solid Waste**	**B-**
Inland Waterways	**D-**	**Transit**	**D**
Levees	**D-**	**Wastewater**	**D**

A = Exceptional
B = Good
C = Mediocre
D = Poor
F = Failing

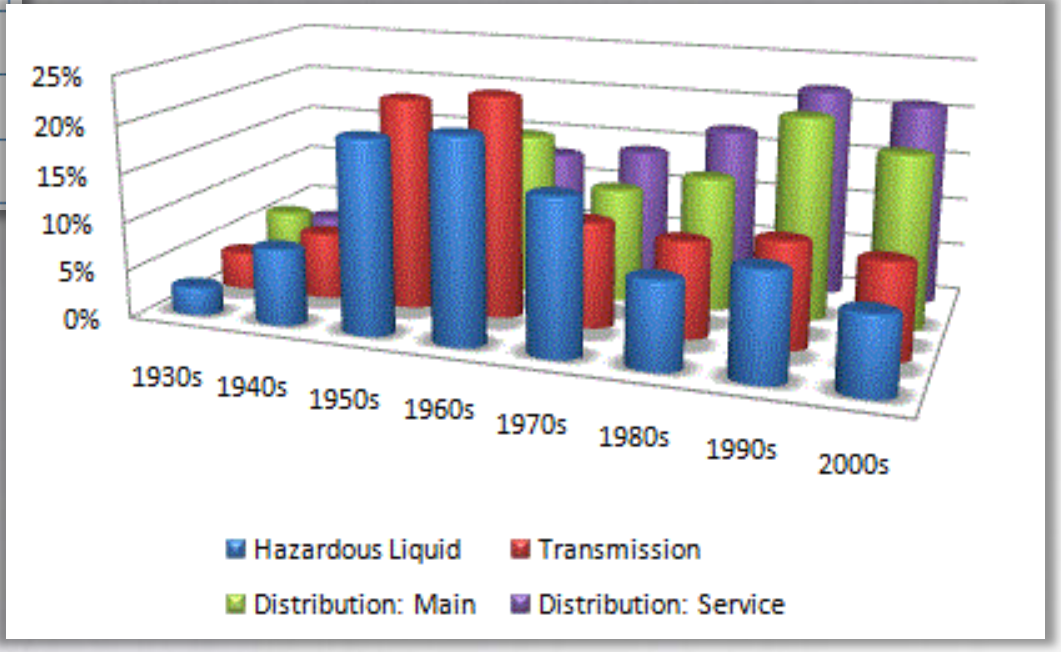
Estimated investment needed by 2020 =

$3.6 trillion

Aging Pipeline Infrastructure

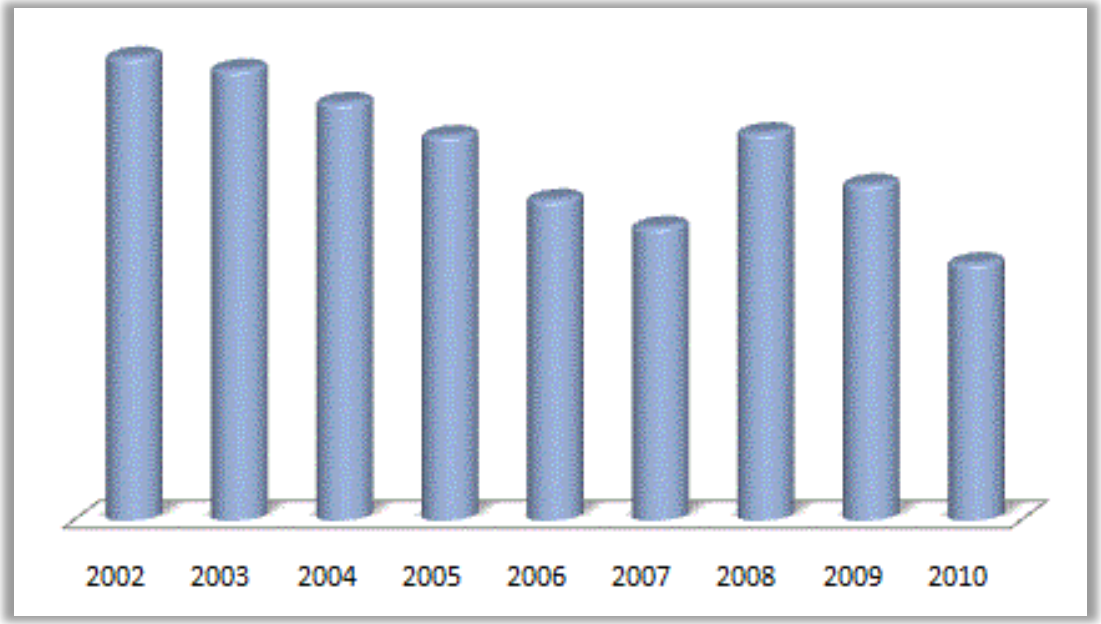
Decade	Hazardous Liquid	Transmission	Distribution	
			Main	Service
UNK/Pre 20s	2%	---		
1920s	2%	2%	---	---
1930s	3%	4%	6%	3%
1940s	8%	7%	2%	2%
1950s	20%	22%	10%	8%
1960s	21%	23%	17%	13%
1970s	16%	11%	12%	14%
1980s	9%	10%	14%	17%
1990s	11%	11%	21%	22%
2000s	8%	10%	18%	21%

Source: Pipeline Safety Update, U.S. Department of Transportation, September 2012, https://www.hsdl.org/?view&did=722017

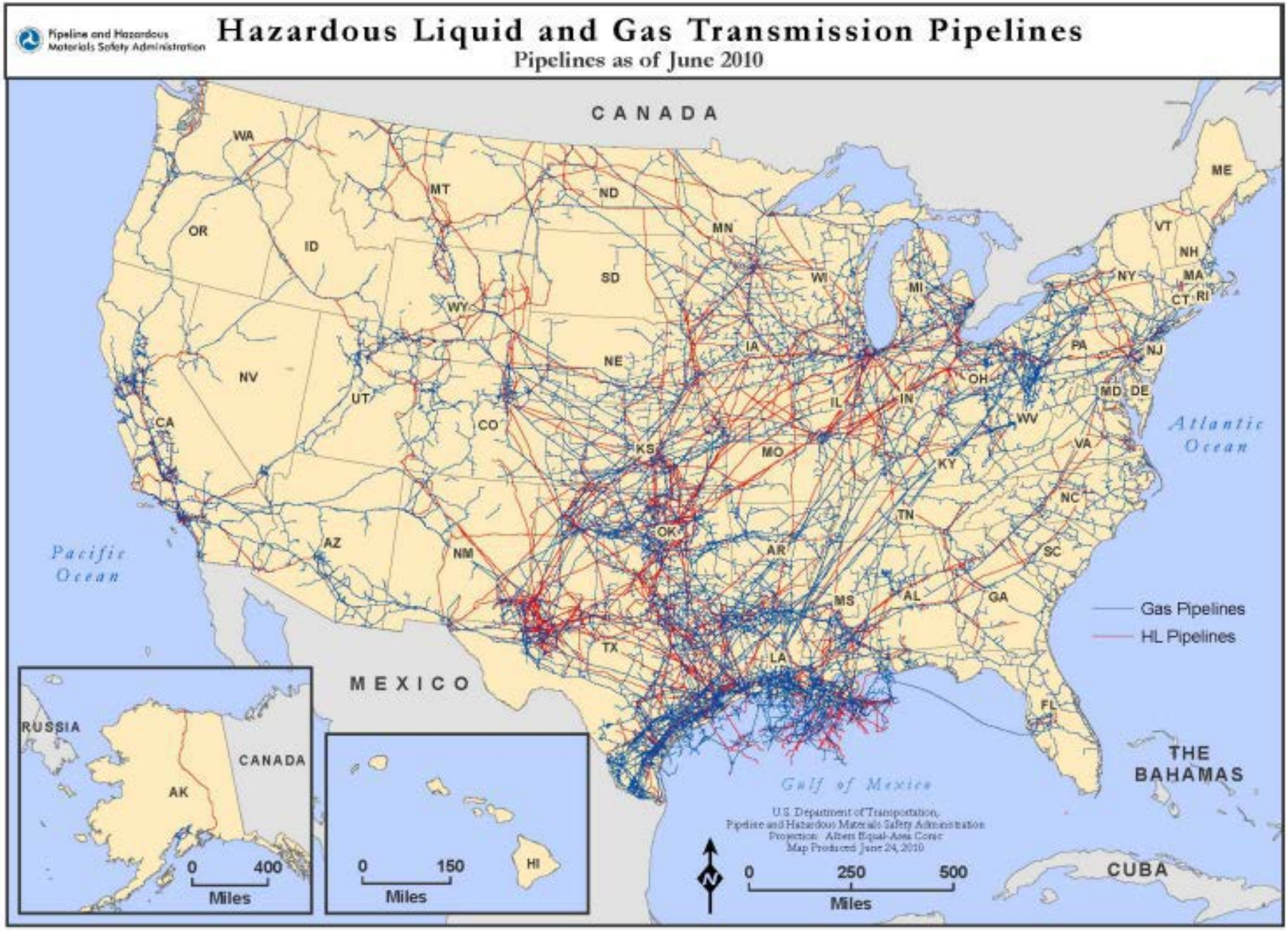


Liquid Pipeline Spills with Environment Consequences

Year	Spills
2002	153
2003	149
2004	138
2005	127
2006	106
2007	97
2008	128
2009	111
2010	85

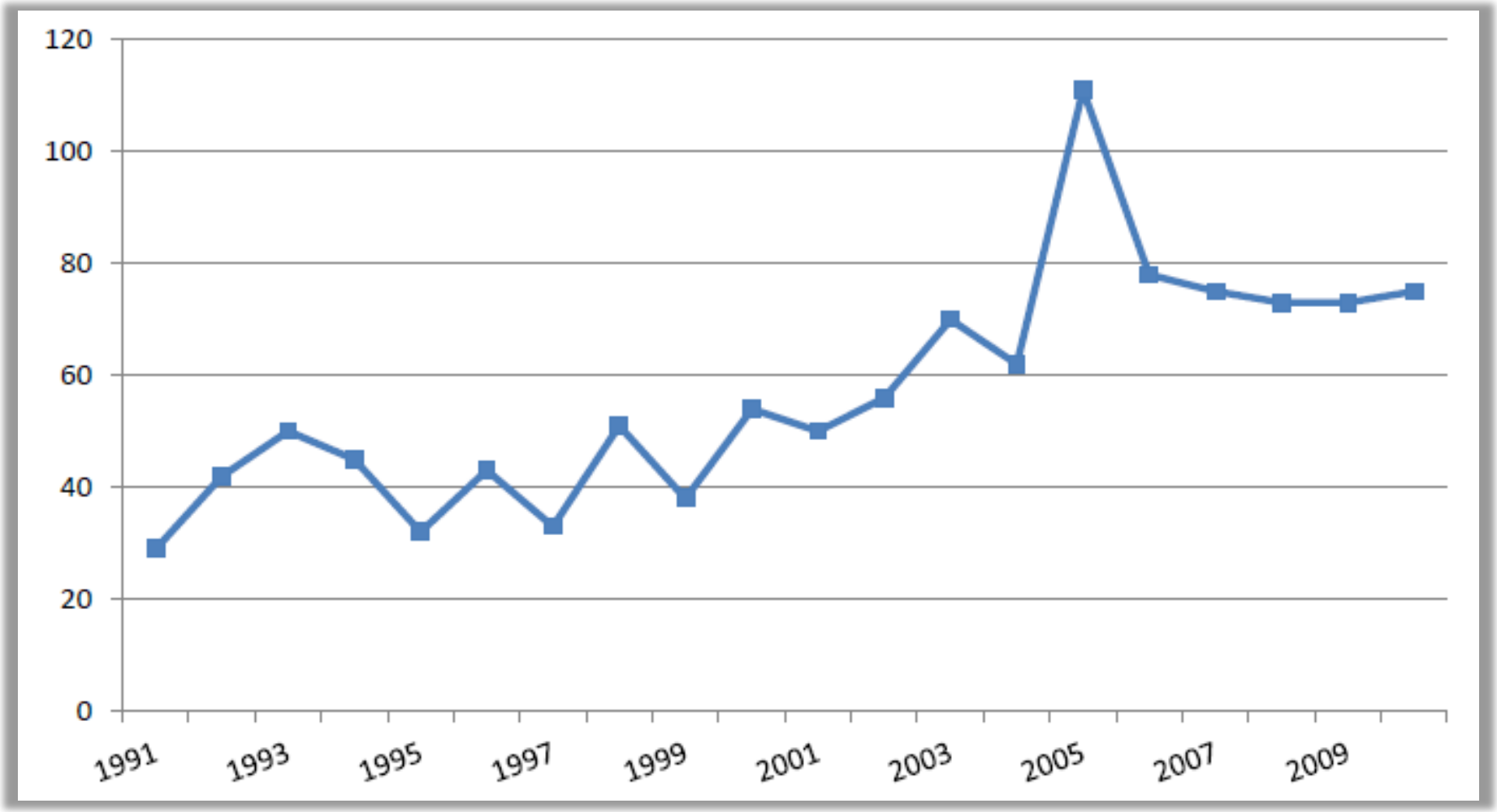


Source: Pipeline Safety Update, U.S. Department of Transportation, September 2012, https://www.hsdl.org/?view&did=722017



Source: Pipeline Safety Update, U.S. Department of Transportation, September 2012, https://www.hsdl.org/?view&did=722017

Significant Incidents for Gas Transmission Pipelines



Source: Pipeline Safety Update, U.S. Department of Transportation, September 2012, https://www.hsdl.org/?view&did=722017

Pipeline System Significant and Serious Incidents per year – 2005-2010

Pipeline Type	Average Miles (2005-2010)	Average Number of Significant Incidents per year (2005-2010)	Average Number of Significant Incidents per 1,000 Miles per Year	Average Number of Serious Incidents per year (2005-2010)	Average Number of Serious Incidents per 1,000 Miles per Year
Hazardous Liquid	170,000	115	0.67	3.2	0.019
Gas Transmission	302,000	81	0.27	6.0	0.020
Gas Distribution	2,009,000	70	0.036	30.2	0.035

Source: Pipeline Safety Update, U.S. Department of Transportation, September 2012, https://www.hsdl.org/?view&did=722017