Alabama in the Late 21st Century:
Sustainability and Risks

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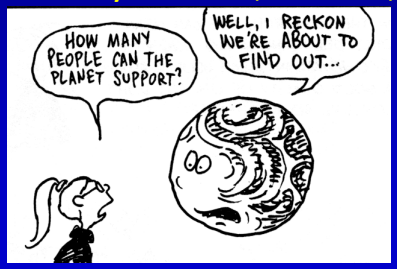


Gonick and Outwater. *The Cartoon Guide to the Environment*

1

Formula for "Survival"

$$\frac{\text{(Population) X (Demand)}}{\text{(Sustainable Supply)}} \text{ must be } < 1$$

2

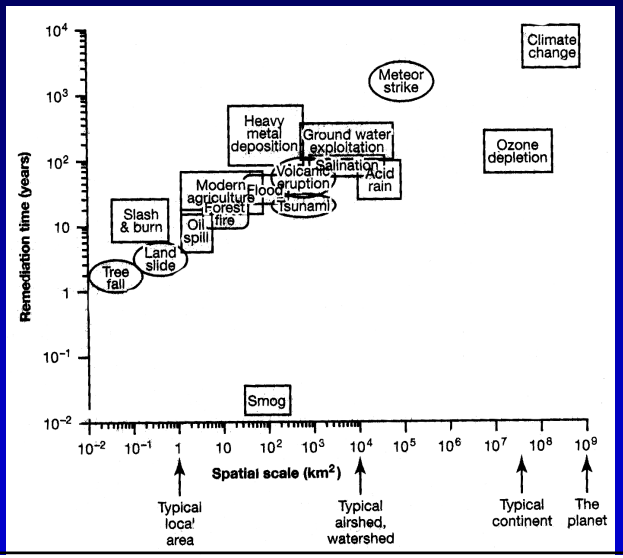
Environmental Trends Shaping the 21st Century

State of the World 2000

- Population growth
- Rising temperature
- Falling water tables
- Shrinking cropland per person
- Collapsing fisheries
- Shrinking forests
- Loss of plant and animal species

3

Time and Scale of Environmental Concerns (Graedel)



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Problems in Our Future (recovery periods for individual actions)

- **Short Term (< 100 years):**
  - Tree falls
  - Land slides
  - Oil spills
  - Slash and burn
  - Forest fires
  - Floods
  - Tsunamis
  - Volcano eruption
  - Acid rain
- **Long-Term (>100 years):**
  - Heavy metal deposition
  - Groundwater exploitation
  - Ozone depletion
  - Meteor strike
  - Climate change

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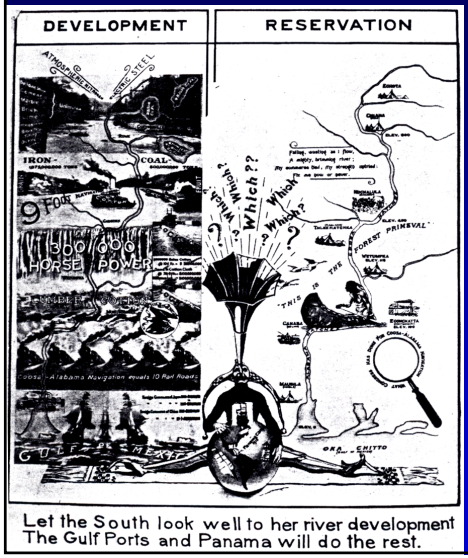
Water Supply and Water Quality

- Conservation easiest to develop and cheapest new water source
- Water quality problems becoming better understood
- Habitat destruction becoming recognized as serious issue

6

Development or Reservation?



Development:
Atmospheric nitrogen, electric steel, cement, marble, brick, lime, iron, coal, fruit, lumber, and cotton.

300,000 horsepower

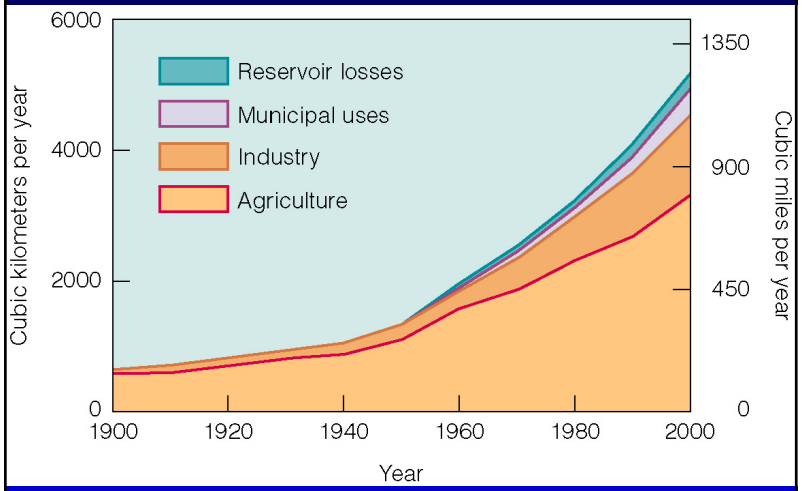
Coosa-AL navigation = 10 railroads

Reservation:
Falling, wasting as I flow.
A mighty brimming river.
My commerce tied,
my strength untried.
Fix me now or never.

W.P. Lay. *River Problems of Alabama*. 1915

7

National Annual Water Withdrawals for Various Uses



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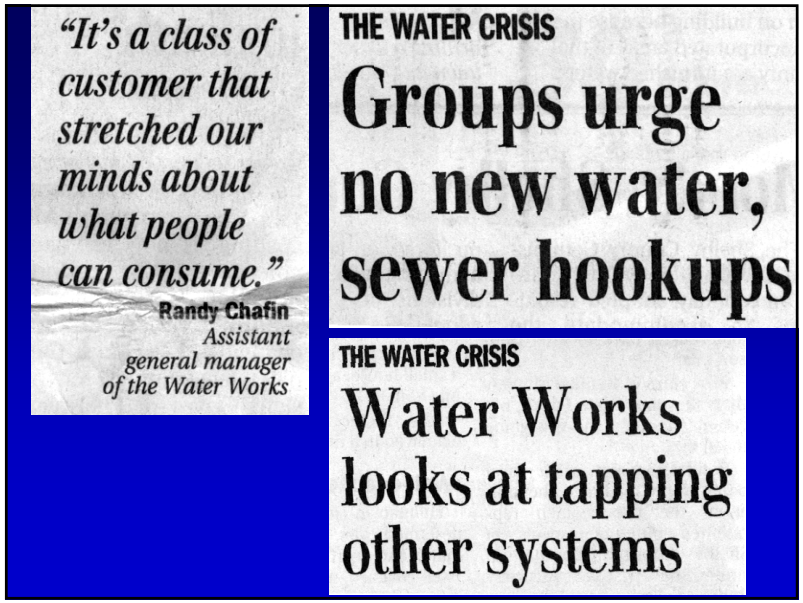

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A fact known for a number of years:

"Nearly the entire spectrum of conservation and efficiency options cost less than the development of new water sources."

Sandra Postel 1996

10

Estimated Costs of Water Management Options

	Estimated cost range (cents/m^3)
Reducing demand through conservation/efficiency	5 – 50
Treatment and reuse of wastewater for irrigation	30 – 60
Desalination of brackish water	45 – 70
Development of marginal water	55 – 85
Desalination of seawater	100 – 150

World Bank 1995

11

Large-Scale Water Reuse Sites

- Bethlehem Steel, Baltimore (400,200 m^3/day)
- Dan Region, Israel (274,000 m^3/day)
- Los Angeles and Orange Counties (200,000 m^3/day)
- Wroclaw, Poland (170,000 m^3/day)
- Muskegan Co., Michigan (159,000 m^3/day)
- Mexico City (155,500 m^3/day)
- Riyadh, Saudi Arabia (120,000 m^3/day)
- Nevada Power Co, Los Vegas (102,200 m^3/day)

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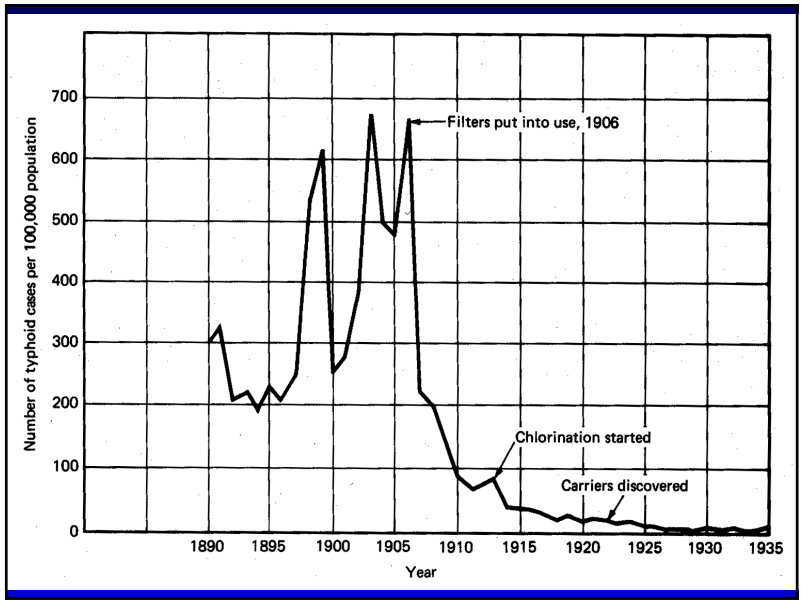

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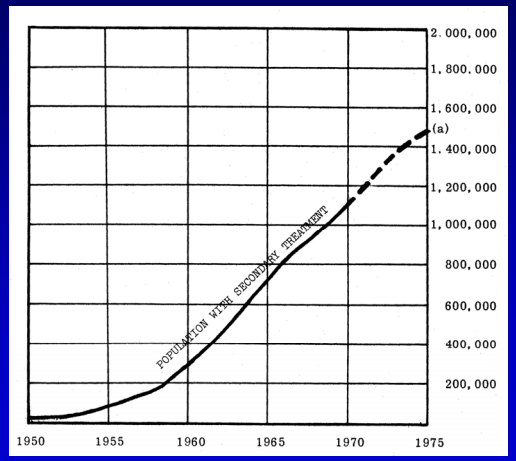
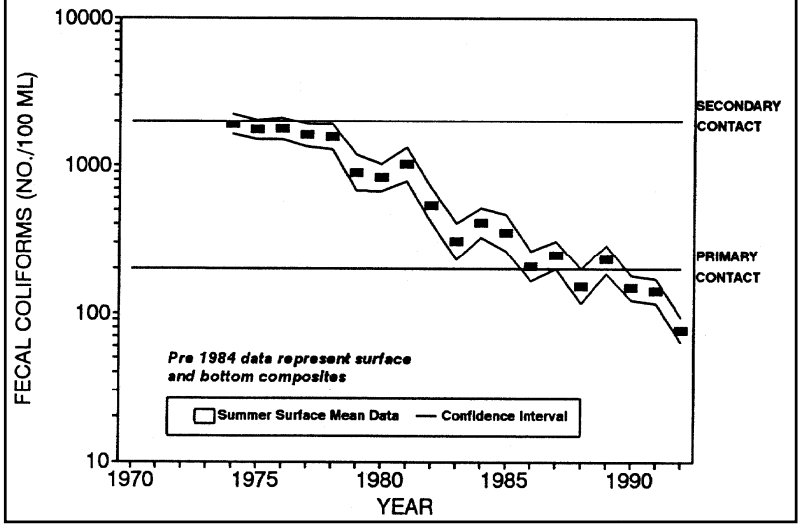
Secondary Municipal Wastewater Treatment in Alabama before 1975 (population served)



Auburn University

14

Off-Shore New York City Bacteria Level Improvements



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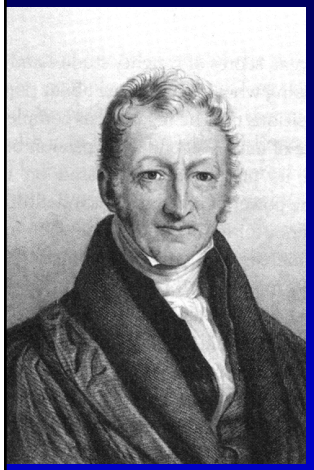
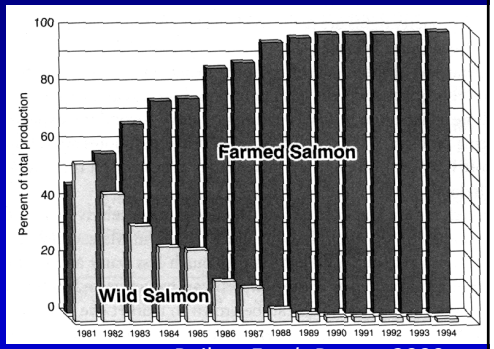


Thomas Malthus
1766 - 1834

"A decade ago, a fish Malthusian might have predicted the end of salmon as a food. Human ingenuity seems to have beaten nature once again."

Forbes 1990

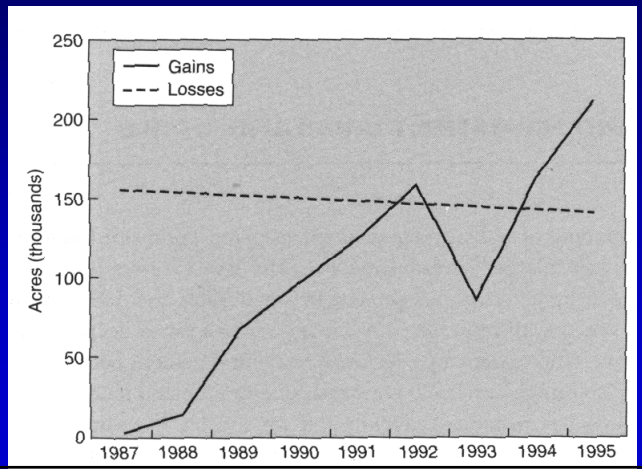


Bailey, *Earth Report 2000*.

16

Wetland Gains and Losses

Unfortunately, most constructed wetlands are much less productive than natural wetlands.



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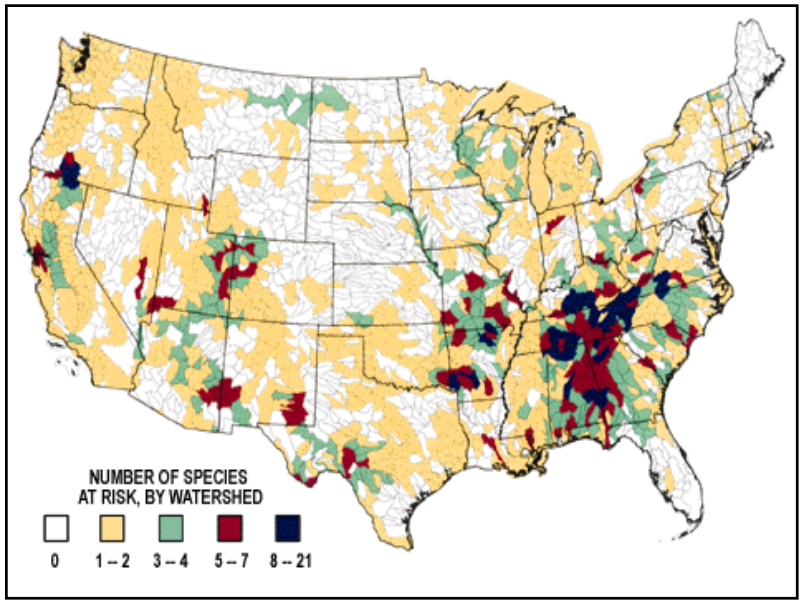


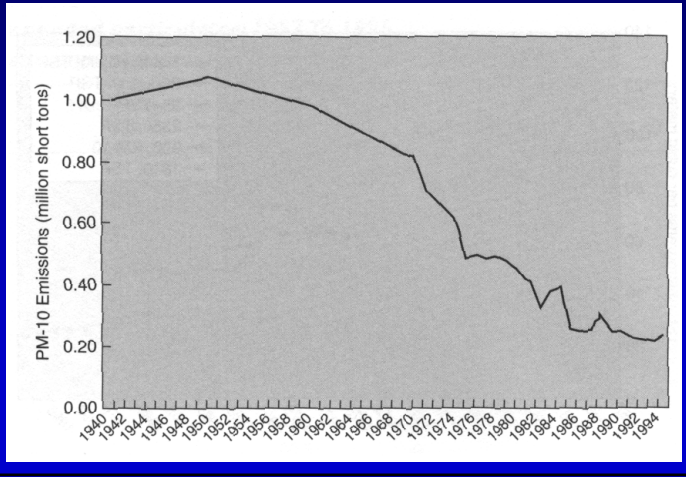
18

Air Quality has Generally Continued to Improve

- Historical particulate and sulfur dioxide problems greatly improved in Birmingham area.
- Greater emphasis now on ground-based ozone problems.
- Ozone levels have remained reasonably level for the past 20 years, but more stringent standards are now in place.
- Air quality has improved with dramatically decreased industrial and automobile emissions, however, increased automobile use now more than compensating for improved emissions and worsening in air quality expected.

19

Major Reductions in Particulate Emissions due to Clean Air Act Amendments of 1970



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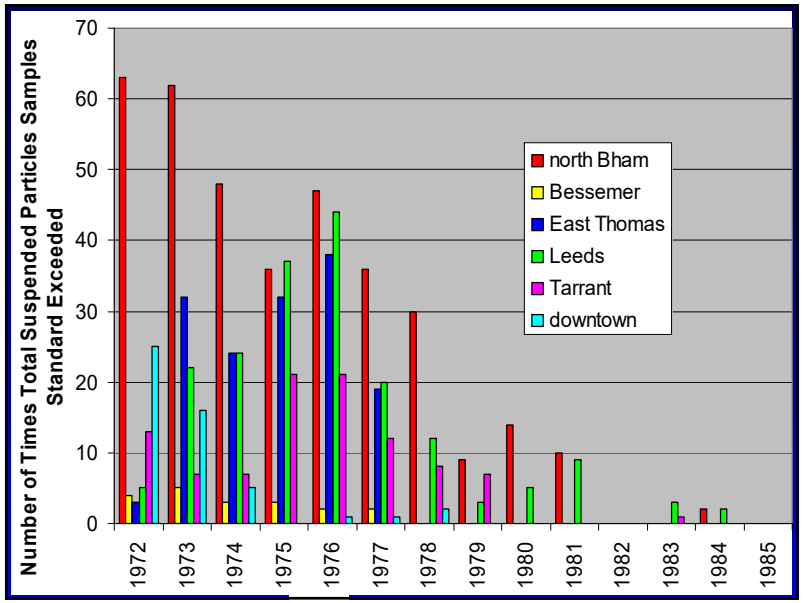

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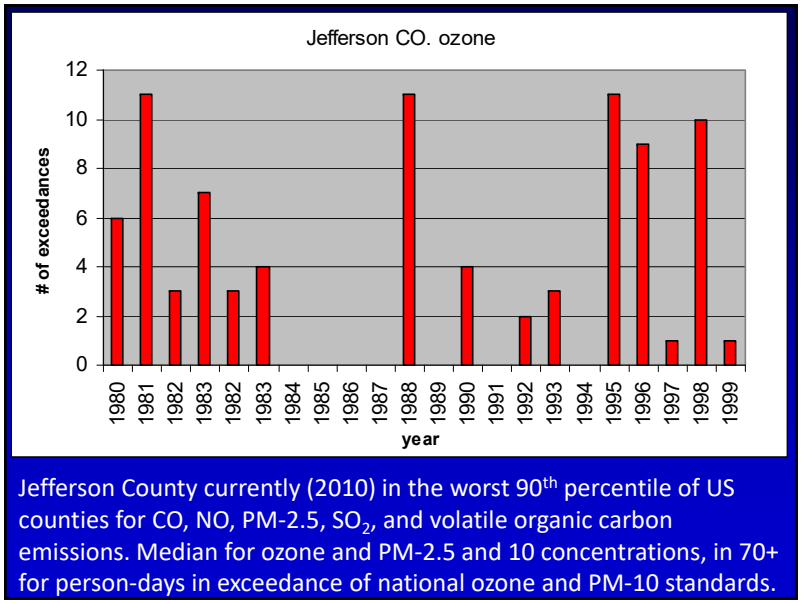

Jefferson County currently (2010) in the worst 90th percentile of US counties for CO, NO, PM-2.5, SO_2, and volatile organic carbon emissions. Median for ozone and PM-2.5 and 10 concentrations, in 70+ for person-days in exceedance of national ozone and PM-10 standards.

22

Natural vs. Technological Disaster

- Natural disasters seen as part of the order of things, i.e., "acts of God."
  - Such calamities are to be expected because we do not have and do not expect to have control of nature.
- Manmade/technological disasters seen as preventable.
  - Expectation to be able to control technology.
  - It MAY be more of a blow to suffer a technological catastrophe since it could have been prevented.
  - Issues of blame and responsibility show up more in man-made disasters. These disasters can produce much higher levels of anger and distrust than natural disasters.

23

"The Risks that Kill Are Not Necessarily the Risks that Anger and Frighten"

- To experts, risk means annual mortality.
- To the public, risk means much more (although it includes) annual mortality.
- Risk = Hazard + Outrage
- Public more focused on outrage while experts more focused on hazard.

24

Lifetime Risks to Life Commonly Faced by Individuals (Table 41.1, Burke, Singh and Theodore)

Cause of Risk	Lifetime (70-yr) Risk, Per Million Persons
Cigarette Smoking	252,000
All Cancers	196,000
Construction	42,700
Agriculture	42,000
Police Killed in Line of Duty	15,400
Air Pollution (Eastern United States)	14,000
Motor Vehicle Accidents (Traveling)	14,000
Home Accidents	7,700
Frequent Airplane Traveler	3,500
Pedestrian Hit by Motor Vehicle	2,900
Alcohol, Light Drinker	1,400
Background Radiation at Sea Levels	1,400

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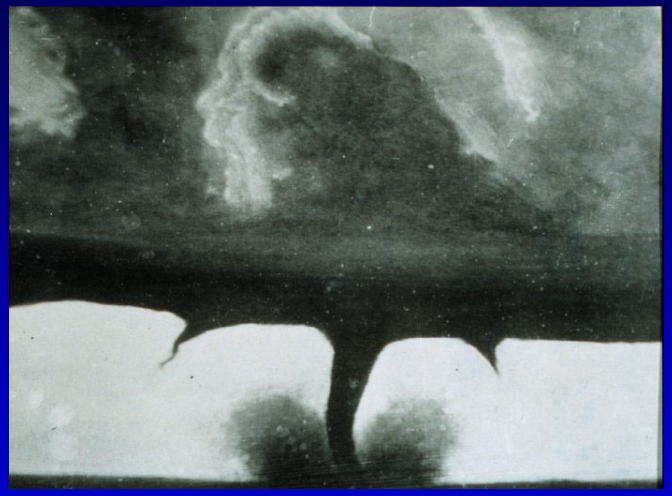
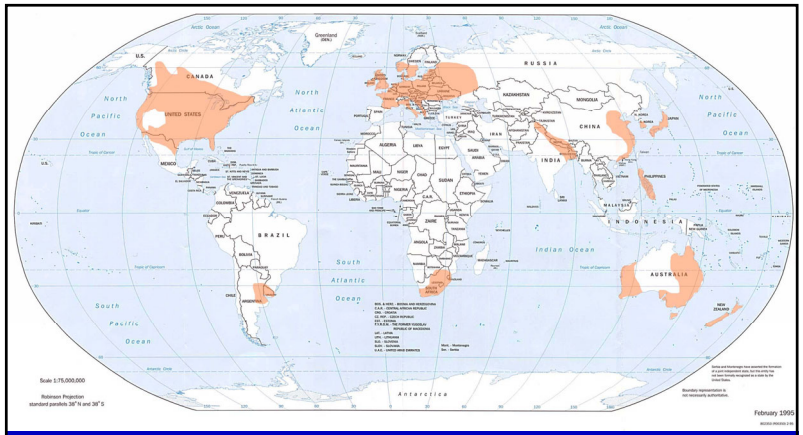


First photograph of tornado, 1884 (US NCDC)

26



Areas of the world having the greatest frequencies of tornados (US has the most severe tornados)

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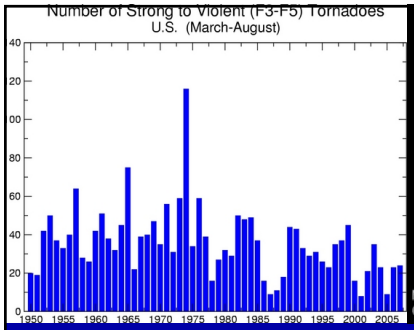
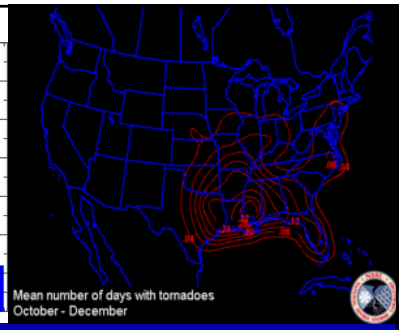




Numbers of violent tornados by year in the US (NCDC)

"Tornado Dixie alley" area having large numbers of storms

28

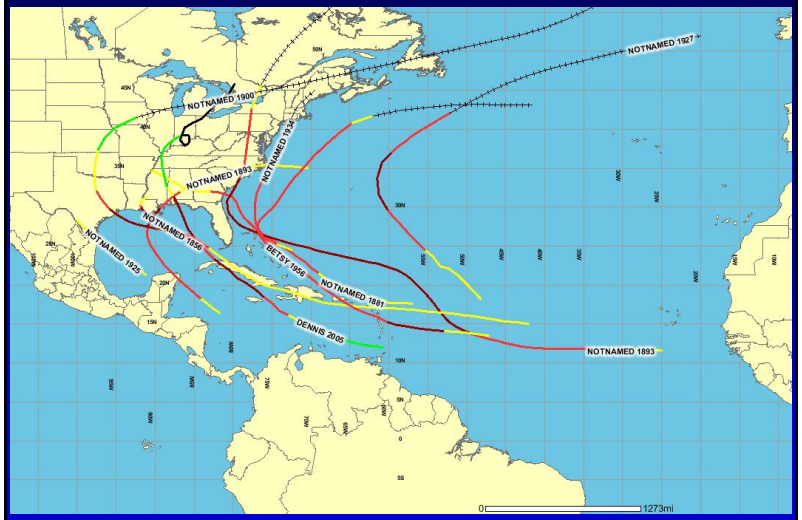
US Mainland Hurricane Strikes (1900 – 1996)

AREA	Saffir/Simpson Category Number					ALL	MAJOR
	1	2	3	4	5	1,2,3,4,5	3,4,5
U.S. (Texas to Maine)	58	36	47	15	2	158	64
Texas	12	9	9	6	0	36	15
Louisiana	8	5	8	3	1	25	12
Mississippi	1	1	5	0	1	8	6
Alabama	4	1	5	0	0	10	5
Florida	17	16	17	6	1	57	24
Georgia	1	4	0	0	0	5	0
South Carolina	6	4	2	2	0	14	4
Virginia	2	1	1	0	0	4	1
Maryland	0	1	0	0	0	1	0
Delaware	0	0	0	0	0	0	0
New York	3	1	5	0	0	9	5
Connecticut	2	3	3	0	0	8	3
Rhode Island	0	2	3	0	0	5	3

US National Hurricane Center

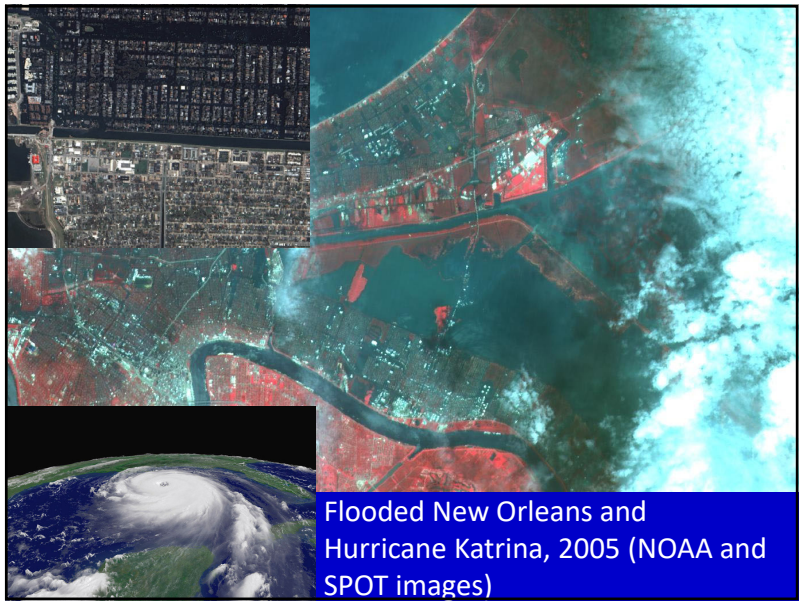
29

Tracks of Ten Deadliest US Hurricanes (1851 – 2007)



NOAA Coastal Services Center

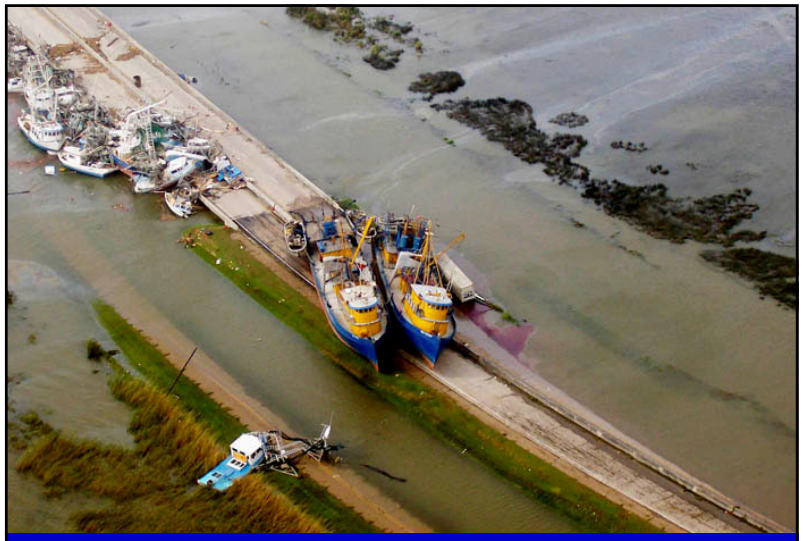
30



Flooded New Orleans and Hurricane Katrina, 2005 (NOAA and SPOT images)

31

32



Fuel and other material leakage from damaged boats. Hurricane Katrina (NOAA photo)

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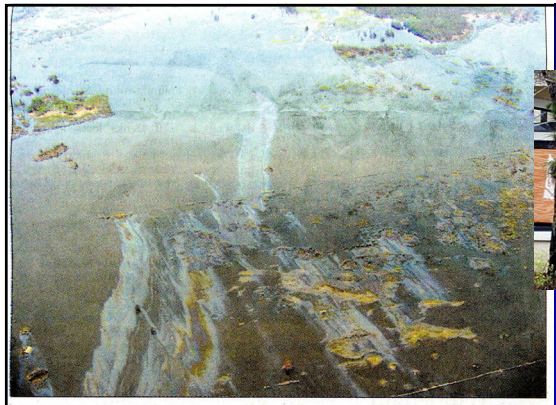


AP

An oil sheen can been seen on water covering an oilfield in Cameron Parish in southwest Louisana after Hurricane Ike roared through.

Ike's fury pollutes Gulf, land with oil, gas release

Multiple destructive hurricanes in short period (2004)

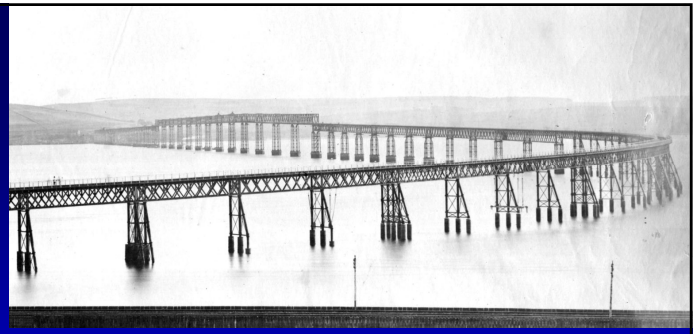
October 6, 2008
Birmingham News

35

Why Do Disasters Happen?

- Widespread use of hazardous materials.
- Highly complex and interconnected systems.
- Increased movement of hazardous materials.
- Rapid industrialization.
- Inadequate training.
- Inadequate regulation.

36



River Tay Bridge, Dundee, Scotland

Designed by civil engineer, *Thomas Bouch*, the first Tay Bridge took six years to build and cost over £300,000. Six hundred men were employed throughout the construction, twenty of whom lost their lives. *Queen Victoria* knighted Thomas Bouch in 1879.

37


CHRISTIAN HERALD
AND SIGNS OF OUR TIMES.
VIEW OF THE TAY BRIDGE BEFORE THE ACCIDENT.
VIEW OF THE TERRIBLE RAILWAY ACCIDENT AT TAY BRIDGE ON DEC. 28.

On December 28, 1879, during a violent storm, the bridge collapsed taking with it a train carrying over seventy passengers, leaving no survivors.

The principal failure theories include:

- a vertical waveform, progressively amplified by the various forces in play that night, effectively shook the bridge apart,
- a carriage was derailed by the wind and an axle hit a buttress on one pillar of the high girders,
- the force of the wind on the bridge set up a domino effect whereby, one after the other, the upper courses of masonry on the bridge piers became detached from the lower courses

38

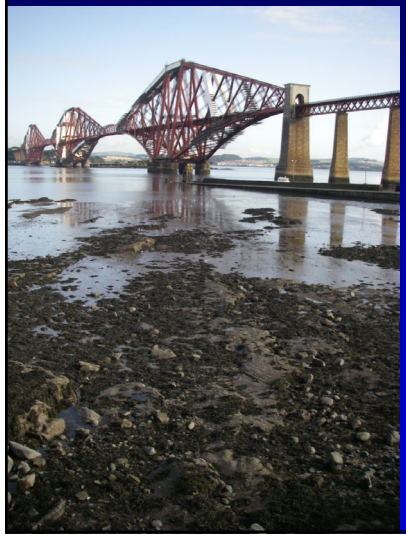
Whatever the actual cause or causes, the bridge was badly designed, badly constructed and badly maintained.

Lying on a sandbank in the river, this section of the high girders awaits recovery by one the salvage vessels. The entire train, with the exception of the second-class carriage and the van, was contained within the fifth span.

The inherent weaknesses of the flanged joints are clearly illustrated by the clean break above the second line of columns on the pier in the middle distance.

39

Firth of Forth railroad bridge



"Construction of an earlier bridge, designed by Sir Thomas Bouch, got as far as the laying of the foundation stone, but was stopped after the failure of the Tay Bridge. Bouch had proposed a suspension bridge but the public inquiry into the Tay bridge disaster showed that he had under-designed the structure and mistakenly used cast iron, which weakened the entire structure. On Bouch's death the project was handed over to Sir John Fowler and Sir Benjamin Baker. It was built in steel alone, the first bridge to use that material."

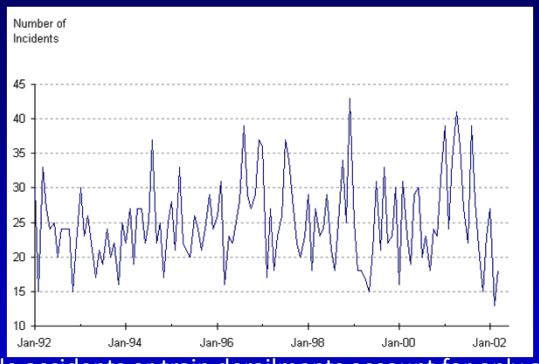
Up to 200 trains per day crossed the bridge in 2006.

40

The First of the Great Train Horrors. Camp Hill, PA. A violent head-on crash killed 66 young people from St. Michael's church in Philadelphia who were on an excursion into the country. July 17, 1856. (Collection of the Library of Congress).

41

Hazardous Materials Incidents Involving Motor Vehicles or Train Derailments



Motor vehicle accidents or train derailments account for only a small portion of the total number of hazardous materials incidents. However, their consequences are often the most severe. This figure shows that in the ten year period from January 1992 through January 2002, about 15 to 40 of these accidents occur in the US every month.

42

Alabama has about 200 transportation accidents a year involving hazardous materials. This is typical for most states.

Birmingham News (Alabama)

43

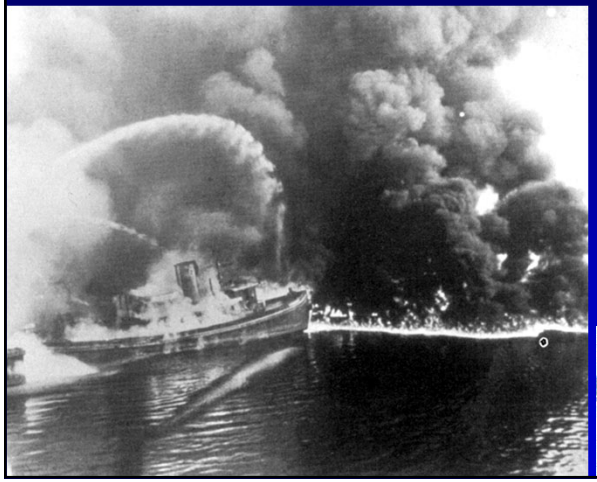
I-65 Southbound Bridge in Birmingham, Alabama
January 2002 – after gasoline tank truck collision with bridge and subsequent explosion)

44

It happened again in 2004, same place, gasoline truck also, unfortunately, there was one death (even though both happened near peak traffic hours, this was the only fatality for both of these accidents, although the bridge was destroyed and closed to traffic for several months each time).

45

Cuyahoga River in Cleveland often caught on fire between 1952 and 1969. The Clean Water Act of 1972 was passed in response to this embarrassment.



46

Fire from 200,000 gallons of spilled gasoline in residential area from Bellingham, WA, pipeline rupture (June 1999)

Bellingham Herald (Washington)

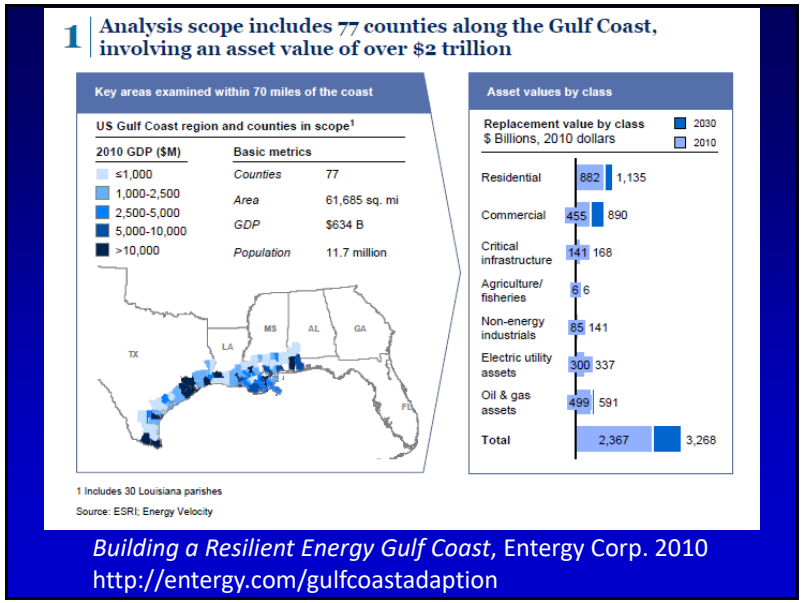
47

Spill/tanker	Location	Date	millions of US gallons (308 gal/ton)
Kuwaiti oil fires, lakes, and spills	Kuwait	Jan to Nov 1991	43,000 to 65,000
Lakeview Well Gusher	Kern County, CA	May 14, 1910 to Sept 1911	378
Deepwater Horizon Platform	US Gulf of Mexico	April 20 to July 15, 2010	172 to 180
Ixtoc 1 Platform	US Gulf of Mexico	June 3, 1979 to March 23, 1980	140 to 148
Atlantic Empress/Aegean Captain	Trinidad and Tobago	July 19, 1979	88
Fergana Valley well blowout	Uzbekistan	March 2, 1992	88
Nowruz Field Platform	Iran, Persian Gulf	February 4, 1983	80
ABT Summer	Angola	May 28, 1991	80
Castillo de Beliver	South Africa, Saldanha Bay	August 6, 1983	78
Amoco Cadiz	France, Brittany	March 16, 1978	67

48

Deepwater Horizon: On July 15, 2010 the leak was stopped by capping the gushing wellhead after releasing about 4.9 million barrels (780×10^3 m^3), or 185 million gallons.

49



Building a Resilient Energy Gulf Coast, Entergy Corp. 2010
http://entergy.com/gulfcoastadaption

50

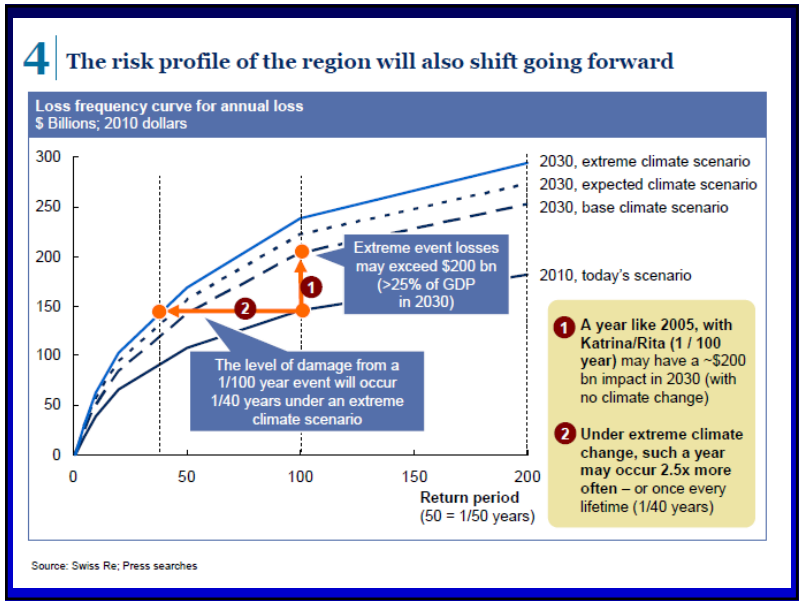
The Gulf Coast is vulnerable to growing environmental risks today with >$350 billion of cumulative expected losses by 2030

Economic losses will increase by 50-65 percent in the 2030 timeframe driven by economic growth and subsidence, as well as the impacts of climate change: Wind and storm surge damage from hurricanes drives significant losses in the Gulf Coast today. On average, the Gulf Coast faces annual losses of about $14 billion.

Over the next 20 years, the Gulf Coast could face cumulative economic damages of some $350 billion: 7 percent of total capital investment for the Gulf Coast area and 3 percent of annual GDP will go towards reconstruction activities.

In the 2030 timeframe, hurricane Katrina/Rita-type years of economic impact may become a once in every generation event as opposed to once every ~100 years today. The impact of severe hurricane in the near-term could also have a significant impact on any growth and reinvestment in the region.

51



52

Conclusions: The Main Environmental Issues for Alabama in the Late 21st Century

- Population increases and increased demand on water supplies and receiving waters (hopefully increased water conservation and reuse of wastewaters)
- Population increases and increased use of automobiles (hopefully better mileage and/or alternative fuels, and improved mass transit)
- Population increases and increased generation of solid wastes (hopefully increased "reduce, reuse, and recycle")

53

- Many examples of sustainable urban activities from which to choose.
- Demand more energy efficient products, and be willing to pay.
- Demand local mass transit and be willing to ride.
- Demand that politicians consider environmental costs of alternatives.
- Choose wisely.

54

"Nature has no reset button"

State of the World 2000

55