

U.S. Sea Level Trends
1900-2000

Proceedings of the 2010 Land Policy Conference



CLIMATE CHANGE AND LAND POLICIES

Non-Point Source CO₂ emissions by Hours
a Percentage of Daily Total

335,609	24,272	26,299
22,932	70,832	75,326
65,955	114,747	121,659
~ 432	22,280	88,611
		61,640

Geographic Diversity and Storage

1 2 3 4 5

13 14 15 16

16 Day

= CO₂ after red

Edited by Gregory K. Ingram and Yu-Hung Hong

Composite Output with Ge...

1900 1910 1920 1930 1940 1950

Climate Change and Land Policies

Edited by

Gregory K. Ingram and Yu-Hung Hong

L LINCOLN INSTITUTE
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Preparing for Rising Water Along U.S. Coastlines

Bruce Babbitt

The onset of global warming is reshaping the face of the land, from mountain heights through river basins and along the coasts of the United States, affecting forests, wetlands, prairies, and agriculture. Precipitation patterns are changing. Storm events are becoming more extreme, generating more frequent and intense flooding along river channels. Yet the most extensive changes in the land are occurring along our coastlines.

Sea levels are rising more or less uniformly across the planet, driven by thermal expansion of ocean waters and increased volumes of water reaching the oceans from melting ice caps in Greenland and Antarctica, as well as from terrestrial glaciers. Along the coasts, these rising sea levels are steadily encroaching on lowland regions, and inevitably coastal flooding will require major adjustments in land use patterns.

Scenario planning in response to rising sea levels and consequent coastal inundation has scarcely begun. Yet even a cursory look at the data suggests the magnitude of the changes that will occur in the coastal states. Projections for sea-level rise in this century are now clustering around a minimum increase of three feet, sufficient to submerge large areas of the Atlantic coast, extending from Maine to Florida, and along the Gulf of Mexico to Texas, with massive encroachment throughout the Chesapeake Bay, loss of the Outer Banks off North Carolina, and significant losses in Florida and the Mississippi Delta. The Pacific coast, where the clash of tectonic plates has produced a sharply defined and relatively elevated coastline, will be less affected. Nonetheless, there will be areas of major inundation in the California Delta at the head of San Francisco Bay and along the estuary of the Columbia River in the Northwest. Rising waters will require

redesigning and relocating roads, bridges, rail corridors, pipelines, levee systems, water and wastewater facilities, and in some cases entire communities.

Even as rudimentary scenarios take form, two contrasting response patterns are emerging. One, which might be called the fortress model, advocates defensive lines consisting of massive levees and seawalls to hold back the water and salvage the land even as it goes below sea level. The experience of The Netherlands in reclaiming land from the North Sea is frequently used as an example in favor of this approach.

An alternative model consists of adapting to, rather than seeking to prevent, the changes in coastal land patterns. Adaptation encompasses a mixture of responses, including designing elevated structures, raising highways and bridges, and relocating infrastructure and settlement to higher ground as a form of managed retreat. In recent years, these measures have increasingly been used in response to recurrent flooding along inland river channels.

Louisiana, in the wake of Hurricane Katrina, has moved to the center of the debate about future management of U.S. coastlines. Most vulnerable is the Louisiana Delta at the mouth of the Mississippi River, where more than 5,000 square miles of land lie less than three feet above sea level. To complicate matters, the land surface in the Louisiana Delta is sinking at the rate of one to three feet per century from causes independent of sea rise. Adding together these two figures—three feet of sea-level rise and another one to three feet of land subsidence—yields a stark conclusion: much of the region is likely to disappear beneath four to six feet of water by the end of this century.

From its earliest settlement in the seventeenth century, Louisiana has struggled to control flooding along the Mississippi River by constructing extensive systems of levees. As levees repeatedly failed, in 1963 the Corps of Engineers raised the ante by constructing a massive complex, called the Old River Control Structure, designed to tame the river for all time by diverting floodwaters westward into the Atchafalaya River basin. At last, it seemed, the delta was completely engineered and protected.

Then Hurricane Katrina came along in 2005, shifting attention to threats coming from another direction—the ocean waters of the Gulf of Mexico. Facing the onset of global warming and rising sea levels, local leaders again turned to the Corps of Engineers and huge construction projects to solve the problem. That has led to what has become known as the Great Wall of Louisiana.

The Great Wall is nothing less than a seawall along the entire coastline. The first step toward its construction is known as “Morganza to the Gulf,” a 70-mile coastal levee in the delta region west of New Orleans. Close behind is planning for a second segment, called “Donaldsonville to the Gulf.” Ultimately, Great Wall advocates propose incorporating these two levees into a continuous seawall all the way along the Louisiana coast, anchored on the west at the Texas border and on the east in Mississippi.

The cost of building the Great Wall, which has not been projected in any detail, would surely run to hundreds of billions of dollars. The real costs, however,

would eventually be in the destruction of coastal wetlands and the Louisiana fishing industry. Seawalls create clean, impenetrable lines of demarcation between land and sea. Then, as the protected inland areas fill in and the seaside yields to the open ocean, wetlands shrink and disappear. The natural salinity gradients from seawater to fresh water that nurture oysters, crabs, crayfish, shrimp, and other shellfish also disappear.

The alternative to seawalls and wholesale elimination of coastal wetlands is to plan for strategic retreat and adaptation, a process that concedes some land to the sea while also allowing adjacent wetlands space to migrate inland, adjusting naturally to changing conditions that will maintain habitats and fisheries. Adaptation planning provides for protecting population concentrations through the construction of ring levees, the use of resilient structures, and some movement and relocation toward higher ground.

Proponents of adaptation also suggest that some portion of the delta can be restored through better management of the Mississippi River. Scientists tell us that in the past, the natural land subsidence in the delta was counterbalanced by new sediment deposited by the river as it meandered across the region. In modern times, much of this sediment has been trapped behind hundreds of dams on upstream tributaries.

Adaptation advocates seek to divert increasing amounts of water from the main river channel in controlled flows across the delta, hoping to restore at least some of the natural land-building processes. Delta restoration through partial diversion of river water is hardly a complete answer, for the river no longer carries enough sediment to fully replicate historic processes. Moreover, the need to maintain a fixed channel with sufficient water depth for oceangoing vessels sharply limits the amount of water that can be diverted upstream. Given these limitations, large areas of delta land and wetlands will continue to be lost as the sea advances.

In all adaptive planning scenarios, greater New Orleans will be preserved by continually raising and strengthening the seawalls and levees that currently surround the city. Eventually, though, New Orleans will become an American Venice—a richly historical and cultural island surrounded by seawater and connected to the mainland by a causeway paralleling the bank levees along the Mississippi River.

Other delta communities, including Lafayette, Morgan City, and Houma, can similarly be protected by rings of high levees. Outside the protected urban areas, however, in the other 95 percent of the delta region, choices will have to be made about where to stand and where to retreat. Land use plans will need to be linked to the decisions made about the design and location of infrastructure for flood protection and about realigning transportation and utility routes to connect with the protected urban centers. In some areas of the delta, such plans also could identify limited areas of higher ground along the natural levees left by abandoned river channels as appropriate spaces for industry and agriculture.

Ultimately, these decisions about infrastructure will require regional land use

plans showing in detail what can and cannot be saved, what can be relocated, and how coastal wetlands will be allowed to migrate. The most beneficial plans will incorporate the best hydrology, social science, ecosystem science, and resource economics, along with strong community participation. Delta residents will be well served if the planning process gets under way soon, while there is still time to adjust.

As if the future of the Louisiana Delta were not sufficiently complex, Louisiana is only one of 23 coastal states that will be affected by rising sea levels. California will probably be the next state to demand federal assistance for coastal reconstruction.

In that state, rising sea levels are encroaching on the low-lying lands at the head of San Francisco Bay, where the Sacramento and San Joaquin rivers flow together to form a vast marshland that originally extended inland toward Sacramento and Modesto. Like Louisiana, this region is threatened by both rising sea levels and subsidence resulting from oxidation and drying of organic soils formed from the tule marshes that formerly covered this delta landscape. Today these lands are maintained by an extensive system of levees built to reclaim the area for agriculture. Fields and orchards, however, are being rapidly transformed into suburban developments radiating out from Sacramento and other communities.

The California Delta is also the center of the infrastructure that transfers water along the length of the state, from north to south, through a complex system of pumping stations and canals. Rising sea levels are pushing saline seawater inland toward the pumps, threatening to contaminate fresh water delivered to urban areas as far south as Los Angeles and San Diego. To avoid drawing salt water into the system, massive new diversion works will be required to take water from sources higher upstream on the Sacramento River.

Despite decades of controversy, California has yet to settle on a plan for reconfiguring and reconstructing its water system. And legislators have been unable to agree on a land use plan to effectively control the spread of suburban development into low-lying areas inadequately protected by ancient levees. Whatever plan is eventually agreed on, California is lining up behind Louisiana to petition Congress for large funding commitments. Other states will no doubt be joining that line soon.

In the present fiscal environment, the prospects for a nationally led, adequately funded coastal infrastructure program may seem less than promising. Yet recognition of the need is increasing, as evidenced by highway and high-speed-rail and mass transit appropriations in the 2009 stimulus legislation and by proposals, endorsed in concept by President Barack Obama, for longer-term commitments in the form of a national infrastructure bank. Three ideas on the table could eventually lead to a coastal infrastructure program: (1) using fines and penalties from the 2010 BP oil spill in the Gulf of Mexico, as well as future oil royalties from Gulf oil production, to fund such a program; (2) extending the Build America Bond program to provide additional funding; and (3) establishing a national infrastructure bank.

The BP oil spill has once again drawn national attention to the plight of the Louisiana Delta. In a televised speech to the nation in 2010, President Obama pledged not only to fix the damage caused by the spill, but also to reverse the decades of degradation of delta land that occurred prior to it. In addition, the administration has endorsed in principle congressional proposals to devote some portion of the expected penalties resulting from the BP spill to pay for restoration of the Gulf coast.

The BP disaster has also revived discussion of using federal offshore oil royalties to finance such restoration. The federal government collects approximately \$10 billion annually in revenues from offshore oil and gas development in federal waters (which in most states lie more than three miles offshore). A portion of this income is already distributed to coastal states in the form of unrestricted revenue sharing. In the wake of the BP spill, the Gulf states are requesting that an even larger share of these funds be distributed to them, with no restrictions on the money's use.

Future penalties and offshore royalties, however, are national income and might more appropriately be used to advance clearly defined national objectives. Rather than writing checks to the states, Congress could establish a national fund for coastal restoration, to be shared equitably by all coastal states. To receive money from the fund, states would be required to produce realistic plans that acknowledged the effects of rising sea levels and contained an appropriate mix of reconfigured coastal infrastructure and managed-retreat measures.

Designing and financing a federal-state coastal restoration program with meaningful land use plans will be a complex task. A good starting point would be to review our experience with other national infrastructure programs, including railroads, highways, airports, and water management systems. Of the many programs Congress has established over the years, one stands out for its clarity of purpose and effective execution. The Interstate Highway Act of 1956 could serve as a useful benchmark for comparing contemporary infrastructure financing proposals.

The Interstate Highway Act authorized the construction of a network of more than 40,000 miles of highways, built to uniform standards, throughout the nation. Administrators on the federal and state levels negotiated the design and location of these highways in advance of the legislation. As a result, the legislation produced a clearly focused, technically sound system of roads. This procedure stands in sharp contrast to the way Congress often operates today, authorizing infrastructure projects cluttered with earmarks and leaving too much discretion to agency administrators, who are in turn subject to even more special-interest influence.

The financing of the interstate highway system was not left to the vagaries of the annual appropriation cycle. Project financing to completion was ensured in advance by user fees in the form of a federal gas tax, an approach that may seem untenable in today's political climate. Although it is not easy to characterize the temper of the electorate in that distant time, support for a gas tax was

surely related to a clear public perception of the benefits that would flow from the highway system.

Such clarity of public purpose and understanding of the cost-benefit relationship are not distinguishing features of our newest federal infrastructure program, Build America Bonds (BABs), which was established by the 2009 stimulus legislation. This program makes no pretense of defining or even suggesting national priorities. It is designed solely to expand the existing municipal bond market by offering states and municipalities a federal subsidy of 35 percent of the interest obligation on bonds issued as taxable obligations.

BABs have been very successful in enabling municipalities to expand their market for capital improvement bonds. To date more than 100 billion of these bonds have been sold. Yet with no federal guidance regarding the use of the revenues, taxpayer dollars are subsidizing projects, such as the construction of a sports stadium in Indianapolis, that have no national purpose.

Initially promoted as a temporary short-term stimulus, the BAB program has been so popular in the states and on Wall Street that Congress is considering extending it. BAB reauthorization could provide an opportunity for progress toward a national infrastructure program. Congress would need only to limit the use of these revenues to defined national priorities for investment in essential infrastructure.

Another opportunity for a comprehensive infrastructure program is likely to come in the form of a national infrastructure bank. President Obama has asked Congress to appropriate \$50 billion for initial funding of such a bank to invest in transportation projects, including highways, railways, and airport upgrades. Although the president's proposal is lacking in details, it refers to legislative proposals by Senator Chris Dodd and Representative Rosa DeLauro as appropriate beginning points for consideration.

The Dodd and DeLauro bills call for the creation and funding of an independent government corporation overseen by a board of directors appointed by the president. The corporation would be vested with broad discretion to choose among proposals submitted by state and local governments relating to transportation, water, wastewater, public housing, and other infrastructure needs.

The strength of this approach is that it would presumably eliminate the pervasive use of congressional earmarks. Without a clear legislative delineation of priorities, however, the potential for abuse remains even in a nominally independent corporation. And rhetorical allusions to the great successes of the past, such as the transcontinental railroads and the interstate highway system, only underline the lack of any comparable national priorities today.

The president and legislators are equally vague as to how the infrastructure bank would be financed. A "bank," by most definitions, is an institution that lends capital with the expectation of repayment, which generates more capital for more lending. Without a provision for loan repayment, such as user fees, "infrastructure bank" is simply another name for a new stream of congressional appropriations. Yet for all the deficiencies in these proposals, the infrastructure

bank concept is gaining visibility and support across the political spectrum as coastal erosion, more frequent floods, deteriorating roads, collapsing bridges, and exploding gas pipelines make news.

The need to address rising water along our coasts and other climate change issues is real, and Congress will inevitably be required to act. The time is at hand for a national discussion leading to a clear and definitive commitment to planning and investment in programs that will protect our coastlines and infrastructure.