Title
Levees that might have been

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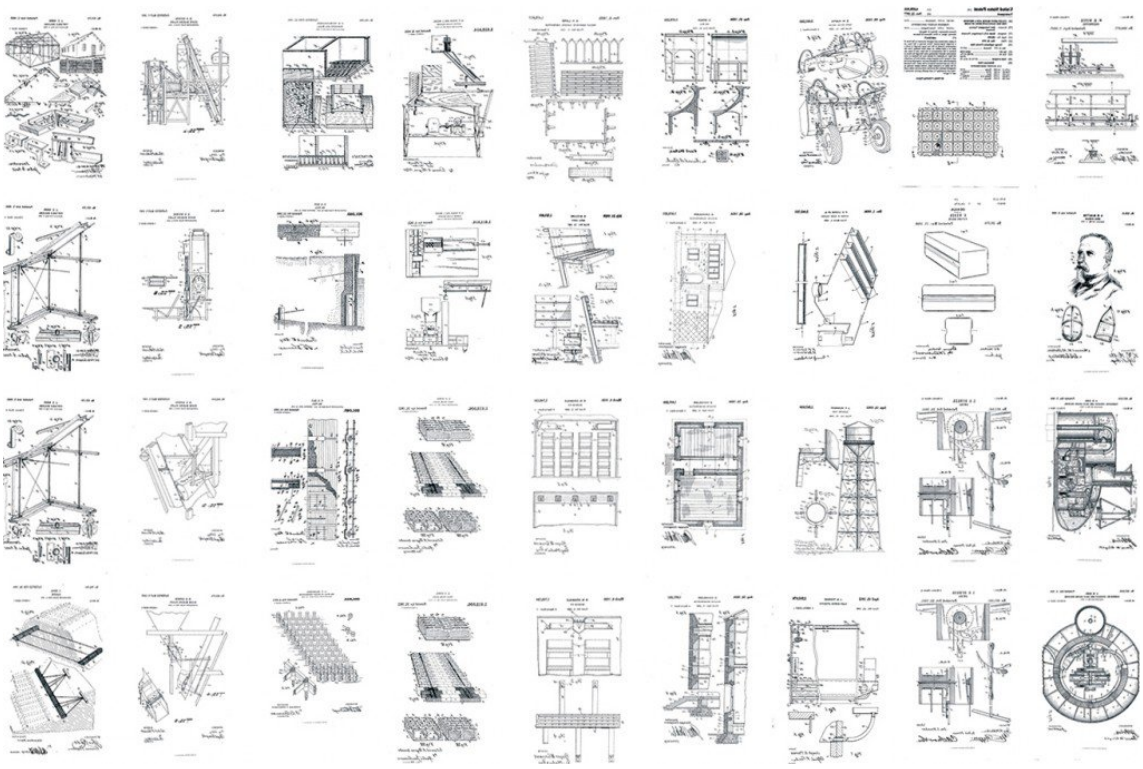
Levees That Might Have Been

A history of forgotten inventions that would have produced a very different landscape along American rivers.

RICHARD L. HINDLE MAY 2015



The levees of the 1920s were about six times as high as their earlier predecessors, but really no more effective. In a sense, they had been an empirical experiment — in aggregate, fifteen hundred miles of trial and error.

— John McPhee, *The Control of Nature*

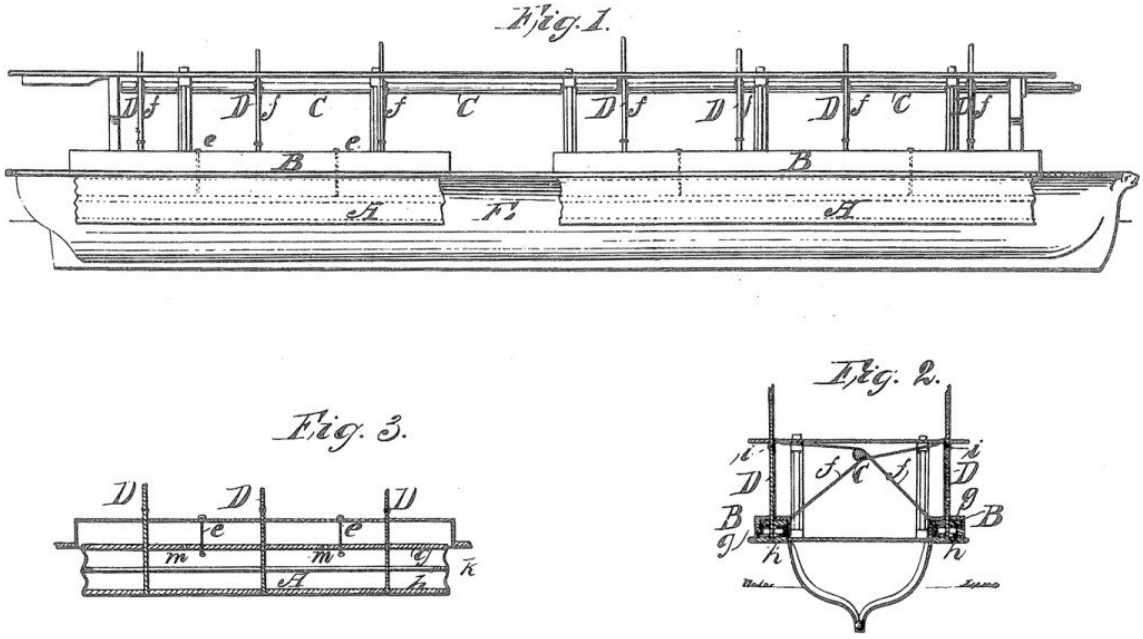
Last month, the United States issued Patent No. 9,000,000 (for a rainwater-harvesting windshield washer). Every patent tells a story, and a virtual tour through the archive offers a remarkable view of American society, policy, industry, and environment. Here we find technologies that

shape a nation but many more machines that fail and ideas that never catch on. Yet to regard the patent office merely as a protectionist legal institution or a hall of curiosities is a mistake, for if every lost invention represents an alternate history, it also contains the seeds of a possible future.

> The intensively engineered rivers we know today were not inevitable.

This is especially true for patents granted under the Department of Interior in the late 19th and early 20th centuries, when the infrastructures that supported national expansion were being developed, tested, and improved. Consider the history of attempts to control and modify American rivers, culminating in the vast levee systems that transformed the Mississippi River Basin and Sacramento–San Joaquin Delta, opening vital transportation corridors and buildable lands while devastating riparian and coastal ecosystems. Behind every mainstream levee technology — every dragline excavator and clamshell dredge — there is a host of forgotten and highly speculative inventions that would have produced a very different landscape: the levees that might have been.

First, let's remember that the intensively engineered rivers we know today were not inevitable. Abraham Lincoln, the only U.S. president to hold a patent, envisioned a country in which boats would adapt to the rivers they navigated, rather than the other way around. Lincoln's Patent No. 6469, "Buoying Vessels Over Shoals" (1849), proposed to equip boats with buoyant chambers that would decrease hull draft depths, allowing the boats to move freely over sand bars and shallow water without removing their cargo. Lincoln's invention was never commercialized, and today it seems radical to imagine a landscape in which the fluvial geomorphology of rivers remains intact while shipping vessels adapt to water levels and other changing conditions.



Abraham Lincoln's Patent No. 6469, "Buoying Vessels Over Shoals."

Of course, modern American rivers have been modified not only for navigation but also for flood control, power production, and irrigation. More than 4,600 miles of levees have reconfigured the historic floodplains of the Mississippi Basin and the California Delta, part of a grand experiment in hydrologic design that "protects" millions of acres of agricultural and urbanized land. The American *levee* — an artificial embankment built to prevent flooding — finds its etymological root in the French *levée* ("to lift"), and can be traced back to the founding of New Orleans in the early 18th century. The levee system built by French settlers and their slaves was later extended throughout southern Louisiana, to Baton Rouge and beyond. In California after the Gold Rush, similar levees were built in the deltaic landscapes of the Sacramento and San Joaquin Rivers to "improve" swamplands for agricultural uses. Today, these levee systems are among the most conspicuous geological features of the Anthropocene.

> How do we critique or reimagine an infrastructure that is so deeply embedded in society?

The ubiquity and scale of American levee systems makes it difficult to imagine a world without them. Pierre Bélanger's essay "Landscape as

Infrastructure" clearly argues this point: "the histories and complexities of land transformation and infrastructure deployed in the 18th, 19th, and 20th centuries present important evidence of a large system of biophysical resources, agents, and services that support urban economies in North America."[1] When we view landscape in this way, linking extant morphology to the very fiber of our cultures and economies, such infrastructures acquire an air of permanence or immutability. Even events as dramatic as the failure of flood control systems in New Orleans or the current water crisis in California's Central Valley do not disrupt American river policy. For what is the alternative? Contemporary environmental imperatives such as sea level rise, climatic volatility, drought, subsidence, and hypoxic oceans challenge the basic logic of levees. But how do we critique or reimagine an infrastructure that is so deeply embedded in society?

In fact, the "levees only" policy that dominates planning under the Army Corps of Engineers has been challenged many times since it was first articulated in documents like "Report of the Physics and Hydraulics of the Mississippi" (1867).[2] A few critics predicted even then that levees would lead to increased flooding, subsidence, and the eventual collapse of the Mississippi Delta.[3] And yet, at various points in history, when the form, scope, and implementation of regional levee systems remained indeterminate, or at least unconsolidated under the Army Corps, individual inventors were experimenting with diverse methods for building levees and radical ideas about how they might function. The patent archive offers a valuable record of innovation in landscape infrastructure, as well as models for future intervention.

3D-printed model of a biomorphic jetty design patented in 1915. [Richard Hindle]

The history of technology is in many ways a history of environmental modification. While the patent system has roots in ancient Greece, the first true patent was issued in 1421, in Venice, Italy, to the architect Filippo Brunallesci for the ship that transported materials to build his Duomo of Florence.[4] Roughly 80 million patents have been issued globally since the English Statute of Monopolies (1624), which helped shift European economies from feudalism to capitalism. Following in the Anglo tradition, the U.S. Constitution established federal authority to "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries," which justified the Patent Act of 1790. So deep is the connection between technological innovation and American progress that

Thomas Jefferson, as Secretary of State from 1790–93, was rumored to keep patents in a box under his bed for personal review.

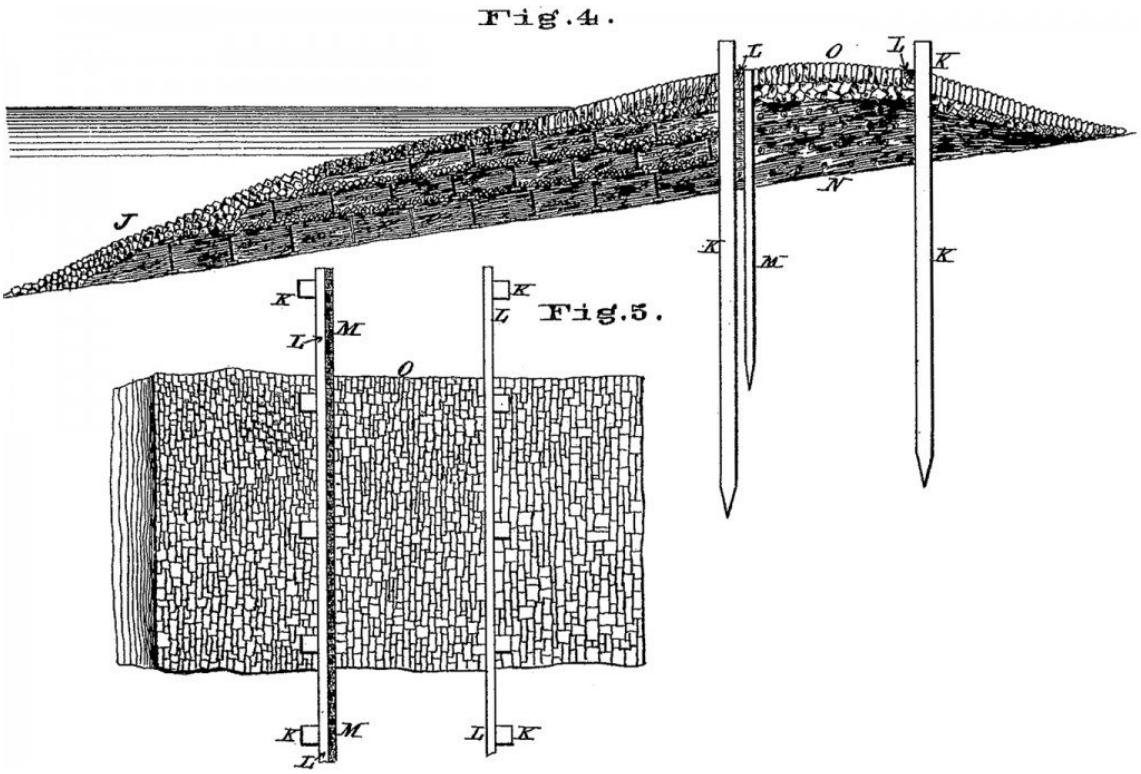
The patent office moved from the State Department to the newly established Department of Interior in 1849. Its tenure there coincided with an unprecedented period of national expansion, when patents supported the development of infrastructures from highways and navigable rivers to electrical grids and sewage systems. In 1925, the office moved to the Department of Commerce, where it remains today, a sad vestige deluged by consumer gadgets and protectionist lawsuits. Irrespective of its current futility, the patent office played an intricate and often deterministic role in the expansion of America and its infrastructures.

Patent No. 170,832: Eads's Sunken Jetties

The wicked problem of how to "improve" American rivers has beguiled engineers since the colonists' first hasty experiments. As the oceanic shipping industry converted from sail-powered boats to steamships in the mid 18th century, the problem of interior river navigation gained new urgency. There were few precedents in method or technology. Engineers had to cope with variable manufacturing standards and the inherent unpredictability of river environments. These uncertainties created fertile ground for innovation, and a flurry of patents followed, incentivized by government award programs, land policies, economics, war, and environmental imperatives. There was no national levee plan, but rather a series of local experiments. The shoals, currents, and shifting sandbars of the Mississippi; the thick tule and wet soils of the Sacramento-San Joaquin Delta; and their vast floodplains were subjected to an iterative design process. For a brief moment, radically different futures could be envisioned.

> "There was no national levee plan, but rather a series of local experiments. For a brief moment, radically different futures could be envisioned."

The jetties constructed at the southern pass of the Mississippi River in the late 1870s exemplify this pattern of innovation. In 1875, the self-taught engineer James Buchanan Eads, designer of iron-clad warships and an iconic steel arch bridge in St. Louis, petitioned Congress with an unorthodox plan to deepen navigable channels at the Head of Passes, where the river splits before emptying into the Gulf of Mexico. To eliminate the need for constant dredging, Andrew Humphreys, chief of the Army Corps of Engineers, had proposed a permanent concrete canal connecting New Orleans with the Gulf. Eads and his partner James Andrew envisioned a more flexible method of channel construction.[5] In Patent No. 170,832 [PDF], "Mattrass for Forming Embankment" (1875), they describe using willow, straw, timber, and other material to construct floatable jetties that could be launched and positioned before they were sunk to define the desired channel geometry. Anchored in place, the jetties would be encased in silt and become a permanent part of the river bottom. After prototyping the jetties on the lower Mississippi over a period of four years, Eads and Andrews received their fee and saved the Port of New Orleans by allowing deeper drafted ships to reach the city.[6] Although their patent is notable on its own merits, it is also important as a methodological example. As today's designers confront environmental problems, they might be inspired by the tale of two outsiders who prototyped a large-scale landscape system that challenged the status quo.



Patent No. 170,832, “Mattrass for forming embankment” (1875)

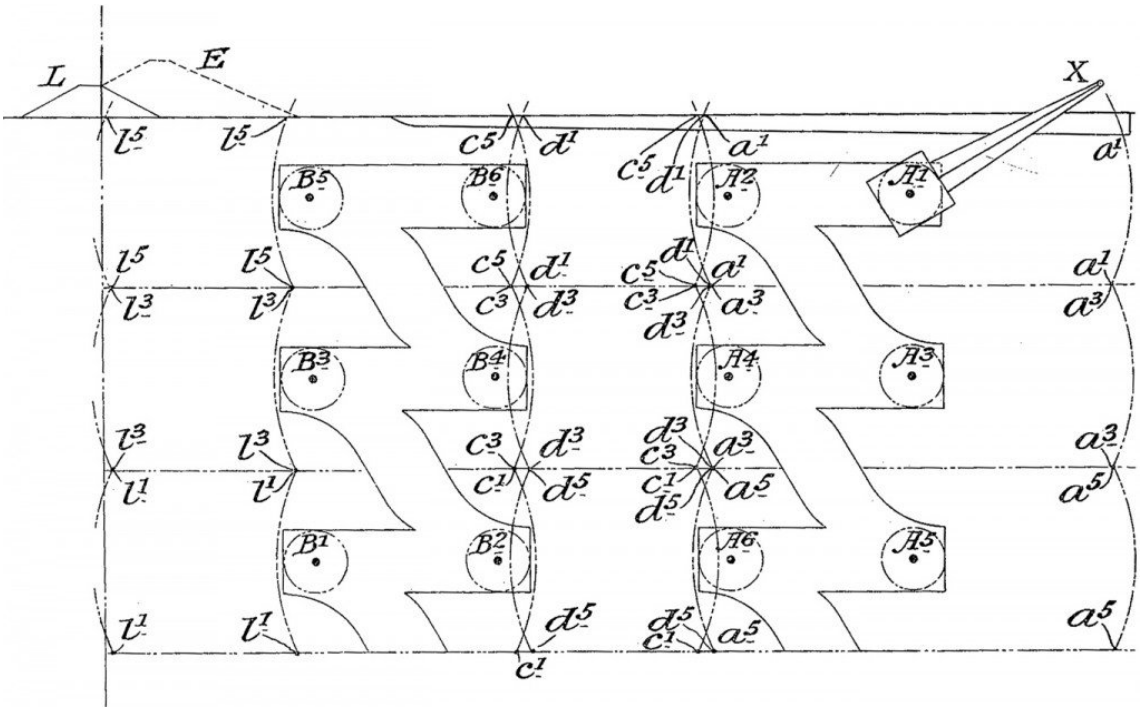
Patents No. 1,279,150 and No. 1,279,151: Scripting the Earthmovers

Just as the mechanized plow broke the plains, the mechanization of levee construction broke productive wetlands across the United States. The Swamp Land Act of 1849 hastened the conversion of wetlands to agriculture, catalyzing technologies to drain, pump, levee, and cultivate these lands. In the Sacramento–San Joaquin Delta, the invention of hydraulic, bucket, and clamshell dredges reconfigured the landscape, as more than 1,000 miles of levees were built through the repetitive piling of dredged material onto leveed berms.[7] Each of these dredge types has its own deterministic tool geometry and rational path through the landscape, a signature which can be read in the morphology of the levees that demarcate these regions today.

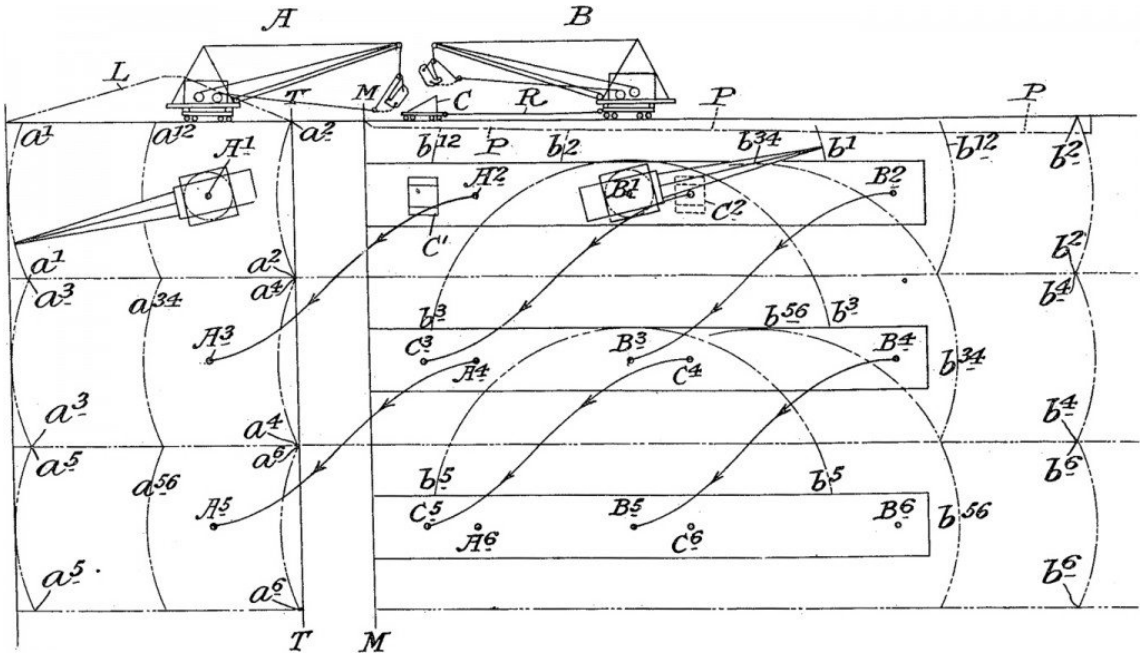
In Louisiana, the self-proclaimed inventor of mechanized levee construction was Arsene Perrilliat of New Orleans. First as a state engineer and then as a private contractor, he built hundreds of miles of levees in the Mississippi and Atchafalaya Basins. In his illustrious career,

he also served as director of the Port of New Orleans, exhibition curator at the St. Louis World's Fair, and expert witness to Congress, but perhaps his most significant contribution was perfecting the art of constructing levees with the dragline excavator.

In 1918, Perrilliat received Patents 1,279,150 [PDF] and 1,279,151 [PDF], "Method(s) of Building Levees and Embankements," which described a rigorous choreography for the movement, path, and geometry of dragline excavators, and the resultant formation of levees and burrow pits — essentially a pre-computational script for earthmoving. Perrilliat's methods made levee construction far more efficient and facilitated the expansion of regional infrastructure funded by the federal government. He died two years later, and today his contributions are nearly lost to history, but the land script disclosed in his patents can be traced throughout the Mississippi Basin, eerily omnipresent in the levees and borrow pits that now define the floodplain.



Patent 1,279,150, "Method of Building Levees and Embankements" (1918)



Patent 1,279,151, “Method of Building Levees and Embankements” (1918)

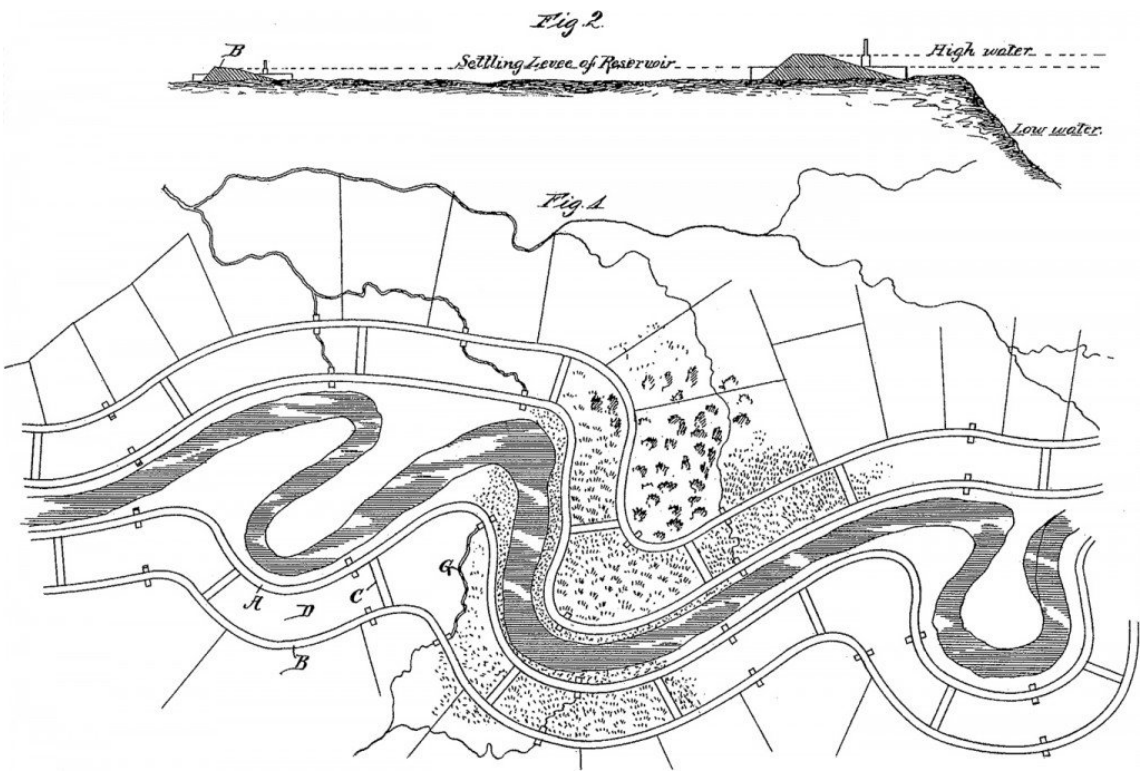
Patent No. 452,989: Mediating the River’s Boundary

Of course, innovation does not occur in a vacuum. The Eads and Perrilliat patents are only a few salient examples of technologies that transformed the landscape infrastructure of American rivers. Many other ideas were patented but never realized. Years ago, it was fashionable to acquire patent rights for profit or pride, and to disclose ideas through the patent office and its bulletins to individuals in all sectors of industry and the valuable arts. Most patents related to levee construction are unremarkable: armoring blocks, methods for patching crevasses, machines for moving earth, and so forth. Yet among these are a vanguard collection of patents that suggest radically different landscape futures. Some of these are astoundingly prescient, incorporating scientific principles that were not yet named and defined. The term *ecology*, for example, was not widely disseminated in North America until the mid 20th century,[8] decades after the first ecologically engineered levees were disclosed in patent.

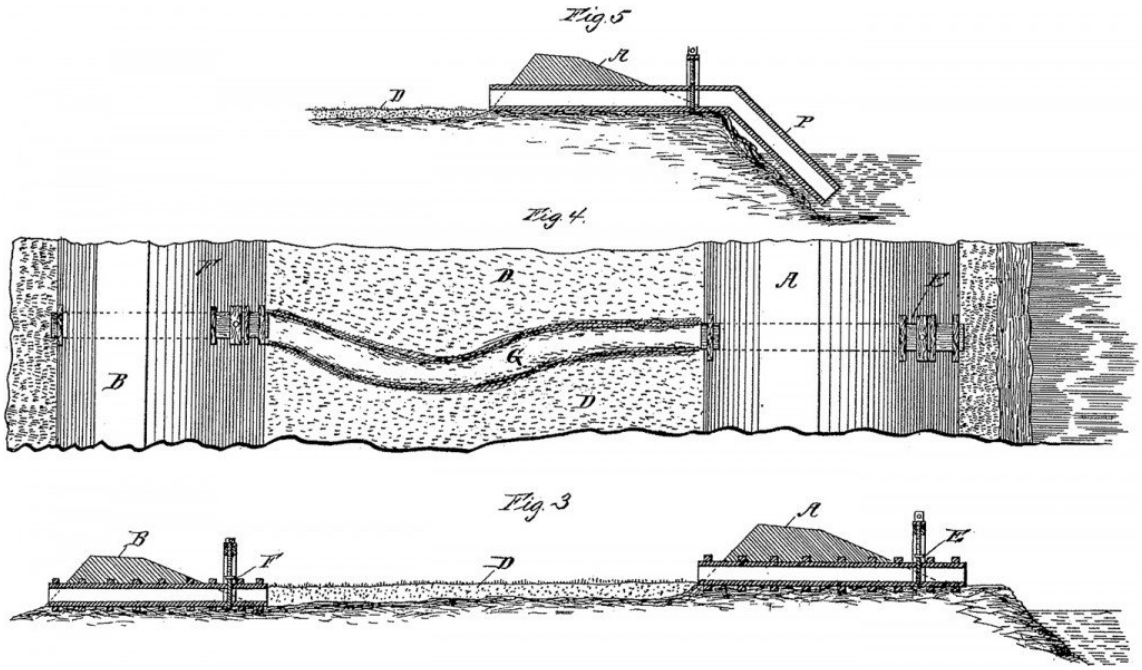
In 1891, George B. Boomer received Patent No. 452,989 [PDF] for a “Method of Constructing Levees” that sought to balance wetland and riparian ecology, agricultural production, conveyance of floodwaters, and

sediment management through a system of multiple, parallel, compartmentalized levees. Extensive floodplains are instrumental to healthy river systems; they accommodate excess water during cyclical periods of overflow and support a unique ecology adapted to the fluctuations of sediment, water, growth, and decay. However, conventional levees (then as now) compress the floodplain to a sliver of ground between the river and levee known as the *batture*, producing an unnatural gradient of wet and dry within engineered lines.

Boomer envisioned a system of compartmentalized levees that would provide increased flood storage capacity and control stream inflow, while allowing for ecological function or agricultural production within a thicker, mediated boundary between land and river. Without using the word *ecology*, he addressed the recharge of sediments in wetland systems, as well as nutrient balance, habitat preservation, and groundwater recharge. If deployed at scale, his system would separate and buffer adjacent land uses through redundant flood control structures, reducing risk and altering the regional and urban landscape.



Patent No. 452,989, "Method of Constructing Levees" (1891)



Patent No. 452,989, "Method of Constructing Levees" (1891)

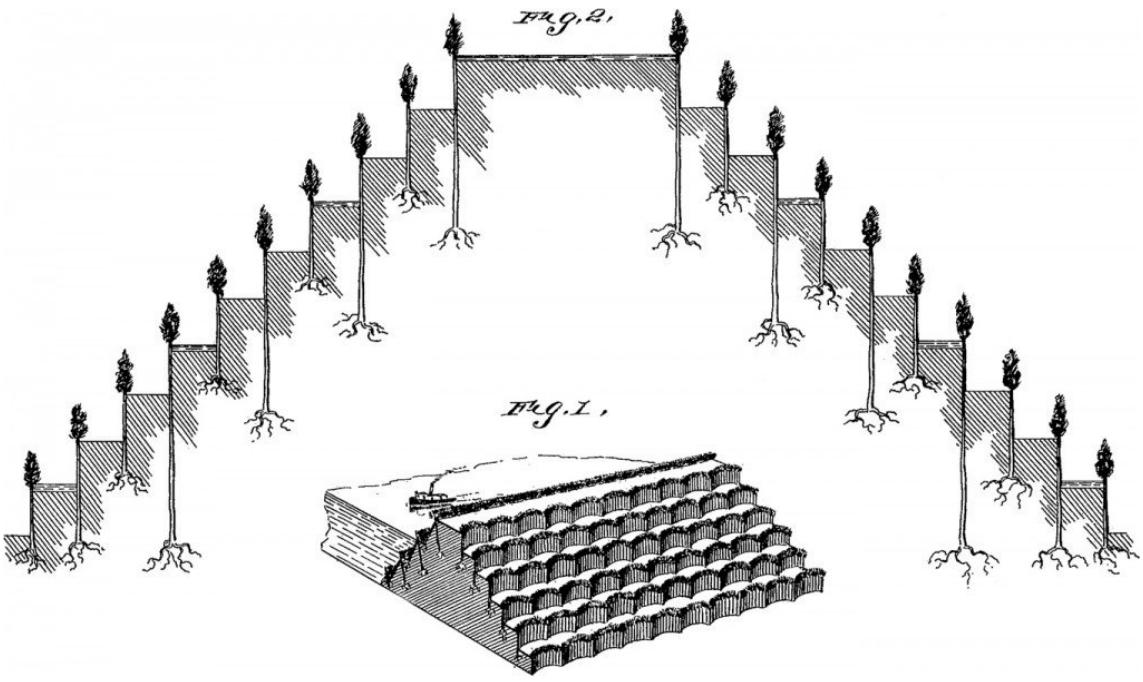
Patent No. 700,076: Bioengineered Levee Walls

Although the field of bioengineering did not emerge as such until the 1970s, designers and builders have long explored ways of integrating living organisms in engineered structures. The raw material of rivers — soil, sediment, slope, stone, water, and plants — provides an especially rich palette for landscape design. Levee patents in the late 19th and early 20th century disclose various techniques that would today be considered bioengineering. The simplest utilize fascines and live plants to create enclosures for sediment capture, or weave vegetated armoring for levees in a manner similar to plashing (a technique of hedge construction used in the Midwest as an alternative to barbed wire). Others make highly speculative and radical claims for construction that integrates living plants into levees systems, blurring the lines between cultivation and construction.

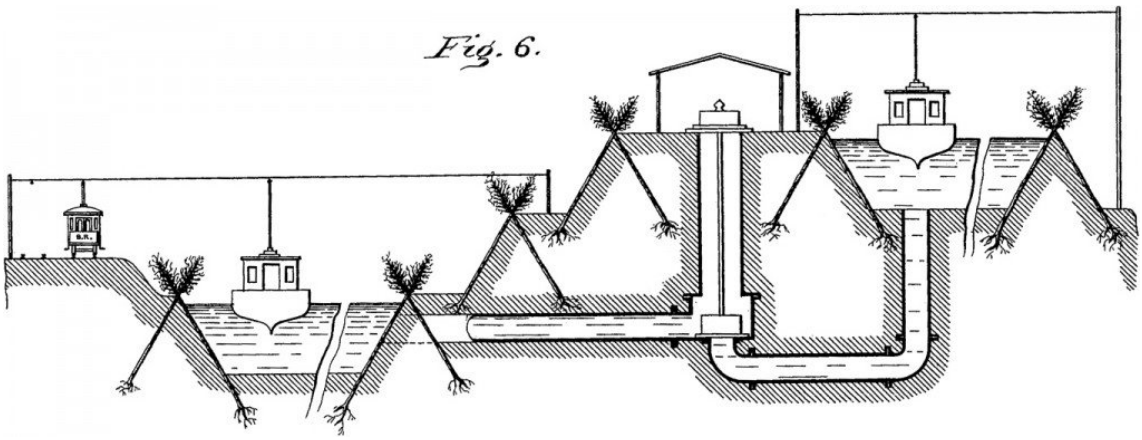
John Patten's Patent No. 700,076 [PDF], for a "Live Wood Wall for Levees" (1902), exemplifies the exuberance of early designs. He envisioned trees fastened mechanically so that they would grow together to form living enclosures for sediment and levee formation. The roots of the walls would form a union with new sediment layers, anchoring the levees in place and

providing a foundation for expansion. Patten's scheme is elaborate, involving the cultivation of nursery stock, the milling and fastening of live wood, the pumping of sediment slurries, and eventually the growth of the root matrix. His levees would use the strength of living trees and the mass of earth to resist the forces of moving water.

His patent invites us to imagine a regional-scale biomechanical structure that hybridizes woodland and high ground into a new synthetic landform. The species selected in the initial construction would establish a new ecology on the river's edge, which over generations would blend landform and vegetated form indistinguishably. These new wooded levee systems could create extensive wildlife corridors, like hedgerows, layering ecological connectivity with flood protection.



Patent No. 700,076, "Live Wood Wall for Levees" (1902)



Patent No. 700,076, “Live Wood Wall for Levees” (1902)

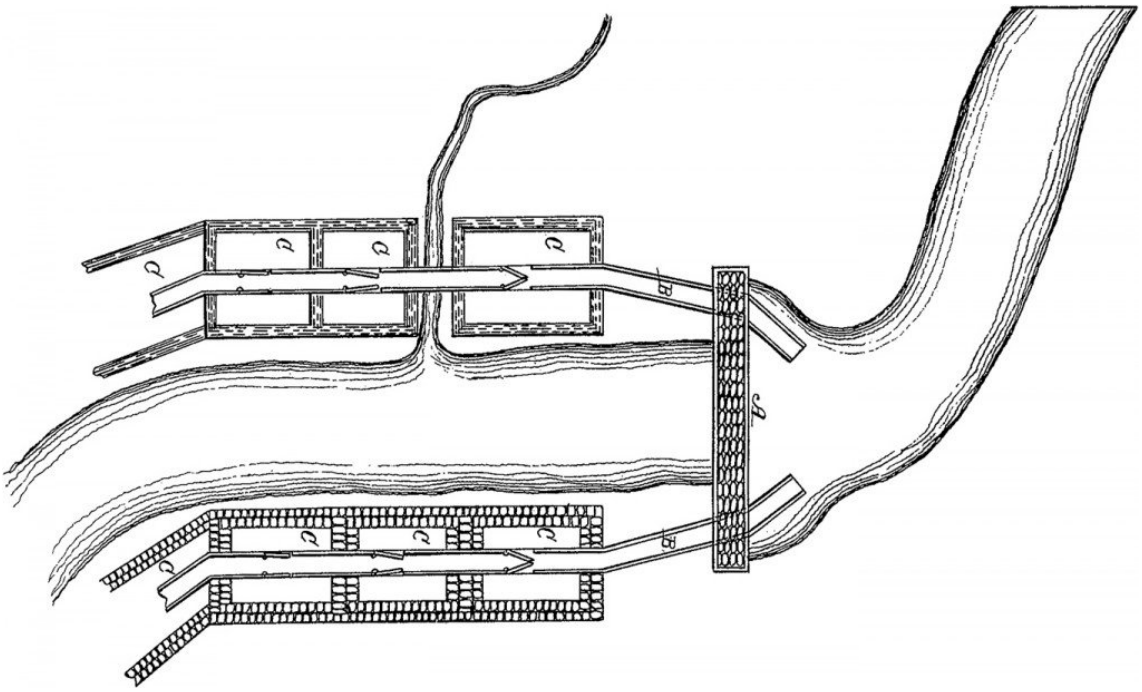
Patent No. 235,967: Levees as Sediment Bars

Of course, levee construction requires energy, supplied at first by human bodies and later by steam or diesel fuel. Conventionally, the energy expended and embedded in the process is intentionally contrary to the forces of the river itself. Hydraulic, clamshell, dragline, and bucket dredges built the Mississippi and California levees by repositioning millions of cubic feet of sediment, at a significant energy cost. Within this conventional paradigm, river water and topography are forces to fight against.

Newton Sewell’s Patent No. 235,967 [PDF], for a “Method of Relieving River Channels of Sediment and Forming Levees” (1880), represents a radical departure from this logic, utilizing the energy of the river itself. Sewell, a county assessor in Yuba, California, described a passive hydraulic method for levee formation. Low crested check-dams within the river diverted accumulated sediment to a series of settling enclosures that then became levees. As each levee formed (at an increased height relative to the original river elevation), the dam was removed, the water level receded, and the elevated levee remained. Sewell’s design was topographical in nature, correlating the location of the levees with the slope of rivers, dam sequence, and sediment enclosure. We can envision a mosaic of leveed lands similar to the natural bars and highlands formed by migrating rivers.

Sewell conceived his invention in the later years of hydraulic dredge gold mining in the upper tributaries of the Sacramento and San Joaquin, a

practice that produced sediments which almost choked the delta and the San Francisco Bay. His design is notable not only for linking levee formation to topographical change, but also for its mastery of source-sink sediment budgets in river systems, using the sediment generated upstream to build levees downstream. This innovation was timely in the era of Sierra Nevada gold prospecting, and it may prove timely once again, given the volumes of sediment currently trapped behind dams in the upper reaches of the Mississippi.



Patent No. 235,967, "Method of Relieving River Channels of Sediment and Forming Levees" (1880)

Patent No. 1,129,719: Levees as Biomorphic Stabilizers

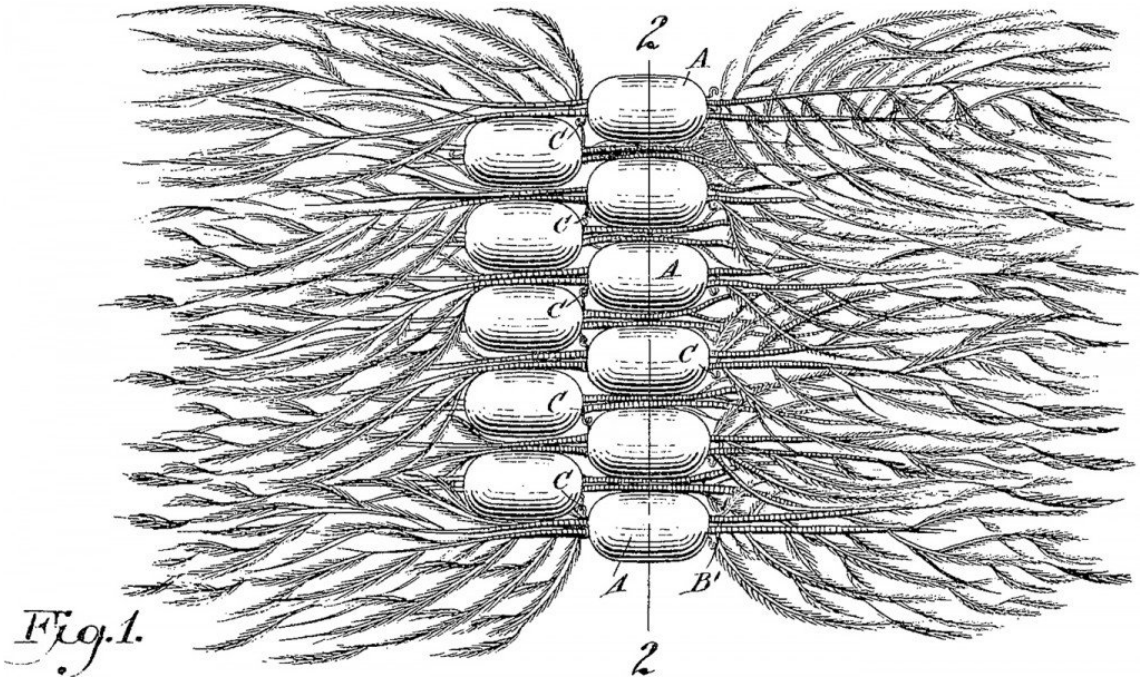
Riparian edges and coastal wetlands are areas of dynamic flux. Within these zones, vegetation helps stabilize sediment, create habitat, and control water currents. For examples, tule grasses in the Sacramento–San Joaquin Delta create a sturdy three-dimensional structure that slows floodwater and collects sediment in its thick stalk matrix. Woodlands and wetlands perform a similar function in the Mississippi Delta. Today, we would use the term *biomorphic design* to describe the replication of this mechanical functioning in a designed object or system.

Richard D. A. Parrott's Patent No. 1,129,719 [PDF] for "Jetty Construction" (1915) attempted to do just that. Parrott described a method of building "jetties, bulkheads, groins, breakwaters, dikes, levees and the like," using pill-shaped concrete blocks and long fabric "tufts" to capture sediment deposits, mimicking the three-dimensional structure of riparian and coastal vegetation. His proposal intentionally introduced complexity into river design, creating a foothold for emergent ecologies which are not easily accommodated by the more rational formulations of conventional engineering.

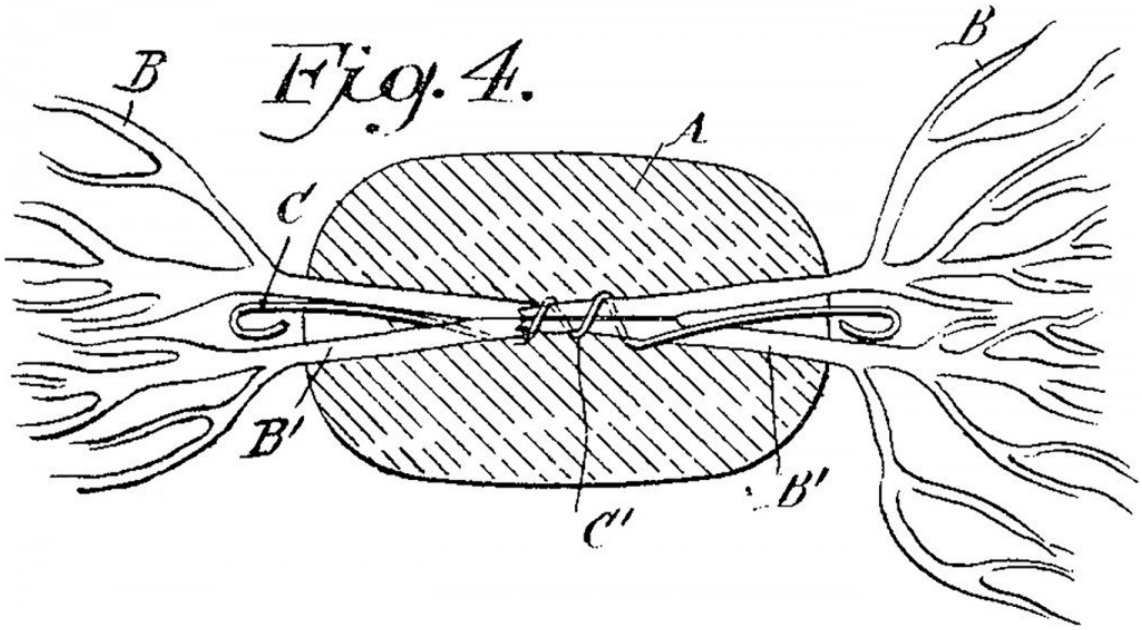
Performance criteria for the Mississippi and Sacramento–San Joaquin levees are strict. Any variation in the friction coefficient, irregularity in channel section, or subsurface composition spells disaster, and so rational order and standardization prevail. As river historian Martin Reuss observes:

> In the last two and a half centuries engineers have applied mathematical rationalization to structural design, allowing each unique design to respond to the particular combination of variables affecting flow in a given stretch of river over time. The challenge is somewhat analogous to designing suits for a customer who is both demanding in his needs and discontented with his shape, constantly indulging in fad diets and binge eating. Even experts may wonder how to design a suit — or dam, revetment, or levee — for a constantly changing profile.[9]

For this reason, conventional levees are singular in their conception and design. Large vegetation is removed, alternate uses and access are restricted, and the levee berms stand as monoliths. Parrott's snarled and tangled biomorphic design suggests an alternative in which friction is increased to encourage accretion and ultimately the formation of new ecological structures.



Patent No. 1,129,719, “Jetty Construction” (1915)



Patent No. 1,129,719, “Jetty Construction” (1915)

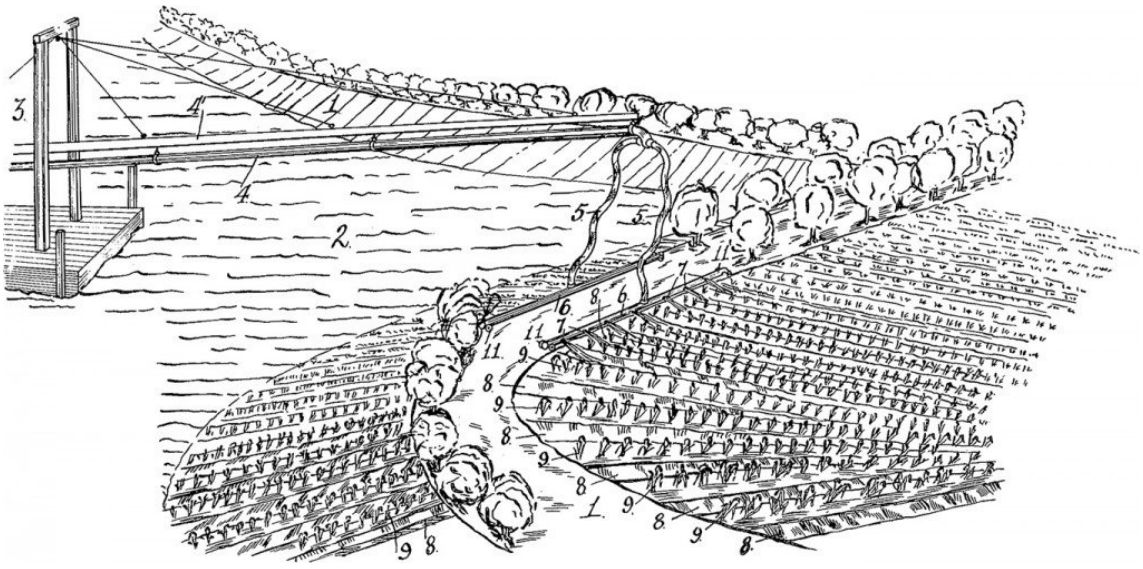
Patent No. 1,262,898: Cultivated Levees

The 4,600 miles of levees that enclose the Mississippi and Sacramento–San Joaquin systems create a vast discontinuity between the rivers and their adjacencies. Thousands of acres are dedicated to flood control, and only a fraction of this land area supports cultural activity or native ecology. It is therefore surprising to discover patents for levees that

integrate alternative programs, such as agriculture. Frank V. Wright, inventor, businessman, and landowner in the California Delta, was granted Patent No. 1,262,898 [PDF], for a "Method of Concurrently Maintaining and Cultivating Levees" (1918). He describes a new art of growing crops and raising levees simultaneously:

> I first plant a crop on the levee surfaces in rows, and make trenches between the rows. Then I raise mud-carrying water from the bottom of the stream. This mud-carrying water I distribute in the trenches in a quantity sufficient for irrigation and for the deposit of a relatively thin layer of mud in said trenches. This distribution of the mud-carrying water I repeat at intervals until the crop is harvested and the trenches are filled with mud. Then I plant a new crop in the mud-filled trenches and I make new trenches in the ground from which the first crop was harvested. I then begin the distribution of the mud-carrying water to the new trenches and repeat it at intervals until the second crop is harvested and the new trenches filled with mud. Then I plant a third crop in the mud filled second trenches, and make a third set of trenches in the ground from which the second crop was harvested: thereafter I repeat the cycle of operations indefinitely. ... Under my method the levee becomes more permanent, each year that it is maintained; with an increasing factor of safety, with the addition of time.

Applying sediment slurry as irrigation water would reduce berm cracking due to dehydration and increase levee height incrementally. Wright's carefully orchestrated process cultivates new ground in a manner reminiscent of Mexico's *chinampas*. The patent is striking for its evocation of themes that are popular nearly a century later: multifunctionality and programming of landscape infrastructure. If applied nationally, tens of thousands of acres of levees would be in cultivation — a radical vision, today and in 1918.



Patent No. 1,262,898, “Method of Concurrently Maintaining and Cultivating Levees” (1918)

The Levees That Might Have Been

The diverse array of levee patents granted in the late 19th and early 20th century provide a record of unrealized landscape infrastructure. Their existence in the public domain is testament to the efficacy of a patent system that incentivizes innovation and disclosure. Whether these designs, if they were deployed at scale, would have changed the present for the better we can only guess. But as existing levees fail, sea levels rise, and landscape managers adapt to changing environmental conditions, the patent archive furnishes a rich store of images and ideas that may inspire future innovations. The prescience of these early inventors stands as a strong reminder of the spirit of human ingenuity, itself an infrastructure of resilience.

EDITORS’ NOTE

Richard L. Hindle’s research is the subject of a forthcoming book and a recent exhibition at the University of California, Berkeley, *Geographies of Innovation: Vanguard Landscape Technology and Infrastructure from the United States Patent Archive*.

NOTES

1. Pierre Bélanger, "Landscape as Infrastructure," *Landscape Journal* 28.1 (2009): 79–95. ↩

2. Andrew A. Humphreys and Henry L. Abbot, *Report upon the Physics and Hydraulics of the Mississippi River*... Bureau of Topographical Engineers, War Department, 1861. ↩

3. E. L. Corthell, "The Delta of the Mississippi River," *The National Geographic Magazine* 7.12 (1897): 351–354. ↩

4. Craig Allen Nard, *The Law of Patents* (New York: Wolters Kluwer Law & Business, 2010). ↩

5. John M. Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America* (New York: Simon & Schuster, 2007). ↩

6. E. L. Corthell, *A History of the Jetties at the Mouth of the Mississippi River* (New York: J. Wiley & Sons, 1880). ↩

7. John Thompson and Edward A. Dutra, *Tule Breakers: The Story of the California Dredge* (Stockton, CA: The Stockton Corral of Westerners, 1983). ↩

8. Chris Reed and Nina-Marie Lister, "Ecology and Design: Parallel Genealogies," *Places Journal*, April 2014. See also: Reed and Lister, *Projective Ecologies* (ACTAR and Harvard Graduate School of Design, 2014). ↩

9. Martin Reuss, "The Art of Scientific Precision: River Research in the United States Army Corps of Engineers to 1945," *Technology and Culture* 40.2 (1999): 292–323. ↩

CITE

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