UNITED STATES FLOOD CONTROL POLICY: THE INCOMPLETE TRANSITION FROM THE ILLUSION OF TOTAL PROTECTION TO RISK MANAGEMENT

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I. INTRODUCTION: FROM PASSIVE TO ACTIVE ADAPTATION

A. The Transition From Passive Adaptation to Maximum Protection

A flood occurs when water overflows a river or a lake and covers land that is not normally submerged. Floods are an inevitable function of the hydrologic cycle, and flood cycles were originally seen as blessings because they sustained riverine ecosystems and the floodplain economies dependent on them. Floods became a social problem only when they did not occur. However, as more people settled in floodplains, floods transformed into a social problem because they both disrupted agricultural production and caused extensive damage to settlements. Floodplain dwellers soon expected governments to reduce or prevent flood damages through hydrologic engineering. The construction of dykes to halt the spread of flood waters and increase the current to flush silt downstream dates back to at least the eighth century CE in China.[1] Roman-raised embankments in the Fens lasted until the eighteenth century in England.[2]

Until the mid-twentieth century, the story of modern flood control was the transition from adaptation to the inevitable to an expectation that government would provide maximum flood

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1. *E.g.*, RANDALL A. DODGEN, CONTROLLING THE DRAGON: CONFUCIAN ENGINEERS AND THE YELLOW RIVER IN LATE IMPERIAL CHINA 14 (2001) (explaining that efforts to control flooding on the Yellow River using levees and canals were documented as early as the sixth century B.C.E.).

2. JEREMY PURSEGLOVE, TAMING THE FLOOD: A HISTORY AND NATURAL HISTORY OF RIVERS AND WETLANDS 40 (1988).

prevention and generous post-disaster relief for floodplain dwellers. For the last sixty years or so, the story has been the growing recognition, especially as the understanding of climate change has increased, that the goal of maximum protection is unobtainable because flood damage is an inevitable risk that can *only* be managed, but never totally avoided. Thus, we are now making the transition to the idea that we must manage floodplains through a combination of structural defenses, upstream storage, and land-use controls.[3]

This transition to integrated floodplain management will be a painful and controversial process because the expectation that we can outsmart nature through maximum flood prevention is deeply embedded in our thinking about floods. Three powerful and related scientific, technological, and ideological nineteenth century developments contributed to this expectation.

First, the science of hydrology developed rapidly in the nineteenth century.[4] The new understanding of water's behavior, along with the development of new engineering technologies enabling construction of large dams, increased the options for flood control. Second, these scientific and engineering developments reinforced the belief, rooted in ancient Greece,[5] that humans should use our understanding of nature to improve upon her imperfect processes by controlling them when they threaten to impede human activity.[6]

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3. *See, e.g.*, ASSOCIATED PROGRAMME ON FLOOD MGMT., LEGAL AND INSTITUTIONAL ASPECTS OF INTEGRATED FLOOD MANAGEMENT 11 (2006) ("Given the enormous influence of land use on flood risks . . . it is imperative that land use planning and water allocation are properly coordinated.").

4. *See* NAT'L RESEARCH COUNCIL, OPPORTUNITIES IN THE HYDROLOGIC SCIENCES 37–45 (1991) (tracing the development of the science from the Greeks to the present day).

5. *See* J. DONALD HUGHES, PAN'S TRAVAIL: ENVIRONMENTAL PROBLEMS OF THE ANCIENT GREEKS AND ROMANS 195 (1994) (tracing the evolution of ancient civilization's earlier view of nature as fundamentally sacred to the later secular and self-interested view that nature exists to serve human ends and concluding that this approach did not as much lead to useful knowledge as it did from the Enlightenment on because natural philosophers merely speculated but did not observe and experiment).

6. For a classic example of the belief that we can engineer our way out of natural disasters, see Cornella Dean, *Lifeline Built on Shifting Sands*, N.Y. TIMES, Mar. 5, 2012, at D1, which describes the reconstruction efforts of the Highway 12 on the Outer Banks of North Carolina. The bridge, rebuilt after Hurricane Irene, is already stressed. *Id.* North Carolina has decided not to follow the example of King Canute. The Danish King of England refused to listen to his sycophantic court who claimed that he was all powerful. Along the seashore, he asked if he could turn back the tide and demonstrated that he could not by wading into the water as it rose around him. *See also* Jonathon Claybourne, *Is Sea Level Rise Dead*, WASH. DAILY NEWS, Feb. 18, 2012, http://www.wdnweb.com/2012/02/18/is-sea-level-rise-dead/ (describing the 2012 debate surrounding the North Carolina Coastal Commission proposal to

Third, a powerful, central state gradually became accepted as the entity to control nature, and thus promote human progress.[7]

Beginning in the 1860s, these trends led to a policy of maximum flood prevention.[8] The rub is that the assumptions on which the policy is based no longer hold in their original form. However, the United States has not found a coherent replacement for maximum flood protection. For example, since 2006, the federal government has spent $14.5 billion on a post-Katrina flood protection system for New Orleans, although the 133-mile chain of levees, flood walls, gates, and pumps still puts the city at risk because it is based on the outmoded concept of the 100-year flood.[9]

B. The Demise of Maximum Protection

Engineers have long promised floodplain dwellers that structural measures such as levees, dykes, and upstream storage reservoirs can substantially prevent flood damage. Students of flood policy know that promise to be illusory for four basic reasons. First, global climate change has undermined many of the fundamental hydrologic assumptions upon which flood control, from levee construction to reservoir management, is premised. Hydrologists have long assumed that they could predict with considerable accuracy the frequency and scale of floods.[10] Today, the underlying assumption that hydrologic regimes are relatively "stationary" over time has been replaced with

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add a requirement that county coastal plans include protection for an anticipated 39 inch sea rise over the next 100 years, but this bad news was deleted from the current proposed plan after protests by county officials fearing a loss of real estate development); H.R. 819, GEN. ASSEMBLY (2012) (North Carolina legislation passed in July 2012 forbidding any mention of projected sea level rise in any planning document until 2016, a modification of an earlier version which contained a permanent prohibition against the inconvenient truth).

7. *See, e.g.*, ROBERT KELLEY, BATTLING THE INLAND SEA: FLOODS, PUBLIC POLICY, AND THE SACRAMENTO VALLEY xxi–xxii (1998) [hereinafter KELLEY, BATTLING THE INLAND SEA] ("The decades-long struggle to get control of the Sacramento River illustrates . . . how a society originally build almost exclusively around individualism and localism was slowly but irresistibly pushed on to construct, out of necessity, strong regulatory central authorities. In this sense, *Battling the Inland Sea* is a study in the history of American federalism.").

8. *See infra* notes 33–36.

9. John Schwartz, *Vast Defenses Now Shielding New Orleans Against Big Storms*, N.Y. TIMES, June 15, 2012, at A28.

10. *See* INTERAGENCY FLOODPLAIN MGMT. REVIEW COMM., SHARING THE CHALLENGE: FLOODPLAIN MANAGEMENT INTO THE 21ST CENTURY 2 (1994) (discussing the use of projections such as the 100 and 500 year flood, which are used in the design of flood control structures).

the climate-change-influenced assumption that they are non-stationary.[11]

Second, even before the current efforts to de-legitimate the federal government,[12] Congress had lost interest in funding large-scale water projects,[13] which in the eastern United States meant flood-control reservoirs. The federal government continues to be the major, but not exclusive, source of levee maintenance and construction. Nevertheless, all indications suggest that the federal government will reduce investment in flood control, especially in dams, and instead will shift more responsibility for flood management downward to equally cash-starved state and local governments.[14]

Third, experts (if not politicians) have recognized that not only is maximum flood protection an impossible goal; it also has the perverse effect of increasing flood damage by encouraging more people to occupy floodplains.[15]

Fourth, the environmental movement has created more respect for the functions and ecosystem services that floods provide. The argument is that, to achieve social objectives such as flood control, it is often better social policy to work with, not against, natural riverine processes.[16]

This essay examines the evolution of United States flood policies, the laws that have implemented them, and the current debate about the merits of these policies and laws. It first examines the relationship among major flood disasters, the scientific and engineering debates about flood management that the disasters stimulated, and the

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11. P.C.D. Milly et al., *Stationarity is Dead: Whither Water Management?*, 319 SCI. 573, 573 (2008). *See generally* Robin Kundis Craig, *"Stationarity is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law,* 33 HARV. ENVTL. L. REV. 9 (2010) (providing five principles for developing environmental law in the face of climate change).

12. *See generally* THOMAS E. MANN & NORMAN J. ORNSTEIN, IT'S EVEN WORSE THAN IT LOOKS: HOW THE AMERICAN CONSTITUTIONAL SYSTEM COLLIDED WITH THE NEW POLITICS OF EXTREMISM (2012) (giving a sobering assessment of the impact of the 2012 Congressional election on the operation of the federal government).

13. NAT'L RESEARCH COUNCIL, NATIONAL WATER RESOURCES CHALLENGES FACING THE U.S. ARMY CORPS OF ENGINEERS 2–3 (2011).

14. *Id.* at 17.

15. *See* U.S. ARMY CORPS OF ENG'RS, FLOOD RISK MANAGEMENT: VALUE TO THE NATION 4 (2009) (noting that total flood prevention is impossible). National flood damages averaged around $3.9 billion per year in 1980s and nearly doubled from 1995 to 2004, and total disaster assistance for both emergency response operations and subsequent long-term recovery efforts increased from an average of $444 million during the 1980s to $3.75 billion during the 1995-2004 decade. *Id.*

16. PURSEGLOVE, *supra* note 2, at 149.

policies and legal institutions that emerged post-disaster. It next examines the current criticisms of our flood management policies and the laws that reflect these policies. It concludes with a discussion of the European Union's 2007 Floods Directive as an example of a coherent risk-management policy for floods, and identifies three barriers to adopting and implementing such a policy in the United States. These are (1) the lack of a coherent flood-management vision, (2) the fragmentation of federal spending and its impact on local government flood-control programs, and (3) the chilling impact of the Supreme Court's takings jurisprudence.

II. FIVE BASIC WAYS TO COPE WITH FLOODS

Flood-protection policy is a product of four factors: a devastating flood, the state of flood-mitigation knowledge, available technological options, and the political priorities of the time. Flood-protection policy has evolved through five overlapping stages: passive adaptation, channel control, upstream water retention, floodplain management, and integrated flood-risk management. All have been attempted, and all are in place around the country.

A. Passively Adapt to Flood Cycles

Humans have long accepted floods as inevitable and have passively adapted to them. Adaptation is a continuum of strategies which range from mere retreat to the use of low-level technologies to take advantage of the inevitable flood or to avoid the damages.

The Nile River in ancient Egypt is the classic example of adaptation through using minimal technology to harness the benefits of floods. Civilization was only possible in a narrow fertile band along the River and depended "on the life-giving waters of the Nile."[17] Because the River's annual floods created embankments along the river and the valley was convex, it was possible to build an intricate system of gravity canals and regulators to distribute the water and nutrient-laden silt to irrigate the grains, vegetables, and flax that sustained the kingdom.[18]

17. TOBY WILKINSON, THE RISE AND FALL OF ANCIENT EGYPT 29 (2010).

18. ROBERT O. COLLINS, THE NILE 132–33 (2002). The use of technology did not accelerate until the late 19th century after the British drove out the last Turkish Pasha in 1882. *See id.* at 141–76. They quickly developed a basin wide flood management program which included dams, flood control lakes and diversion canals. *See id*.

Native Americans also dealt with floods by quick adaptation. Before the French founded New Orleans, the local hunter–gatherer Indian tribes that lived in the region simply retreated to higher ground when the Mississippi River flooded.[19] However, the United States government did not learn from them and has instead tried to prevent the maximum amount of flood damage.[20] Once a substantial human settlement is established, retreat is not an option and societies turn to damage-prevention technology. Still, the inevitability of floods can be integrated into the expectations of residents. For example, consider Davenport, Iowa. The city is built on a narrow floodplain and steep hills along the Mississippi and the adjoining bluffs to the west. Its neighbor across the river, Moline, Illinois, has levees along its banks, but there are none in Davenport. Instead, Davenport deals with floods by warnings, by preserving open space adjacent to the river, by building temporary dykes, and, of course, by concentrating dwellings on the hills.[21]

Adaptation can be cheap, but it is always a risky political strategy for government. Ancient Egypt's prosperity and thus political stability depended on the annual flood cycle, and her rulers identified the relation between the natural order of the Nile and political order.[22] A low flood year could undermine political stability and, over time, create pressures for more sophisticated technological control.[23] A series of low flood years may have speeded Egypt's fall to the Roman Empire during Cleopatra's reign (52–30 BCE).[24] The ensuing famine was seen as a sign that the Gods had deserted her, "a

19. In the 16th century, Spanish explorers of the Mississippi observed that the Indians built their houses on high land and, in low areas, built mounds to live on during floods. CHAMP CLARK, FLOOD 65–87 (1982); *see also* LAWRENCE N. POWELL, THE ACCIDENTAL CITY: IMPROVISING NEW ORLEANS 7 (2012); Tristram R. Kidder, *Making the City Inevitable: Native Americans and the Geography of New Orleans*, *in* TRANSFORMING NEW ORLEANS AND ITS ENVIRONS: CENTURIES OF CHANGE 9, 11 (Craig E. Colten, ed. 2000).

20. *See generally* George S. Pabis, *Subduing Nature through Engineering: Caleb G. Forshey and the Levees-only Policy, 1851-1881*, *in* TRANSFORMING NEW ORLEANS, *supra* note 19, at 64 (detailing the development of a total flood control policy during the middle of the nineteenth century).

21. *See* DAVENPORT, IOWA, CODE § 15.44 (2000) (restricting development within the Mississippi River and tributary creek floodplains and requiring the elevation of residential structures and the flood proofing of commercial buildings located in the floodplain areas).

22. WILKINSON, *supra* note 17, at 27–30.

23. COLLINS, *supra* note 18, at 18, 130.

24. *See* WILKINSON, *supra* note 17, at 496; *cf.* DODGEN, *supra* note 1, at 3 (explaining that Classical Chinese history attributed the fall of a dynasty with the loss of the mandate of heaven, a major symptom of which was "the inability to control the Yellow River").

profoundly worrying development."[25] The lessons were repeated in China, where flood control was central to the emperor's legitimacy.[26] In the United States, the failure of the federal government to prevent and ameliorate the negative consequences of the disastrous 1927 Mississippi Delta Flood pried African-Americans away from the Republican Party of Lincoln and helped to create the New Deal coalition that sustained the Democratic Party from 1932 to 1952.[27]

B. Confine the River to Its Bed and Manipulate It

Permanent human settlement precludes retreat as a strategy, and therefore produces demand for levee construction and channel alteration. Levees are the oldest type of human intervention with hydrologic regimes.[28] Soon after its founding in 1717, New Orleans built its first levee.[29] Long before New Orleans, the Chinese realized that they needed to control upstream flood dynamics because silt-laden runoff raised riverbeds and increased the spread of floodwaters.[30] In the United States, farmers in the Sacramento Valley linked the severity of floods in part to the flushing of hydraulic mining waste into Sacramento's tributaries, which raised the riverbed and caused frequent winter floods.[31]

Levees and channel alteration emerged as the flood-protection strategy of choice after the Civil War, when Congress assigned to the United States Army Corps of Engineers lead responsibility for protecting land along the Mississippi River (alongside its primary mission of navigation enhancement).[32] Rival engineers advocated competing theories of how to control flooding by moving water as

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25. WILKINSON, *supra* note 17, at 496.

26. DODGEN, *supra* note 1, at 3.

27. *See* JOHN M. BARRY, RISING TIDE: THE GREAT MISSISSIPPI FLOOD OF 1927 AND HOW IT CHANGED AMERICA 412–15 (1997) (discussing the social, cultural, and economic impact of the Mississippi flood of 1927 on the African-American community).

28. Larry W. Mays, *Irrigation Systems, Ancient*, WATER ENCYCLOPEDIA: SCI. & ISSUES, http://www.waterencyclopedia.com/Hy-La/Irrigation-Systems-Ancient.html (last visited Nov. 18, 2012).

29. Christopher Morris, *Impenetrable but Easy: The French Transformation of the Lower Mississippi Valley and the Founding of New Orleans*, *in* TRANSFORMING NEW ORLEANS, *supra* note 19, at 22, 34; *see also* POWELL, *supra* note 19.

30. DODGEN, *supra* note 1, at 13.

31. ROBERT KELLEY, GOLD VS. GRAIN: THE HYDRAULIC MINING CONTROVERSY IN CALIFORNIA'S SACRAMENTO VALLEY 57 (1959).

32. Christine A. Klien & Sandra B. Zellmer, *Mississippi River Stories: Lessons from a Century of Unnatural Disasters*, 60 SMU L. REV. 1471, 1478–80 (2007).

quickly as possible into the Gulf of Mexico.[33] Andrew Humphreys, Chief Engineer of the Corps, argued that levees alone were the best strategy because they would accelerate the current and deepen the river channel.[34] Humphreys's rival, the brilliant engineer James Eads, convinced the Corps that the same result could be more effectively achieved by constructing jetties at the mouth of the River.[35]

Political ideology also impeded flood-control policy. The Corps did construct some navigation-improvement levees along the Mississippi and other large rivers. However, in the nineteenth century, Jeffersonian ideology ensured that flood control was a local, or at best, a state function,[36] even though rivers such as the Mississippi spanned many states.[37] Today, the United States still has no unified levee system; there are over 100,000 miles of levees in various states of repair and deterioration in the United States, and eighty-five percent are locally owned.[38]

The levees-only policy could not prevent flood damage in part because coverage was fragmented.[39] The Mississippi River Commission tried to coordinate levee construction through its standard-setting policy, but the weaknesses of that approach became increasingly apparent over time.[40] Congress took a first step toward federal responsibility for flood prevention by passing the Flood Control Act of 1917.[41] The Act authorized levee construction, but only on the condition that the levees would be turned over to local interests for maintenance.[42] It took the 1927 Mississippi River Flood to fundamentally change United States policy.

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33. *See* Richard G. Weingardt, *James Buchanan Eads*, 5 LEADERSHIP & MGMT. ENGINEERING 70, 73 (2005).

34. Klien & Zellmer, *supra* note 32, at 1479.

35. Weingardt, *supra* note 33, at 73–74.

36. *See, e.g.*, KELLEY, BATTLING THE INLAND SEA, *supra* note 7, at 31–32 (telling the story of the increasing centralization and scale of flood control in California's Sacramento River Valley).

37. The Mississippi River Commission was formed in 1879 and adopted a policy of coordinated levee construction in 1882. MISS. RIVER COMM'N, THE MISSISSIPPI RIVER & TRIBUTARIES PROJECT: HISTORY OF LOWER MISSISSIPPI RIVER LEVEE SYSTEM 5–6 (2007).

38. Am. Soc'y of Civil Eng'rs, *Levees*, REPORT CARD FOR AMERICA'S INFRASTRUCTURE, http://www.infrastructurereportcard.org/fact-sheet/levees (last visited Sept. 22, 2012).

39. *See* Klein & Zellmer, *supra* note 32, at 1482–83.

40. *See* U.S. WATER RES. POLICY COMM'N. WATER RESOURCES LAW 128–29 (1950).

41. Flood Control Act of 1917, ch. 144, 39 Stat. 948 (codified as amended at 33 U.S.C. §§ 701–703 (2006)).

42. *Id.* § 1(d).

Students of environmental law have demonstrated how major disasters, such as floods or persistent air pollution, have contributed to the development of new public-policy responses and laws.[43] Among other events in the late 1920s, the 1927 Mississippi Flood illustrates this thesis. In brief, extraordinarily heavy rains in the Missouri-Mississippi valleys from August 1926 to April 1927 caused levee failures from Missouri to Louisiana in April 1927.[44] "The 1927 Great Mississippi Flood inundated 27,000 square miles (70,000 square kilometers) of land with as much as 30 feet (9 meters) of water. It took until mid-August for all of the water to recede, leaving a mud-covered, barren landscape."[45]

Congress responded to the 1927 flood by enacting the Flood Control Act of 1928,[46] which had five major consequences for United States flood control policy that continue to the present. First, the 1928 Act cemented federal responsibility for flood control by making it a Corps mission of equal if not greater importance than navigation.[47]

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43. *See, e.g.*, JAMES E. KRIER & EDMUND URSIN, POLLUTION & POLICY: A CASE ESSAY ON CALIFORNIA AND FEDERAL EXPERIENCE WITH MOTOR VEHICLE AIR POLLUTION, 1940–1975, at 263–77 (1977) (using the history of the Los Angeles pollution crises to explain the role episodic crises play in policymaking).

44. BARRY, *supra* note 27, at 194–201.

45. RISK MGMT. SOLUTIONS, THE 1927 GREAT MISSISSIPPI FLOOD: 80-YEAR RETROSPECTIVE 7 (2007), *available at* http://www.rms.com/publications/1927_MississippiFlood.pdf. The social impacts of the flood were as important as the physical ones. African-Americans were forced to reinforce levees—many of the breaches flooded lands on which they lived—and neither the federal nor state governments provided significant relief. BARRY, *supra* note 27, at 314–17, 371. The inadequate federal response triggered the Great Migration north, and pried African-Americans from the Republican Party, *see id.* at 414–16.

46. Flood Control Act of 1928, ch. 569, 45 Stat. 534 (codified as amended at 33 U.S.C. §§ 702a–702m, 704 (2006)). Section 2 of the Act stated the following:

> [I]n view of the extent of national concern in the control of these floods in the interests of national prosperity, the flow of interstate commerce, and the movement of the United States mails; and, in view of the gigantic scale of the project, involving flood waters of a volume and flowing from a drainage area largely outside the States most affected, and far exceeding those of any other river in the United States, no local contribution to the project herein adopted is required.

Id. § 2. However, Congress did not expressly endorse federal responsibility for flood control nationwide until 1936. Klein & Zellmer, *supra* note 32, at 1485; *see also infra* notes 61–64 and accompanying text.

47. *See, e.g.*, Flood Control Act of 1928 § 1 (placing the flood control project under the supervision of the Army Corp of Engineers). The 1928 Act was an immediate response to the flood and forced the Corps to recant its longstanding opposition to the Progressive Conservation idea of basin-wide multiple purpose water projects. Klein & Zellmer, *supra* note 32, at 1484–85. The Act itself continued the levees-only policy but took a major step toward federal responsibility for comprehensive river-basin management by authorizing $325 million to

Second, the 1928 Act laid the foundation for the demise of the levees-only approach, with a transition to the construction of upstream reservoirs. Third, the 1928 Act formally committed the Corps to the Progressive Conservation Era vision of a river-basin-wide approach to water management.[48] For the first time, the Corps was directed to include "the establishment of a reservoir system" in its basin-wide planning for the Mississippi.[49] Fourth, the 1928 Act enshrined as the dominant flood-management paradigm structural defense through dams and levees, supplemented by dedicated flood ways.[50] Fifth, the 1928 Act's commitment to structural defense created the seeds of its partial demise as flood damages continued to rise, eventually triggering the debate between the merits of taming, as opposed to working with, nature. This debate currently dominates flood control policy.

C. Retain Flood Waters in Large Reservoirs

Levees remain a popular flood-control strategy. Their physical bulk gives the impression that building behind them is safe. But this is an illusion. Levees fail in various ways.[51] To complement this strategy, flood-control policymakers pursued the dream of maximum damage

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construct levees and outlets on land subject to flood easements. *See* Flood Control Act of 1928 § 1.

48. *See* Flood Control Act of 1928 § 1 (authorizing "the project for the flood control of the Mississippi River in its alluvial valley"); *see also* ARTHUR E. MORGAN, DAMS AND OTHER DISASTERS: A CENTURY OF THE ARMY CORPS OF ENGINEERS IN CIVIL WORKS 300–02 (1971) (criticizing the Corps, the author's long time antagonist).

49. 33 U.S.C. § 702j (2006). The roots of the legislation go back to a 1925 act, Act of Mar. 3, 1925, 43 Stat. 1186 (1925), which mandated joint Federal Power Commission and Corps studies of the feasibility of power development on navigable streams. The resulting 308 studies, H.R. Doc. No. 69-308 (1927), laid the foundation for the subsequent expansion of Corps planning responsibility and mission expansion. For Corps planning mandates from 1925 to 1944, see U.S. WATER RES. POLICY COMM'N, *supra* note 40, at 408–17.

50. 33 U.S.C. § 702c (reinforcing the maximum structural protection strategy by immunizing the federal government from any liability for "damage from floods or flood waters at any place"). *But see* Cent. Green Co. v. United States, 531 U.S. 425, 436–437 (2001) (creating an exception for non-flood waters running in a federal flood control project); In re Katrina Canal Breaches Consolidated Litigation, 696 F.3d 436, 446–48 (5th Cir. 2012) (refusing to apply § 702c's immunity to the negligent construction of a navigation channel, the Missisippi River Gulf Outlet, that carried the storm surge from Hurricane Katrina into New Orleans, although ultimately finding immunity under the discretionary-function exception of the Federal Tort Claims Act).

51. *See* Evan Lehmann & ClimateWire, *When the Levee Breaks: U.S. Flood Protection Inadequate*, SCI. AM. (Jan. 18, 2012), http://www.scientificamerican.com/article.cfm?id=us-flood-protection-inadequate-levee-breaks.

elimination through dams and reservoirs throughout most of the twentieth century. Flood-control dams date from the third or second millennium BCE,[52] but they did not come into widespread use until the nineteenth century in Europe.

In the United States, the modern flood-control dam is the legacy of Arthur Morgan, the visionary engineer widely credited as the first proponent of a strategy of water-retention. In response to a disastrous 1913 flood in Dayton, Ohio,[53] Morgan convinced the city to build upstream flood-control storage reservoirs on the Miami River.[54] His solution for the Miami Conservacy District became the template for federal policy when it was adopted by the United States Congress in the 1928 Act.[55] The Miami model launched Morgan's career; from 1933 to 1938, he was the chairman of the Tennessee Valley Authority, and the dams and reservoirs that are part of the Lower Mississippi flood-control system are his most concrete legacy.[56]

Into the 1920s, the Corps was still under the spell of its levees-only policy and opposed dams even as its new rival, the Bureau of Reclamation, was building multiple-purpose dams, primarily for irrigation and hydroelectric power production.[57] But Congress dragged the Corps into dam building. Starting in 1925, Congress required that the Federal Power Commission and the Corps prepare river-basin plans for the "improvement" of streams for navigation,

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52. *See* ROBERT B. JANSEN, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, DAMS AND PUBLIC SAFETY 1–2 (1983), *available at* http://ussdams.com/ussdeducation/Media/damsfrombegin.doc (discussing the early history of dams, especially dam projects on the Nile River).

53. The flood is well documented. For a list of links to information about the flood and to personal accounts, see *The Great Dayton Flood of 1913*, DAYTON HISTORY BOOKS ONLINE, http://www.daytonhistorybooks.com/page/page/1566099.htm (last visited Sept. 20, 2012).

54. J. David Rodgers, The 1913 Dayton Flood and the Birth of Modern Flood Control Engineering in the United States (unpublished PowerPoint presentation), *available at* http://web.mst.edu/~rogersda/umrcourses/ge301/Dayton%20Flood-Updated.pdf.

55. *See* 33 U.S.C. § 702j. It is difficult to trace Morgan's influence directly. He claimed paternity for Corps of Engineers flood control dams. MORGAN, *supra* note 48, at 302; LELAND R. JOHNSON, THE FALLS CITY ENGINEERS: A HISTORY OF THE LOUISVILLE DISTRICT, CORPS OF ENGINEERS, UNITED STATES ARMY 195–96 (1974), *available at* http://publications.usace.army.mil/publications/misc/un22/c-12.pdf, provides more objective evidence that Corps engineers who studied the Miami Valley dams incorporated the success of dams into their thinking, which in turn influenced Congress.

56. MORGAN, *supra* note 48, at 344.

57. *See* SAMUEL P. HAYS, CONSERVATION AND THE GOSPEL OF EFFICIENCY: THE PROGRESSIVE CONSERVATION MOVEMENT, 1890–1920, at 208–11 (1959) (explaining the hostilities of the Corps towards dam construction).

hydroelectric power, irrigation, and flood control.[58] These "308 Reports," named after the document number for the first report, were submitted to Congress in 1926,[59] and the 1928 Act required that a 308 Report for the Mississippi be prepared that included, *inter alia*, a determination of whether additional flood control could be "attained through the control of flood waters in the drainage basins of the tributaries by the establishment of a reservoir system."[60]

The floodwater-retention strategy was enshrined in United States law and policy during the Great Depression and the aftermath of World War II. During his four terms, President Franklin Roosevelt first embraced dams as engines of employment to combat skyrocketing joblessness during the Depression, and after the Allied victory became certain, saw them as sources of employment for returning veterans.[61] Congress agreed and enacted two New Deal Congressional acts committing the United States to multiple-purpose dams where flood control was a primary purpose. The Flood Control Act of 1936[62] declared that flood control on navigable rivers and their tributaries was a "proper activity of the Federal Government in cooperation with States, their political subdivisions and localities."[63] In an attempt to rationalize federal spending, it also introduced benefit–cost analysis as the standard for project construction.[64]

The Tennessee Valley Authority (TVA), created under the Tennessee Valley Authority Act of 1933, was the first to put floodwater retention into large-scale practice. During World War II, an effort was made to apply the lessons of the TVA to the Missouri

58. Act of Mar. 3, 1925, ch. 467, § 3, 43 Stat. 1186, 1190.

59. *See* H.R. Doc. No. 69-308 (1926).

60. 33 U.S.C. § 702j.

61. JOHN R. FERRELL, BIG DAM ERA: A LEGISLATIVE AND INSTITUTIONAL HISTORY OF THE PICK-SLOAN MISSOURI BASIN PROGRAM 2–3 (1993) (quoting the statement of Franklin D. Roosevelt's Secretary of the Interior, Harold L. Ickes, to the National Reclamation Association in 1943 "that the Bureau of Reclamation was prepared to neutralize demobilization's negative effect on the West").

62. Flood Control Act of 1936, Pub. L. No. 74-738, 49 Stat. 1572.

63. *Id*.

64. United States v. W. Va. Power Co., 122 F.2d 733, 736–37 (4th Cir. 1941). Although the Corps and the Office of Management and Budget are committed to formal benefit-cost analysis, Congress is not bound by good practice and has unlimited discretion to decide whether a project it chooses to approve meets the statutory standard.

River.[65] By the 1940s, the rural population of the Missouri River watershed was declining.[66] Urban areas were growing, and Omaha and other upstream cities experienced serious flooding in 1943.[67] These floods led to pressure for a quick, federal, and structural solution.[68] Within a short time, the Missouri River Division Corps Engineer, General Lewis A. Pick, proposed a flood-control plan that relied on the construction of five mainstream reservoirs on the Missouri from North Dakota to the northeastern border of Nebraska.[69] William Sloan, of the Bureau of Reclamation, prepared a competing plan that was more favorable to upstream irrigation interests. Congress combined the plans, and funded the new Pick–Sloan Plan in 1944.[70] The five authorized dams were completed by the early 1960s.[71] Other flood-control dams followed in the 1950s and 1960s.[72] Nationwide, the Corps currently owns over 600 flood-control dams on both large and small rivers.[73]

Ironically, these two New Deal programs made it impossible for the federal government to manage river basins, contributing to the fragmentation that characterizes current United States water-management policy. President Roosevelt hoped to first apply the TVA regional-authority model to the Missouri and then to the world, but the Basin states and Congress blocked any efforts to "TVA-ize"

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65. *See* DAVID P. BILLINGTON, DONALD C. JACKSON & MARTIN V. MELOSI, THE HISTORY OF LARGE FEDERAL DAMS: PLANNING, DESIGN, AND CONSTRUCTION IN THE ERA OF BIG DAMS 269–99 (2005).

66. FERRELL, *supra* note 61, at 2.

67. *Id.* at 8.

68. *Historic Floods on the Missouri River*, NEB. DEP'T OF NAT. RES., http://www.dnr.ne.gov/floodplain/mitigation/mofloods.html (last visited Sept. 22, 2012).

69. FERRELL, *supra* note 61, at 50–51. An earlier dam, Fort Peck, was constructed in the 1930s by the Works Progress Administration and was incorporated into the Pick-Sloan Plan in 1944. *Id.*

70. *See id.* at 39–68 (providing a history of the quick of resolution of the two plans, one focused on irrigation, and the other on flood control).

71. BILLINGTON ET AL., *supra* note 65, at 288. The dams have prevented considerable downstream flooding, but flooding on the Missouri and Mississippi continues. *See infra* notes 87–88. The controversies surrounding the allocation and management of the Missouri are beyond the scope of this paper.

72. For example, thirty-seven flood control dams were built in West Virginia between 1938 and 1988. *Flood Control,* W. VA. ENCYCLOPEDIA, http://www.wvencyclopedia.org/articles/2196 (last visited Sept. 22, 2012).

73. NAT'L RESEARCH COUNCIL, *supra* note 13, at 8.

the Missouri in the 1944 legislation.[74] Administrative support for a Missouri Basin Authority died with President Roosevelt in 1944.

The dream of comprehensive, federal river-basin development lived on until the 1970s. After the New Deal, federal support for large dam construction continued but only on a project-by-project basis.[75] The Eisenhower Administration (1952–1960) followed a "no-new starts" water-resources-development policy, and stressed increased local responsibility for smaller projects.[76] This policy was reversed in the Kennedy and Johnson administrations (1960–1968); new Corps dams were built in the 1960s in the Southeast and Midwest.[77] President Johnson was a committed dam builder,[78] and he tried to revive New Deal-style river-basin planning. The Water Resources Planning Act of 1965[79] created seven river-basin commissions coordinated by a federal Water Resources Council.

The attempted revival was too late. Congress was funding fewer dams, levees, and canals, leaving these commissions with no clearly-defined role.[80] Water planning had historically meant water-*project* planning, and it was impossible to adjust this model to basin management.[81] The National Water Commission, which operated between 1968 and 1973, identified many of the problems of trying to adapt a construction model to the changing water demands with which the Corps was struggling.[82] The Commission accurately noted that "[t]he Corps . . . is not likely to exist as any agency specializing in the construction of great engineering works; it seems virtually certain that in the future the United States will need relatively few major

74. FERRELL, *supra* note 61, at 74–86.

75. STEVEN SOLOMON, WATER: THE EPIC STRUGGLE FOR WEALTH, POWER, AND CIVILIZATION 343 (2010).

76. MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER 280 (1986).

77. *Id.* at 283.

78. ROBERT A. CARO, THE PATH TO POWER (1990).

79. 42 U.S.C. §§ 1962 to 1962d-3 (2006).

80. *See* SOLOMON, *supra* note 75, at 249 ("America's age of great dams drew to a close during the 1970s. By then, virtually all the best large dam sites had been exploited."). For the best account of President Jimmy Carter's role in bringing the Big Dam Era to a close, see REISNER, *supra* note 76.

81. *See* NAT'L RESEARCH COUNCIL, U.S. ARMY CORPS OF ENGINEERS WATER RESOURCES PLANNING: A NEW OPPORTUNITY FOR SERVICE 36–41 (2004) (tracing the evolution of water resources planning from project to environmental restoration and risk-based planning).

82. NAT'L WATER COMM'N, WATER POLICIES FOR THE FUTURE 366 (1973).

navigation, flood control, or water projects."[83] The Commission was especially critical of the lack of focus and coordination in federal water-resources planning, which could be essentially characterized as planning for planning's sake.[84]

D. Manage Floodplains

Dams and levees do prevent significant flood damage, but suffer from two major limitations. First, flood damage can never be totally prevented; it can only be minimized. The Mississippi River illustrates this first problem: its middle and lower sections "are not impounded by any main-channel dams."[85] These dams are insufficient to prevent flood events, especially in the Upper Basin, such as those that occurred in 1993[86] and 2011.[87] Similar examples can be found all over the country.[88]

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83. *Id.* at 412.

84. *Id.* Congress does sometimes mandate a basin-wide approach. For example, in an omnibus act passed in 2009, Congress directed the Secretary of the Interior to assess specific risks to the water supply of each major reclamation river basin, analyze the extent to which changes in the water supply of the United States will impact meeting the needs of the basin resources, and consider and develop appropriate strategies to mitigate each impact of water supply changes. Omnibus Public Land Management Act of 2009, Pub. L. No. 111-11, §§ 9501–08, 123 Stat. 991, 1329–46 (codified as amended at 42 U.S.C. §§ 10361–68 (Supp. III 2009)). "Major reclamation river basins" are defined to include the Columbia, Colorado, Missouri, and Sacramento/San Joaquin river basins. *Id.* § 9502(12)(B), 123 Stat. at 1331.

85. JASON S. ALEXANDER, RICHARC C. WILSON & W. REED GREEN, U.S. GEOLOGICAL SURVEY, A BRIEF HISTORY AND SUMMARY OF THE EFFECTS OF RIVER ENGINEERING AND DAMS ON THE MISSISSIPPI RIVER SYSTEM AND DELTA 11 (2012), *available at* http://pubs.usgs.gov/circ/1375/C1375.pdf. "However, all of [the middle and lower sections] major tributaries have impoundments." *Id.*

86. *See generally* THE GREAT FLOOD OF 1993: CAUSES, IMPACTS, AND RESPONSES (Stanley A. Changnon ed., 1996) (describing a major flood that occurred in 1993 on the Upper Mississippi River and Missouri River Basins); Woltemade, *supra* note 85 (stating the 1993 flood caused $12 billion in damages).

87. *See 2011 Mississippi River Floods*, WIKIPEDIA.ORG, http://en.wikipedia.org/wiki/2011_Mississippi_River_floods (last visited Sept. 23, 2012) (describing major flooding on the Mississippi River in 2011).

88. *See, e.g.*, *Flood Control*, *supra* note 72 ("Despite flood-control efforts, West Virginia remains prone to damaging floods. A flood on April 5, 1977, along the Tug Fork of the Big Sandy River saw 11 counties declared major disaster areas. In November 1985, record flooding in central and eastern West Virginia, especially in the headstream areas of the Greenbrier, Potomac, Monongahela and Little Kanawha rivers, resulted in 47 deaths and hundreds of millions of dollars in property damage. Occasionally, floods strike even in watersheds protected by dams, as was the case in the Little Kanawha Valley downstream of the Burnsville Dam in 1985 and 1994.").

Second, structural solutions have perverse effects: floodplain protection encourages settlement, so that when a flood occurs, the damage often exceeds that which would have been expected prior to dam construction. This is a classic moral-hazard problem. Moral hazard refers to socially undesirable, often inefficient, behavior that is encouraged by the expectation that there will not be punishment; rather, there may often be rewards.[89] The concept originated with insurance-company efforts, such as deductibles, designed to induce beneficiaries to refrain from activities that would trigger liability under a policy.[90]

Today, the need to adjust to the inevitability of floods is accepted by all students of flood policy and is partially reflected in federal flood-control law and policy.[91] But the structural-defense paradigm remains firmly entrenched because of the strong expectations of safety and security it has engendered. Thus, adjustment is often fiercely resisted because it means limiting floodplain development and shifting responsibility to individual landowners to take avoidance actions.[92] The rise of the adjustment or floodplain-management paradigm is the legacy of the late geographer Gilbert White, one of the great students of water and disaster policy in the twentieth century. White's seminal 1942 University of Chicago thesis, *Human Adjustment to Floods*,[93] remains the bible of modern flood-control thinking. "Few publications can claim to have transcended the original field in which they were written, by shaping a wide range of research areas and philosophies."[94] White pioneered the argument that structural flood defense creates a classic moral-hazard problem because government's expectation that dams and levees would protect floodplains leads them to encourage floodplain development.[95] When the inevitable flood comes, property losses and

89. RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 136–37 (8th ed. 2011).

90. *Id*.

91. WORLD METEOROLOGICAL ORG., THE ROLE OF LAND-USE PLANNING IN FLOOD MANAGEMENT: A TOOL FOR INTEGRATED FLOOD MANAGEMENT 22 (2007).

92. In flood control management, "one of the key considerations would be how much land is required to pursue a local development agenda and how much of it is located in hazardous areas. This usually limits the choices considerably." *Id.*

93. GILBERT FOWLER WHITE, HUMAN ADJUSTMENT TO FLOODS: A GEOGRAPHICAL APPROACH TO THE FLOOD PROBLEM IN THE UNITED STATES (1945).

94. N. Macdonald et al., *The Significance of Gilbert White's 1945 Paper "Human Adjustment to Floods" in the Development of Risk and Hazard Management*, 36 PROGRESS PHYSICAL GEOGRAPHY 125, 125 (2012).

95. *See id.* at 127.

other damage increase—the opposite outcome of the justification for structural defense.

White's thinking is now the conventional wisdom when examining flood-protection initiatives. For example, in criticizing the California Central Valley Flood Protection Plan—California's ambitious attempt to address flooding at a large geographic scale—two academics argued that the failure of the plan to impose limits on growth was a classic example of the problems White identified:

> Increasing protection levels actually *increases* risk where it *induces urbanization* and increases the valuable life and property exposed in areas that would otherwise remain undeveloped. That levees induce urban development where it was formerly discouraged by nuisance flooding is well documented. The effect is accepted by scientists and policy analysts, going back to the pioneering work of Gilbert White (1945) . . . .[96]

Adjustment is not just an academic theory. White's thinking formed the basis of the 1968 National Flood Insurance Program.[97] The federal government became involved in flood insurance because private insurance policies do not cover flood (as opposed to wind) damage.[98] Efforts to provide federal insurance date back to 1956, but accelerated when Lyndon Johnson's Administration created task forces to recommend a national flood-insurance program.[99] The ensuing legislation reflected an appreciation of White's moral-hazard analysis, but did not fully implement it. The Bureau of the Budget's task force recommended that Congress first enact an experimental program to evaluate its effectiveness at actually preventing damage.[100] However, in the last burst of faith in government before the Vietnam

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96. Letter from G. Mathias Kondolf, Professor & Chair, Dep't of Landscape Architecture & Envtl. Planning, Univ. of Cal. Berkeley, & Jessica Ludy, Fulbright Fellow, Delft Univ. of Tech., Neth., to Cent. Valley Flood Prot. Bd. (Apr. 20, 2012), *available at* http://thewateraway.wordpress.com/2012/04/24/a-closer-look-at-the-cvfpp-1-does-increasing-protection-increase-risk/. *See generally Central Valley Flood Protection Plan*, CENT. VALLEY FLOOD PROT. BD., http://www.cvfpb.ca.gov/CVFPP/ (last modified Aug. 29, 2012) (providing information on the plan as approved in 2012).

97. Press Release, Fed. Emergency Mgmt. Agency, FEMA Leaders' Statements on the Passing of Gilbert F. White (Oct. 6, 2006), *available at* http://www.fema.gov/news-release/fema-leaders-statements-passing-gilbert-f-white; *see A Chronology of Major Events Effecting the Federal Flood Insurance Program*, NAT'L INST. FOR RESEARCH, http://biotech.law.lsu.edu/blaw/FEMA/nfip_eval_chronology.pdf.

98. *Facts About Flood Insurance*, FED. EMERGENCY MGMT. AGENCY, http://www.fema.gov/pdf/about/divisions/disaster_ops/flood_fs.pdf (last visited Sept. 19, 2012).

99. *See generally* H.R. DOC. NO. 89-465 (1966) (evaluating the benefits of a national flood protection plan).

100. *Id.* at 39.

War, Watergate, and the rise of the right, Congress enacted a national insurance program.

The core elements of the National Flood Insurance Act of 1968[101] are the mapping of 100-year floods, the adoption of local flood-management programs that limit construction in 100-year floodplains, and the requirement that landowners in the hazard areas purchase flood insurance to qualify for a loan.[102] The program provides subsidized rates for buildings constructed before 1974, the year Flood Insurance Rate Maps (FIRMs) were prepared.[103] Post-FIRM buildings must pay full actuarial rates.[104]

The federal flood-insurance program was flawed from the start, and its problems have progressively worsened. In combination with the construction of flood-control projects, a federal flood-insurance program encourages over-building in high-risk areas.[105] Writing on the twenty-fifth anniversary of the program, Gilbert White and the equally distinguished disaster-risk expert Howard C. Kunreuther noted that flood damages continued to increase due to several factors. First, although nine to eleven million people lived in floodplains, only 2.5 million insurance policies were in force.[106] This coverage gap occurred both because many real-estate agents failed to disclose when structures were located in a floodplain, and because banks were lax in enforcing the mandatory insurance requirement for mortgages.[107] Second, a large number of grandfathered structures suffered repeated losses but were not relocated.[108] Third, in the past decade, the federal flood-insurance program has been on life support, living on temporary extensions that have allowed politicians to avoid hard

101. National Flood Insurance Act of 1968, Pub. L. No. 90-448, 82 Stat. 572 (codified as amended at 42 U.S.C. §§ 4001–4127 (2006)).

102. 42 U.S.C. § 4012(a) (2006).

103. *Id.* § 4015(b).

104. *Id.* § 4015(c).

105. *See* Erwann O. Michel-Kerjan, *Catastrophe Economics: The National Flood Insurance Program*, J. ECON. PERSP., Fall 2010, at 165, 179 ("Many residents living in hazard-prone areas not only lack interest in purchasing natural hazard insurance and keeping it, they also rarely undertake voluntary loss prevention measures to protect their property."); *see also* Valdis Wish, *Can Insurers Cope with Climate Change?*, ALLIANZ (Oct. 16, 2009), http://www.knowledge.allianz.com/search.cfm?98/can-insurers-cope-with-climate-change.

106. Howard C. Kunreuther & Gilbert F, White, *The Role of the National Flood Insurance Program in Reducing Losses and Promoting Wise Use of Floodplains*, WATER RESOURCES UPDATE, Spring 1994, at 31, 32.

107. *Id.* at 32–33.

108. *Id.* at 32.

reform questions. The costs of the 2005 hurricane season, which were primarily due to Hurricane Katrina, added eighteen billion dollars of debt to the program, even though it was already running in the red.[109] In July 2012, Congress responded to a strong push by the real-estate industry and extended the program.[110] The National Flood Insurance Extension Act basically leaves the program intact, with minor improvements, but does raise the cap on premium increases for secondary and vacation homes from ten percent to twenty-five percent.[111]

The 1968 Act pressures cities to develop flood-control plans with a mix of structural and non-structural solutions to further stretch the available local, state, and federal money. Cedar Rapids, Iowa is an example of this strategy. In 2008, the city suffered six billion dollars in damages when the Cedar River overflowed its banks.[112] The city responded by creating a flood-management plan to increase the span of floodwalls around the downtown area, but also to develop a greenway across the river to spread the flood waters.[113] The plan raises a classic environmental-justice issue since lower-income residences are often built in unprotected floodplains. Nonetheless, it is an example both of Gilbert White at work and of state-of-the-art river management.

E. Adopt Integrated Risk-Based Floodplain Management

Since 1908, the floodplain-management community has fully embraced the idea that flood damages can at best be minimized, but

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109. Flood Insurance Reform Priorities Act of 2010, H.R. 495, 111th Cong., 22 (2010), reported that the program's debt stood at $18.75 billion primarily because of 2005 hurricane claims. *See generally* WILL HEYES & ANDREW FAHLUND, AM. RIVERS, WEATHERING THE CHANGE: POLICY REFORMS THAT SAVE MONEY AND MAKE COMMUNITIES SAFER 5 (2011), *available at* http://www.americanrivers.org/assets/pdfs/global-warming-docs/weathering-change/weathering-change-full-report.pdf.

110. *See* National Flood Insurance Program Extension Act, Pub. L. No. 112-123, 126 Stat. 365 (2012).

111. *Id.* § 2(b)(2). Second homeowners whose property is destroyed or damaged by a hurricane will no longer be eligible for subsidized rates.

112. Dennis P. Robinson, Regional Economic Impacts of the 2008 Cedar Rapids Flood (May 17, 2010) (unpublished manuscript), *available at* http://www.cedar-rapids.org/city-news/flood-recovery-progress/floodrecoveryplans/Documents/Regional%20Economic%20Development%20Report%205.17.10.pdf.

113. *Cedar Rapids River Corridor Redevelopment Plan*, SASAKI ASSOCS., INC., http://www.sasaki.com/project/131/cedar-rapids-river-corridor-redevelopment-plan/ (last visited Sept. 19, 2012).

this embrace has yet to fully play out on the ground.[114] The assumption that flood damage could be satisfactorily controlled by a combination of structural defense and preventing the construction of vulnerable structures in floodplains proved too simplistic. This assumption has been replaced by the concept of integrated flood-risk management. The policy changes and the difficulties in implementing them are reflected in the responses to the two major flooding events in recent years. The first event was the 1993 Upper Mississippi Flood and the second was Hurricane Katrina in 2005.

During the summer of 1993, heavy rains fell on already-wet soil in the Upper Mississippi basin, causing twelve to sixteen billion dollars in damages.[115] Rainfall amounts ranged from 200 to 350% of normal,[116] and in some areas the floods exceeded 500-year-occurrence estimates.[117] The damage was widespread, especially for farms and small river towns, but it extended to flooded basements in Chicago.[118] Large cities such as Kansas City and St. Louis escaped major flooding,[119] but there were levee failures in both places.[120] A federal task force led by Brigadier General Gerald E. Galloway was formed to investigate the causes of the flood.

The resulting "Galloway Report" remains the most comprehensive examination of flood policy produced by the federal government, but its lessons have yet to be fully implemented.[121] The Report endorsed Gilbert White's call for comprehensive, federal flood management rather than the piecemeal, uncoordinated management strategy that existed then and continues to this day.[122] It also endorsed the notion that flood management had to be done on a

114. *See generally* JAMES M. WRIGHT, ASS'N OF STATE FLOODPLAIN MANAGERS, THE NATION'S RESPONSES TO FLOOD DISASTERS: A HISTORICAL ACCOUNT (Wendy L. Hessler ed., 2000), *available at* http://www.floods.org/PDF/hist_fpm.pdf (providing a detailed account of the evolution of the program and other flood control management initiatives).

115. INTERAGENCY FLOODPLAIN MGMT. REVIEW COMM., *supra* note 10, at 18.

116. *Id.* at 10.

117. *Id.* at 9.

118. *Id.* at 17.

119. *Id.* at 6.

120. *Id.* at 18.

121. For example, the 2012 extension of the National Flood Insurance Program illustrates that inability of Congress to craft a new flood management program. *See supra* notes 109–10 .

122. INTERAGENCY FLOODPLAIN MGMT. REVIEW COMM., *supra* note 10, at 73 (quoting GILBERT WHITE ET AL., ACTION AGENDA FOR MANAGING THE NATION'S FLOOD PLAINS 4–5 (1992)).

watershed basis.[123] The Report is especially notable for its exploration of the role that undeveloped or restored riparian areas and wetlands could play in floodwater retention.[124]

Hurricane Katrina was the worst flood disaster since the 1927 Mississippi River Flood. The response to the disaster was paradoxical. Federal taxpayers have re-armored New Orleans but also recognized the limits of this strategy.[125] Katrina's storm surge damaged some 169 of the 350 miles of floodwalls and levees around New Orleans.[126] The United States Army Corps of Engineers and the National Research Council both evaluated what went wrong, and both reached two major conclusions. First, the system of levees and floodwalls in place was not an integrated, coordinated, and well-maintained system.[127] Second, flood protection strategy in at-risk areas such as New Orleans must be based on an integrated risk-based system that expressly rejects the expectation that complete structural protection against all hydrologic contingencies is possible.[128]

III. THE FUTURE OF FLOOD POLICY

There is a widespread consensus that risk-based adjustment will be the basis for future flood-protection strategy, and that such a strategy is a crucial element of the transition from unsustainable to sustainable urban development.[129] White's vision has been articulated by the policy forum that honors him:

> There is a stronger trend in 2050 toward higher-density development, clustering, in-filling of urban areas, and planning for green infrastructure. The full range of flooding events is taken into account in planning, including low-probability, high-consequence storms. Many no-build zones—such as deep coastal storm surge zones, deep riverine floodplains, and other high-hazard or

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123. *Id.* at 141.

124. *Id.* at 66–67.

125. Schwartz, *supra* note 9.

126. CHRISTINE F. ANDERSEN ET AL., HURRICANE KATRINA EXTERNAL REVIEW PANEL, AM. SOC'Y OF CIVIL ENG'RS, THE NEW ORLEANS HURRICANE PROTECTION SYSTEM: WHAT WENT WRONG AND WHY 25 (2007).

127. U.S. ARMY CORPS OF ENG'RS, BUILDING A STRONGER CORPS: A SNAPSHOT OF HOW THE CORPS IS APPLYING LESSONS FROM KATRINA 8 (2009).

128. NAT'L RESEARCH COUNCIL, THE NEW ORLEANS HURRICANE PROTECTION SYSTEM: ASSESSING PRE-KATRINA VULNERABILITY AND IMPROVING MITIGATION AND PREPAREDNESS 4–5 (2009).

129. *E.g.*, UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME, PLANNING SUSTAINABLE CITIES: GLOBAL REPORT ON HUMAN SETTLEMENTS 2009, at 5 (2009).

> environmentally sensitive areas—are in place, analogous to the floodways and coastal barrier resources system units of the twentieth century. These no-build areas are respected in order to sustain the natural benefits they provide to society, including high-quality water, appropriate habitat for fish, wildlife, and flora; groundwater recharge; recreation; and open spaces, in addition to flood damage abatement. Some communities have been relocated in whole or in part.[130]

The problem is that the United States has been unable to translate the consensus among experts into a coherent policy. The most striking aspect of United States flood policy is the growing gap between, on the one hand, the increasing sophistication of flood and hazard mapping and risk assessment and communication, and on the other, the failure to incorporate these developments into law and policy. We continue to rely on uncoordinated, structural defenses,[131] even as our understanding of the limits of that policy increases and we continue to encourage floodplain development. The last part of the article identifies three barriers to adopting a flood-control policy centered on risk-based adjustment to flood hazards.

A. Lack of an Authoritative Vision

The United States lacks a coherent flood-control strategy that is binding on the states. A vision alone cannot create a coherent flood-management strategy, but it can provide a standard that all subordinate units of government must follow instead of the every-area-for-itself approach that characterizes much of the current United States flood-control practice. The European Union (EU) has implemented such a strategy. In 2007, the EU adopted a Floods

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130. GILBERT F. WHITE NAT'L FLOOD POLICY FORUM, FLOODPLAIN MANAGEMENT 2050, at 13 (2007).

131. For over twenty years, water planners have been urged to plan at the watershed level. The lesson is slowly being absorbed, but the broader scale often only comes about when downstream or upstream interests oppose a project. The Fargo, North Dakota-Moorhead, Minnesota metro area is a case in point. The area is subject to frequent and severe flooding from the Red River, which flows north into Canada. In cooperation with the Corps, the towns are developing a multi-stage $1.7 billion plan which includes a strategy to divert the River around the towns when the River reaches a flood stage. F-M AREA DIVERSION, http://www.fmdiversion.com/ (last visited Sept. 20, 2012). The original diversion has been modified to provide upstream storage facilities to hold back water after downstream cities complained that the diversion would shift the flood damage to them. Jonathan P. Scoll, *Flood Control on the Red River as a Complex Environmental Decision System*, NAT. RESOURCES & ENV'T, Winter 2012, at 24, 27 (2012) (providing a history of the project from the perspective of a lawyer representing downstream communities).

Directive,[132] which integrates flood management into a previously existing Water Framework Directive. EU directives are binding on the member states.[133] They describe general outcomes which must be achieved in the member states through a combination of management and new legislation.[134] The Floods Directive requires that all member states develop river-basin management plans to correct a deficiency in the Water Framework Directive, which failed to include flood-risk minimization as a management objective.[135]

The Flood Directive proceeds from the premise that floods cannot be totally prevented but that the major risks associated with floods can be managed.[136] To this end, all member states must identify the portions of rivers within their boundaries with significant flood risks, and then prepare flood-hazard maps that display the following three flooding scenarios and the probable adverse consequences in each scenario:[137]

> (a) floods with a low probability, or extreme event scenarios;
>
> (b) floods with a medium probability (likely return period $\geq$ 100 years);
>
> (c) floods with a high probability, where appropriate.[138]

The maps form the basis for risk-management plans, which

> shall take into account relevant aspects such as costs and benefits, flood extent and flood conveyance routes and areas which have the potential to retain flood water, such as natural floodplains, the environmental objectives of Article 4 of Directive 2000/60/EC [The

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132. Directive 2007/60/EC of the European Parliament and of the Council of 23 Oct. 2007 on the Assessment and Management of Flood Risks, 2007 (L 288) 27.

133. *E.g.*, Case C-147/07, Comm'n v. France, 2008 E.C.R. 1-0000 (finding that France failed to meet water quality objectives of the Water Framework Directive).

134. *See, e.g.*, Directive 2007/60/EC, *supra* note 132, at art. 4 (dictating that member states shall assess flood risks on river basins, produce flood risk maps, and develop flood risk management plans). CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EUROPEAN UNION, Official J. of the European Union C83/47 Art. 288 (2010) (Treaty of Lisbon). *See generally* TREVOR C. HARTLEY, THE FOUNDATIONS OF EUROPEAN COMMUNITY LAW: AN INTRODUCTION TO THE CONSTITUTIONAL AND ADMINISTRATIVE LAW OF THE EUROPEAN COMMUNITY (7th ed. 2010).

135. *See* Directive 2007/60/EC, *supra* note 132, at art. 7.

136. *Id.* intro. ("Floods are natural phenomena which cannot be prevented. . . . It is feasible and desirable to reduce the risk of adverse consequences, especially for human health and life, the environment, cultural heritage, economic activity and infrastructure associated with floods.").

137. *Id.* arts. 4–6.

138. *Id.* art. 6(3).

> Water Framework Directive], soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure.
>
> Flood risk management plans shall address all aspects of flood risk management focusing on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin. Flood risk management plans may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event.[139]

EU Directives face many implementation problems, but they can lead to the development of new and useful science-based standards[140] and innovative national legislation.[141]

B. No Coherent Disbursal of Federal Funds for Flood Control

The federal government has mostly stopped building large dams but has not stopped the scattered distribution of funds. The federal government now funds flood-control structures, but in an irrational way. The construction of small dams, levees, and other defenses is now the product of two factors: congressional politics and the magnitude of a potential disaster. While this was always the case, the previous constraints on pure pork-barrel politics have been loosened. Congress can still open the federal treasury as it has done for New Orleans after Hurricane Katrina,[142] but, in general, it is funding only small flood-control projects and often only those initiated by local communities. This makes it virtually impossible to follow the precept

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139. *Id.* art. 7(3).

140. The Water Framework Directive requires that pollution management decisions be based on ecological effects rather than sole reliance on the standard parameters of pollution. This has led to innovative monitoring and ecological assessment systems. Daniel Hering et al., *The European Water Framework Directive at the Age of 10: A Critical Review of the Achievements With Recommendations for the Future*, 408 SCI. TOTAL ENV'T. 4007, 4008 (2010). For a less sanguine conclusion, see Henrik Josefsson & Lasse Baaner, *The Water Framework Directive—A Directive for the Twenty-First Century?*, 23 J. ENVTL. L. 463 (2011).

141. Scotland used the Floods Directive in 2009 to enact The Flood Risk Management Act, "which deliberately focuses attention on the extent to which the reduction of flood risk might be achieved through both structural and non-structural options . . . including the potential for 'natural features' in the landscape to help retain flood water." Chris Spray, Tom Ball & Josselin Rouillard, *Bridging the Water Law, Policy, Science Interface: Flood Risk Management in Scotland*, 20 WATER L. 165, 171–72 (2009).

142. Over fifteen billion dollars have been spent to construct a new levee system. John Schwartz, *New Orleans Levees Nearly Ready, But Mistrusted*, N.Y. TIMES, Aug. 24, 2010, at A1, *available at* http://www.nytimes.com/2010/08/24/us/24levee.html?_r=1.

of the EU Floods Directives that floods must be managed at the river basin or watershed scale. The primary federal agency responsible for flood control, the United States Army Corps of Engineers, is not authorized to prioritize the allocation of federal funds.[143]

In 1974, Congress abandoned the practice of large-scale, basin-level project financing exemplified by the 1936 and 1944 Flood Control Acts in favor of episodic Water Resource Development Acts (WRDAs).[144] WRDAs authorize all manner of water projects proposed by individual members of Congress and filtered through the House Committee on Transportation or the Senate Committee on Environment and Public Works. The final legislation is an example of the politics of resource redistribution.[145] This fragmentation was cemented in the 1986 WRDA, which imposed a variety of cost-sharing formulas for new projects, accepting the post–New Deal argument that small projects were only of local importance.[146]

The U.S. Army Corps of Engineers has never had the independent authority to propose and build projects; rather, it must seek Congressional funding on a project-by-project basis. By contrast, through the 1960s, the Corps and Congress worked more closely to plan on larger scales than is the case today.[147] Currently, WRDAs dilute and fragment the Corps' authority to initiate projects, both within the Corps itself and between the Corps and Congress. They also create a strong institutional bias against both planning and constructing on a basin-wide scale and matching money to the magnitude of flood risk and project benefits.[148] WRDAs have also

143. NICOLE T. CARTER & H. STEVEN HUGHES, CONG. RESEARCH SERV., RL32064, ARMY CORPS OF ENGINEERS WATER RESOURCE PROJECTS: AUTHORIZATION AND APPROPRIATIONS 6 (2006).

144. The last WRDA was enacted in 2007. *See* Water Resources Development Act of 2007, Pub. L. No. 110-114, 121 Stat. 1041. The 2007 WRDA was enacted over President George W. Bush's veto and authorizes over 900 Corps of Engineers projects. *U.S. Resources Development Act of 2007,* HYDRO-LOGIC (Nov. 10, 2007), http://hydro-logic.blogspot.com/2007/11/us-water-resources-development-act-of.html.

145. One of the leading students of water project funding characterizes Congressional funding as an example of the politics of the widespread geographical distribution of federal largesse. HELEN INGRAM, WATER POLITICS: CONTINUITY AND CHANGE 38–39 (1990).

146. *See* Water Resources Development Act of 1986, Pub. L. No. 99-662, § 103, 100 Stat. 4082, 4084–85.

147. *See* FERRELL, *supra* note 61, at 125 (describing the coordination between Congress, states, and the Corps beginning in the 1930s).

148. CARTER & HUGHES, *supra* note 143, at 6.

decreased the power of the Corps to use benefit–cost analysis to weed out inefficient local projects.

The inclusion of a project in a WRDA does not ensure its construction. It must also receive an appropriation. The appropriations process is shared between the Corps, the Executive (through the Office of Management and Budget), and Congress.[149] There is no benefit–cost screen for inclusion in a WRDA, but there is for appropriations.[150] However, WRDAs can dribble planning funds to keep small projects alive. As the Congressional Research Service has observed, "the appropriated funds for an individual study or project . . . [may be] insufficient to permit the optimum programming of work by the Corps."[151]

The focus on small projects, often kept alive for years as individual representatives secure the authorization of small amounts of planning money, means that real problems continue to worsen. For example, many of the nation's levees were not constructed to deal with the 100-year flood, let alone the increased frequency and magnitude of floods associated with climate change.[152] In 2010, the Association of State Floodplain Managers issued the following warning concerning risks resulting from the deteriorating levees, climate change, and federal budget priorities:

> We will soon enter an era of levee 'triage'—the process of prioritizing federal response to flood risk associated with levees and rationing scarce federal dollars on multiple-objective risk reduction projects that may include floodplain restoration, reconfiguration of structural systems, and combinations of systems that make the best use of resources.[153]

C. The Chilling Effect of Supreme Court Takings Jurisprudence

Supreme Court takings jurisprudence presents a major barrier to incorporating risk and moral-hazard considerations into land-use

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149. *See* NICOLE T. CARTER & CHARLES V. STERN, CONG. RESEARCH SERV., R41243, ARMY CORPS OF ENGINEERS WATER RESOURCE PROJECTS: AUTHORIZATION AND APPROPRIATIONS 6 (2011).

150. *Id.* at 7.

151. CARTER & HUGHES, *supra* note 143, at 6.

152. For example, after an assessment of Dallas' levees, the Corps withdrew its support for FEMA certification of "a 100 year event." U.S. ARMY CORPS OF ENG'RS, ENVIRONMENTAL ASSESSMENT: 100-YEAR FLOOD EVENT REMEDIATION MEASURES DALLAS FLOODWAY SYSTEM ES-2 (2011).

153. ASS'N OF STATE FLOODPLAIN MANAGERS, NATIONAL FLOOD RISK MANAGEMENT—LEVEE SAFETY COMPONENT 1 (2010).

decisions designed to limit floodplain development. Fairness is the core norm inherent in the Fifth Amendment's prohibitions against the taking of property without due process.[154] Fairness has two dimensions: protecting landowners who are the victims of discrimination and avoiding surprise. Discrimination occurs when a single property owner (or a small group) is singled out to bear a disproportionate burden.[155] The easiest takings cases are usually equal protection cases where the regulation comes too late to be effective.

Unfairness also occurs when a landowner is justifiably surprised by a regulation. The Court incorporated the protection against surprise into takings law in the 1978 *Penn Central* case.[156] *Penn Central*, which upheld a landmark designation, announced a balancing test that implicitly narrowed the situations in which surprise could be claimed by limiting compensation to cases where the government interferes with "reasonable,"[157] "distinct investment-backed expectations."[158]

Flood-control regulation squarely raises the question of whether property owners who develop in a floodplain have any basis to claim they have been unfairly discriminated against or surprised. In general, the answer is no, although flood-control maps still underestimate risks and communities have resisted adjusting them to climate change.[159] Much building in floodplains, at least today, can be characterized as moral-hazard behavior. The problem is that the Court's takings

154. Frank Michelman, *Property, Utility, and Fairness: Comments on the Ethical Foundations of Just Compensation Law*, 80 HARV. L. REV. 1165, 1245 (1967) ("We tend naturally to think of fairness as a standard against which to test political action, a discipline to be administered specifically and with deliberation, an extrinsic constraint to be imposed on an intrinsically nonfair political process.").

155. Armstrong v. United States, 364 U.S. 40, 49 (1960).

156. Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 123–24 (1978). The Supreme Court identified "[t]he economic impact of the regulation on the claimant, and, particularly, the extent to which the investment has interfered with distinct investment-backed expectations" are the major relevant factors in deciding whether compensation is due. *Id.* at 124.

157. Justice Brennan was influenced by Professor Frank Michelman's path-breaking article. *See Penn Cent.*, 438 U.S. at 128 (citing Michelman, *supra* note 154). Professor Michelman identified notice that a claimed property interest would not be recognized as a legitimate basis to deny compensation, and Justice Brennan cited a leading example. *See id.* at 125 (citing United States v. Chandler-Dunbar Water Power Co., 229 U.S. 53 (1913) (holding the Federal government's paramount interest in the use of navigable waters imposes a servitude on such waters and prevents the recognition of the private riparian against the federal government)).

158. *Penn Central*, 438 U.S. at 127 (citing Pa. Coal Co. v. Mahon, 260 U.S. 393 (1922)).

159. DAN HUBER, CTR. FOR CLIMATE & ENERGY SOLUTIONS, FIXING A BROKEN NATIONAL FLOOD INSURANCE PROGRAM: RISKS AND POTENTIAL REFORMS 4 (2012), *available at* http://www.c2es.org/docUploads/flood-insurance-brief.pdf.

jurisprudence creates incentives for property owners to engage in risky behavior.[160] Thus, it performs the opposite of what the surprise component of fairness is designed to do: compensate victims of regulation who have suffered substantial and *unanticipated* losses in the value of their property, which are disproportionate in comparison to those suffered by similarly situated right holders.[161]

Floodplain regulation has a long history, but takings law casts doubts on its ability to deal with the expected severity and geographical scope of floods. Early efforts to limit development in floodplains were initially questioned because the primary purpose was deemed paternalistic.[162] Courts, however, upheld ordinances limiting development in floodplains.[163] An influential Connecticut case involved a challenge to state Water Resources Commission setback restrictions along a river that had recently flooded.[164] A riparian property owner whose buildings were destroyed by a flood and could only use sixty square feet to rebuild challenged the setbacks as a taking.[165] The court held that the refusal to allow a new cinder-block building on a concrete foundation was a "justifiable" preventative measure in light of the loss of life and property caused by the flood.[166]

Floodplain regulation has become harder to sustain under the Supreme Court's post-1978 jurisprudence. Three major opinions involve flood-control regulations, and the Court found a potential

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160. The self-executing nature of the Fifth Amendment and the Court's unwillingness to accept environmental justifications for land use regulations, discussed *infra*, creates a substantial incentive for land owners to challenge regulations as a taking. *See* Klien & Zellmer, *supra* note 32, at 1510–18 (describing the phenomenon as a "double take" because taxpayers subsidize bad behavior through both paying for the construction of flood control structures and compensating land owners for regulatory takings when building in floodplain areas is prohibited). If communities allow risky behavior in flood plains, the government often subsidizes protection through levees and insurance. *Id.* at 1510. If communities try to prevent the behavior, "taxpayers may be forced to compensate disappointed developers." *Id.*

161. *See* Joseph L. Sax, *Land Use Regulation: Time to Think About Fairness*, 50 NAT. RESOURCES J. 455 (2010).

162. Allison Dunham, *Flood Control Via the Police Power*, 107 U. PA. L. REV. 1098, 1107 (1959).

163. *E.g.*, Turner v. County of Del Norte, 101 Cal. Rptr. 93, 96 (Cal. Ct. App. 1972); Turnpike Realty Co. v. Town of Dedham, 284 N.E.2d 891, 901 (Mass. 1972); Vartelas v. Water Res. Comm'n, 153 A.2d 822, 826 (Conn. 1959).

164. *Vartelas*, 153 A.2d at 824–26.

165. *Id.* at 823.

166. *Id.* at 825–26 (noting that the plaintiff had failed to establish that an alternative structure "would serve the plaintiff's purposes and permit the economic utilization of the property").

taking in each. *First English Evangelical Lutheran Church of Glendale v. County of Los Angeles*[167] held that a church camp could claim a temporary taking when Los Angeles County prevented it from rebuilding after the camp was destroyed in a flash flood.[168] The case established for the first time that a court may award damages for a taking in this context, but contained no discussion of the desirability of preventing the land owner from engaging in behavior that is a moral hazard.[169] *Lucas v. South Carolina Coastal Council*[170] held that a state setback regulation on barrier islands, designed to prevent houses from crashing into each other in a hurricane, was a *per se* taking because it deprived the land owner of all economic value of his land.[171] South Carolina argued that the setback regulation was well within its police powers because the setbacks were designed to prevent a landowner from engaging in a harmful use, as opposed to unjustifiably and unfairly forcing her to confer a benefit on the community.[172] The distinction has been urged as a useful test to decide when fairness demands compensation, but Justice Scalia dismissed the distinction on the ground that it was incoherent.[173] For Justice Scalia, a regulation which denies a land owner all valuable development options could only be justified if there was an inherent limitation on the landowner's title, and none was found in this case.[174] For all its questionable analysis, the much-parsed *Lucas* is a simple equal-protection case; the state applied a setback to a barrier island after development on all but plaintiff's lots had occurred.

The third Supreme Court case to ignore the merits of flood-damage prevention involved a city's approval of the expansion of development on a riparian property, on the condition that the owner dedicate a portion of the property in the floodplain for an improved storm drainage system.[175] Development exactions are usually imposed

167. 482 U.S. 304 (1987).

168. *Id.* at 307–08, 322.

169. *See id.* at 322. The Church never recovered damages because a California appellate court held that the regulation was a valid health and safety regulation. First English Evangelical Lutheran Church of Glendale v. County of Los Angeles, 258 Cal. Rptr. 893 (Cal. Ct. App. 1989), *cert. denied*, 493 U.S. 1056 (1990).

170. 505 U.S. 1003 (1992).

171. *Id.* at 1007–09, 1028–32.

172. *Id.* at 1022–1024.

173. *Id.* at 1026.

174. *Id.* at 1027.

175. Dolan v. City of Tigard, 512 U.S. 374, 377–82 (1994).

to offset the external costs of a specific proposed development,[176] and the Supreme Court requires an "essential nexus" between the impact of the development and the exaction and "rough proportionality" between the exaction and the predicted consequence.[177] The Court had no trouble finding a nexus between preventing flood damage and limiting development, but it imposed a very high burden on the city to justify the exaction:[178] "The city has never said why a public greenway, as opposed to a private one, was required in the interest of flood control."[179] The net result of these cases is that courts will still uphold floodplain regulations but are open to takings challenges.[180]

As more is known about flood risk, one could argue that regulation can hardly come as a surprise to property owners. However, the Court has been reluctant to allow governments to provide notice to landowners through legislation that they should not engage in moral-hazard behavior. *Palazzolo v. Rhode Island* seemed to foreclose such legislative notice but nevertheless left a door open to such notice. In that case, Rhode Island defended its refusal to allow the landowner to fill a wetland on the grounds that forty years of wetland regulation had put landowners on notice that it would be difficult to obtain such permission.[181] The Court dismissed the argument that the purchaser of highly-regulated property assumes the risk of development denial with the quip that "[t]he state may not put so potent a Hobbesian stick into the Lockean bundle."[182] Locke himself might be surprised that his labor theory now incorporates the Roman law right of *ius abutendi*—the right to destroy property.[183] However, Justice O'Connor's increasingly influential concurrence opened the door to incorporating moral hazard into takings law. She posited that the level of regulation was relevant to the property owner's reasonable investment-backed expectations, and thus the

176. Nollan v. Cal. Coastal Comm'n, 483 U.S. 825, 837 (1987).

177. *Dolan*, 512 U.S. at 391.

178. *Id.* at 386–87.

179. *Id.* at 393.

180. *See, e.g.*, April v. City of Broken Arrow, 775 P.2d 1347, 1348, 1355–56 (Okla. 1989).

181. Palazzolo v. Rhode Island, 533 U.S. 606, 614, 627 (2001).

182. *Id.* at 627. In her concurrence, Justice O'Connor argued that the property owner's knowledge of the extent of regulation was an element to be considered in determining the compensation, if any, to which he was entitled under the interference with investment backed-expectations standard. *Id.* at 634–35 (O'Connor, J., concurring). On remand, the Rhode Island trial court found that proposed fill would be a public nuisance. J.B. Ruhl, *Making Nuisance Ecological*, 58 CASE W. RES. L. REV. 753, 776 (2008).

183. *See* Lior Jacob Strahilevitz, *The Right to Destroy*, 114 YALE L.J. 781, 787–89 (2005).

level of reasonable compensation.[184] Justice O'Connor's analysis has been adopted by the Federal Circuit in a variety of contexts to deny compensation.[185]

The case that came closest to incorporating moral hazard into takings law is *Casitas Municipal Water District v. United States*.[186] The District had a state water right to apply 2,800 acre-feet of water per year to beneficial use, but to comply with a National Marine Fisheries Biological Opinion (BiOp), the District was required to construct a fish ladder at the intersection of a dam and canal, and to divert between 1,349 and 3,200 acre-feet per year to supply the ladder.[187] Reversing a lower court decision denying compensation, the Federal Circuit Court of Appeals held that the regulation was a physical taking and remanded for a calculation of damages.[188]

On remand, the District invoked projected decreases in water supply from climate change as a reason that the loss of water was a taking.[189] However, after a trial, the Court of Federal Claims found that no damages had occurred and thus did not reach the District's climate change argument.[190] The District argued that the biological opinion had caused a permanent loss of 1,915 acre-feet, measured by the annual reduction of the project's safe yield.[191] The court rejected that damage measure because the measure of any water right is beneficial use.[192] Applying this standard, the court found that storage

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184. *Palazzolo*, 533 U.S. at 634–35 (O'Connor, J., concurring). Compare Justice O'Connor's analysis with her plurality opinion in Eastern Enterprises v. Apfel, 524 U.S. 498, 522 (1998), in which she concluded that retroactive coal miner health care liability interfered with investment-backed expectations of a company that went out of business.

185. *See, e.g.*, Palmyra Pac. Seafoods, L.L.C. v. United States, 561 F.3d 1361, 1365–71 (Fed. Cir. 2009), *cert. denied*, 130 S.Ct. 2402 (2010) (refusing compensation for designation of tidal lands on Palmyra Atol as wildlife refuge closed to commercial fishing); Appolo Fuels, Inc. v. United States, 381 F.3d 1338, 1348–49 (Fed. Cir. 2004) (denying compensable taking in designation of lands under Surface Mine Reclamation Act as unsuitable for coal mining); Rith Energy, Inc. v. United States, 270 F.3d 1347, 1353–53 (Fed. Cir. 2001) (disavowing compensation for revocation of mining permit).

186. 543 F.3d 1276 (Fed. Cir. 2008). For an analysis of the decision see A. Dan Tarlock, *Takings, Water Rights, and Climate Change*, 36 VERMONT L. REV. 731, 753–56 (2012).

187. *Casitas*, 543 F.3d at 1282.

188. *Id.* at 1296.

189. Plaintiff's Post-Trial Brief, Casitas Mun. Water Dist. v. United States, 102 Fed. Cl. 443 (2011) (No. 05-168L), ECF No. 213, asserts that the District has no surplus water and climate change will aggravate its thin margin of safety. The assertion is based on the Expert Report of Edward Aguado, Department of Geography, San Diego State University. *Id.*

190. *Casitas*, 102 Fed. Cl. at 472.

191. *Id.* at 465.

192. *Id.* at 470.

allowed the District both to meet its delivery obligations and to comply with the bypass requirements of the BiOp.[193] Thus, the District's takings claim was not ripe because it had not suffered "an actual reduction in beneficial use."[194] The court's reaffirmation that a water right is limited to water actually applied to beneficial use is an important step in the incorporation of risk and moral hazard into takings law. In explaining why there had not been an interference with beneficial use, the court observed that the District continued to add customers but, "ha[d] not changed how it allocates water to its customers, has not purchased alternative water supplies, has not instituted any mandatory conservation measures or changed its drought contingency measures, and has not increased the price of water due to the biological opinion."[195]

The facts of Casitas do not present a classic moral-hazard problem. There was a forty-year lag between the time that the District signed a contract with the Bureau of Reclamation to obtain water from the Ventura River Project and the time that it was asked to construct a fish ladder to protect listed endangered species.[196] Nonetheless, the court explicitly suggested that the beneficial-use doctrine may require a water-right holder to take affirmative steps to avoid a loss caused by the need to adapt to changed conditions—an implicit moral-hazard analysis.[197] It sanctioned the water-right holder for engaging in moral-hazard behavior by failing to take action that would have avoided the loss.

IV. CONCLUSION

There is a firm consensus among students of flood control policy that the future of flood-management policies must adopt risk-management strategies that mix structural protections with more aggressive land-use and building regulations. There are a great deal of innovative flood protection and management initiatives taking place around the United States, and technological advances in hazard mapping now allow risk managers to display climate range risks at fine scales. However, it will not be easy to translate this consensus into policy on the ground. Three reasons stand out. First, flood

193. *Id.* at 461–62.
194. *Id.* at 474.
195. *Id.* at 470.
196. Casitas Mun. Water Dist. v. United States, 543 F.2d 1276, 1283 (Fed. Cir. 2008).
197. *Casitas*, 102 Fed. Cl. at 454.

control is slowly being devolved to local and regional bodies. The lack of federal money and guidance means that the potential for communities to shift flood risks to upstream or downstream communities remains high. Second, too often the Federal Flood Insurance Program, and the land-use regulations enacted to comply with it, function to allow too much development in at-risk areas.[198] Third, the seemingly deep and entrenched denial of climate change in the United States[199] makes it very difficult for many areas to adjust flood maps to incorporate realistic climate change scenarios, as they must. Thus, in contrast to Europe, the United States has de facto adopted a reactive flood control policy, pursuant to which we are likely to wait for flood disasters and then construct new protection structures while along the way engaging in modest attempts at natural flood retardation and floodplain retreat. Time will tell if this strategy will be adequate to deal with a changing climate and a growing population that loves to be near water.[200]

198. "Even without climate change, these [FEMA-required] maps create incentives to locate in areas of high risk, because flood insurance is only required within areas with at least a one percent chance of serious flooding in any given year." ELLEN HANAK & JAY LUND, ADAPTING CALIFORNIA'S WATER MANAGEMENT TO CLIMATE CHANGE 22–23 (2008), *available at* http://www.ppic.org/content/pubs/report/r_1108jlr.pdf.

199. It is difficult to measure climate change attitudes. A 2012 University of Texas poll taken during the 2012 drought in the center of the country found that 70% of persons surveyed believe that climate change is occurring. Dorsi Diaz, *70 Percent of People in U.S. Now Believe in Climate Change*, EXAMINER (July 20, 2012), http://www.examiner.com/article/70-percent-of-people-u-s-now-believe-climate-change. However, a poll of Iowa farmers found that while 68% percent of those surveyed believe that climate change is occurring, only 10% of the 68% attribute it to human causes. Gregory Meyer, *Climate Skepticism Drenches Drought-Hit US Corn Belt*, FIN. TIMES, Aug. 16, 2012, at 3.

200. The current United States population is 313 million and projections vary from 323 to 458 million as the Bureau of Census explains. "The U.S. population is projected to increase over the next four decades in all of the projection series. The size of the increase in each series is dependent on the level of net international migration." JENNIFER M. ORTMAN & CHRISTINE E. GUARNERI, UNITED STATES POPULATION PROJECTIONS: 2000 TO 2050, at 2 (2009), *available at* http://www.census.gov/population/www/projections/analytical-document09.pdf.