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Escaping a Rigidity Trap: Governance and Adaptive Capacity to Climate Change in the Everglades Social Ecological System

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ESCAPING A RIGIDITY TRAP: GOVERNANCE AND ADAPTIVE CAPACITY TO CLIMATE CHANGE IN THE EVERGLADES SOCIAL ECOLOGICAL SYSTEM

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1. INTRODUCTION

The Everglades is perhaps one of the most recognized ecosystems on the planet. Its international reputation arose in part because of the writings of Marjory Stoneman Douglas, who wove together a rich, natural, social, and cultural depiction of the area entitled *River of Grass*.¹ The ecosystem is characterized as a subtropical wetland, rich in biodiversity and other environmental values.² Such values are reflected in the portions of the Everglades set aside for conservation and preservation.³ The areas of the Everglades with the deepest organic soils now support agricultural production of sugar and vegetables that rely on federal economic support.⁴ A mild subtropical climate also contributes to a tourist economy, and abundant rainfall provides water resources for millions of inhabitants.⁵ Such complexities illustrate a few of the interactions between people and their environment that can be distilled into a conceptual framework of the social-ecological system of the Everglades.

Thousands of years ago, climate change created the Everglades ecosystem and the vast expanse of wetlands that has been the ecological component of a dynamic social-ecological system.⁶ The Everglades wetlands first appeared at the end of the Holocene epoch, some six to eight thousand years before present, due to combination of lower sea levels, a wider Floridian peninsula, and a dryer climate.⁷ As sea levels rose, the climate and topography created the wetland soils hydrology and the vegetation that we now know as the Everglades.⁸ For the past several thousand years, the wetland complex has been sustained by flat topography, large rainfall inputs and saturated soils for most of the year.⁹

Humans have lived in, adapted to, and modified the south Florida ecosystem for millennia.¹⁰ For thousands of years prior to the arrival of Europeans, the Everglades existed as a social-ecological system (SES).¹¹ Archaeological evidence suggests that humans lived in the area long before the current wetland ecosystem came into being, and adapted to a transforming landscape.¹² Pre-Columbian humans modified their environment in a variety of ways, including small-scale construc-

1. See generally MARJORY STONEMAN DOUGLAS, *THE EVERGLADES: RIVER OF GRASS* (1947).

2. See generally Lance H. Gunderson & William F. Loftus, *The Everglades*, in *BIODIVERSITY OF THE SOUTHEASTERN UNITED STATES/LOWLAND TERRESTRIAL COMMUNITIES* 199–255 (William H. Martin ed., 1993); *EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION* (Steven M. Davis & John C. Ogden eds., 1994) [hereinafter *EVERGLADES*].

3. See generally Stephen S. Light et al., *The Everglades: Evolution of Management in a Turbulent Ecosystem*, in *BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS* 103–68 (Lance H. Gunderson et al. eds., 1995).

4. G.H. Snyder & J.M. Davidson, *Everglades Agriculture: Past, Present and Future*, in *THE EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION* 85–116 (Steven M. Davis & John C. Ogden eds., 1994).

5. See generally Lance H. Gunderson et al., *Lessons from the Everglades: Learning in a Turbulent System*, 45 *BIOSCIENCE SUPP.* 66–73 (1995).

6. Patrick J. Gleason & Peter Stone, *Age, Origin, and Landscape Evolution of the Everglades Peatland*, in *EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION* 149–98 (1994).

7. *Id.*

8. See generally *EVERGLADES*, *supra* note 2.

9. See generally *EVERGLADES*, *supra* note 2.

10. See generally *TEBEAU*, *supra* note 8.

11. See generally *id.*

12. See generally *DOUGLAS*, *supra* note 1, at 57–79.

tions of agricultural sites, dwellings, middens, and travel routes throughout the interior regions of the area.¹³ On larger scales, humans moved plants and animals throughout the Caribbean region, changing the composition of the flora and fauna.¹⁴ Early dwellers also actively managed fire, a key ecological process, using it for a variety of purposes such as game management.¹⁵

While the biophysical environment has shaped the Everglades ecosystem for tens of thousands of years, it was during the past century that humans have increased their control over nature in south Florida.¹⁶ That control was achieved by creating a complex social-ecological system for managing water, reflecting a commanding role of humans in the system.¹⁷

In order to originally meet a small set of social objectives, such as flood control, the water management system developed technologies and rule sets to control, redirect, and stabilize hydrological and ecological processes.¹⁸ That is, structures such as levees and reservoirs not only increase the storage capacity of water systems, but also alter the timing, magnitude and distribution of downstream flows.¹⁹ Levees prevent the spreading of floodwaters into areas designated for human use, such as development or agriculture areas. In addition to redirecting and redistributing water, land use changes also resulted in redirection of sediments and nutrients movement.²⁰ These structures and management systems have been successful in achieving a diverse set of societal goals, albeit some more than others. However, these systems are not static entities.

The water management system of the Everglades has changed, adapted, and evolved over time.²¹ When viewed over time frames of decades to centuries, this system responded and adapted to a broad set of factors in such a way that both the social configurations and ecological configurations were transformed.²² The evolution of these resource systems did not unfold in a linear, gradual, progressive fashion, but rather happened in abrupt, disjunctive, and unpredictable steps.²³ Such transformations are characterized by different ecological conditions (indicated by the designation of an endangered species, such as the Cape Sable sparrow) or institutional configurations (such as the creation of South Florida Water Management

13. *See id.*

14. *See generally* Gunderson & Loftus, *supra* note 2.

15. *See, e.g.*, WILLIAM B. ROBERTSON, JR., A SURVEY OF THE EFFECTS OF FIRE IN EVERGLADES NATIONAL PARK 13 (1953), available at http://sofia.usgs.gov/publications/reports/survey_fire/Fire_In_ENP_Robertson_1953.pdf.

16. *See generally* DOUGLAS, *supra* note 1; NELSON MANFRED BLAKE, LAND INTO WATER—WATER INTO LAND: A HISTORY OF WATER MANAGEMENT IN FLORIDA (1980).

17. *See generally* Gunderson et al., *supra* note 5.

18. *See generally* Stephen S. Light & J. Walter Dineen, *Water Control in the Everglades: A Historical Perspective*, in EVERGLADES: THE ECOSYSTEM AND ITS RESTORATION 47, 47–84 (Steven M. Davis & John C. Ogden eds., 1994).

19. *See generally id.*

20. *See generally* EVERGLADES, *supra* note 2.

21. Stephen S. Light et al., *The Everglades: Evolution of Management in a Turbulent Ecosystem*, in BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS 103, 103–168 (1995).

22. *See generally* Light et al., *supra* note 3.

23. *See generally* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS (Lance H. Gunderson & C.S. Holling eds., 2002) [hereinafter PANARCHY].

District). Such changes have been described by many authors,²⁴ and have been a result of changes to the system property of ecological resilience.²⁵ Such abrupt transformations occur as a result of at least three pathways:²⁶ (1) Human technology alters key biophysical processes that lead to a direct ecological or social regime shift; (2) Infrequent, large-scale events such as storms or extreme precipitation overwhelm the system's capacity to control or contain or manage the event that can lead to ecological and social transformations; or (3) Human management to stabilize key ecosystem processes leads to an erosion of ecological resilience that in turn alters ecological and social regimes.

Regime shifts or transformations²⁷ are one way of describing dramatic and systemic change in coupled social-ecological systems. In the ecological realm, sudden and unexpected changes in populations are observed. Algae blooms, in lakes and shallow marine systems, are a result of a sudden increase in population of these microbes as a result of complex trophic and nutrient dynamics.²⁸ The invasion of exotic species, such as zebra mussels in the US Great Lakes, can lead to shifts in dominant biological and physical processes.²⁹ In the socio-economic domain, changes in political power, economic, and market demands can also result in abrupt shifts of land use and profitability. Other such economic factors can heavily influence how and whether large-scale water management projects develop or are shelved and collapse. Many regional scale water resource systems have a history of recurring shifts in the ecological and social components of the system.³⁰ Such changes are described in more detail below.

Changing climate will pose important questions for those who manage the water infrastructure in southern Florida. One such question is will the climate become wetter, drier, or both? How will changes in tropical cyclones influence the manifestation of those changes at regional scales? What is the capacity of the social system to adapt, evolve, or devolve? How can conservation lands adapt to rising sea levels and the resultant ecological shifts?

We attempt to respond to these questions in four subsequent sections. We begin with a recap (Part II) of the historic pattern of development in the Everglades SES during the twentieth century, indicating the ebb and flow of resilience, and shifts in social values and environmental crises. Part III assesses the resilience of the current water resource system (ecological and human components) to future

24. See generally Carl Folke et al., *Regime Shifts, Resilience, and Biodiversity in Ecosystem Management*, 35 ANN. REV. OF ECOLOGY, EVOLUTION, & SYSTEMATICS 557, 557–81 (2004); RESILIENCE AND THE BEHAVIOR OF LARGE SCALE SYSTEMS (Lance H. Gunderson & L. Pritchard eds., 2002).

25. See generally C.S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. OF ECOLOGY & SYSTEMATICS 1, 1–23 (1973).

26. See generally PANARCHY, *supra* note 23.

27. B. WALKER & D. SALT, RESILIENCE THINKING: SUSTAINING ECOSYSTEMS AND PEOPLE IN A CHANGING WORLD (2006); Brian Walker et al., *Resilience, Adaptability and Transformability in Social-Ecological Systems*, 9 ECOLOGY & SOC'Y no. 2, art. 5 (2004), available at <http://www.ecologyandsociety.org/vol9/iss2/art5/>.

28. Scheffer et al., *Catastrophic Shifts in Ecosystems*, 413 NATURE 591, 591–96 (2001).

29. See generally WALKER & SALT, *supra* note 27.

30. See generally Gunderson et al., *supra* note 5; W. Franklin Harris, *Policy and Partnership: What Have We Learned? How Can We Do Better?*, 45 BIOSCIENCE SUPP. 64, 64–65 (1995); Jerry F. Franklin, *Scientists in Wonderland: Experiences in Development of Forest Policy*, 45 BIOSCIENCE SUPP. 74, 74–78 (1995).

climate change. Part IV evaluates the adaptive capacity (the ability of the system to manage regime shifts) of the current governance (including legal constraints) to anticipated climate shifts. We conclude in Part V with a summary of how the SES seems to be in a hierarchy or rigidity trap³¹, and a discussion of obstacles to and opportunities for adaptation to impending climate change.

II. HISTORY OF ADAPTATION AND TRANSFORMATION

Since the late 1800s, people have attempted to command and control the water resources of south Florida for specific societal goals.³² Those goals have included: a) preventing floods and draining excess water, b) supplying water during droughts, and c) maintaining high quality, clean water. While trying to achieve these goals, the management system has altered the quality, quantity, and distribution of water in south Florida. “This was accomplished by constructing and operating a massive water-control system of levees, canals, pumps, spillways, other structures, and adopting a complex set of operating rules that are implemented by governmental agencies at the local, state and federal level.” That system of water control has enabled dramatic development of urban and economic development along the southeastern coast.³³ Currently, about eight million people reside in the watershed and depend upon this large system for water supply and flood control,³⁴ as do a viable agricultural community and a thirsty environment. The allocation of water among urban, agricultural, and environmental sectors has as rich and disputed history as the water management system itself.

Understanding the historical development of the south Florida water management system provides insight into the resilience of the current SES. Resilience is about the capacity of the system to respond to an external or unforeseen shock or perturbation.³⁵ Historical shocks or perturbations in the Everglades water management SES were unforeseen floods, droughts, and water pollution.³⁶ Many of these shocks were viewed as a type of environmental crisis, when the ecosystem behaves in surprising or unexpected manner, and usually signals a failure of extant policy.³⁷ Moreover, Light and colleagues presented a pattern of development of the south Florida water management system in which environmental crisis (or instabilities in the system) led to shifts in the management regime.³⁸ Such changes in the SES correspond to a regime shift.³⁹ The following paragraphs describe how the SES transformed or adapted in response to three categories of events that tested the resilience

31. A hierarchy or rigidity trap occurs when a complex SES maintains stability over time, is resilient to change, is resistant to new ideas or experimentation, and requires large flows of resources to maintain the stable state. See generally PANARCHY, *supra* note 23.

32. See Gunderson et al., *supra* note 5, at 67.

33. Mark A. Harwell et al., *Ecosystem Management to Achieve Ecological Sustainability: The Case of South Florida*, 20 ENVTL. MGMT. 497 (1996).

34. *About Us*, S. FLA. WATER MGMT. DISTRICT, <http://www.sfwmd.gov/portal/page/portal/xweb%20about%20us/sfwmd%20about%20us> (last visited Dec. 19, 2014).

35. C.S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. OF ECOLOGY & SYSTEMATICS 1 (1973).

36. Light et al., *supra* note 3, at 103–68.

37. *Id.*

38. *Id.*

39. Holling, *supra* note 35.

of the SES; 1) too much water (floods), 2) too little water (droughts), and 3) unclean water (pollution episodes).

A. Changes in Management Regimes Due to Floods.

In 1905, Napoleon Bonaparte Broward was elected Governor of Florida in part on a promise to drain the Everglades, and make wet land dry.⁴⁰ Early canals were dug to remove excess standing and floodwaters. This drainage led to development and the construction of small earthen dikes around the southern part of Lake Okeechobee to protect the growing population. These levees were breached during the hurricane of 1928, resulting in extensive flooding and a loss of about 2,400 lives.⁴¹ In response, the federal government funded the construction of the Herbert Hoover Dike around the lake, which was completed by 1938, in order to contain floodwaters. Extensive flooding returned in 1947, following an extremely wet season. The flood resulted in the federal Flood Control Act in June 1948.⁴² The act authorized the U.S. Army Corps of Engineers to develop a plan known as the Central and Southern Florida Project for Flood Control and Other Purposes. The plan called for the protection of the east coast and agricultural areas from flooding, and to provide recharge of regional aquifers in order to prevent saltwater intrusion. In 1949, the state legislature created the Central and Southern Florida Flood Control District (FCD)⁴³ to act as local sponsors for the federal project. In 1977 the FCD was renamed the South Florida Water Management District (SFWMD), at which time other objectives of managing water supply and enhancing environmental resources were added to the agency's mission.

B. Changes in Management Regimes Due to Droughts

Just as flood events triggered regime shifts, so did a series of droughts, as they prompted reexamination of the legal underpinnings that guided rules for allocation among users in the system. In 1962 a drought prompted federal scientists to develop a formula for delivering water to Everglades National Park.⁴⁴ This conflict, created by a diversion of upstream waters away from a National Park Service unit, was subsequently resolved by the passage of the River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970,⁴⁵ which assured the park a minimum flow of water. Droughts of the late 1960s and early 1970s led to sweeping reforms in state legislation with the passage of the Florida Water Resources Act of 1972 (Chapter 373, Florida Statutes) codifying Dean Frank Maloney's reasonable-beneficial use doctrine that anticipated severe droughts requiring

40. See generally BLAKE, *supra* note 16, at 94–112.

41. See BLAKE, *supra* note 16, at 113.

42. Flood Control Act of 1948, Pub. L. No. 80-858, 62 Stat. 1171.

43. See Richard Hamman, *Florida's Water Management Framework*, in ADAPTIVE GOVERNANCE AND WATER CONFLICT: NEW INSTITUTIONS FOR COLLABORATIVE PLANNING 15, 17 (John T. Scholz & Bruce Stiftel eds., 2005).

44. A. Dan Tarlock, *Protection of Water Flows for National Parks*, 22 LAND & WATER L. REV. 29, 35 (1987).

45. River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970, Pub. L. No. 91-282, 84 Stat. 310.

water restrictions in the future.⁴⁶ In the same act, the Florida Legislature established five water management districts around the state, each based on hydrologic boundaries.⁴⁷ A nine-member board governs each district, with each member appointed by the Governor. The districts have authority over almost all aspects of freshwater notwithstanding the estuaries and certain water quality responsibilities. They oversee four principal functions: water supply, flood control (including storm water), water quality (for resource protection), and natural systems. The districts allocate permits to municipalities for withdrawal, treatment, and distribution. All withdrawals for agricultural, residential, industrial, and commercial developments require permits that are managed by the districts. The districts' operations are funded by ad valorem property taxes, which have provided a stable and exceptional fiscal base for the institution. The districts have been assessed as innovative and responsive organizational⁴⁸ and institutional⁴⁹ structures for water management.⁵⁰

The legal theory behind the Water Resources Act is the Reasonable Beneficial Use Doctrine drafted by Dean Maloney of the University of Florida Law School.⁵¹ The doctrine is a hybrid of the two principal water doctrines in the United States: the prior appropriation doctrine, which makes water a privately held right, and the riparian doctrine, which requires existing users to share water with new users as they come on line. The doctrine and subsequent acts have created a flexible and equitable process for distributing water. Through permitting, water is allocated based on the public interest test, which is intended to be equitable, and sustainable in the sense of preserving resources (wetlands, archeological sites, minimum flows, and levels) for the future.⁵²

C. Water Pollution Events Trigger Lawsuits and Ecosystem Restoration

In the 1980s, the degradation of water quality became the major environmental issue in south Florida. Recurring algae blooms in Lake Okeechobee were attributed to nutrient runoff from cattle farms to the north of the lake and from crop and agriculture to the south.⁵³ “The water quality crisis in the lake led to a shift in policies of how water was moved across the landscape, and to management practices that limited nutrient inputs to the lake.” When water could no longer be pumped from agricultural fields to the lake, it was moved south, resulting in shifts in vegetation, algae and benthic communities⁵⁴. In 1988, the US federal government filed a lawsuit against the State of Florida alleging that the State had failed to enforce the

46. Hamman, *supra* note 43, at 17.

47. *Id.*

48. Organizations are defined as formal and informal groups of people. See BLACK'S LAW DICTIONARY 1274 (10th ed. 2014).

49. Institutions are comprised of laws, procedures, and rules that guide human decisions and actions. See *id.* at 918.

50. See ADAPTIVE GOVERNANCE AND WATER CONFLICT: NEW INSTITUTIONS FOR COLLABORATIVE PLANNING (John T. Scholz & Bruce Stiftel eds., 2005); Lance H. Gunderson et al., *Water RATs (Resilience, Adaptability, and Transformability) in Lake and Wetland Social-Ecological Systems*, 11 *ECOLOGY & SOC'Y* no. 1, art. 16 (2006), available at <http://www.ecologyandsociety.org/vol11/iss1/art16/>.

51. See generally A MODEL WATER CODE (FRANK E. MALONEY ET AL., 1972).

52. See Hamman, *supra* note 43 at 17; Gunderson et al., *supra* note 5.

53. Nicholas Gerard Aumen, *The History of Human Impacts, Lake Management, and Limnological Research on Lake Okeechobee, Florida (USA)*, 45 *ADVANCES IN LIMNOLOGY* 1–16 (1995).

54. See EVERGLADES, *supra* note 2.

state's water quality laws that implemented the federal Clean Water Act, damaging federal resources.⁵⁵

Since 1990, a major focus of management in the Everglades has been ecosystem restoration. This effort began with a modest attempt by scientists in the system to synthesize existing information in ways that would help to solve chronic environmental issues, such as decline in wading bird populations, vegetation changes, and changes in aquatic biota, among others.⁵⁶ The scientific volume,⁵⁷ in turn, led a number of formal planning processes such as the United States Army Corps of Engineers' Restudy of the Central and Southern Florida Flood Control Project,⁵⁸ a state-federal taskforce, and the Governor's Commission for a Sustainable South Florida, which culminated in the passage of the Everglades Restoration Act in 2000 by Congress.⁵⁹ "That act authorized up to \$7.8 billion for restoration purposes."⁶⁰ A key goal of the restoration program was to restructure the timing, distribution, and magnitude of water flow to Everglades National Park⁶¹ while still meeting societal objectives of flood control, water supply, and nutrient abatement. As of this writing, ecosystem restoration has foundered on the shoals of competing interests.⁶² The outcomes and practices of this long-term project will be discussed in the subsequent section on adaptive governance.

D. The Role of Law in Adaptation and Transformation

Historically, the water management districts of Florida had great discretion in operating regional flood control systems.⁶³ But litigation spawned and swamps the modern era of Everglades' restoration.⁶⁴ The lawsuit filed in 1988, in which the United States sued the South Florida Water Management District, cited the adverse water quality effects of water management upon Everglades National Park and the Loxahatchee National Wildlife Refuge.⁶⁵ In other words, the state governmental entity charged with responsibility to operate the regional flood control system was sued by the federal government for the consequences of operating the system that the federal government had designed, built and approved.

The lawsuit served as a critical turning point for the Everglades. It triggered years of multi-party litigation, including affirmative defenses against the US Army Corps of Engineers and disputes over intervention.⁶⁶ But eventually, the parties

55. DEWITT JOHN, CIVIC ENVIRONMENTALISM: ALTERNATIVES TO REGULATION IN STATES AND COMMUNITIES 136 (1994).

56. See generally EVERGLADES, *supra* note 2.

57. *Id.*

58. Water Resources Development Act of 1992, Pub. L. No. 102-580, § 309(I), 106 Stat. 4842.

59. Water Resources Development Act of 2000, Pub. L. No. 106-541, 114 Stat. 2572.

60. Gunderson et al., *supra* note 5.

61. See *Everglades Restoration: Section Overview*, COMPREHENSIVE EVERGLADES RESTORATION PLAN (CERP), http://www.evergladesplan.org/about/landing_about.aspx (last visited Nov. 19, 2014).

62. Gunderson et al., *supra* note 5, at 332.

63. See, e.g., *Platt v. S. Fla. Water Mgmt. Dist.*, 370 So.2d 1159 (Fla. Dist. Ct. App. 1978); *S. Dade Land Corp. v. Sullivan*, 155 F.R.D. 694 (S.D. Fla. 1994).

64. See John J. Fumero & Keith W. Rizzardi, *Everglades Ecosystem: From Engineering to Litigation to Consensus-Based Restoration*, 13 ST. THOMAS L. REV. 667 (2001).

65. *United States v. S. Fla. Water Mgmt. Dist.*, No. 88-1886-CIV-HOEVELER (S.D. Fla. 1988).

66. *United States v. S. Fla. Water Mgmt. Dist.*, 922 F.2d 704 (11th Cir. 1991).

pursued an alternative path. Without prior briefing of the lawyers representing the state entities, Florida Governor Lawton Chiles—a lawyer himself—walked into the federal courthouse in Miami on May 21, 1992, and announced that the State of Florida was prepared to change history and end the litigation:

I came here today convinced that continuing the litigation does little to solve the problem to restore the Everglades. . . . I am ready to stipulate today that that water is dirty. I think that [what] we are really about, Your Honor, though is how do we get clean water? What is the fastest way to do that? . . . I am here and I brought my sword. I want to find out who I can give that sword to and I want to be able to give that sword and have our troup[sic] start the reparation, the clean-up. . . . We want to surrender. We want to plead that the water is dirty. We want the water to be clean, and the question is how can we get it the quickest.⁶⁷

Governor Chiles's statements led to the negotiation of a settlement agreement, eventually codified as a court-approved federal consent decree.⁶⁸ In addition, in return for Flo-Sun Land Corporation's agreement to reduce phosphorus flows in the Everglades by complying with the emerging regulatory program, the United States agreed not to sue the sugar company for a period of 10 years. The court upheld that agreement, too.⁶⁹ Ultimately, the principles of these settlement agreements were codified by state law in the Everglades Forever Act (EFA), Section 373.4592, Florida Statutes. But the consent decree and EFA, rather than sculpting a new vision for the Everglades, simply introduced a new tool. An era of endless Everglades litigation began. Waves of regulation and litigation have relentlessly modified, slowed, or even stopped the restoration progress.

When the South Florida Water Management District, Florida Department of Environmental Protection, and US Department of Justice finally agreed to those historic settlement terms, interested stakeholders quickly sought administrative review of the agency decisions. At the time, the court concluded that administrative review of the settlement was premature. Instead, the court concluded that additional scrutiny would be afforded when the agency took actions to implement the agreement.⁷⁰

How right those judges were. The scrutiny has never stopped. To begin with, despite the state's investment of \$1.8 billion, construction of 57,000 acres of treatment marshes, treatment of more than 1,700 tons of phosphorus, and regulation of 640,000 acres of agricultural lands, "excursions" from water quality requirements continue to occur.⁷¹ Indeed, twenty years after the historic settlement, the US De-

67. Transcript of Hearing Proceedings at 76–77, *United States v. S. Fla. Water Mgmt. Dist.*, No. 92-4314-CIV-HOEVELER (May 21, 1992).

68. *United States v. S. Fla. Water Mgmt. Dist.*, 847 F. Supp. 1567 (S.D. Fla. 1992).

69. *Miccosukee Tribe of Indians of Fla. v. United States*, 6 F. Supp. 2d 1346 (S.D. Fla. 1998).

70. *Pahokee Water Control Dist. v. S. Fla. Water Mgmt. Dist.*, 617 So.2d 1065 (Fla. Dist. Ct. App. 1993); *Fla. Sugar Cane League v. S. Fla. Water Mgmt. Dist.*, 617 So.2d 1065 (Fla. Dist. Ct. App. 1993).

71. S. Fla. Water Mgmt. Dist., *Quick Facts on Everglades Restoration*, EVERGLADES RESTORATION PROGRESS, Jan. 2014, available at http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/spl_everglades_progress.pdf; S. FLA. WATER MGMT. DIST., SOUTH FLORIDA ENVIRONMENTAL REPORT: EXECUTIVE SUMMARY 2014 5 (2014), available at

partment of Justice continues to pursue enforcement actions against the South Florida Water Management District for consent decree violations.⁷²

Meanwhile, the state statute, the Everglades Forever Act, was supposed to be the blueprint for Everglades' restoration. Instead, it too became an independent source of decades of litigation. Permits issued pursuant to the EFA, which recognized the near-term and long-term "schedules and strategies" at issue, have been upheld by Florida courts.⁷³ The establishment of ten parts per billion of phosphorus as the numeric interpretation of a narrative "no imbalance of flora and fauna" standard also proved time consuming and controversial, albeit ultimately defensible.⁷⁴ Yet actual compliance with the water quality standards in the ecosystem has proven difficult, and delays in construction of the stormwater treatment areas and other considerations eventually led the state legislature to modify the deadlines in the EFA. The amendments spawned yet another lawsuit. Concerned that the amended EFA was inconsistent with the original consent decree, the court appointed a special master to supervise the process, and later, to determine appropriate remedies.⁷⁵

E. Rewriting the Everglades Blueprints

Through settlement and legislative negotiations, the executive and legislative branches of the state and federal government labored intensely to plan for a sustainable Everglades. But despite the good intentions of the Everglades Consent Decree and Everglades Forever Act, the ecological system continues to surprise. Floods and droughts influence water quality compliance, and the 1,800 miles of canals sprawling throughout the entire Central and South Florida Flood Control system—built more than fifty years ago—were not designed with water quality compliance in mind. In the compartmentalized and channelized Everglades ecosystem, sustainability is a difficult task, even under the best conditions. Climate change, of course, will change the Everglades even more. In its report, *Climate Change and Water Management in South Florida*, the South Florida Water Management District concluded that the Everglades ecosystem could be substantially altered by (1) rising seas; (2) temperature and evapotranspiration; (3) rainfall, floods, and drought; and (4) tropical storms and hurricanes.⁷⁶

http://my.sfwmd.gov/portal/page/portal/pg_grp_sfwmd_sfer/portlet_prevreport/2014_sfer/2014_sfer_executive_summary.pdf.

72. See, e.g., *United States v. S. Fla. Water Mgmt. Dist.*, 2011 WL 1099865 (S.D. Fla. 2011); *United States v. S. Fla. Water Mgmt. Dist.*, 2011 WL 4591946 (S.D. Fla. 2011); *United States v. S. Fla. Water Mgmt. Dist.*, 2011 WL 4595016 (S.D. Fla. 2011); *United States v. S. Fla. Water Mgmt. Dist.*, 2010 WL 1292275 (S.D. Fla. 2010); *United States v. S. Fla. Water Mgmt. Dist.*, 2010 WL 6268442 (S.D. Fla. 2010); *United States v. S. Fla. Water Mgmt. Dist.*, 2005 WL 1327359 (S.D. Fla. 2005).

73. *Miccosukee v. S. Fla. Water Mgmt. Dist.*, 721 So.2d 389 (Fla. Dist. Ct. App. 1998).

74. News Release, Fla. Dept. of Env'tl. Prot., Judge Favors Everglades Water Quality Standards (June 17, 2004), available at http://internetbeta.dep.state.fl.us/secretary/news/2004/june/0617_efa.htm; see also Keith W. Rizzardi, *Translating Science into Law: Phosphorus Standards in the Everglades*, 17 J. LAND USE & ENVTL. L. 149 (2001).

75. *United States v. S. Fla. Water Mgmt. Dist.*, 2003 WL 21145799 (S.D. Fla. 2003); *United States v. S. Fla. Water Mgmt. Dist.*, 373 F.Supp.2d 1338 (S.D. Fla. 2005).

76. INTERDEPARTMENTAL CLIMATE CHANGE GRP., S. FLA. WATER MGMT. DIST., CLIMATE CHANGE AND WATER MANAGEMENT IN SOUTH FLORIDA 6–18 (2009), available at

Perhaps the state and federal executive agency bureaucrats, and the many legislators, could craft plans to adapt to the future. Yet the most formidable obstacle to Everglades restoration might now be the competing interest group interpretations of the countless other laws within which the Everglades legislation must operate. Any comprehensive measure implemented by water managers seeking to restore or modify the Everglades ecosystem can be sidetracked or second-guessed. Single-purpose regulatory programs like the Clean Water Act (CWA) and Endangered Species Act (ESA), and process oriented requirements of the National Environmental Policy Act (NEPA) and even the Federal Advisory Committee Act, become platforms for stakeholders to intervene in the restoration process to tweak it in their favor or block aspects they perceive as counter to their interests. Instead of promoting ecological and social resilience, these laws and programs fragment the SES into pigeonholes (water quality, species habitat, flood control, etc.) and frustrate inter-agency coordination. They also erect powerful substantive and procedural demands that are not necessarily always in the best interests of comprehensively and adaptively restoring and maintaining SES resilience.

Unsatisfied with the consent decree and EFA process, tribes and other environmentally minded advocates have frequently used the CWA to require even more stringent requirements to be imposed in the Everglades. For example, they challenged the state EFA as a change in water quality standards, one that must be reviewed and approved by the United States Environmental Protection Agency.⁷⁷ Litigation over this one procedural nuance of the CWA has been ongoing for more than a decade, leaving continuous uncertainty over the legality of the blueprint for Everglades restoration, and the deadlines therein.⁷⁸ Similarly, stakeholders have argued over whether various water management structures throughout the Everglades, which move water, require National Pollutant Discharge Elimination System (NPDES) permits. Litigation over this point has reached the United States Supreme Court,⁷⁹ necessitated controversial new federal rulemaking,⁸⁰ and once again, has spread over more than a decade.⁸¹ Complicating matters even more, the

http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/climate_change_and_water_management_in_sflorida_12nov2009.pdf.

77. *Id.*

78. *Miccosukee Tribe of Indians of Fla. v. United States*, 105 F.3d 599 (11th Cir. 1997); *Miccosukee Tribe of Indians of Fla. v. United States*, No. 04-21448-CIV, 2011 WL 1624977 (S.D. Fla. 2011); *Miccosukee Tribe of Indians of Fla. v. United States*, 706 F. Supp. 2d 1296 (S.D. Fla. 2010); *Miccosukee Tribe of Indians of Fla. v. United States*, No. 04-21448-CIV, 2010 WL 3860712 (S.D. Fla. 2010); *Miccosukee Tribe of Indians of Fla. v. United States*, 722 F. Supp. 2d 1293 (S.D. Fla. 2010); *Miccosukee Tribe of Indians of Fla. v. United States*, No. 04-21448-CIV, 2008 WL 2967654 (S.D. Fla. 2008); *Miccosukee Tribe of Indians of Fla. v. S. Fla. Water Mgmt. Dist.*, No. 98-06056-CIV, 2007 WL 7377465 (S.D. Fla. 2007); *Miccosukee Tribe of Indians of Fla. v. United States*, No. 04-21448-CIV, 04-22072-CIV., 05-20663-CIV, 2006 WL 648055 (S.D. Fla. 2006); *Miccosukee Tribe of Indians of Fla. v. United States*, No. 95-0533-CIV-DAVIS, 1998 WL 1805539 (S.D. Fla. 1998).

79. *S. Fla. Water Mgmt. Dist. v. Miccosukee Tribe of Indians*, 541 U.S. 95 (2004).

80. National Pollutant Discharge Elimination System (NPDES) Water Transfers Proposed Rule, 71 Fed. Reg. 32887 (proposed June 7, 2006).

81. *Friends of the Everglades v. EPA*, 699 F.3d 1280, 1282 (11th Cir. 2012); *Friends of the Everglades v. S. Fla. Water Mgmt. Dist.*, 570 F.3d 1210, 1210 (11th Cir. 2009); *Miccosukee Tribe of Indians of Fla. v. S. Fla. Water Mgmt. Dist.*, 559 F.3d 1191, 1192 (11th Cir. 2009); *Miccosukee Tribe of Indians of Fla. v. S. Fla. Mgmt. Dist.*, 280 F.3d 1364 (11th Cir. 2002); *Friends of the Everglades v. S. Fla. Water Mgmt. Dist.*, 865 F. Supp. 2d 1159, 1161 (S.D. Fla. 2011); *Friends of the Everglades, Inc. v. S. Fla. Water*

State of Florida is also implementing additional “numeric nutrient criteria” and Total Maximum Daily Loads (TMDL) programs that create new CWA-based water quality requirements for the canals and water bodies of South Florida.⁸² Those requirements can only complicate the abundant choices and challenges already facing the water managers who manage the Everglades ecosystem.

In fact, the NEPA mandates careful consideration of those alternative choices. And that process creates yet another way for Everglades stakeholders to demand that their preferred alternatives be considered. For example, the lack of an environmental impact analysis, and a NEPA challenge, was used by agricultural interests to challenge the original Everglades Consent Decree.⁸³ Similarly, when water managers sought to elevate the Tamiami Trail to allow waters to flow underneath the bridge, a NEPA case brought by the Miccosukee Tribe was only stopped when Congress passed an appropriations rider demanding the project to be completed, “notwithstanding any other law.”⁸⁴

The ESA also provides a constant source of controversy in the Everglades. Arguing over the effects of the Everglades restoration on endangered Cape Sable seaside sparrow and the threatened Everglades snail kite, stakeholders have frequently used the ESA to second-guess water management decisions.⁸⁵ Fights over the Florida panther, thus far, have led to opinions upholding the federal decisions.⁸⁶ Yet even when the plaintiffs succeed in court, the influence of those victories has been subtle, at best. A battle over the supplementation of an administrative record,⁸⁷ or even a remanded biological opinion requiring the United States Fish and Wildlife Service to calculate a precise number of sparrows that could acceptably and incidentally be harmed, killed, or otherwise “taken,” might create new procedural burdens for the agencies, but accomplishes little in clarifying how to manage the entirety of the Everglades ecosystem. As both the United States Fish and Wildlife Service and the federal courts have recognized, the choice to offer beneficial protection of a single species can have detrimental consequences for many others.⁸⁸

Mgmt. Dist., No. 02-80309-CIV, 2006 WL 3635465, 1 (S.D. Fla. 2006); Miccosukee Tribe of Indians of Fla. v. S. Fla. Water Mgmt. Dist., No. 98-6056-CIV, 98-6057-CIV, 1999 WL 33494862 (S.D. Fla. 1999).

82. FLA. STAT. ANN. § 403.067 (West, Westlaw through Ch. 255 (End) of the 2014 Reg. Sess. and Sp. “A” Sess. of the Twenty-Third Legislature); Fla. Wildlife Fed’n v. S. Fla. Water Mgmt. Dist., 647 F.3d 1296, 1298 (11th Cir. 2011); Fla. Wildlife Fed’n v. S. Fla. Water Mgmt. Dist., 853 F. Supp. 2d 1138, 1142 (N.D. Fla. 2012); Cynthia D. Norgart, *Florida’s Impaired Waters Rule: Is There a “Method” To The Madness?* 19 J. LAND USE & ENVTL. L. 347, 371 (2004).

83. United States v. S. Fla. Water Mgmt. Dist., 28 F.3d 1563, 1567 (11th Cir. 1994).

84. Miccosukee Tribe of Indians of Fla. v. U.S. Army Corps of Eng’rs, 619 F.3d 1289, 1291 (11th Cir. 2010); Miccosukee Tribe of Indians of Fla. v. United States, 509 F. Supp. 2d 1288, 1289 (S.D. Fla. 2007).

85. Miccosukee Tribe of Indians of Fla. v. United States, 528 F. Supp. 2d 1317, 1319 (S.D. Fla. 2007); Miccosukee Tribe of Indians of Fla. v. United States, 430 F. Supp. 2d 1328, 1330 (S.D. Fla. 2006); Natural Res. Def. Council, Inc. v. U.S. Army Corps of Eng’rs, No. 99CV2899, 2001 WL 1491580, at *1 (S.D. Fla. 2001).

86. Conservancy of Sw. Fla. v. U.S. Fish & Wildlife Serv., No. 2:10-cv-106-FtM-SPC, 2011 U.S. Dist. LEXIS 38021 (M.D. Fla. Apr. 6, 2011).

87. Miccosukee Tribe of Indians of Fla. v. United States, 396 F. Supp. 2d 1327, 1328 (S.D. Fla. 2005).

88. See Ctr. for Biological Diversity v Salazar, 770 F. Supp. 2d 68 (D.D.C. 2011); Endangered and Threatened Wildlife and Plants; Critical Habitat Designation for the Cape Sable Seaside Sparrow, 71 Fed. Reg. 63980-01 (proposed Oct. 31, 2006) (codified at 50 C.F.R. § 17).

Yet the legislative history of the Central and Southern Florida Project refers to the Everglades as “a single watershed.” Recognizing the complexity of managing an ecosystem, state and federal bureaucrats undertook a renewed comprehensive planning effort during the 1990s and early 2000s, seeking to build on the goals set forth in the Everglades Forever Act.⁸⁹ They focused on a sustainable SES. Governor Chiles’s Commission for a Sustainable South Florida envisioned its restoration effort as directly supporting a “sustainable South Florida economy and quality communities.”⁹⁰ The planning efforts eventually led to the restoration-oriented Water Resources Development Act of 1996 “for the purpose of restoring, preserving, and protecting the South Florida Ecosystem.” Implementation of that Comprehensive Everglades Restoration Plan, however, just like the waters of the Everglades, has moved slowly. The United States Army Corps 2003 Programmatic Regulations required the agency to develop the CERP adaptive management program. Instead of helping restoration, the regulations helped to stop it. Frustrated with the slow pace of federally funded projects, the South Florida Water Management District elected to construct a reservoir in the Everglades Agricultural Area (EAA) with state funds, unconstrained by the Corps’ regulations. The Natural Resources Defense Council disagreed, and challenged the project permits. Rather than risking liquidated damages on construction contract claims, the South Florida Water Management District stopped the project, and the court eventually declared the lawsuit moot.⁹¹

Disputes over land acquisition also helped to delay CERP and similar restoration planning initiatives.⁹² Expansion of the boundaries of Everglades National Park was disputed. Efforts to acquire the 8.5 square mile area built in the historic Everglades, west of the protective levee system were challenged.⁹³ And the state’s unprecedented effort to buy the land holdings of the United States Sugar Corporation offered a particularly interesting series of ultimately unsuccessful lawsuits, including allegations of Government in the Sunshine violations by decisionmakers,⁹⁴ Tribal demands to resume construction of the EAA reservoir instead,⁹⁵ and New Hope Sugar’s lawsuit to stop the purchase of lands.⁹⁶ While much of this land acquisition proceeded anyway, the litigation increased costs, created delays, and frequently, forced modifications to the comprehensive planning efforts.

Battles over environmental policy have also been fought in a context only tangentially related to environmental law. The Miccosukee Tribe has repeatedly used leasehold rights, Indian trust doctrine, due process and equal protection claims

89. See Alfred R. Light, *Beyond the Myth of Everglades Settlement: The Need for a Sustainability Jurisprudence*, 44 TUL. L. REV. 253, 259–60 (2008).

90. *Id.* at 260.

91. See generally *Case Docket: Natural Res. Def. Council, Inc. v. Van Antwerp*, RECAP ARCHIVES, available at <http://ia802607.us.archive.org/0/items/gov.uscourts.flsd.296384/gov.uscourts.flsd.296384.docket.html> (last visited Nov. 25, 2014) (showing Order of Dismissal Without Prejudice on June 26, 2009).

92. *United States v. 480.00 Acres of Land*, 557 F.3d 1297, 1300–02 (11th Cir. 2009).

93. *Garcia v. United States*, 2002 WL 34395260, at *2 (S.D. Fla. July 8, 2002).

94. *New Hope Sugar Co. v. S. Fla. Water Mgmt. Dist.*, No. SC10-330, SC10-336, 2010 WL 4709713, at *1 (Fla. 2010).

95. *United States v. S. Fla. Water Mgmt. Dist.*, No. 88-1886-CIV, 2008 WL 3833258, at *1 (S.D. Fla. 2008).

96. *New Hope Sugar Co.*, 2010 WL 4709713, at *1.

to oppose United States Army Corps water management efforts, albeit with limited success.⁹⁷ Former Florida Governor Claude Kirk unsuccessfully sued the sugar industry, making allegations of campaign-contribution induced conspiracies to allow a continued public nuisance.⁹⁸ The Supreme Court of Florida dodged the dispute, applying the doctrine of primary jurisdiction and deferring to the administrative agencies, empowered by Florida law to manage air and water pollution. And a particularly determined group of riparian landowners living adjacent to the Central and South Florida Flood Control Project sought \$50 million in compensation for an alleged physical taking of their riparian rights.⁹⁹ The lawsuits backfired on the waterfront plaintiffs, leading the Federal Circuit to conclude that Florida law did not establish a riparian right to be free from pollution.¹⁰⁰

Sometimes, entirely procedural arguments associated with the operation of the bureaucracy, wholly unrelated to environmental considerations, have also been used in efforts to alter plans in the Everglades. Violations of the Federal Advisory Committee Act led to a lawsuit and injunction that altered the cooperation of a group of state and federal representatives on managing water levels in the Southern Everglades,¹⁰¹ but did not succeed in preventing the Army Corps from obtaining expert feedback on wildlife biology from a non-federal conflict resolution group.¹⁰² The content and timeliness of responses to public records requests pursuant to the federal Freedom of Information Act and to state laws have also been the source of litigation.¹⁰³

Finally, even the cost of the Everglades restoration, and who pays for it, can become just as controversial as the restoration itself. Citizens have tried to eliminate taxes paid by allegedly non-polluting parties, relying upon a citizen-passed amendment to the Florida Constitution to demand that the polluters must pay more to fund the Everglades restoration. The litigation proved, once again, to be a distraction. Courts deferred to the Legislature and found the constitutional clause not to be self-executing.¹⁰⁴ Challenges to plans to pay for the Everglades restoration using bonds were also unsuccessful.¹⁰⁵ Yet money remains a central force in Everglades litigation; lawsuits must be financed and paid for, too, so attorney's fees

97. *Miccosukee Tribe of Indians of Fla. v. United States*, 680 F. Supp. 2d 1308 (S.D. Fla. 2010); *Miccosukee Tribe of Indians of Fla. v. United States*, 656 F. Supp. 2d 1375, 1380 (S.D. Fla. 2009); *Miccosukee Tribe of Indians of Fla. v. United States*, 259 F. Supp. 2d 1237, 1240 (S.D. Fla. 2003); *Miccosukee Tribe of Indians of Fla. v. United States*, 980 F. Supp. 448, 465 (S.D. Fla. 1997).

98. *Flo-Sun Inc. v. Kirk*, 783 So. 2d 1029 (Fla. 2001).

99. *Mildenberger v. United States*, 91 Fed. Cl. 217, 229 (2010).

100. *Id.* at 245–46; *Mildenberger v. United States*, 643 F.3d 938, 943 (Fed. Cir. 2011).

101. *See generally* *Miccosukee Tribe of Indians of Fla. v. S. Everglades Restoration Alliance*, 304 F.3d 1076 (11th Cir. 2002).

102. *Miccosukee Tribe of Indians of Fla. v. United States*, 420 F. Supp. 2d 1324, 1338–39 (S.D. Fla. 2006).

103. *See generally* *Miccosukee Tribe of Indians of Fla. v. United States*, 516 F.3d 1235 (11th Cir. 2008) (Native American Indian Tribe brought action against the Environmental Protection Agency (EPA), and various EPA officials, alleging violation of the Freedom of Information Act).

104. *See generally* Advisory Opinion to the Attorney General, 681 So. 2d 1124 (Fla. 1996); Advisory Opinion to the Governor, 706 So. 2d 278 (Fla. 1997); *Barley v. S. Fla. Water Mgmt. Dist.*, 823 So. 2d 73 (Fla. 2002).

105. *Miccosukee Tribe of Indians of Fla. v. S. Fla. Water Mgmt. Dist.*, 48 So. 3d 811, 820 (Fla. 2010) (approving bonds to pay for purchase of lands, but not for purchase of an option to buy lands in the future).

routinely become yet another source of litigation,¹⁰⁶ to which staff and restoration dollars must be diverted.

Year	Trigger	Policy	Infrastructure	Organizations	Law
1905	Flood 1903	Drain for Agriculture and Devel- opment	Canals	Everglades Drainage Dis- trict	Un- known
1932- 1938	Hurri- cane 1928	Protect against Lake Okeecho- bee Floods	Hoover Dike	US ACOE Drainage Dis- trict	River and Har- bor Act of 1930
1948	Flood 1947	The system was design and built to prevent flooding of agricultural and urban areas. The land uses of Ever- glades Ag- ricultural Area (EAA), Water Con- servation areas were defined. The Kis- simmee River	Levees, Canals, pumps	Central and Southern Flor- ida Flood Con- trol District USACOE	PL 80- 858

106. Friends of the Everglades v. S. Fla. Water Mgmt. Dist., 678 F.3d 1199, 1201–03 (11th Cir. 2012) (litigation fees related to NPDES permitting dispute); Friends of the Everglades v. S. Fla. Water Mgmt. Dist., No. 02-8039-CIV, 2011 WL 4402115, at *1 (S.D. Fla. 2011); Miccosukee Tribe of Indians of Fla. v. United States, 2010 WL 9034623 (S.D. Fla. March 15, 2010) (fees litigation related to EFA as change in water quality standard); Miccosukee Tribe of Indians of Fla. v. S. Fla. Water Mgmt. Dist., No. 98-6056-CIV, 98-6057-CIV, 2000 WL 35594555, at *1 (S.D. Fla. 2000) (fees dispute related to NPDES permitting); Miccosukee Tribe of Indians of Fla. v. United States, No. 950533CIVDAVISTURNOF, 1999 WL 33320443, at *1 (S.D. Fla. 1999) (fees litigation related to consent decree).

		channeliza- tion began			
Year	Trigger	Policy	Infrastructure	Organizations	Law
1949	Conser- vation	Creation of Everglades National Park		US DOI, Na- tional Park Service	48 Stat 816
1960	Fidel Castro assumes power in Cuba	Incentives to improve US sugar production	Local water control groups	Sugar price supports, led to large major- ity of sugar cane agricul- ture in Ever- glades Ag	
1970	Drought 1962, 66	Minimum Flow to Everglades Park	Modify S-12 gates, regula- tion schedule	USACOE	PL 91- 282 Mini- mum Flow
1977	Drought 1972	Water Sup- ply, Water Quality	Saltwater dams, Water supply to urban aquifers	South Florida Water Man- agement Dis- trict (SWFMD) created	Water Re- sources Act of 1972 (Chapter 373, Florida Statutes
Year	Trigger	Policy	Infrastructure	Organizations	Law
1982	Algal blooms in Lake Okee- chobee	Changes to water Schedules, rules for delivery	Cessation of use of pumps to move water to Lake Okeecho- bee	SFWMD/ Florida Dept. of Environ- mental Protec- tion	State Permit
1981	Pollution in Lake Okee- chobee	Dechannel- ize Kis- simmee River	Adaptively re- move flood structures, rec- reate meander	SFWMD	
1983	ENSO Flood	Open flow to ENP restore	Adjust delivery rules	SFWMD Everglades Coalition	PL-181 Experi- mental

		hydrology			Water Delivery
1985	ENSO Flood	Rainfall Plan	None	SFWMD	None
1988	Cattail and nutrient pollution lawsuit	Water quality (Phosphorus) standards	Nutrient removal marshes (STA)	US DOJ vs State of Florida	
1985	ENSO Flood	Expansion of Everglades National Park	Adjust water delivery rykes	USA COE DOI NPS	PL 101-229
1989	Chronic environmental losses, ENSO Flood,	Seek integrated water quantity/quality.f easability of ecosystem restoration		Epistemic Collaborative Group, AEAM workshops	None
2000	Restudy	Comprehensive Ecosystem Restoration Plan (CERP)	STA, Aquifer recharge	USACOE/ SFWMD	PL 106-541

TABLE 1. A summary of historical regime shifts in the Everglades SES since 1900. The table is organized by a triggering event or disturbance to the SES, which led to an adaptation (modification of policy) or transformation (change in infrastructure, organizations and/or laws). For each event, the adaptation is indicated by the year that a change in the rules and norms occurred. A transformation occurred when the perturbation led to changes in physical infrastructure, organizations, and law.

This section of the article highlights how the history of the Everglades SES can be characterized by sudden regime shifts in the ecosystems, institutions, and organizations as a result of the interaction of a number of factors.¹⁰⁷ These examples suggest that the physical structure and rules of the water management system, as well as the organizational and institutional structures can exist in multiple configurations or alternative regimes.¹⁰⁸ Moreover, they suggest that these alternative management regimes change when the resilience of the system is tested by a dis-

107. L.H. Gunderson et al., *Surprises and Sustainability: Cycles of Renewal in the Everglades*, in PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 315 (L.H. Gunderson & C.S. Holling ed. 2002).

108. *Id.*

turbance in the form of an environmental crisis.¹⁰⁹ Hence, the resilience of the SES is subject to recurring challenges by the ecosystem (in the form of weather events) and the legal system (in the form of lawsuits). This history provides a framework for assessing the adaptive capacity¹¹⁰ of the Everglades SES in response to foreseeable climate changes in the future.

III. CLIMATE CHANGE AND REGIME SHIFTS IN SOUTH FLORIDA

A. South Florida Climate and Climate Change

The climate of an area is the average conditions of the weather as exhibited by temperature, wind velocity, and precipitation over periods of multiple decades.¹¹¹ South Florida climate has a Tropical Savanna climate.¹¹² Temperature patterns indicate that average temperatures are mild during the winter months and hot during the summer months. Along with the hot summers, most (80%) of the annual rain falls during this time frame.¹¹³ The wet summer season is the result of circulation patterns created by differential heating of the Floridian peninsula and surrounding oceans, as well as evaporation of water vapor from the seas.¹¹⁴ This has been called the rain machine, and is part of the climate that drives the annual pattern of rainfall around which much of the water management and ecology is structured.

Whether changes in temperature and rainfall patterns in south Florida are occurring is an ongoing debate among scientists. Swain¹¹⁵ reports that for the State of Florida, no discernable changes in temperature or rainfall can be determined from the twentieth century data. Other authors indicate that changes are occurring; specifically wet season rainfall (July–August) has declined because of changing land uses and that maximum daily temperatures have increased during the twentieth century.¹¹⁶ Temperature and precipitation patterns represent two defining variables of climate, yet other environmental conditions such as sea level rise and cyclonic activities are part of the climate change debate.

Another trend that is debated in the scientific literature centers on hurricane activity in the Atlantic. A rise in global sea surface temperatures, which is an ob-

109. *Id.*

110. Adaptive capacity is defined as the ability of the social system to respond to a specific perturbation in the ecosystem.

111. *Climate Definition*, MERRIAM-WEBSTER.COM, <http://www.merriam-webster.com/dictionary/climate> (last visited Nov. 21, 2014).

112. See generally Ilmo Hela, *Remarks on the Climate of South Florida*, 2 BULL. OF MARINE SCI., 439, 439–47 (1952) (describing Florida's climate).

113. Alaa Ali et al., *Temporal and Spatial Characterization of Rainfall over Central and South Florida*, 36 J. AM. WATER RESOURCES ASS'N 833, 833–48 (2000).

114. Patrick T. Gannon, Sr., NOAA Technical Report ERL 402-NHELM2, *Influence of Earth Surface and Cloud Properties on South Florida Sea Breeze* (1978), available at <https://ia601601.us.archive.org/19/items/influenceofearth00gann/influenceofearth00gann.pdf>.

115. THE CTR. FOR SCI. AND PUB. POL'Y, *CLIMATE CHANGE IN FLORIDA: IS THERE A HUMAN FOOTPRINT IN FLORIDA'S CLIMATE HISTORY?* 1 (2007), available at http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/449/Florida_Human_Role_Lacking_in_CC_-_CSPP_2007.pdf [hereinafter CLIMATE CHANGE IN FLORIDA].

116. Curtis H. Marshall et al., *The Impact of Anthropogenic Land-Cover Change on the Florida Peninsula Sea Breezes and Warm Season Sensible Weather*, 132 MONTHLY WEATHER REV. 28, 42 (2004).

served and forecasted trend associated with global climate change,¹¹⁷ will likely lead to an increase in the frequency and severity of hurricanes. Emanuel¹¹⁸ found evidence that the amount of energy and increase in destructive potential of hurricanes have increased over the past thirty years. Swain¹¹⁹ suggests that no long-term trend can be found in the number of hurricanes that have struck Florida last century. Regardless of changes in the patterns and intensities of storms that are striking and will strike south Florida, one clear trend is that these weather events are causing dramatic increases in the damage and social costs associated with these events.¹²⁰

Recent analyses of sea level data¹²¹ suggest rates have increased since the early twentieth century and are now about one foot per century. This is subject to non-linear increases due to the accelerated melting of ice packs and glaciers.¹²² With such a flat topography, and elevations in the Everglades ecosystem of only a meter in many areas, the area will likely go underwater (again) in the near future.

In summary, at least four general types of broad-scale climatic changes are anticipated to occur in south Florida. One is a shift in the annual cycle of wet and dry seasons, because of shifting land use patterns and changes in atmospheric circulation patterns. Such changes may lead to a decrease in rainfall and increase in evaporation, which would result in a change in net water availability for ecosystem, agricultural, and human consumption. The second is a shift in long-term flood/drought cycles linked to global phenomena such as El Niño Southern Oscillation. Such shifts in periodicity would likely result in shorter intervals between floods and droughts years. The third anticipated change is an increase in the severity and frequency of hurricanes and tropical cyclones. The fourth anticipated change is associated with a rising sea level.

B. Managing Social-Ecological Resilience during Climate Change

One approach to managing resilience in an SES is based on an assumption that resilience is a normative property.¹²³ In this view resilience should be cultivated, built and maintained by management and governance systems. The definition of resilience by the National Research Council¹²⁴ implies this convention. In this light,

117. IPCC 2013, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 121 (Thomas F. Stocker et al. eds., 2013), available at http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_ALL_FINAL.pdf.

118. Kerry Emanuel, *Increasing Destructiveness of Tropical Cyclones over the Past 30 Years*, 436 NATURE 686, 686–88 (2005).

119. See CLIMATE CHANGE IN FLORIDA, *supra* note 115, at 5–7.

120. Adam B. Smith & Richard W. Katz, *U.S. Billion-dollar Weather and Climate Disasters: Data Sources, Trends, Accuracy and Biases*, 67 NAT. HAZARD 387, 388–89 (2013), available at <http://link.springer.com/article/10.1007/s11069-013-0566-5>.

121. SOUTHEAST FLORIDA REGIONAL CLIMATE CHANGE COMPACT COUNTIES, A UNIFIED SEA LEVEL RISE PROJECTION FOR SOUTHEAST FLORIDA (2011), available at <http://www.broward.org/NaturalResources/ClimateChange/Documents/SE%20FL%20Sea%20Level%20RIse%20White%20Paper%20April%202011%20ADA%20FINAL.pdf>.

122. See IPCC 2013, *supra* note 117.

123. THE NAT'L ACADEMIES, DISASTER RESILIENCE: A NATIONAL IMPERATIVE 1 (2012).

124. *Id.* These authors define resilience as “the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events.”

the desired system state is defined by the boundaries of a threshold. Such thresholds occur when the system undergoes a shift in controlling processes. In the Everglades ecosystem one such threshold is defined by the soil phosphorus concentration. Once the amount of phosphorus in the soil exceeds the thresholds (on the order of thirty parts per million), then the native vegetation types of sawgrass and wet prairies are replaced by cattail community, following a disturbance.¹²⁵ Such state shifts require a great deal of study and understanding of the mechanisms and variables that define those thresholds. This occurred in the Everglades with research starting in the 1970s of dosing experiments in the wetlands and continues to date. Following a lawsuit in the late 1980s, significant research and rule making developed strict water quality standards for the Everglades to keep the system away from this threshold. In general, most monitoring programs are established to evaluate the system status in light of these thresholds. In these cases, management practices are structured to keep the system from crossing the threshold, and then to adopt another set of practices if the threshold is crossed.

Another way in which resilience is managed is based upon an assessment that the regime shift becomes the management goal. In the Everglades, much work in the 1990s led to the comprehensive restoration program, which continues to dominate management to date. In this case, a number of ecological variables such as wading bird nesting populations and endangered species populations are the targets of the restoration. That is, the restoration of Everglades species, communities, and landscapes is sought to be achieved by reestablishment of the quantity and quality of the water that flows through the southern Everglades. The Water Resources Development Act of 2000 initiated this large, polycentric management program. In this act, the US Congress stated that an Adaptive Management approach would be applied, with costs shared between the federal government (US Army Corps of Engineers) and the South Florida Water Management District (SFWMD).¹²⁶ In such an approach, management actions are structured in such a way as to resolve key uncertainties of what is needed to facilitate a regime shift in the ecosystem. Resources in the form of expertise to undertake the monitoring and evaluation of those actions are needed to facilitate the type of social learning that occurs in adaptive management. Another requirement is capacity to experiment. In Everglades restoration, that experiment would take place by introducing larger volumes of clean water into the remnant Everglades. Such water exists in most years, and may become more plentiful and frequent under a changing climate.

One finding of climate change scientists is that patterns of temperature and rainfall are becoming less predictable and more variable.¹²⁷ Floods will likely occur more often (a one-in-a-hundred-year flood will happen every other year). Record temperatures (both high and low) will be frequently broken. More frequent and severe flood and drought conditions will occur. Instead of viewing these as disturb-

125. Lance H. Gunderson et al., *A Summary and Synthesis of Resilience in Large-Scale Systems*, in *RESILIENCE AND THE BEHAVIOR OF LARGE-SCALE SYSTEMS* 249 (Lance H. Gunderson & Lowell Pritchard Jr. eds., 2002).

126. Andrew J. LoSchivao et al., *Lessons Learned from the First Decade of Adaptive Management in Comprehensive Everglades Restoration*, 18 *ECOLOGY & SOC'Y*, Dec. 2013, no. 4, art. 70, <http://www.ecologyandsociety.org/vol18/iss4/art70/>.

127. Christoph Schär et al., *The Role of Increasing Temperature Variability in European Summer Heatwaves*, 427 *NATURE* 332 (2004).

ances to be managed against, they could be viewed as ways for managers to test ideas (i.e. passively experiment) as to how to achieve management objectives.

In the early 1980s, high rainfall over south Florida saturated the Everglades. The general management strategy was to discharge this water as quickly as possible to the ocean and Gulf of Mexico. Indeed a similar issue occurred during 2013, when the Governor of Florida blamed the federal government for ruining estuaries and degrading tourism by discharging excess freshwater. But rather than play politics with the environment, thirty years ago managers requested that the excess water be delivered to Everglades National Park.¹²⁸ Such a change in policy required an act of Congress. As a result, Congress passed an experimental water delivery act,¹²⁹ which redirected the flow to the park as a test of a different policy. The result of this experiment was resolution of three chronic problems with water management that had persisted for decades. The first problem involved the fact that the park was receiving less than a fair share of the water, and moreover the pattern of delivery was harming resources. In other words, water managers had been delivering a set amount of water to the park, regardless of rainfall or ambient conditions. As a result of the flow test, managers developed a rainfall-based formulation to deliver water in synch with the weather. As a result the park has gotten more water in wet years and less water in dry years, much more like the way the ecosystem functioned prior to intensive development. The second lesson revealed by this experiment was that water quality and water quantity were intimately linked, as scientists and managers realized that any sources of upstream water would carry nutrients that could cause unwanted flips in vegetation communities. The third lesson was that passive experiments such as this one could be used to determine solutions to long-term problems such as how much water should be delivered to the park.

With more than a decade of experience with the Everglades restoration many lessons have been gleaned about how to use a learning-based process such as adaptive management.¹³⁰ These lessons include the need for legitimacy through legislative and regulatory authorities, the difficulties of applying such an approach within existing institutional structures, the need for integrating science and decision making, articulation of uncertainties, and the role of independent programmatic review. Other evaluations of the ongoing adaptive management program suggest that it has been successful in planning experiments, and less so in executing such policy probes.¹³¹ These limitations have led some authors¹³² to define adaptive governance as the institutional and organizational framework that promulgates adaptive management. Such considerations are discussed in the final section of this article.

C. Potential Transformations and Surprises in South Florida SES

The future is mostly unpredictable, including not only how climate may change, but also to the impacts of climate change on the SES of south Florida. In

128. S.S. Light et al., *The Southern Everglades: The Evolution of Water Management*, 69 NAT'L F. 1, 11–14 (1989).

129. Supplemental Appropriations Act of 1984, Pub. L. 98-181, 97 Stat. 1153 (1983).

130. LoSchiavo et al., *supra* note 130.

131. Gunderson et al., *supra* note 5, at 326.

132. See generally Carl Folke et al., *Adaptive Governance of Social-Ecological Systems*, 30 ANN. REV. ENV'T & RES. 441 (2005).

general terms, three scenarios can be envisioned that lay out potential transformations in the SES, along with some likely surprises. One plausible scenario is a much drier climate, in which precipitation decreases, evaporation increases, and sea level slowly rises. Another scenario is for a dystopic future, in which repeated storms and rising sea level lead to a collapse of a viable SES. A third scenario is for an adaptive, viable SES, one that has emerged from a rising tide of disasters and surprises. Each are briefly sketched in the following paragraphs.

1. A Withered South Florida Transforms into a Different SES.

Prolonged droughts and dramatic increases in water demands have resulted in chronic water shortages. Shortages that used to last for a few months now last for many years. Wells run dry (or become saline and no longer useful) as water becomes scarce due to decreasing precipitation, evaporation, increasing demands of the population and a rising sea. Vegetation patterns shift as the wetlands in the interior shrink and become more terrestrial. Commercial agriculture has largely disappeared due to unavailability of water and loss of federal price supports and other subsidies. The agricultural demand has been offset by urban needs. To secure new water sources, counties have made new inter-municipal connections, which along with inter-basin transfers from rivers and aquifers outside the district, complement increased storage within the system. As cities and counties sensed threats to their water supply, they have asserted themselves politically to seize control of available water resources. State water law is transformed to give decision authority to local users and the ability to control water use through rationing and tight regulation. Federal engagement shrinks as the park and reserve areas disappear. Prompted by decreasing water availability, large investments have been made in technological solutions that would increase water supplies. Urban potable water is obtained through energy intensive reverse osmosis and filtration systems that can use brackish or salt water, wastewater, and polluted runoff. Government-based water institutions have proved incapable of regulating the use of scarce resources. Water rights became privately held, and water markets have been established to allocate water efficiently. Due to the privatization of water and increasing costs of securing water, prices for potable water exceed \$50 per gallon and underground economies arise.

2. Increasing Disasters Lead to a Collapse of the SES.

Unprecedented strings of natural and human induced disasters pummel the region. More floods and droughts have occurred, leading to damages in infrastructure. Recurring category 5 hurricanes continue to destroy property and key structures, such as Hoover Dike. As private insurance companies withdraw, governments attempt to create insurance programs, but they too cannot cover the rising costs of natural disasters. For many reasons, people are moving out of Florida, leading to a decline in government revenue and fiscal resources. Eventual inundation of the wealthy coastal communities creates another reason for exodus and dramatic decline in economic viability. Cities are abandoned. With rising sea levels, salinity wedges have moved inland, resulting in the loss of coastal wells. The cost of energy has soared as worldwide demands increase. The regional water system has fallen into disrepair because of escalating operation and maintenance costs in a

time of declining revenues. Counties and cities are left to their own devices to secure water. The collapse of subsidized agriculture has created more land to provide a different set of ecosystem goods and services.

3. South Florida becomes an Adaptive SES.

Worldwide demand for, and declining supplies of, oil and gas, rising sea levels, and the continuing threat of climate change has triggered unprecedented economic trauma and propelled Florida to seek and support economically sustainable green technologies—solar, wind, tidal, and biomass energy sources. Floridians have learned how to live with, and profit from, nature's renewable goods and services. The Everglades have become a viable, but much smaller ecosystem, because of sea level rises. South Florida has emerged as a global example of sustainability. A diversity of mechanisms for storing water has been developed, including household and community cisterns, neighborhood ponds, aquifer storage, and recovery and urban lakes. Cities routinely treat water for reuse and household demand has been cut to thirty gallons per person per day. Purification plants and filtration systems are solar-powered with backup energy systems. Infrastructure in urban areas has downsized, with a focus on resilience of small-scale systems for water management to fluctuations in water input and use. Urban systems have become self-sufficient for water supplies, and do not rely on the Everglades wetlands for water.

IV. ADAPTIVE GOVERNANCE; INTEGRATING ECOLOGY, INSTITUTIONS AND LAW

A. Adaptive Governance

Adaptive governance incorporates formal organizations, informal groups, and individuals at multiples scales¹³³ and requires collaboration, communication, and adaptation in response to social and ecological monitoring.¹³⁴ At the essence of many definitions of adaptive governance, is the capacity to anticipate, manage, and adapt to ecological regime shifts.¹³⁵ As such, governance structures must incorporate scientific and technical understanding of different types of resilience practice. These practices fall into categories of: (1) maintaining resilience for desired system configurations, (2) intentionally changing ecosystem regimes, and (3) developing transformational capacity.¹³⁶ This definition includes the idea that adaptive govern-

133. *Id.* at 449.

134. Ahjohnd S. Garmestani & Melinda Harm Benson, *A Framework for Resilience-Based Governance of Social-Ecological Systems*, 18 *ECOLOGY & SOC'Y* no. 1, art. 9 (2013), <http://www.ecologyandsociety.org/vol18/iss1/art9/>.

135. Per Olsson et al., *Navigating the Transition to Ecosystem-Based Management of the Great Barrier Reef, Australia*, 105 *PROC. OF THE NAT'L ACAD. OF SCI. OF THE U.S. OF AM.* 28, 9489–94 (2008), available at <http://www.jstor.org/stable/25463000>.

136. B. Cosens et al., *The Adaptive Water Governance Project: Assessing Law, Resilience and Governance in Regional Socio-Ecological Water Systems facing a Changing Climate*, Introduction to this edition of the Idaho Law Review.

ance is a framework that allows for adaptive management of natural resources.¹³⁷ Law, policy, and intermediaries (e.g., bridging organizations) are also important aspects of adaptive governance, producing networks that can increase political and financial support critical for fostering adaptive management.¹³⁸ Intermediaries foment the development of new ideas, facilitate communication between entities, and create the flexibility necessary for the interplay of ecological and social systems for successful environmental governance. Other definitions of adaptive governance indicate a type of governance that is inclusive of informal institutions, stakeholders, and other relevant actors who participate with formal institutional structure.¹³⁹ Additionally, adaptive governance must include considerations of structure, scale, adaptive capacity, legitimacy, and power.¹⁴⁰

The current governance structures in south Florida can be described in context of existing organizations that address 1) climate change and 2) ecosystem restoration. For both of these issues, a polycentric, redundant structure exists (Table 2). Scientific information informs management at multiple scales, but sometimes there is a disconnect between science and management, so intermediaries bridge the disconnect between scales in an organizational hierarchy.¹⁴¹ The bridging function acted upon by intermediaries can create improved governance via the tightening of the feedback between science and managers in an iterative manner. Intermediaries, such as the Climate Change Compact and the Everglades Coalition, are part of the organizational governance structure of the Everglades.

Organization	Climate Change	Everglades Restoration
Government- Federal Agencies	EPA DOD- US Army Corps of Engineers DOI- U.S. Geological Survey, Everglades National Park, DOI, US Fish and Wildlife Service Commerce, NOAA Natural Marine Sanctuaries, DOI	DOD- US Army Corps of Engineers, DOI -U.S. Geological Survey, Bureau of Indian Affairs, Everglades National Park, US Fish and Wildlife Service, Commerce: NOAA Natural Marine Sanctuaries, EPA
Government- State Agencies	South Florida Water Management District, Florida Energy and Climate Commission,	South Florida Water Management District

137. Lance Gunderson & Stephen S. Light, *Adaptive Management and Adaptive Governance in the Everglades Ecosystem*, 39 POL'Y SCIENCE 323, 326 (2006).

138. Per Olsson et al., *Shooting the Rapids: Navigating Transitions to Adaptive Governance of Social-Ecological Systems*, 11 ECOLOGY & SOC'Y no. 1, art. 18 (2006), available at <http://www.ecologyandsociety.org/vol11/iss1/art18/>.

139. RONALD D. BRUNNER ET AL., ADAPTIVE GOVERNANCE: INTEGRATING SCIENCE, POLICY, AND DECISION MAKING 275–76 (2005).

140. Brian C. Chaffin et al., *A Decade of Adaptive Governance Scholarship: Synthesis and Future Directions*, 19 ECOLOGY AND SOC'Y no. 3, art. 56 (2014).

141. See C.S. Holling & Lance H. Gunderson, *Resilience and Adaptive Cycles*, in PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 25, 25–63 (2002).

	South Florida Regional Planning Council, Treasure Coast Regional Planning Council, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, Jonathan Dickenson State Park	
Government- County	Broward Miami-Dade County Monroe Palm Beach	
Government Local	City of Hollywood, Ft. Lauderdale, Miami	
Non-Governmental	U.S. Green Building Council, Ecological Advisors, Inc., Audubon Everglades Foundation,	National Academy of Scientists, Independent Technical Panels
Universities	UF, FAU, FIU, UMiami, Cooperative Extension Service	UF, FIU, FAU, UMiami
Private Firms	Tetratech, Chappell Group, Deady Law, The Nature Conservancy	

TABLE 2. List of institutions and organizations involved with changing climate and ecosystem restoration in south Florida. The list includes both formal (federal, state, and local agencies) and informal groups, such as non-governmental organizations, scientific, and professional groups. From the regional climate action plan and the CERP website.

Adaptive capacity in social systems is characterized by open and frequent lines of communication and collaboration between both formal and informal entities at multiple scales. The generation of adaptive capacity in management entities is a necessary “insurance policy” for sustainability.¹⁴² Adaptive capacity refers to the ability of the Everglades SES to respond to ecological regime shifts.¹⁴³ Identification of adaptive capacity includes both evidence of social learning and the authority to experiment and adapt. Hence, adaptive capacity of a system involves the ability of the governance system to undertake and execute programs of adaptive management. The application of adaptive management is indeed authorized for the restoration program. This requires the capacity to integrate management actions

142. Lance H. Gunderson, *Stepping Back: Assessing for Understanding in Complex Regional Systems*, in *BIOREGIONAL ASSESSMENTS: SCIENCE AT THE CROSSROADS OF MANAGEMENT AND POLICY* 27, 37 (Norman K. Johnson et al. eds., 1999), available at http://courses.washington.edu/esrm427/Gunderson_Chapter2_Stepping_Back.pdf

143. Claudia Pahl-Wostl, *A Conceptual Framework for Analyzing Adaptive Capacity and Multi-Level Learning Processes in Resource Governance Regimes*, 19 *GLOBAL ENVTL. CHANGE* 354, 354–65 (2009), available at <http://www.sciencedirect.com/science/article/pii/S0959378009000429>.

that are structured as much for learning as for achieving social goals, the capacity to monitor appropriate ecological indicators, evaluate how systems respond to management actions, and to provide pathways and repositories for knowledge and experience. While there is some debate as to the level of experimentation necessary for management to be adaptive,¹⁴⁴ we suggest that many factors create a barrier to adaptive management in the Everglades. The large experiments that are necessary to test hypotheses of restoration have yet to be done.¹⁴⁵ This is evidence of limited adaptive capacity and little or no adaptive governance. Similar arguments apply to necessary experiments needed for adapting to climate change.

There is apparently sufficient authority in the federal and state laws to manage adaptively with respect to resilience. Legislation, such as the Water Resources Development Act of 1999, directly defines the social values of a desired ecological regime. In this case, a restored state would be indicated by stable populations of key endangered species, lack of nutrient transformed vegetation, restoration of ecological processes of water flow, nutrient cycling, and landscape disturbances. A larger number of nesting wading birds as well as the absence of keystone exotic species would also define a restored condition.

We also introduce the idea that the shape, form, and function of adaptive governance must deal with three prototypical models of change in the SES. One is the need to establish thresholds and maintain resilience of the system, the second is to erode/manage resilience to facilitate a regime shift, and the third is to facilitate transformation of the ecological and social components of the system. Preliminary proposals about the interactions between facets of adaptive governance and resilience management are presented in Table 3.

Function/ Feature of AG	Maintaining Trajectory	Ecosystem Restoration New Trajectory	Adaptation – Unknown New Trajectory
Structure			
Redundancy Networks	Efficacy of cor- rect policy	Multiple, over- lapping functions	Small, epistemic, infor- mal groups
Experimenta- tion	Discover and monitor thresh- olds	Discover alterna- tive pathways	Create feasible futures
Scale			
Match	Institutions match ecologi- cal scale (SFWMD)	Polycentric insti- tutions, multiple ecologi- cal scales (slow/fast)	Meshing, epistemic groups, create new insti- tutions

144. See Craig R. Allen & Lance H. Gunderson, *Pathology and Failure in the Design and Implementation of Adaptive Management*, 92 J. OF ENVTL. MGMT. 1379, 1384 (2011), available at http://www.grandcanyontrust.org/documents/gc_adaptiveManagement.pdf.

145. See Gunderson, *supra* note 142.

Capacity			
Adaptive	Buffering shocks, rapid state detection recovery (insurance)	Reversibility, hysteresis, ability to experiment	Recognize, create and act in windows of opportunity, new visions
Participatory	Formal (compacts, FACA)	Formal/Informal	Informal, ephemeral
Legitimacy			
Results-based systemic, deliberative, procedural, order-based	Setting standards, enforcing standards (such as water quality rules)	Designing adaptive experiments, designed for policies that facilitate social learning	Creating new visions of possible futures
Power	Power maintained, questioned, threatened	Reassembled, transition of power	Accumulating power, small accumulates to large

TABLE 3. Features and functions of adaptive governance in contrast to three modes of adaptive/resilience management.

B. Perspectives on Legal Obstacles and Opportunities for Adaptive Capacity

Florida's Governor, Napoleon Bonaparte Broward, once promised a grand "Empire of the Everglades." Anticipating an abundance of agricultural crops, his engineer declared that "it will be impossible to form or declare an adequate idea of the importance and extent of this enterprise."¹⁴⁶ Congress, too, envisioned the Everglades as a vast, interconnected SES when it enacted the flood control programs in the 1940s. Now, after more than a century of executive and legislative efforts to manage the balance between agriculture and the environment, water supply and water quality, we have learned that Broward's engineer was right, but unintentionally so. In the Everglades, it has indeed proven impossible to form an adequate idea. Instead, the judiciary has swamped the Everglades restoration, and a proliferation of litigation under narrowly focused statutory schemes and provisions has relentlessly altered plans for comprehensive restoration. In a world enduring climate change, this dynamic will inevitably continue.

C. Anticipating a Future of Climate Change Litigation in the Everglades.

Ultimately, for all these reasons, the goal of a comprehensively and adaptively managed SES in the Everglades, benefitting both agriculture and alligators, has

146. James M. Kreamer, C.E., *Report on the Construction of the Atlantic Coast Steamboat Canal and the Drainage of Lake Okeechobee and the Everglades, in Drainage of the Everglades and South Florida*, Univ. of Fla., available at <http://ufdc.ufl.edu/UF00102914/00001/4x>.

been continuously thwarted by the directional shifts caused by legislators, litigators, and the legal system. Indeed, this summary of the many ways that litigation has altered the Everglades restoration contains references to more than eighty cases. Any one case can alter decades of planning, and every case—even the meritless ones—can bring publicity that still succeeds in undermining public confidence in the overall policy objectives. But in the future, as the forces of climate change reshape the Everglades, countless decisions will be subjected to stakeholder and judicial second-guessing. Sea level rise could transform Everglades National Park, so decisions to spend billions of dollars to clean up phosphorus for a freshwater system seem suspect when the ecosystem is at risk of becoming an estuary or salt marsh, yet preserving the Everglades might actually be essential to protect South Florida.¹⁴⁷ Rising temperature could accelerate evapotranspiration, affecting the entire strategy of using reservoirs to store and treat water.¹⁴⁸ Patterns of rainfall, floods, and drought will change, and the engineering assumptions for the drainage system could all prove fundamentally flawed in an era suffering from the “death of stationarity”—where past statistical highs and lows are no longer predictive of future results.¹⁴⁹ And at any moment, the huge effects of tropical storms and hurricanes can cause catastrophe, especially for the Lake Okeechobee dike, part of America’s most vulnerable infrastructure.¹⁵⁰

Neither the Everglades consent decree, nor the Everglades Forever Act, were written with climate change in mind. Eventually, these problems will become the subject of even more Everglades litigation, using laws like the Clean Water Act, Endangered Species Act, National Environmental Policy Act, and countless others named above, and not yet even thought of. But in a climate change world—a world full of competing stakeholder opinions—the Everglades Forever Act, and its goal of a restored and sustainable Everglades system, may forever be an elusive ideal.

V. SUMMARY

The SES of south Florida is an internationally renowned wetland ecosystem. At the international scale, the Everglades is designated as a Ramsar Wetland and a Biosphere Reserve/World Heritage Site. At the national scale, much of south Florida is set aside for conservation as Everglades and Biscayne National Parks, Big Cypress National Preserve, Art R. Marshall Loxahatchee National Wildlife Refuge. Such ecological areas comprise about one-half of the land area, and are situated at

147. Bruce Dorminey, *As Sea Level Rises, Everglades Become More Vital to South Florida’s Survival*, CLIMATE CENTRAL (Oct. 11, 2011), available at <http://www.climatecentral.org/news/as-sea-level-rises-everglades-become-more-vital-to-south-floridas-survival/>.

148. M. NUNGESSER ET AL., POTENTIAL EFFECTS OF CLIMATE CHANGE ON FLORIDA’S EVERGLADES PEATLANDS, available at http://www.ces.fau.edu/climate_change/everglades-recommendations-2014/pdfs/session-a-resource-4.pdf.

149. P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, SCIENCE, Feb. 2008 at 573.

150. LLOYD’S EMERGING RISKS TEAM, LLOYD’S, THE HERBERT HOOVER DIKE: A DISCUSSION OF THE VULNERABILITY OF LAKE OKEECHOBEE TO LEVEE FAILURE; CAUSE, EFFECT AND THE FUTURE, available at http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Climate%20reports/Lake_Okeechobee_Report.pdf.

the downstream end of the hydrologic system, comprised of Kissimmee River, Lake Okeechobee and the Everglades.

During the twentieth century, the Everglades SES was partitioned into land uses of agriculture, recreation and conservation. This was accomplished by a massive water control system, consisting of infrastructure, technology, and rule sets to constrain and control water movement. System management and governance is cross-scale—comprised of federal, state, and local level governments and large numbers of non-governmental groups (mostly environmental). Much of this management and governance is on issues of water allocation among the different land uses, in terms of quantity and timing over an annual cycle. The land use interactions have also deteriorated the water quality in the Everglades SES.

The history of the water management has been one of periods of increasing control over the water, each new period or era triggered by an ecological crisis (loss of resilience and ensuing state change). New infrastructure, new rules and regulations, new laws, and new institutions have characterized such new governance eras. Responses to perceived ecological crises have been large scale, expensive, and technologically based solutions: more money, more concrete, more control. Environmental governance of the Everglades has had limited success because of entrenched organizational hierarchies, as well as the inability to resolve disagreements associated with implementation of federal and state law.¹⁵¹ Moreover, attempts at collaborative management have, in the end, resorted to an adversarial, litigation model for resolving uncertainties. This legal and organizational rigidity limits the experimentation necessary for environmental governance in light of our current understanding of the dynamics of social-ecological systems.¹⁵²

Changes in water quality and water quantity have resulted in loss of ecological resilience in the wetland system. This is manifest as changes in freshwater marsh vegetation from oligotrophic species (sawgrass) to eutrophic species (cattails). Other ecological regime changes include a decline in nesting wading birds from numbers in the hundreds of thousands to now tens of thousands. More than twenty species are on the federal endangered species list, again signifying a loss of resilience. Other major ecological shifts are associated with homogenization of landscape patterns (loss of diversity), and decline in stocks of natural capital, especially organic soil. It is the key areas of endangered species and water quality that the ecological components of the SES have low resilience. That is, thresholds are very low, and the consequences of crossing those thresholds are socially unacceptable.

In contrast to low ecological resilience, the human or social components of the Everglades SES are very resilient. The system has a high institutional diversity (numerically and functionally) and has proven to only change and adapt under severe perturbations/disturbances. The governance consists of a network of formal governmental agencies with formal policies and informal groups. While polycentric, the governance system is hierarchical, rigid, and inflexible. This is indicated by the difficulties in using adaptive management to seek Everglades restoration, or

151. Sandra Zellmer & Lance Gunderson, *Why Resilience May Not Always be a Good Thing: Lessons in Ecosystem Restoration from Glen Canyon and the Everglades*, 87 NEB. L. REV. 893, 911 (2009).

152. *Id.*; Gunderson & Light, *supra* note 137.

to passively confront climate change. Another indication is the inability to negotiate (or even discuss) many policy changes, much less attempt them. As a result, the current governance and management system is in a hierarchy or rigidity trap. The existing complex of institutions and actors has maintained an ongoing conflict over water use for at least forty years. This conflict has been stable and persistent, and illustrates a perversely resilient system. As such, the system seems incapable of moving beyond planning into practice unless some sort of crises (ecological, economic, political, or social) unlocks the stability of the system. Climate change will provide more frequent crises. Such crises should not be viewed as surprises to avoid, but as opportunities for increasing adaptive capacity and adaptive governance. Ultimately what may evolve in the Everglades is a more adaptive governance framework that utilizes a suite of innovative and flexible regulatory instruments to confront and adapt to an uncertain climatic future.¹⁵³

153. See Ahjond S.Garmestani et al., *Can Law Foster Social-Ecological Resilience?*, 18 *ECOLOGY & SOCIETY* no. 2, art. 37, (2009), <http://www.ecologyandsociety.org/vol18/iss2/art37/>; Robin Kundis Craig & J.B. Ruhl, *Designing Administrative Law for Adaptive Management*, 67 *VAND L. REV.* 1, 15 (2014); See generally Robin Kundis Craig & J.B. Ruhl, *Governing for Sustainable Coasts: Complexity, Climate Change, and Coastal Ecosystem Protection*, 2 *SUSTAINABILITY* 1361 (2010).