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The Shape of Illusion: Water Law and Policy in the Fourth Dimension

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THE SHAPE OF ILLUSION: WATER LAW AND POLICY IN THE FOURTH DIMENSION

By George William Sherk[†]

I. INTRODUCTION: "YOU CAN'T HANDLE THE TRUTH!"

With these words, Colonel Nathan R. Jessep, played by Jack Nicholson in the movie *A Few Good Men*, expressed his outrage at being caught in a lie. The lie is not relevant to our purposes today. What is relevant is the fact that the truth eventually became known.

As we look to secure water supplies for the future, it is essential that decisions regarding the allocation and management of water resources be based as much as possible on truth, not on illusions created and perpetrated in the name of political expediency. As Col. Jessep could not stand being caught in a lie, future water allocation and management decisions will not stand if they are based on illusion.

This paper addresses three illusions. The following Section focuses on the myth of stationarity. The second Section debunks the assumption that physically available water supplies are also legally available. The third Section addresses the illusion of "state primacy" in the allocation and management of water resources. Conclusions are contained in the final Section, "The Fourth Dimension."

II. ILLUSION: STATIONARITY

"Stationarity—the idea that natural systems fluctuate within an unchanging envelope of variability—is a foundational concept that per-

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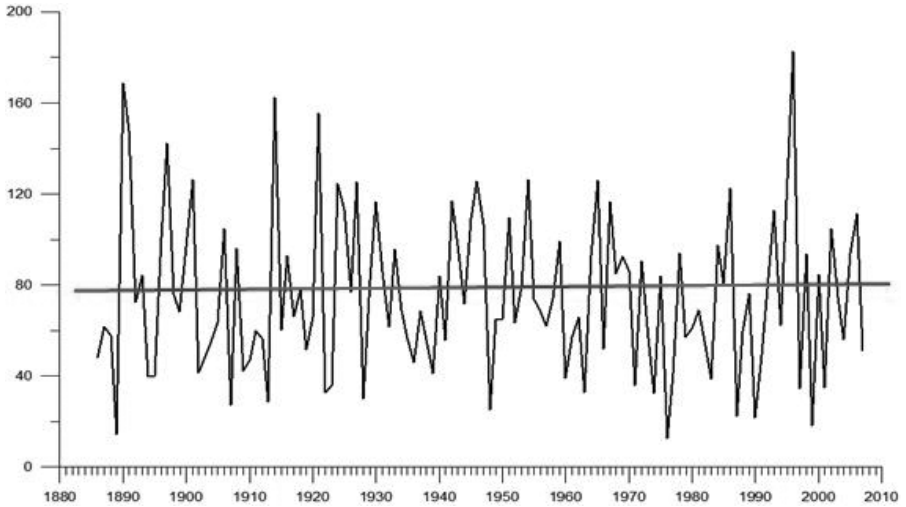
meates training and practice in water-resource engineering."[1] This concept was illustrated by Sauchyn:[2]

FIGURE 1: HYPOTHETICALSTATIONARITY



Unfortunately, while stationarity may be a foundational concept, it is an illusion. As Milly, *et al.*, have noted, "stationarity is dead and should no longer serve as a central, default assumption in water-resource risk assessment and planning."[3]

1. P.C.D. Milly, et al., *Stationarity Is Dead: Whither Water Management?*, 319 SCIENCE 573 (2008).

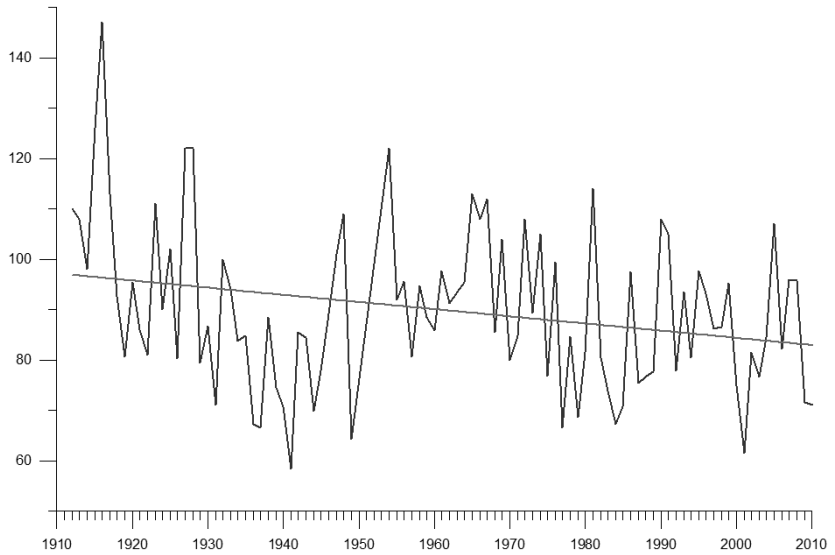
2. Dave Sauchyn, PowerPoint Presentation, *Historic Water and Climate Fluctuations: The Effects of Climate on Water in the Canadian West Over the Last 1,000 years*, WATER, ENERGY AND CLIMATE SEC. IN A CHANGING WORLD CONFERENCE (Oct. 15–19, 2012) (on file with Author).

3. *See* P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, *supra* note 1, at 573. A closely related issue, unfortunately beyond the scope of this brief overview, is the death of policy stationarity. As Wiltshire has noted, "[p]olicy stationarity—the blind adherence to old courses of action—will no longer work in the era of climate change." Kimery Wiltshire, *Beyond Stationarity: Building the Center for Change*, 8 SW. HYDROLOGY 28 (2009). *See also*, Robert W. Adler, *Climate Change and the Hegemony of State Water Law*, 29 STAN. ENVTL. L.J. 1, 7 (2010) ("There are serious limitations in the ability of the dominant existing systems of water law to respond adequately to major changes in water supplies."). Adler has also noted that "[w]ithout substantial reforms, existing water institutions will have difficulty meeting *existing* demands on water resources, let alone the increased demands brought about by climate change." Robert W. Adler, *Water Marketing as an Adaptive Response to the Threat of Climate Change*, 31 HAMLINE L. REV. 729, 738 (2008) (emphasis in original). *Accord*, John N. Matthews et al., *Converging Currents in Climate-Relevant Conversation: Water, Infrastructure, and Institutions*, 9 PLOS BIOLOGY e1001159 (2011); John N. Matthews and A. J. Wickel, *Embracing Uncertainty in Freshwater Climate Adaptation: A Natural History Approach*, 3 CLIMATE & DEV. 269 (2009).

The cause of death? "[S]ubstantial anthropogenic change of Earth's climate is altering the means and extremes of precipitation, evapotranspiration and rates of discharge of rivers."[4] In essence, the effects of climate change have rendered the concept of stationarity illusory.[5]

In Figure 1, while the streamflow varies dramatically, the annual average flows do not vary at all. This was a teddy bear belief, comforting but not real. Recent research by Sauchyn[6] (and others) has shown that average annual flows are decreasing throughout western North America:

FIGURE 2: AVERAGE ANNUAL FLOW (M^3/SEC), BOW RIVER AT BANFF, ALBERTA, 1911-2010



4. *See* Milly et al., *supra* note 1, at 573.

5. An excellent summary was provided by Abrams and Hall:

> Anthropogenic climate change (climate change caused by human activities such as pollution) has undercut the reliability of the stationarity assumption. That is the conclusion of leading scientists, and is already evidenced by observed changes in means and extremes of precipitation, evaporation, and rates of discharge of rivers. The changes being observed in recent years are beyond what can be explained using the stationarity hypothesis, but are consistent with the observed results and updated predictions of improved climate change models. In layman's terms, what stationarity-based models cannot explain, climate change models do explain. Moreover, the changes that those improved climate models predict for water availability in the United States are momentous because the impacts exacerbate, rather than relieve, existing regional shortages and flooding events.

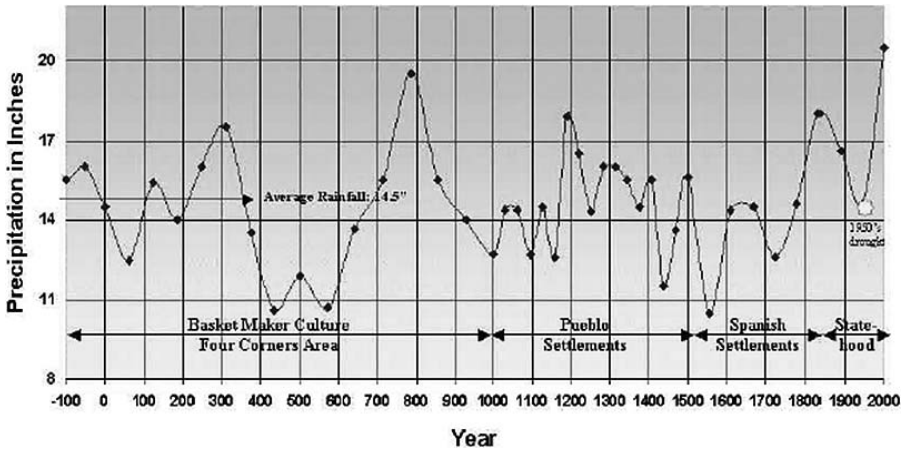
Abrams and Hall, *Framing Water Policy in a Carbon Affected and Carbon Constrained Environment*, 50 NAT. RES. J. 3, 11–12 (2010) (citations omitted).

6. *See* Sauchyn, *supra* note 3. The Bow River in Alberta is not unlike any number of rivers in North America that have their headwaters in mountainous regions and then flow through populated areas.

The myth of stationarity had the effect of concealing natural variability. Such variability must be considered with regard to the physical availability of water to meet both present and future water supply needs. Not to consider such variability is to build a house (or a water supply system) on sand.

This is illustrated in Figure 3, a depiction of long-term rainfall variability in New Mexico:

FIGURE 3: NEW MEXICO RAINFALL[7]



Two aspects of Figure 3 are of note: The average rainfall over the period of record (14.5") and the 1950's drought of record. Note the similarity. In essence, what had been perceived as the "drought of record" was not an anomalous event; it was the long-term average. The illusion that it had been the "drought of record" was based on rainfall occurring only at the end of the Spanish Settlement period and the beginning of the Statehood period. Given the reconstruction of the historic record illustrated above, fundamental assumptions regarding the physical availability of water were incorrect.[8] As noted above, water allocation and management decisions will not stand if based on such illusions.

7. Henri D. Grissino-Mayer, *A 2129-Year Reconstruction of Precipitation for Northwestern New Mexico, USA*, TREE RINGS, ENV'T. & HUMANITY 191, 198 (J.S. Dean & T.W. Swetnam eds., Radiocarbon 1996).

8. J. L. Banner, et al., *Climate Change Impacts on Texas Water: A White Paper Assessment of the Past, Present and Future and Recommendations for Action*, 1 TEX. WATER J. 1, 4, 6 (2010) (it should be noted that in Texas "[t]he 1950s drought is commonly used as the worst-case-scenario for drought planning.").

III. Illusion: Physically Available Water is Legally Available[9]

The mere fact that water is flowing in a stream or is impounded in a reservoir does not mean that the water is legally available for use or appropriation. There are multiple constraints on the legal availability of water. Some of these constraints are obvious while others are more subtle.

Perhaps the most obvious constraint is the need to protect existing water rights or permits from adverse impacts associated with new uses. While there are multiple, state-specific exceptions, state water rights or permit systems almost always protect existing uses. In the prior appropriation doctrine states, this would amount to protecting senior appropriators from the effects of more junior water uses. In permit riparian states, one of the factors almost always included in the list of factors to be considered when a new use is proposed is whether that use will adversely impact existing uses.[10]

Any number of federal and state statutes may also restrict the legal availability of water. For example:

A. *Hydropower*

In 1920, Congress enacted the Federal Water Power Act[11] which gave the Federal Power Commission ("FPC")[12] virtually exclusive authority over the licensure of hydroelectric projects.[13] The provisions of the 1920 Act were incorporated into the Federal Power Act of 1935 (the "FPA").[14]

With regard to the legal availability of water, of particular relevance is the language of 16 U.S.C. § 802(a)(2) which requires license applicants to present to the FPC "[s]atisfactory evidence [of compliance] with the requirements of the laws of the State or States within which the proposed project is to be located with respect to bed and banks

9. Portions of this section are adapted from George William Sherk, *The Management of Interstate Water Conflicts in the Twenty-First Century: Is it Time to Call Uncle?* 12 N.Y.U. Envtl. L.J. 764 (2005).

10. *See generally* George William Sherk, *East Meets West: The Tale of Two Water Doctrines*, 5 Water Res. Impact 5 (2003); George William Sherk, *Meetings of Waters: The Conceptual Confluence of Water Law in the Eastern and Western States*, 5 Natural Res. & Env't 3 (1991); and George William Sherk, *Eastern Water Law: Trends in State Legislation*, 9 Va. Envtl L.J. 287 (1990).

11. Federal Water Power Act of 1920, ch. 285, 41 Stat. 1063 (codified as amended at 16 U.S.C. §§ 791a–828c (2006 & Supp. V 2011)).

12. Pursuant to the Department of Energy Organization Act of 1977, Pub. L. No. 95-91, 91 Stat. 565 (codified as amended at 42 U.S.C. §§ 7101–7385o (2000)), the FPC was terminated, and its hydroelectric licensing power was transferred to the newly-created Federal Energy Regulatory Commission (FERC). 42 U.S.C. §§ 7171(a), 7172(a)(1)(A) (2000).

13. 16 U.S.C. § 817 (2000).

14. Federal Power Act of 1935, ch. 687, 49 Stat. 838 (codified as amended at 16 U.S.C. §§ 791a–828c (2006 & Supp. V 2011)).

and to the appropriation, diversion and use of water for power purposes." In terms of the "laws of the State or States," Congress disclaimed any intent "to affect or in any way interfere with the laws of the respective States relating to the control, appropriation, use, or distribution of water used in irrigation or for municipal or other uses, or any vested right acquired therein."[15]

For twenty-five years following enactment of the Federal Water Power Act, the FPC interpreted these provisions as requiring it to defer to state water laws.[16] This changed in 1946 when the Supreme Court addressed these provisions in a case involving licensure of a project for which the license applicant had failed to obtain a state permit. In *First Iowa Hydro-Electric Cooperative v. FPC*, the Court concluded that "[t]he detailed provisions of the [Federal Power] Act providing for the federal plan of regulation leave no room or need for conflicting state controls."[17] The Court rejected Iowa's contention that 16 U.S.C. § 821 required a contrary result, concluding that this provision preserved only "proprietary rights" or "rights of the same nature as those relating to the use of water in irrigation or for municipal purposes."[18]

In 1990, the *First Iowa* decision was reaffirmed in *California v. FERC ("Rock Creek")*.[19] In a case involving the establishment of minimum stream flows, the Supreme Court, in an opinion written by Justice O'Connor, refused to overturn *First Iowa*, concluding:

> As Congress directed in FPA § 10(a), FERC set the conditions of the license, including the minimum stream flow, after considering which requirements would best protect wildlife and ensure that the project would be economically feasible, and thus further power development. . . . Allowing California to impose significantly higher minimum stream flow requirements would disturb and conflict with the balance embodied in that considered federal agency determination. FERC has indicated that the California requirements interfere with its comprehensive planning authority, and we agree that allowing California to impose the challenged requirements would be contrary to congressional intent regarding the Commission's licens-

15. 16 U.S.C. § 821 (2006).

16. Roderick E. Walston, *State Regulation of Federally Licensed Hydropower Projects: The Conflict between California and First Iowa*, 43 OKLA. L. REV. 87, 91 (1990) (The FPC refused "to issue licenses for hydropower projects if the applicants failed to acquire water rights under state law."), *cited in* George William Sherk, *Approaching a Gordian Knot: The Ongoing State/Federal Conflict Over Hydropwer*, 31 LAND & WATER L. REV. 349, 352 (1996).

17. First Iowa Hydro-Elec. Coop. v. Fed. Power Comm'n, 328 U.S. 152, 181 (1946) (footnote omitted).

18. *Id*. at 176.

19. California v. Fed. Energy Regulatory Comm'n ("Rock Creek"), 495 U.S. 490 (1990).

> ing authority and would "constitute a veto of the project that was approved and licensed by FERC."[20]

The *Rock Creek* decision made it clear that the authority of the Federal Energy Regulatory Commission ("FERC") under the FPA will preempt conflicting state laws and regulations and could preclude the issuance of water use permits under state law. In essence, water needed for hydroelectric projects licensed by FERC may be legally unavailable for other uses.[21]

B. *Water Quality*

With enactment of the Federal Water Pollution Control Act Amendments in 1972 (now known as the Clean Water Act), Congress intended to restore and maintain the chemical, physical, and biological integrity of the nation's water resources.[22] To achieve these objectives, the Clean Water Act imposes a number of requirements that may have the effect of limiting the legal availability of water.

One of these requirements is the National Pollutant Discharge Elimination System ("NPDES") permit.[23] These permits, the issuance of which is a condition precedent to the discharge of pollutants, contain specific provisions relating to the type and concentration of materials to be discharged. The provisions contained in the NPDES permit are determined in part by the assimilative capacity of the watercourse into which the pollutants are to be discharged. If the assimilative capacity of the watercourse changes (as would occur through a reduction in streamflows), then the provisions of specific NPDES permits may have to be changed in order to reduce the type or concentration of materials to be discharged.[24] In essence, the streamflows anticipated when NPDES permits were issued, specifically the assimilative capacity provided by a given streamflow, may have the effect of limiting the availability of water for future uses that would reduce these streamflows.

C. *Species Protection*

There are a number of federal and state species protection statutes. Perhaps the best known is the Endangered Species Act ("ESA") which essentially prohibits any federal agency from taking any action (including destruction of critical habitat) that would jeopardize the continued existence of a threatened or endangered plant or animal

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20. *Id.* at 506–07 (citations omitted) (quoting California *ex rel.* State Water Res. Control Bd. v. Fed. Energy Regulatory Comm'n, 877 F.2d 743, 749 (9th Cir. 1989)).

21. The potential for conflict regarding such conflicting uses is addressed in greater detail in Sherk, *Approaching a Gordian Knot: The Ongoing State/Federal Conflict Over Hydropwer*, *supra* note 16.

22. 33 U.S.C. § 1251(a) (2000).

23. 33 U.S.C. §1342 (2000).

24. *Id.*

species.[25] The ESA also prohibits all parties (both public and private) from undertaking actions that would result in the "taking" of a threatened or endangered species.[26]

In essence, the ESA was intended to protect threatened and endangered species virtually irrespective of the cost of the protection.[27] Of particular importance with regard to the legal availability of water, the ESA may require restrictions on the use of water to protect a threatened or endangered species.[28]

D. *Resource Management*

With the enactment of the Coastal Zone Management Act ("CZMA"), Congress established a national goal "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations."[29] One way to achieve this goal, Congress noted, was "to encourage the states to exercise their full authority over the lands and waters in the coastal zone by assisting the states, in cooperation with federal and local governments and other vitally affected interests, in developing land and water use programs for the coastal zone, including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance."[30]

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25. *See generally* Endangered Species Act, 16 U.S.C. §§ 1531–1544 (2006 & Supp. V 2011).

26. *Id.* at § 1538(a)(1). "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." 16 U.S.C. §1532(19) (2000). "[E]ndangered species" are defined as "any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this chapter would present an overwhelming and overriding risk to man. 16 U.S.C. §1532(6) (2000). "[T]hreatened species" are defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. §1532(20) (2000).

27. *See* Tenn. Valley Auth. v. Hill, 437 U.S. 153, 184 (1978) (protection of the endangered snail darter under the ESA could preclude completion of a water project).

28. One of the clearest examples of the relationship between the ESA and state laws regarding the allocation of water is Sierra Club v. Lujan, No. MO-91-CA-069, 1993 WL 151353, at *1 (W.D. Tex. Feb. 1, 1993), *sub nom.* Sierra Club v. Babbitt, 995 F.2d 571 (5th Cir. 1993). At issue in the case was the relationship between the pumping of ground water from the Edwards Aquifer (pursuant to Texas law) and the need to provide flows from Comal and San Marcos Springs in order not to adversely affect species protected by the ESA. The decision of the district court judge was succinct: "Priority is to be given to species whose survival is in conflict with economic activities, such as withdrawal of water from the Edwards." Slip opinion at 32. *See also* Riverside Irrigation Dist. v. Stipo, 658 F.2d 762 (10th Cir. 1981), *sub nom.* Riverside Irrigation Dist. v. Andrews, 568 F. Supp. 583 (D. Colo. 1983), *aff'd* 758 F.2d 508 (10th Cir. 1985) (exercise of water rights on the South Platte River in Colorado could be restricted in order to ensure supply of water for endangered species located in Nebraska).

29. 16 U.S.C. § 1452(1) (2000).

30. 16 U.S.C. § 1451(i) (2000).

As a mechanism to "encourage the states to exercise their full authority over the lands and waters in the coastal zone," the CZMA provided that "[a]ny Federal agency which shall undertake any development project in the coastal zone of a state shall insure that the project is, to the maximum extent practicable, consistent with the enforceable policies of approved state management programs."[31] Coastal states are authorized to prepare such coastal zone management programs which are then submitted to the National Oceanic and Atmospheric Administration, Department of Commerce, for approval.

Once the state coastal zone management program has been approved, activities of federal agencies (including activities undertaken by federal agencies, activities requiring federal permits, and activities receiving federal funding) must be consistent with the approved program to the maximum extent practicable.[32] These federal activities need not occur in the coastal zone. Only the effects of the activities need be felt there.[33]

As a result, water that is physically available in an upstream state may not be legally available if (a) development of the water resource would involve any federal agency[34] and (b) the impacts of the proposed development would be inconsistent with a lower basin state's approved coastal zone management plan.

E. *Allocation Mechanisms*

Among the more subtle restrictions on the legal availability of water are the different mechanisms by which interstate water conflicts

31. 16 U.S.C. § 1456(c)(2) (2000).

32. 15 U.S.C. § 1455 (2000).

33. *See* 16 U.S.C. § 1456(c)(1)(A) ("Each Federal agency activity *within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone* shall be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved State management programs.") (emphasis added).

34. For example, it would be virtually impossible to develop a water project without discharging dredge or fill materials into watercourses and wetlands. Such discharges are prohibited absent the issuance of a permit by the U.S. Army Corps of Engineers. 33 U.S.C. §1344. *See* United States v. Riverside Bayview Homes, Inc., 474 U.S. 121, 123 (1985) ("Under §§ 301 and 502 of the [Clean Water] Act, 33 U.S.C. §§ 1311 and 1362, any discharge of dredged or fill materials into 'navigable waters'—defined as the 'waters of the United States'—is forbidden unless authorized by a permit issued by the Corps of Engineers pursuant to § 404, 33 U.S.C. § 1344). Applications for "§404 permits" are subject to Environmental Protection Agency review and may also be reviewed by the Fish and Wildlife Service and the National Marine Fisheries Service. Factors to be considered when permit applications are reviewed include the anticipated impacts on water quality, fish, wildlife, recreation, land use, and aesthetics. 40 C.F.R. § 230.10(c). The need to protect from flood damage that could result from the dredge or fill activity must also be considered. 40 C.F.R. § 230.41. Permit applications are to be denied "if there is a practicable alternative to the proposed discharge that would have less impact on the aquatic ecosystem." 40 C.F.R. § 230.10(a).

are managed in the United States. In general, there are three alternative (but not mutually exclusive) conflict management mechanisms: Interstate water compacts (*e.g.*, the Colorado River Compact[35]), federal legislation (*e.g.*, the Boulder Canyon Project Act[36]), and Supreme Court equitable apportionment decisions (*e.g.*, *Kansas v. Colorado*[37]). Compliance with the provisions of any of these conflict management mechanisms may preclude an upstream state from using water to which a lower basin state has an entitlement.

IV. Illusion: State Primacy

In 1978, the Supreme Court in *California v. United States* addressed the relationship between the federal government and the states regarding the allocation and management of water: "The history of the relationship between the Federal Government and the States in the reclamation of the arid lands of the Western States is both long and involved, but through it runs the consistent thread of purposeful and continued deference to state water law by Congress."[38] Three years later, former Solicitor of the Interior William Coldiron noted that the federal government had deferred to state water in thirty-seven separate statutes[39] beginning with the Mining Law of 1866[40] and the Desert Land Act of 1877.[41]

Such comments would appear to suggest that state primacy in the allocation and management of water is not an illusion. While state primacy may have been less of an illusion in an era of abundant water supplies, when conflicts over the use of water had yet to become the norm, the actual relationship between the federal and state governments was described by Justice Douglas in *Oklahoma ex rel Phillips v. Guy F. Atkinson Co.*:[42]

> "Whenever the constitutional powers of the federal government and those of the state come into conflict, the latter must yield." Florida v. Mellon, 273 U.S. 12, 17 . . . . [T]he suggestion that this project

35. The Colorado River Compact, 70 Cong. Rec. 324 (1928), is discussed at George William Sherk, Dividing the Waters: The Resolution of Interstate Water Conflicts in the United States at 25–26 (2000).

36. 43 U.S.C. §§ 617–617(v) (2000); *see also* Arizona v. California, 373 U.S. 546, 564–65 (1963) (concluding that Congress, when it enacted the BCPA in 1928, "intended to and did create its own comprehensive scheme for the apportionment among California, Arizona, and Nevada of the Lower Basin's share of the mainstream waters of the Colorado River, leaving each State its tributaries.").

37. *See generally* George William Sherk, Dividing the Waters: The Resolution of Interstate Water Conflicts in the United States (2000).

38. California v. United States, 438 U.S. 645, 653 (1978).

39. W. Coldiron, Nonreserved Water Rights—United States Compliance with State Law, 88 Interior Dec. 1055, 1060 (11 Sept. 1981), http://www.doi.gov/solicitor/decisions/doi_decisions_088.pdf.

40. Submerged Lands, ch. 29, 14 Stat. 251 (1866).

41. Desert Land Act, ch. 107, 19 Stat. 377 (1877).

42. 313 U.S. 508, 534–535 (1941).

> interferes with the state's own program for water development and conservation is likewise of no avail. That program must bow before the "superior power" of Congress.

The "superior power" of Congress is based on several Constitutional provisions, including the Property Clause,[43] the Commerce Clause,[44] and the Treaty Clause.[45] To the extent that the allocation or management of water resources is affected by federal laws or regulations based on any of these Constitutional provisions, conflicting state laws may be preempted. The language of the Supremacy Clause[46] is clear:

> This Constitution, and the Laws of the United States which shall be made in pursuance thereof; and all treaties made, or which shall be made, under the authority of the United States, shall be the supreme law of the land; and the judges in every state shall be bound thereby, anything in the constitution or laws of any state to the contrary notwithstanding.

In essence, a different rule has emerged to replace the illusion of state primacy: States have primacy over that quantity of water that is not required for federal purposes.

V. Conclusion: The Fourth Dimension

In *The Tempest*, Shakespeare noted that what is past is prologue. With regard to the allocation and management of water resources, precisely the opposite is likely to become the rule. As Barnett, *et al.*, have noted, "the greatest risk about the future of climate-sensitive systems is to assume that the climate of the last century will be the climate we will face in the next."[47]

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43. U.S. Const. art. IV, § 3, cl. 2, ("The Congress shall have Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States").

44. U.S. Const. art. I, § 8, cl. 3; ("The Congress shall have power . . . [t]o regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes").

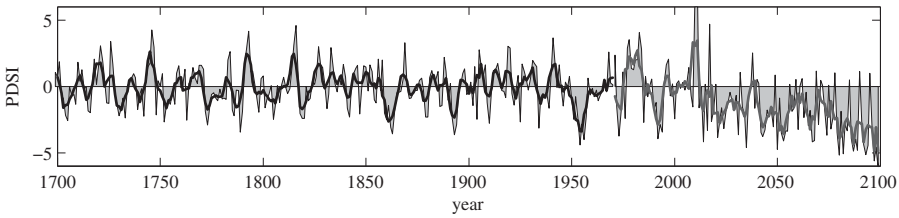
45. U.S. Const. art. II, § 2, cl. 2; ("The President . . . shall have Power, by and with the Advice and Consent of the Senate, to make Treaties, provided two thirds of the Senators present concur").

46. U.S. Const. art. VI, ¶ 2.

47. Tim Barnett, et al., *The Effects of Climate Change on Water Resources in the West: Introduction and Overview*, 62 Climatic Change 1, 8 (2004), *cited in* Robert W. Adler, *Climate Change and the Hegemony of State Water Law*, 29 Stan. Envtl. L.J. 1, 9 (2010). *Accord*, Roger Piekle, *Collateral Damage from the Death of Stationarity*, GEWEX WCRP 5 (May 2009) (". . . we have to improve our ability to anticipate the future, because relying on the statistics of the past will no longer be a useful guide to what is to come").

Particularly in Texas, the physical availability of water is going to decrease.[48] As depicted in Figure 4, the only real question is how much?

FIGURE 4: TREE RING AND CLIMATE MODEL[49] PROJECTED PALMER DROUGHT SEVERITY INDEX[50]



As the amount of water that is physically available decreases, the amount that is legally available will also decrease, perhaps at a greater rate. As physically available supplies decline, the percentage of remaining supplies that is already committed to existing uses and statutory or regulatory requirements may very well increase at a disproportionate rate.

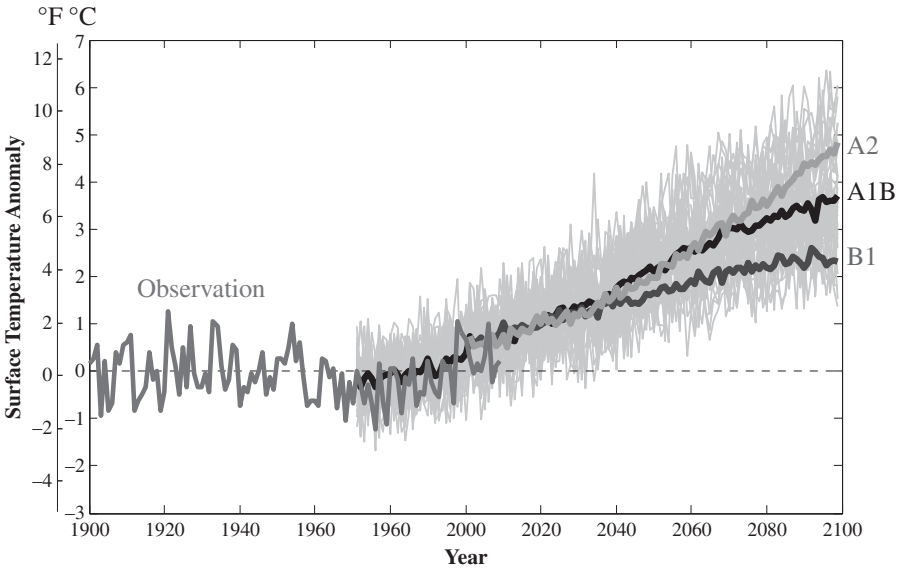
A reduction in both the physical and legal availability of water is going to increase dramatically the risk associated with the development of new water supplies. For example, repayment of revenue bonds issued for the construction of water supply systems, and guaranteed through the delivery of water to municipal and industrial customers, could end up facing default if the water to be delivered is neither physically nor legally available. Similar limitations could face water-dependent industries that plan to develop their own water supplies.

48. "The Southwest appears to be entering a new drought era . . . [A] near perpetual state of drought will materialize in the coming decades as a consequence of increasing temperature." Martin Hoerling & John Eischeid, *Past Peak Water in the Southwest*, 6 SW. HYDROLOGY 18 (2007), *cited in* Adler, *supra* note 3, at 14, *available at* http://www.swhydro.arizona.edu/archive/V6_N1/feature2.pdf.

49. Jay L. Banner, et al., *Climate Change Impacts on Texas Water: A White Paper Assessment of the Past, Present and Future and Recommendations for Action*, 1 TEX. WATER J. 1, 6 (2010), *available at* http://journals.tdl.org/twj/index.php/twj/issue/view/121. The historic record is based on tree ring studies. The future projections are based on Intergovernmental Panel on Climate Change (IPCC) emission scenario A2 using the Canadian Global Climate Model. This model assumes high population growth and slow technological change. It is, in essence, the "business as usual" model.

50. *Id.* The Palmer Drought Severity Index (PDSI) considers both precipitation and temperature.

FIGURE 5: OBSERVED AND MODELED SURFACE TEMPERATURE ANOMALIES FOR TEXAS[51]



With regard to the risks associated with the development of new water supply systems in Texas, the modeled surface temperature anomalies illustrated in Figure 5 provide a disturbing analogy. Each of the emission scenarios (models A2, A1B and B1) show an increase in surface temperature anomalies.[52] It is not a question of whether surface temperature anomalies will increase. The only relevant questions are now how soon and how much?

This is precisely what can be said of the risk associated with the development of new water supply systems. How much is the risk going to increase? How soon? Until such questions have been answered, the success of any attempt to secure water supplies for the future may also be illusory.

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51. *Id.* at 9.

52. *See* Banner, et al., *Climate Change Impacts on Texas Water: A White Paper Assessment of the Past, Present and Future and Recommendations for Action*, *supra* note 49, at 9. Model A2 is the "business as usual" scenario. Model A1B assumed more balanced energy uses. Model B1 assumes a rapid change to clean, efficient energy technologies.