THE DOGMAS OF THE QUIET PAST: POTENTIAL CLIMATE CHANGE IMPACTS ON INTERSTATE COMPACT WATER ALLOCATION

*Jerome C. Muys, Jr.**

*George William Sherk***

This article is dedicated to the memory of Jerome C. Muys, Sr., who made an invaluable contribution to the legal jurisprudence governing the resolution of interstate water disputes and co-authored the Model Interstate Water Compact in furtherance of the goal of sustainable management of transboundary natural resources. Mr. Muys taught federal land and natural resources law at the University of Virginia School of Law for nineteen years.

With regard to the allocation and management of water resources, existing climate change models indicate the potential for significant changes in both intra- and inter-seasonal water supply variability. Precipitation that once fell as snow, and was stored as snowpack, now may fall as rain in areas where there are few, if any, reservoirs to capture the rainfall. The intensity, frequency, and duration of severe storm events may both increase water supply variability and create a need for new flood control structures. Climate change has even caused some to question the foundational concepts of water-resource management such as stationarity.

In various forms, such central, default assumptions are reflected in the interstate water allocation compacts that have been negotiated and ratified in the United States. This article provides a preliminary assessment of the capacity of these compacts to accommodate the effects of climate change. With regard to increased intra- and inter-seasonal variability, this assessment focuses on existing compact water

* LL.M., The George Washington University Law School, J.D., The George Washington University Law School, A.B. The University of North Carolina at Chapel Hill; Sullivan & Worcester, LLP, Washington, D.C.

** D.Sc., School of Engineering and Applied Science, The George Washington University; J.D. University of Denver College of Law; M.A., B.A., Colorado State University; Of Counsel, Sullivan & Worcester, Washington, D.C.; Manager, Regulations and Engineering, Climate Change Branch, Ministry of Environment, Regina, Saskatchewan; Associate, International Water Law Research Institute, University of Dundee, Dundee, Scotland.

allocation mechanisms, such as percentages of stream flow and downstream delivery obligations.

Following this assessment, the identified water allocation mechanisms are compared to similar provisions contained in the Model Interstate Water Compact. Given increasing water supply variability and the static interstate water compact regime, the article concludes with a discussion of the potential need to revise existing interstate water allocation mechanisms, and to develop new ones, in response to the impacts of climate change.

I. INTRODUCTION

With the advent of actual and anticipated water shortages in many parts of the country, there has been a concerted effort by water agencies and the private sector to improve technical and scientific water management practices and to develop new water-efficient technologies. A confluence of factors are contributing to water scarcity, including population growth, irrigation-based agriculture, the enactment of federal regulations restricting interstate water usage, and, most prominently, climate change.

The ultimate success of efforts to manage water shortages will depend in large measure on the existence of an effective legal, political, and administrative framework that empowers the efficient implementation of these practices and technologies. This article explores the ways in which our current system of managing and allocating our nation's water resources, particularly those that are interstate in nature, is inadequate to address the increasing challenges of water scarcity and climate change. It concludes with a discussion of how the approach to interstate water compacts might be restructured to better respond to those challenges.

An interstate compact is an agreement between two or more states. The Supreme Court has held that interstate compacts are subject to most of the doctrines that apply to traditional contracts.[1] However, the U.S. Constitution provides that "no state shall enter into an agreement or compact with another state" without the consent of Congress.[2] Interstate compacts are therefore considered both contracts and, because they are subject to Congressional approval, federal statutes.

Almost all of the nation's rivers are parts of interstate systems.[3] There are some forty-one interstate compacts applicable to portions or all of

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[1] In *Texas v. New Mexico*, 482 U.S. 124, 128 (1987), the Supreme Court noted that "'a compact when approved by Congress becomes a law of the United States' . . . but '[a] Compact is, after all, a contract.' . . . .It remains a legal document that must be construed and applied in accordance with its terms." *Id.* (citing Petty v. Tennessee-Missouri Bridge Comm'n, 359 U.S. 275, 285 (1959) (Frankfurter, J., dissenting); West Virginia *ex. rel.* Dyer v. Sims, 341 U.S. 22, 28 (1951)).

[2] U.S. CONST. art. I, § 10, cl. 3.

[3] *See, e.g.*, DAN SELIGMAN, COL. RIVER COMM'N OF NEV., LAWS OF THE RIVERS: THE LEGAL REGIMES OF MAJOR INTERSTATE RIVER SYSTEMS IN THE UNITED STATES 1–3 (2006).

many of those systems, most of which deal primarily with allocation and/or management of interstate waters.[4] These compacts are the result of negotiations between upstream and downstream states, necessitated by the impact of upstream water usage on downstream states.

Although both Congress and the Supreme Court have jurisdiction over the allocation and management of interstate waters, cooperative regional action through interstate agreements is generally viewed as a desirable alternative to either protracted Supreme Court litigation or federal legislation.[5] Compacts offer the opportunity for states in interstate basins to achieve regional goals not possible under individual state laws because of the territorial constraints imposed by state boundaries. They provide a unique legal and administrative mechanism for cooperative management of shared regional water resources, including the joint exercise of powers beyond those authorized under state law. Additionally, they allow the states to maintain control over their water resources, rather than having their authority supplanted by federal regulation. States participating under a compact may make the interstate program as broad or narrow as they deem appropriate; however, most compacts were negotiated over fifty years ago and are of limited scope.[6] Moreover, the facts and assumptions on which those compacts were negotiated are no longer valid. In particular, climatic conditions and water availability have changed dramatically since existing interstate compacts were originally drafted.

Climate change will have profound impacts on both the physical and the legal availability of water throughout the United States. While it is beyond the scope of this article to review these impacts in detail, the potential effects on existing water allocation compacts raise concerns about the long-term use and effectiveness of such mechanisms.

Because precipitation is more likely to fall as rain rather than snow, combined with warmer air temperatures, climate change will result in

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[4] Jerome C. Muys, Sr., *Will Water Agencies on Interstate Streams be Able to Deal Effectively with Impacts of Climate Change?* 2 (paper presented at the Annual Meeting of the National Lieutenant Governors Association, Baltimore, Maryland, July 31, 2009) (on file with the Virginia Environmental Law Journal).

[5] In *Oklahoma v. New Mexico,* the Supreme Court noted that it had "often expressed [a] preference that, where possible, States settle their controversies by 'mutual accommodation and agreement.'" 501 U.S. 221, 241 (1991) (quoting Colorado v. Kansas, 320 U.S. 383, 392 (1943); Nebraska v. Wyoming, 325 U.S. 589, 616 (1945))). *See also Texas v. New Mexico*, 462 U.S. 554, 572 (1983) ("Time and again we have counseled States engaged in litigation with one another before this Court that their dispute 'is one more likely to be wisely solved by co-operative study and by conference and mutual concession on the part of the representatives of the States which are vitally interested than by proceedings in any court however constituted.'"(quoting *New York v. New Jersey*, 256 U.S. 296, 313 (1921))).

[6] Muys, *supra* note 4, at 2.

decreased snowpack.[7] This will result in reduced stream flows in those river systems dependent on snowmelt, particularly in the western United States.[8] Water availability will change in river systems where stream flows resulting from snowmelt are replaced by stream flows resulting from rainfall.[9]

Climate change will result in increased frequency, intensity, and duration of severe storm events as well as droughts.[10] The consequences of these storm events raise concerns regarding the storage capacity of existing reservoirs and flood protection—an issue that is beyond the scope of the present article. These consequences do, however, raise issues relating to both the safety and the storage capacity of existing reservoirs.[11] Droughts, in general, have increased over the past fifty years in the southeastern and western United States. Meanwhile, the Midwest and Great Plains have seen a reduction in drought intensity.[12] Groundwater resources also are predicted to be at risk, due to evapotranspiration losses that can reduce aquifer recharge and storage.[13] Increasing temperatures associated with climate change both reduce available water supplies and increase the demand for water due to evapotranspiration and other phenomena.[14]

Because existing water compacts were crafted long before the term "climate change" became part of our common parlance, the current institutional arrangements on most of the nation's interstate waterways did not contemplate many of the present and future challenges to regional water quantity and quality confronting the states on those streams.[15] Most compacts were not developed with the flexibility needed to accommodate climate variability.

As water becomes scarcer, the stakes associated with water rights allocation proceedings will increase, as will the length of time it takes to negotiate the terms of water compacts. Subsequent litigation by stakeholders dissatisfied with the outcome of the negotiations will also likely increase. The efforts by Georgia, Florida, and Alabama to negotiate an interstate compact allocation formula over the past twenty-five years on the Alabama-Coosa-Tallapoosa and Apalachicola-

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7 *See infra* notes 33–36 and accompanying text.
8 *See infra* notes 34–36 and accompanying text.
9 *See infra* notes 34, 36 and accompanying text.
10 *See infra* notes 37–40 and accompanying text.
11 *See infra* notes 37–38 and accompanying text.
12 *See infra* notes 39–40 and accompanying text.
13 *See infra* note 40 and accompanying text.
14 *See infra* note 40 and accompanying text.
15 Muys, *supra* note 4, at 1.

Chattahoochee-Flint basins in the Southeast are but one example of this failing.[16]

A significant effort at reform of the interstate water compact system was undertaken with the 2007 publication of the Model Interstate Water Compact by the Utton Center on Transboundary Resources at the University of New Mexico School of Law.[17] Among the key objectives of the drafters of the Model Compact was to create a document that offered a meaningful alternative to litigation, was "user-friendly," and was flexible enough so that states could adapt it to their particular circumstances.[18] In furtherance of those goals, the Model Compact includes a wide a range of approaches for addressing water management issues and resolving interstate water conflicts, many of which are relevant to the challenges posed by increasing water scarcity and climate change.[19]

Although there are faults in the current compact scheme, these negotiated agreements provide states the opportunity to shape their own destiny and to address problems unique to their regions, rather than have the Supreme Court or Congress do so. Because the management of our water resources is by necessity highly localized, continued reliance on compacts as a principal feature of our interstate water management system seems reasonable and prudent so long as the shortcomings in that system can be addressed.

II. WATER SCARCITY AND CLIMATE CHANGE

With the advent of water scarcity concerns in many parts of the country, the need to revise existing water laws and institutions to facilitate the development of water-efficient technologies and improved irrigation practices has become apparent.[20] However, the introduction

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[16] *See generally* George W. 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, 766 (2005).

[17] Jerome C. Muys, Sr., George W. Sherk & Marilyn C. O'Leary, *Utton Transboundary Resources Center Model Interstate Water Compact*, 47 NAT. RESOURCES J. 17 (2007), republished with appendices as JEROME C. MUYS, SR., GEORGE W. SHERK & MARILYN C. O'LEARY, MODEL INTERSTATE WATER COMPACT (2009).

[18] Marilyn C. O'Leary & George W. Sherk, *Reinventing the Interstate Water Compact: A New Model*, 52 ROCKY MTN. MIN. L. INST. 21-1 (2006).

[19] *Id.*

[20] George W. Sherk, *The Shape of Illusion: Water Law and Policy in the Fourth Dimension*, 1 TEXAS A&M J. REAL PROP. L. 113, 114 (2013); *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."); Robert W. Adler, *Water Marketing as an Adaptive Response to the Threat of Climate Change*, 31 HAMLINE L. REV. 729, 738 (2008) ("Without substantial reforms, existing water institutions will have difficulty meeting *existing* demands on water

of these new practices and technologies must be accompanied by the development of fully supportive legal, political, and administrative institutions. This article explores the ways in which one such institution, our system of interstate water compacts, could be modified so as to better address the challenges posed by increasing water scarcity and climate change.

The concept of "stationarity," that water resources are relatively stable and unaffected by drastic changes in long-term weather patterns, has been a foundation of water-resources engineering since long before the first interstate water compact was established.[21] However, with the advent of climate change, our nation is experiencing increased variability in both precipitation and susceptibility to drought.[22] Stationarity can no longer be the "central, default assumption in water-resource risk assessment and planning."[23]

In certain watersheds, climate change already has brought about changes in stream flow, temperature, evapotranspiration rates, and precipitation that are impacting water supplies.[24] Although these impacts have been most evident in the West, principally the states comprising the Colorado River Basin, most climate models predict that the eastern and southeastern United States also will be affected, likely becoming warmer and more humid in coming years.[25]

As our climate becomes more variable, we are increasingly subject to more frequent droughts and floods.[26] The higher rates of evaporation associated with increasing temperatures tend to both offset the benefits from periods of greater precipitation and intensify the impacts of

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resources, let alone the increased demands brought about by climate change." (emphasis in original)).

[21] *See* Sherk, *supra* note 16, at 113–16.

[22] *Id.*

[23] P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, 319 SCI. 573, 573 (2008). With regard to the death of stationarity:

> The distinguishing feature of all such methods [to simulate variability in water resource system design and operation] . . . is that they assume that an observed record of stream flow, on which planning is based, is statistically stationary—that is, the probability distribution(s) from which the observations are drawn does not change with time . . . .[I]n the era of climate change this assumption is no longer tenable.

Dennis P. Lettenmaier et al., U.S. Climate Change Sci. Program, *Water Resources*, *in* THE EFFECTS OF CLIMATE CHANGE ON AGRICULTURE, LAND RESOURCES, WATER RESOURCES, AND BIODIVERSITY IN THE UNITED STATES 121, 121–22 (Margaret Walsh Ed. 2008).

[24] *See infra* note 30 and accompanying text.

[25] *See infra* notes 39-40 and accompanying text.

[26] *See infra* notes 37–40 and accompanying text.

periods of lesser precipitation.[27] In essence, the effects of climate change are rendering the concept of stationarity illusory.[28]

Until recent years, predicting the availability of adequate water supplies in any given region was a straightforward inquiry.[29] Although the volume of water in a given water system may have fluctuated over the years based on seasonal variability, and occasionally other considerations, annual average flows typically varied very little.[30]

Today, the predictability of average rates of precipitation, and thus annual flow rates, can no longer be assumed. The variability in our climatic systems is increasing pressures on, and challenges to, the management of regional water supplies throughout the United States. Although some regions are forecasted to receive increased precipitation, most are predicted to experience reductions in water supply.[31]

A. Impacts of Climate Change

Climate change will have profound impacts on both the physical and the legal availability of water throughout the United States. These impacts have been characterized as "changes . . . in the timing, volume, quality and spatial distribution of freshwater available for human settlements, agriculture and industrial users in most regions of North America."[32] While it is beyond the scope of this article to review these impacts in detail, their potential impacts on existing water allocation compacts raise concerns about the long-term use and effectiveness of such allocation mechanisms. As discussed in greater detail below, these concerns relate to the physical availability of water (both quantity and timing) and to an increased frequency, intensity, and duration of both severe storm events and droughts.

With regard to the physical availability of water, analyses undertaken for the Intergovernmental Panel on Climate Change ("IPCC") indicate that a general drying pattern is likely to emerge in the future.[33] The impacts of climate change will not be confined to the summer. The

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[27] *See infra* notes 39–40 and accompanying text.

[28] "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." Sherk, *supra* note 16, at 116.

[29] *Id*. at 113–19.

[30] *Id.*

[31] *See infra* notes 33–36, 39–40 and accompanying text.

[32] BRYSON BATES ET AL., (EDS.), INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE AND WATER. TECHNICAL PAPER OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 102 (2008).

[33] *Id.* at 26 (emphasis added).

general drying pattern combined with warmer air temperatures will result in decreased snowpack. This will lead to reduced stream flows in those river systems dependent on snowmelt, particularly in the western United States.

> As early as the mid-1980s, regional hydrologic studies of global warming impacts suggested with increasing confidence that higher temperatures will affect the timing and magnitude of runoff in these regions and studies have now shown that all watersheds with substantial snow dynamics are likely to be affected . . . .Indeed, over the past two decades, this has been one of the most persistent and well established findings on the impacts of climate change for water resources in the United States and elsewhere.[34]

In general, the timing of physical availability will change in response to the general drying trend. More specifically, it will also change in river systems where stream flows resulting from snowmelt are replaced by stream flows resulting from rainfall. As noted by the National Research Council, "among the ongoing changes in the physical climate system that can be linked, at least in part, to increasing temperatures at the Earth's surface are . . . decreases in Northern Hemisphere snow cover . . . ."[35] In essence, "reductions in snowfall and earlier snowmelt and runoff would increase the probability of flooding early in the year and reduce the runoff of water during late spring and summer." [36]

1. Frequency, Intensity and Duration of Severe Precipitation Events

Climate change will result in an increased frequency, intensity, and duration of severe storm events. As noted by the National Research Council in 2011, "[p]recipitation patterns have changed: heavy downpours have become more frequent and more intense . . . ."[37] These

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[34] PETER. H. GLEICK, U.S. GLOBAL CHANGE RES. PROGRAM, WATER: THE POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY AND CHANGE FOR THE WATER RESOURCES OF THE UNITED STATES–THE REPORT OF THE WATER SECTOR ASSESSMENT TEAM OF THE NATIONAL ASSESSMENT OF THE POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY AND CHANGE 37 (2000); *see also* BATES ET AL, *supra* note 32, at 102 ("In projections for mountain snowmelt-dominated watersheds, snowmelt runoff advances, winter and early spring flows increase (raising flooding potential), and summer flows decrease substantially.").

[35] NATIONAL RESEARCH COUNCIL ET AL., AMERICA'S CLIMATE CHOICES 18 (2011) (internal citation omitted); *see also* Lettenmaier et al., *supra* note 23, at 121, 149.

[36] GLEICK, *supra* note 34, at 27 (emphasis added).

[37] NATIONAL RESEARCH COUNCIL ET AL., *supra* note 35, at 19; GLEICK, *supra* note 34, at 35 ("Increases in extreme precipitation events recently have been projected in nested regional models over the United States."); *see also id.* at 99 ("Climate-induced changes in hydrological conditions will affect the magnitude, frequency, and costs of future extreme hydrological events.").

patterns have also been observed by the IPC: "Statistically significant increases in the occurrence of heavy precipitation have been observed across Europe and North America . . . Seasonality of changes varies with location: increases are strongest in the warm season in the USA, while in Europe changes were most notable in the cool season."[38]

2. Frequency, Intensity and Duration of Droughts

Specifically with regard to the southeastern and western United States, the National Research Council has noted that "the frequency of drought has increased over the past 50 years . . . while the Midwest and Great Plains have seen a reduction in drought frequency . . . ."[39] Lettenmaier, et al. reported similar results: "[T]here is some indication of increased drought severity and duration in the western and southwestern United States that may have resulted from increased actual evaporation dominating the trend toward increased soil wetness."[40]

B. The Roots of Water Scarcity

Increasing private and public demands on existing water resources lay the seeds of scarcity in some areas of the country long before the advent of climate change. In the face of that increasing demand, our system of interstate compacts has remained largely unchanged for over fifty years.[41]

Because most of the nation's water compacts were approved over a half-century ago, they do not reflect the vastly increased role of the federal government and the judiciary in the management of our nation's water resources. Since the time that most compacts were approved, there has been (1) a dramatic expansion of environmental legislation by Congress (such as the Clean Water Act and the Endangered Species Act) and also by the states beginning in the early 1970s;[42] (2) significant Supreme Court rulings affecting interstate water rights, including a highly consequential ruling expanding the scope of the doctrine of reserved Indian water rights in 1963;[43] and (3) a significant increase in litigation initiated by national and regional environmental

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38 BATES ET AL., *supra* note 32, at 16.

39 NATIONAL RESEARCH COUNCIL ET AL., *supra* note 35, at 19; *see also* Aiguo Dai et al., *A Global Data Set of Palmer Drought Severity Index for 1870-2002: Relationship with Soil Moisture and Effects of Surface Warming*, 5 J. HYDROMETEOROLOGY 1117, 1117–30 (2004).

40 Lettenmaier et al., *supra* note 23, at 149.

41 Most of the water allocation compacts are located mainly in the West, an area of explosive population and industrial growth to this day. Noah D. Hall, *Interstate Water Compacts and Climate Change Adaptation,* 5 ENVTL. & ENERGY L. & POL'Y J. 237, 258 (2010).

42 Muys, *supra* note 4, at 2.

43 *See, e.g.*, Arizona v. California, 373 U.S. 546 (1963).

organizations,[44] which played a major role in shaping the nation's water policy.[45] Together, these factors limit what can be done with interstate flowing water, contributing to the scarcity issue.

More importantly, most of the existing water compacts were crafted long before the term "climate change" became part of our common parlance.[46] The implications of climate change for the continued viability of our interstate compact system are discussed in Section III, below.

As a result of these changes, the existing institutional arrangements governing most of the nation's interstate waterways, whether grounded solely on state law or outdated interstate agreements, did not contemplate many of the present and future challenges to regional water quantity and quality confronting the states on those streams. However, even in the face of those challenges, most states and Congress seemingly have "remained content to continue to wait for major crises to drive needed reforms in interstate river management."[47]

In recent years, the efficacy of interstate compacts in managing inter-basin water allocations increasingly has come into question. Litigation between states over interstate waters has become customary, even when an interstate compact already is in place.[48] The system stresses posed by water scarcity and climate change will only exacerbate this trend.[49]

1. Increasing Demands on Water Supplies

Increasing population and development in many parts of the country inevitably are creating new demand for water. Not only is this increased demand raising concerns about the potential for future water scarcity, but many parts of the country are facing significant challenges in meeting existing demands for water resources.[50] And, as water shortages become more pervasive, new policies, limitations, and restrictions on water consumption are starting to be implemented.[51]

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44 Muys, *supra* note 4, at 2.

45 *Id.*

46 *Id.*

47 *Id.* at 5.

48 GEORGE W. SHERK, DIVIDING THE WATERS: THE RESOLUTION OF INTERSTATE WATER CONFLICTS IN THE UNITED STATES 51–55 (2000).

49 Because existing interstate water compacts have not been effective in avoiding protracted Supreme Court litigation, it is not surprising that only two water management compacts were entered into during the sixty years preceding Congress' approval of the Great Lakes Basin Compact in the mid-2000's. *See generally Id.*

50 Glen M. MacDonald, *Water, Climate Change, and Sustainability in the Southwest,* 107 PROC. NAT'L ACAD. SCI. 21256, 21259 (2010).

51 Most discussed is California Executive Order B-29-15, (Apr. 1, 2015), which implemented restrictions to reduce state water use by twenty-five percent by the end of February 2016. In 2012

The persistent 2014-2015 drought in California has highlighted the fact that increasing population and the demands of agriculture and industry threaten to overwhelm available water supplies in certain areas.[52] And the threat is not limited to just California. Indeed, the extreme focus on California has obscured the fact that average annual river and stream flows are decreasing throughout western North America.[53] The predictability of reliable water supplies in many parts of our western states and elsewhere has been replaced by the potential that water scarcity could occur in virtually any region of our nation.[54]

In many watersheds, such as the Colorado River Basin, water supplies have barely met demand for decades.[55] These same watersheds often suffer from groundwater depletion as well.[56] Even without the additional pressures of climate change, water resources in many regions are already stressed, particularly with respect to water demand related to irrigation.[57] Climate change will only exacerbate these problems. The higher temperatures anticipated to result from climate change are likely to increase demand for all types of water use.

2. Environmental Protections and New Claimants

In recent years, there has been an explosion of environmental legislation that has created an entirely new class of demands and limitations on our nation's water resources. There now are a multitude of federal and state statutes that have the potential to effectively override pre-existing water rights and permits,[58] and these regulatory

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Oklahoma passed H.B. 3055, which sets a goal of consuming no more freshwater in 2060 than the 2012 amount. Water for 2060 Act, H.B. 3055, 53d Leg., 2d Sess. (Okla. 2012).

[52] DAN KOWALSKI & LEONARD SAHLING, COBANK KNOWLEDGE EXCHANGE, CALIFORNIA DROUGHT IN 2015 AND ITS ECONOMIC IMPACT ON GROUNDWATER 1 (2015).

[53] *See* OFFICE OF THE CHIEF SCIENTIST FOR HYDROLOGY, U.S. GEOLOGICAL SURVEY, CLIMATIC FLUCTUATIONS, DROUGHT, AND FLOW IN THE COLORADO RIVER BASIN 1 (2004).

[54] *Global Warming Effects on Extreme Weather: Hearing before the H. Select Comm. on Energy Independence and Global Warming*, 110th Cong. 2 (2008) (statement of Heather Cooley, Senior Research Associate at The Pacific Institute).

[55] *See* Michael Wines, *Colorado River Drought Forces a Painful Reckoning for States*, N.Y. TIMES, Jan. 6, 2014, at A1.

[56] A 2014 study by NASA and UC Irvine used data from the Gravity Recovery and Climate Experiment ("GRACE") satellite mission to observe changes in the mass of the Colorado River Basin via monthly measurements from 2004 to 2013. The results showed a loss of 53 million acre-feet (sixty-five cubic kilometers) of freshwater, with over seventy-five percent of the loss coming from groundwater. Stephanie L. Castle et al., *Groundwater Depletion During Drought Threatens Future Water Security of the Colorado River Basin*, 41 GEOPHYSICAL RES. LETTERS 5904, 5904, 5909–11 (2014).

[57] *See, e.g.*, MOLLY A. MAUPIN ET AL., U.S. GEOLOGICAL SURVEY, CIRCULAR 1405: ESTIMATED USE OF WATER IN THE UNITED STATES IN 2010, at 7 (2014).

[58] Sherk, *supra* note 16, at 778–806; *see also* Muys, *supra* note 4, at 2.

claims on our water supplies are further exacerbating concerns about water scarcity in many areas.[59]

For example, the Supreme Court has construed the Federal Power Act[60] to preempt conflicting state water laws.[61] This ruling raises the prospect that water needed for hydroelectric projects licensed by the Federal Energy Regulatory Commission may be accorded a right senior to pre-existing rights under state law.[62] The consequence of these rulings can only be increased demand on already-stressed water supplies.[63]

Similarly, Section 404(c) of the Clean Water Act[64] specifically references the intent to protect municipal water supplies, as well as shellfish beds, fishery areas, wildlife, and recreational areas. The U. S. Environmental Protection Agency ("EPA") is expressly authorized under that provision to "veto" a permit issued by the Army Corps of Engineers for the discharge of dredged or fill material into navigable waters if EPA determines that the discharge would have an unacceptable adverse effect on specified water resources.[65] This veto authority has been used, among other purposes, to prohibit the construction of a reservoir that would have addressed a demonstrated need for additional local water supplies.[66]

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59 Sherk, *supra* note 16, at 778–813.

60 16 U.S.C. § 791 (2012).

61 First Iowa Hydro-Electric Coop. v. Fed. Power Comm'n, 328 U.S. 152, 181 (1946) ("The detailed provisions of the [Federal Power] Act providing for the federal plan of regulation leave no room or need for conflicting state controls."). This decision was affirmed in *California v. Fed. Energy Regulatory Comm'n (Rock Creek)*, 495 U.S. 490, 506–07 (1990) ("[A]llowing California to impose the challenged requirements would be contrary to congressional intent regarding the Commission's licensing authority and would constitute a veto of the project that was approved and licensed by FERC.").

62 *See* George W. Sherk, *Approaching a Gordian Knot: The Ongoing State/Federal Conflict Over Hydropower*, 31 LAND & WATER L. REV. 349, 350 (1996).

63 U.S. hydropower capacity has increased by around 1.5 GW from 2005–2013. ROCÍO URÍA-MARTÍNEZ ET AL., U.S. DEP'T OF ENERGY, 2014 HYDROPOWER MARKET REPORT v (2015).

64 33 U.S.C. § 1344(c) (2012).

65 The EPA has only used this veto power 13 times since 1972. EPA, CLEAN WATER ACT: SECTION 404(C) "VETO AUTHORITY" (2016).

66 EPA, FINAL DETERMINATION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S ASSISTANT ADMINISTRATOR FOR WATER PURSUANT TO SECTION 404(C) OF THE CLEAN WATER ACT CONCERNING THE TWO FORKS WATER SUPPLY IMPOUNDMENTS, JEFFERSON AND DOUGLAS COUNTIES, COLORADO (1990). Reservoirs in Kent County, Rhode Island, James City County, Virginia, and Bacon County, Georgia were also vetoed. *See* EPA, FINAL DETERMINATION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S ASSISTANT ADMINISTRATOR FOR WATER PURSUANT TO SECTION 404(C) OF THE CLEAN WATER ACT CONCERNING THE PROPOSED BIG RIVER WATER SUPPLY IMPOUNDMENT, KENT COUNTY, RHODE ISLAND (1990); EPA, FINAL DETERMINATION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S ASSISTANT ADMINISTRATOR FOR WATER PURSUANT TO SECTION 404(C) OF THE CLEAN WATER ACT CONCERNING THE PROPOSED WARE CREEK WATER SUPPLY IMPOUNDMENT, JAMES CITY COUNTY, VIRGINIA (1989); EPA, FINAL DETERMINATION OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S ASSISTANT ADMINISTRATOR FOR WATER PURSUANT TO SECTION

The requirements of the federal Endangered Species Act ("ESA")[67] and similar state statutes also may operate to create a senior claim over pre-existing users in order to protect a threatened or endangered species. The ESA has become a particularly effective tool for stakeholders advocating for higher flow rates in the nation's waterways to protect downstream ecosystems.[68]

The Coastal Zone Management Act ("CZMA")[69] is yet another federal program with the potential to create additional demand on existing water supplies under certain circumstances. States that are subject to the CZMA establish coastal zone management plans which, upon approval by the federal government, have the force of federal law.[70] These plans may effectively result in the imposition of restrictions on the use of water originating in an upland state due to impacts deemed inconsistent with a downstream state's plan.

III. THE CURRENT STATE OF INTERSTATE WATER COMPACTS[71]

A. Existing Compacts

In light of the challenges posed to our nation's water resources by increasing water scarcity and climate change, it has become essential that we bring to bear the best technical and scientific water management practices available to address those challenges. However, our ability to do so is highly dependent on the existence of appropriate political and administrative institutions empowered to effectively implement such practices. This is particularly true with respect to interstate river basins.

In principle, interstate water compacts would seem to present the optimal opportunity for states in interstate basins to achieve regional goals not possible under their individual state laws because of the

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404(C) OF THE CLEAN WATER ACT CONCERNING THE PROPOSED LAKE ALMA WATER SUPPLY IMPOUNDMENT AND PROPOSED MITIGATION OF ASSOCIATED ENVIRONMENTAL IMPACTS, ALMA, BACON COUNTY, GEORGIA (1988).

67 16 U.S.C. § 1531 (2012).

68 It was reported that the California branch of the Bureau of Reclamation ordered the South San Joaquin Irrigation District to let a pulse of water through the dam on the Stanislaus River in order to provide more water to the ESA protected steelhead trout so they could swim to the Pacific. Nick Stockton, *Should California Spend 4 Billion Gallons to Save a Few Fish?*, WIRED (Apr. 10, 2015, 9:55 PM), http://www.wired.com/2015/04/california-spend-4-billion-gallons-water-fish/.

69 16 U.S.C. § 1451.

70 *See, e.g.*, California Coastal Commission v. Granite Rock Co., 480 U.S. 572, 593 (1987) (finding that California's approved coastal zone management program applied to activities undertaken on National Forest lands)

71 This section of the article expands on a number of the themes first introduced in Muys, *supra* note 4.

territorial constraints imposed by state boundaries. Interstate agreements, if approved by Congress as required by the Compact Clause of the Constitution,[72] can authorize cooperative management of shared regional water resources. As early as 1973, the National Water Commission recommended in its report, *Water Policies for the Future*, greater use of interstate compacts, particularly federal-interstate compacts such as those in effect on the Delaware and Susquehanna Rivers, for regional water resources allocation and management.[73] The Western Water Policy Review Advisory Commission made the same recommendation in its 1998 report *Water in the West: Challenge for the Next Century*.[74]

Nonetheless, there is a belief that the "existing institutional arrangements on most of the nation's interstate waterways, whether grounded solely on state law or outdated interstate agreements, are not adequate" to meet present and future water quantity and quality challenges.[75] For example, despite expectations to the contrary, existing compacts have not been particularly effective in curtailing costly and protracted Supreme Court litigation.[76] Moreover, there are a number of additional factors at play as well that have led to general disillusionment with the current system of trans-boundary water management.

First, many of the early interstate compacts failed to establish regional commissions with adequate authority to make binding decisions in the event of a dispute between compact states over management and allocation issues. In the absence of such an arbiter with authority at the commission level, recourse has been to the courts.

Second, many states sharing interstate waters seemingly have not been persuaded that cooperative regional action pursuant to interstate agreements is necessarily in their best interests. In some instances, compact negotiators and administrators bring to the table adversarial philosophies and management styles, which are not conducive to the goal of the compact process—the equitable allocation of a shared common resource.

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[72] U.S. CONST. art. I, § 10, cl. 3 ("No State shall, without the Consent of Congress, . . . enter into any Agreement or Compact with another State, or with a foreign Power.").

[73] NAT'L WATER COMM'N, WATER POLICIES FOR THE FUTURE: FINAL REPORT TO THE PRESIDENT AND TO THE CONGRESS OF THE UNITED STATES 418–26 (1973).

[74] WESTERN WATER POL'Y REV. ADVISORY COMM'N, WATER IN THE WEST: CHALLENGE FOR THE NEXT CENTURY 6-3 (1998).

[75] Muys, *supra* note 4, at 1.

[76] Of course, there are exceptions. For example, a 2007 agreement among the seven Colorado River Basin states and approved by the Secretary of the Interior ended seven decades of Supreme Court litigation and Congressional infighting. *See* Muys, *supra* note 4, at 2.

Third, many compacts were negotiated with too limited a scope, focusing primarily on near-term water supply matters without giving sufficient attention to possible future contingencies. This in part was a function of the fact that compacts were often negotiated without public participation by affected interested groups.

Fourth, a number of high-profile efforts to negotiate interstate compact allocation formulas have resulted in stalemates. The Alabama-Coosa-Tallapoosa River Basin Compact[77] and the Apalachicola-Chattahoochee-Flint River Basin Compact,[78] both now expired, contained a provision authorizing the states to negotiate an Allocation Formula Agreement. Any such agreement was then subject to review and approval by a federal commissioner.[79] The language of both compacts provided that

> once an allocation formula is adopted, each and every officer, agency, and instrumentality of the United States shall have an obligation and duty, to the maximum extent practicable, to exercise their powers, authority, and discretion in a manner consistent with the allocation formula so long as the exercise of such powers, authority, and discretion is not in conflict with federal law.[80]

Even though different Allocation Formula Agreements were proposed, none was ever approved by a federal commissioner, nor was the language quoted above ever subject to judicial review.[81]

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[77] Pub. L. No. 105-105, 111 Stat. 2233 (1997).

[78] Pub. L. No. 105-104, 111 Stat. 2219 (1997).

[79] Article VII(a) of the Apalachicola-Chattahoochee-Flint River Basin Compact provides in relevant part:

> The allocation formula thus agreed upon shall become effective and binding upon the parties to this Compact upon receipt by the Commission of a letter of concurrence with said formula from the Federal Commissioner. If, however, the Federal Commissioner fails to submit a letter of concurrence to the Commission within two hundred ten (210) days after the allocation formula is agreed upon by the State Commissioners, the Federal Commissioner shall within forty-five (45) days thereafter submit to the ACF Basin Commission a letter of nonconcurrence with the allocation formula setting forth therein specifically and in detail the reasons for nonconcurrence; provided, however, the reasons for nonconcurrence as contained in the letter of nonconcurrence shall be based solely upon federal law. The allocation formula shall also become effective and binding upon the parties to this Compact if the Federal Commissioner fails to submit to the ACF Basin Commission a letter of non-concurrence in accordance with this Article.

111 Stat. 2222–23. Because the Apalachicola-Chattahoochee-Flint River Basin Compact served as a model for the Alabama-Coosa-Tallapoosa River Basin Compact, the substantive provisions of the two compacts are essentially identical. Sherk, *supra* note 16, at 776.

[80] 111 Stat. 2223; 111 Stat. 2237.

[81] *See generally* Sherk, *supra* note 16.

Additionally, there is yet an additional concern regarding the existing compact system—whether it is equipped to handle extreme drought conditions that might arise as the impacts of growing water scarcity and climate change are felt. This issue is explored in the next section.

B. Interstate Allocation Mechanisms[82]

With regard to the allocation of interstate water resources, the only consistency appears to be inconsistency. Any number of allocation mechanisms is included in existing interstate water compacts. These mechanisms include allocations based on either temporal priority (the basis of the prior appropriation doctrine) or use priority.

Specific quantities of water may be allocated to one or more compact states. These entitlements may be quantified based on volume (i.e., acre-feet of water) or flow (i.e., cubic feet per second at a specific point). An alternative approach is based on state-specific percentages of available streamflow. Another alternative approach is to base state-specific entitlements on authorized storage capacity in the states sharing the water resource.

Frequently, these mechanisms are combined. For example, a streamflow percentage may be applicable only to streamflows that are not needed to fulfill existing water rights. An alternative approach that appears in more recent compacts is to authorize an administrative entity to develop and implement an allocation plan applicable to the interstate water resource.

1. Adjustment Mechanisms

Not all of the existing interstate water compacts include provisions allowing for adjustments to the allocations authorized by the compacts. Those compacts that do include such provisions also frequently allow the administrative entity to determine (usually on an annual basis) the quantity of water subject to compact allocation.

An alternative approach, intended to accommodate both intra- and inter-seasonal variability, is to use a running average approach, whereby a delivery obligation to a lower basin state is measured over a multi-year period instead of being measured annually. Such variability may also be addressed in specific compact provisions intended to be implemented during low-flow or drought conditions.

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[82] A more detailed discussion of specific allocation mechanisms contained in various interstate compacts is set forth in the Appendix hereto.

2. Allocation Uncertainties

Specific provisions contained in several of the interstate water compacts create uncertainties that may preclude effective implementation of the compacts. Several of the compacts, for example, include language stating that existing water rights are not to be affected adversely by the allocation of the interstate water resource. In situations where "existing water rights" are not quantified, the actual allocation of water under the interstate compact is uncertain.

With regard to the impacts of climate change, a number of the compacts include provisions stating that the terms of the compact (including the interstate allocation) may not be changed absent congressional consent. This is typically the case with respect to compacts in which a specific water allocation or formula is included within the compact. While it reflects the authority of Congress over interstate compacts, it may create political issues unrelated to the interstate allocation of water. However, these problems do not arise in those compacts where an administrative entity has been authorized to develop and implement an interstate water allocation plan.

C. The Model Interstate Water Compact

Over a decade ago, former New Mexico Senator Peter Domenici persuaded Congress to fund the preparation of a model compact, the goal of which would be to minimize interstate water litigation and encourage interstate cooperation.[83] This project was undertaken by the Utton Center on Transboundary Resources at the University of New Mexico, and resulted in the publication of the *Model Interstate Water Compact* ("Model Compact").[84]

The authors of the Model Compact focused principally on two areas of concern with respect to existing water compacts: the need to improve the efficacy of compacts in reducing recourse to the courts to resolve water disputes and the need to make compacts more "user-friendly."[85] In furtherance of those goals, the Model Compact includes a number of wide-ranging recommendations for change, some of which would come into play in the event of extreme drought scenarios. The key provisions of the Model Compact are summarized very generally below:

1. Compact terms would be limited to twenty-five years, at the end of which member states could opt to either renew the compact unchanged, modify it, or terminate it. Most existing compacts remain in effect for

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[83] Muys, *supra* note 4, at 1.

[84] Muys, Sherk & O'Leary, *supra* note 17.

[85] O'Leary & Sherk, *supra* note 18, at 21-01.

perpetuity. Dissatisfied states would be permitted to withdraw unilaterally, subject to honoring their financial and environmental obligations undertaken prior to their withdrawal. In order to permit resolution of important federal issues that might arise whether or not the United States was a party to the compact, such as Native American and environmental rights and obligations, congressional waiver of federal sovereign immunity would be a condition to compact effectiveness. A similar, broader waiver has been in effect on the Colorado River since 1956 with respect to the 1922 Colorado River Compact, which was the first interstate water allocation compact.[86]

2. An interstate commission would be established in most situations, and would be comprised of the governors of the signatory state parties, a Native American member in basins where such sovereigns have substantial water interests, and a high level federal representative. The Commission would be supported by two co-equal agencies - a Council of state, Native American, and federal water officials, and a Division of Scientific Analysis. A wide range of possible powers could be conferred on such a commission, offering a menu from which states could select as needed or desirable for optimum water management in the region. These powers could include: (1) the authority to approve interstate water transfers in critical periods with consent of the states involved or affected; (2) more comprehensive planning authority in furtherance of the development within the basin of necessary water supply projects of various kinds, such as dams, groundwater storage and recharge areas, and conveyance facilities, without regard to state lines; (3) authority to better coordinate state, tribal, and federal water management projects and programs; and (4) authority to establish a broad-based advisory committee that would hold regular meetings open to the public and thus provide in greater transparency for commission programs.

3. Mandatory, prescriptive provisions would be kept to a minimum, making most of a compact commission's actions and powers permissive and supplemental to the states' existing powers. Commissions would be authorized to determine which of their decisions are important enough to require unanimity among the compact parties rather than a simple majority vote. Commissions also would be accorded broad revenue generating authority, the two most significant being the authority to exercise limited taxing of compact program beneficiaries and to charge regional market value for certain kinds of water allocations, primarily for urban or industrial uses.

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[86] *Id.* at 21-10 to 21-11.

4. Because compacts are alternatives to Supreme Court litigation, the principles applied by the Court in its "equitable apportionment" decisions would govern the actions of compact commissions (e.g., recognition of the importance of requiring "reasonable beneficial use" of each state's water apportionment, including increased conservation, the burden of proof to establish compact violations, and protection and restoration of environmental values). This would bring the forum for applying those principles closer to home and ensure that it is comprised of officials familiar with regional issues.

5. There would be incentives to keep the states out of the Supreme Court as long as possible by requiring them to resolve disputes by first exhausting mandatory dispute resolution mechanisms with reasonable sanctions or incentives to do so, such as waiving potential liability to other compact parties if a violation was conceded and an effective remedy implemented, but an obligation to pay litigation costs if dispute resolution procedures were bypassed.

6. The reliability of congressionally approved compact apportionments would be enhanced by providing authority for a compact commission to address inequities flowing from subsequent inconsistent congressional legislation, such as the unforeseen impact of the ESA on previously approved compact programs—a situation that has arisen not infrequently.

7. There would be action-forcing requirements for states to address important intrastate issues that they may not have adequately addressed, if at all, individually, where failure to do so causes demonstrable adverse interstate impacts (e.g., monitoring and having their compact water apportionments charged for use of subsurface water hydrologically connected to apportioned surface flows, and maintenance of water quality with changing flow regimes). Scientific analysis and monitoring would be given a significantly enhanced role as compared to existing compacts.

Among the most significant aspects of the Model Compact is its recognition of the importance of short and long-term interstate transfers in addressing water scarcity issues. In support thereof, reference is made to a 2005 report on the Rio Grande, which concluded that "compared to existing water allocation institutions . . . future drought damages could be reduced by 20% to 33% per year . . . through intra-compact and interstate water markets, respectively, that would extend across current water management jurisdictions."[87]

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[87] Muys, Sherk & O'Leary, *supra* note 17, at 70 n.61 (quoting James F. Booker et al., *Economic Impact of Alternative Policy Responses to Prolonged and Severe Drought in the Rio Grande Basin*, 41 WATER RESOURCES RES., W02026 (Feb. 2005)).

Many of the provisions included in the Model Compact are directly relevant to the present and anticipated interstate water shortages, quality impacts and flooding threats presented by climate change. Unfortunately, little has changed since the Model Compact was published almost eight years ago. Congress and the majority of states are seemingly "content to continue to wait for major crises to drive needed reforms in interstate river management."[88]

IV. REIMAGINING INTERSTATE WATER COMPACTS FOR THE TWENTY-FIRST CENTURY

A. The Case for Compacts

In light of the evident shortcomings of many existing compacts, and the failure of states on interstate waters to embrace the provisions of the Model Compact, some contend that the dual threats of water scarcity and climate change dictate that we replace our system of regional compacts with a federal system—upending our long traditional of local control over water allocation issues.[89] However, there is a strong argument to be made that the challenges of water scarcity and climate change are best addressed by maintaining existing incentives for interstate cooperation and negotiated resolution of interstate water disputes under the Constitution's existing compact authority.

Whatever challenges lie ahead in terms of increasing water scarcity and climate change, cooperative regional action through interstate agreements remains a highly desirable alternative when compared to the prospect of a federally-based system of water allocation. Even assuming that a reasonable federal system for allocating water rights could be fashioned and pass congressional muster, compacts offer the best opportunity for states in interstate basins to effectively address highly localized impacts of water scarcity and climate change.

Congressionally-authorized interstate agreements are unique in offering a legal and administrative mechanism for addressing water scarcity and climate change through cooperative management of shared regional water resources. States negotiating a compact may make the interstate program as broad or narrow as they deem necessary to address conditions in the basin at issue, and may endow a compact commission with powers beyond those available under state law. Because congressional approval makes the compact a federal statute, a compact

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[88] Muys, *supra* note 4, at 5. Efforts to encourage the Chairs and ranking members of the Congressional committees with federal water management responsibilities to hold oversight hearings on the effectiveness and adequacy of existing compacts have been unavailing.

[89] *See generally* Sherk, *supra* note 16.

commission becomes an interstate administrative agency with powers not dependent solely on state law. Thus, these agreements can confer a wide range of powers on interstate commissions established by such agreements to address the impacts of water scarcity and climate change in a particular region.

Each river, stream, and reservoir is different, as is each individual state's water usage needs. Thus, the management of our water resources is by necessity highly localized. A distinct advantage of our system of interstate water compacts is that they enable states to shape their own destiny and address problems unique to their regions, rather than deferring to the Supreme Court or Congress. The continued reliance on compacts as a principal feature of our interstate water management system seems a more reasonable and prudent policy than establishing a new federal water policy that almost certainly would necessitate comprehensive new legislation unlikely to find favor with Congress.

In a highly-variable natural environment where "stationarity is dead" and natural systems fluctuate in increasingly unpredictable ways, the principal challenge will be to persuade states on interstate rivers that cooperative regional action pursuant to interstate agreements is essential to effective interstate water management. Because water scarcity and other manifestations of climate change are largely local and regional phenomena, it is only through the mechanism of interstate water compacts that states will be able to shape their own destiny and address problems unique to their region.

B. The Path Forward in Light of Increasing Water Scarcity and Climate Change

Despite their many positive aspects, interstate water compacts have not been widely embraced. Although the Model Compact made great strides in addressing the most challenging aspects of the existing interstate water compact system, further amendments to existing compacts beyond those the Utton Center recommended will be necessary to meet the challenges posed by water scarcity and climate change. The following is a brief summary of some of those changes.

1. Greater Emphasis on Data Collection and Reporting

Although the Model Compact addressed the need for states to monitor intrastate water usage and to have their compact water apportionments charged for use of subsurface water hydrologically connected to apportioned surface flows, and to maintain water quality with changing flow regimes, the role of scientific analysis and monitoring must be given a significantly enhanced role. States could

benefit from a complete overhaul of their compacts in order to reflect current data on river levels, water consumption demands, and increased flexibility.

2. More Flexible Term Limits

The Model Compact recommended a limitation on the terms of compacts to twenty-five years, at the end of which the compact states could either agree to renewal, modification or termination. This recommendation may be unworkable in a world where precipitation patterns and stream flows are in constant change. With water scarcity on the rise due to global warming and other causes, the specific allocation schemes required by most interstate compacts are likely to become increasingly difficult to fulfill, and a twenty-five year compact term may not be realistic.

3. Greater Federal Government Participation

The Model Compact would make Congressional waiver of federal sovereign immunity a condition to compact effectiveness in order to ensure that federal issues can be addressed. However, experience has shown that federal-interstate compacts, in which the federal government is actually a party and an active participant, are equally, or perhaps more, effective in that regard.

4. More Empowerment of Regional Commissions

Regional Commissions need broader authority beyond that necessary to effectuate interstate allocations. This broader authority should include, at a minimum, the power to (1) approve interstate water transfers in critical periods with consent of the states involved or affected; (2) undertake more comprehensive planning within the basin in order to facilitate the development of necessary water supply projects of various kinds, such as dams, groundwater storage and recharge areas, and conveyance facilities, without regard to state lines; (3) better coordinate state, tribal, and federal water management projects and programs; and (4) establish a broad based advisory committee with regular meetings open to the general public.

5. Interbasin Transfers

The drafters of the Model Compact acknowledged that, "any introduction of water marketing across state lines will be subject to

considerable debate and scrutiny."[90] However, the importance of short and long-term interstate transfers will only increase as our nation confronts the dual challenges of increasing water scarcity and climate change. Intra-compact and interstate water markets, extending across current water management jurisdictions, hold greater promise of significantly reducing drought damages when compared to the efficacy of existing water management institutions.

6. Flexible Allocation Mechanisms

The vast majority of existing compacts contain a specific allocation formula or scheme, which governs the amount of water to be received by each compact state. Compacts that allocate water on this basis typically do so either by percentage of total flow or by discrete amounts in acre-feet or cubic feet per second. With water scarcity on the rise due to climate change and other factors, the specific allocation schemes set forth in most interstate compacts will likely become increasingly difficult to fulfill. Compact states need to move away from the use of formulas that allocate discrete amounts of water and adopt apportionment mechanisms that rely on an administrative board to oversee the allocation and management of interstate water supplies.

7. Integrated Water Resource Management

In response to the impacts of climate change, the IPCC stressed the need for Integrated Water Resource Management ("IWRM").[91] Although the term "has not be[en] defined unambiguously," IWRM is organized around four general principles.[92] These principles can be summarized as follows:

> (1) freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment;
> (2) water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels;
> (3) women play a central part in the provision, management and safeguarding of water;
> (4) water has an economic value in all its competing uses and should be recognised as an economic good.[93]

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[90] Muys, Sherk & Leary, *supra* note 17, at 70 n.61 (quoting James F. Booker et al., *supra* note 87, at 41).

[91] BATES ET AL**.,** *supra* note 32, at 44 n.17.

[92] *Id.*

[93] *Id.*

Implementation of these IWRM principles "could help to resolve conflicts between competing water users . . . [and] facilitate negotiations between competing interest groups to achieve mutually satisfactory problem solving that considers a wide range of factors."[94]

Most compacts were not developed with the flexibility needed to accommodate climate variability. They need to be amended to incorporate an adaptive management approach to interstate water management. The *Model Interstate Water Compact* provides the template.

V. CONCLUSION

If water compacts are to remain relevant in the face of increasing water scarcity and climate change, they must offer a meaningful alternative to litigation, become more flexible in their administration, and most importantly, take into account the possibility of extreme drought conditions. It would seem prudent to first amend existing compacts to address the needed changes discussed above, and then move on to complete the process for those river basins that lack an interstate compact.

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[94] *Id.* at 51.

APPENDIX: COMPARISON OF ALLOCATION METHODOLOGIES[95]

A. Compact Allocations Based on Specified Volumes or Percentages of Water

With regard to the allocation of specific quantities of water, perhaps the best known (and most controversial) is the allocation contained in the Colorado River Compact, which apportions seven million five hundred thousand (7,500,000) acre-feet of water per annum from the Colorado River system in perpetuity to the upper basin and to the lower basin respectively.[96] This approach to allocation provides little latitude for adaption to increased water supply volatility due to climate change impacts.

Subsequent to the Colorado River Compact, the states of the upper Colorado River Basin apportioned their share of the Colorado River in a manner that permits somewhat greater flexibility in responding to increased water supply volatility. ` After allowing for "the consumptive use of fifty thousand (50,000) acre-feet of water per annum" in Arizona,[97] the waters of the upper Colorado were apportioned on a percentage basis: Colorado (51.75%), New Mexico (11.25%), Utah (23%) and Wyoming (14%).[98]

A number of volume-based compacts prescribe scenarios for dealing with supply variability through mandatory adjustments which are triggered when stored capacity falls below a specified volume. For example, under the Costilla Creek Compact, as amended, water allocations between Colorado and New Mexico from the Costilla Reservoir adjust when the usable capacity and safe yield of the reservoir drops below 15,700 acre-feet and 17,900 acre-feet, respectively. [99] The Arkansas River Compact operates in a similar fashion with respect to adjustments in the volume of releases of water from the John Martin Reservoir for use in Colorado and Kansas.[100]

The Rio Grande Compact requires a specific quantity of water (no more than 10,000 acre-feet) to be delivered to New Mexico by Colorado, subject to temporal limitations.[101] In general, New Mexico's delivery obligation to Texas is based on the volume of flow in the Rio

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[95] This Appendix discusses various compact allocation methodologies and their relevance in terms of their capacity to accommodate water scarcity and climate change impacts.

[96] Colorado River Compact of 1922, art. III(a), Pub. L. No. 67-56, 42 Stat. 171 (1921).

[97] Upper Colorado River Basin Compact, art. III(a)(1), Pub. L. No. 81-37, 63 Stat. 31 (1949).

[98] *Id.* art. III(a)(2).

[99] Costilla Creek Compact Amended, art. V(e), Pub. L. No. 88-198, 77 Stat. 350 (1963).

[100] Arkansas River Compact, art. V, Pub. L. No. 81-82, 63 Stat. 145 (1949).

[101] Rio Grande Compact, art. III, Pub. L. No. 76-96, 53 Stat. 785 (1939).

Grande at designated gauging locations, exclusive of the months of July, August, and September.[102] In addition, the Compact provides for a system of debits and credits that can accommodate any intra- and inter-seasonal variability associated with climate change.[103]

An analogous adjustment mechanism is contained in the Republican River Compact, under which allocations are based on the "computed average annual virgin water supply originating" in specific drainage basins.[104] Adjustments are made in the event that "future computed virgin water supply of any source vary more than ten (10) percent from the predicted averages."[105]

B. Compact Allocations Based on Minimum Stream Flows or Storage Limitations

The Sabine River Compact is an example of an allocation methodology based on minimum stream flows to which the lower basin state is entitled.[106] Some compacts based on minimum stream flows, such as the Arkansas River Basin Compact of 1965[107] and the Canadian River Compact,[108] establish state-specific conservation storage limitations which prevent upstream states from hoarding water to the detriment of downstream states in times of scarcity.

C. Combinations of Approaches

The La Plata River Compact between Colorado and New Mexico is an example of an apportionment methodology based principally on mean daily flow at a designated interstate gauging station.[109] When stream flows fall below this level, adjustments to the required allocation are triggered.[110] These obligations are limited, however, by application of the beneficial use requirement of the prior appropriation doctrine, such that Colorado is not required to deliver any water not necessary for beneficial use by New Mexico.[111]

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102 *Id.* art. IV.

103 *Id.* art. VI.

104 Republican River Compact, art. III, Pub. L. No. 78-60, 57 Stat. 86 (1943).

105 *Id.*

106 *See* Sabine River Compact, Pub. L. No. 83-578, 68 Stat. 690 (1954) (amended 1962).

107 Arkansas River Basin Compact of 1965, Pub. L. No. 89-789, 80 Stat. 1409 (1966).

108 Canadian River Compact, Pub. L. No. 82-345, 66 Stat. 74 (1952). In terms of the combination of approaches discussed in the following section, it should be noted that Article III of the Canadian River Compact recognizes and affirms "[a]ll rights to any of the waters of Canadian River which have been perfected by beneficial use . . . ." *Id.*

109 La Plata River Compact, art. II(2)(a), Pub. L. No. 68-346, 43 Stat. 796 (1925).

110 *Id.* art. II(2)(b).

111 *Id.* art. II(4).

A similar approach is taken in the South Platte River Compact between Colorado and Nebraska.[112] In addition to incorporating elements of the prior appropriation doctrine with stream flow requirements, the South Platte River Compact also includes provisions relating to the timing of water uses.[113] The temporal limitations reflect variability in seasonal flow rates.[114] The limitations are also subject to a beneficial use requirement similar to the one contained in the La Plata River Compact.[115]

The Kansas-Nebraska Big Blue River Compact establishes a hybrid approach that specifies minimum stream flows (cubic feet per second) based on seasonal considerations.[116] When flows are inadequate to meet the minimum stream flow requirements at the state line, Nebraska is required to impose additional restrictions on Nebraska water users based on the principles of the prior appropriation doctrine.[117]

The Snake River Compact between Idaho and Wyoming also contains a hybrid approach which specifies a percentage allocation between the two states but excludes certain uses from the calculation.[118] The excluded uses reflect the principles of the prior appropriation doctrine.[119]

The Upper Niobrara River Compact provides that "[t]here shall be no restrictions on the use of the surface waters of the upper Niobrara River by Wyoming except as would be imposed under Wyoming law" and other limitations.[120] Among these limitations are restrictions on the capacity of reservoirs "used solely for domestic and stock water purposes" as well as operational limitations on other reservoirs including when water could be stored and when releases may be required.[121]

The provisions of the Belle Fourche River Compact between Wyoming and South Dakota also reflect this approach. Under this compact, the unappropriated waters of the Belle Fourche River as of the

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112 South Platte River Compact, Pub. L. No. 69-37, 44 Stat. 195 (1926).

113 *Id.* art. IV(1).

114 *Id.* art. IV(2).

115 *Id.* art. IV(3).

116 Kansas-Nebraska Big Blue River Compact, art. 5.2(b), Pub. L. No. 92-308, 86 Stat. 193 (1972).

117 *Id.* art. 5.2(b)(1)–(4). The compact does contain exceptions to the limitation on withdrawals from irrigation wells noted above.

118 Snake River Compact, art. III(a), Pub. L. No. 81-464, 64 Stat. 29 (1950).

119 *Id.* art. III(c). "The term 'established Wyoming rights' shall mean Snake River water rights that have been validly established of record in Wyoming prior to July 1, 1949, for use in Wyoming." *Id.* art. II(a)(v).

120 Upper Niobrara River Compact, art. V(a)(1), Pub. L. No. 91-52, 83 Stat. 86 (1969).

121 *Id.* art. V(a)(1)(A)-(F).

date of the compact were subject to a percentage allocation between the states, subject to beneficial use considerations and limitations on reservoir storage.[122]

The Yellowstone River Compact recognizes appropriative rights with a priority of January 1, 1950, or earlier.[123] The unappropriated water is then allocated to Montana and Wyoming, based on state-specific percentages applicable to the Yellowstone and its tributaries.[124]

The Bear River Compact between Idaho and Utah incorporates the prior appropriation doctrine with different allocation mechanisms for different divisions of the river.[125] Beneficial use principles are applied first, with any remaining water apportioned on a volumetric basis.[126]

The Pecos River Compact between New Mexico and Texas provides a slightly different model by guaranteeing Texas a baseline volume of water based on that available to Texas in 1947.[127] Additional beneficial consumptive use of water is allocated by percentage.[128] The waters to be allocated are calculated in a manner that could accommodate short-term intra- and inter-seasonal variability.[129]

The Klamath River Basin Compact initially recognizes valid water rights existing as of the effective date of the compact.[130] With regard to the appropriation of water after that date, the compact establishes a priority of uses to be followed "when there is insufficient water to satisfy all such applications . . . ."[131] Preference is to be given to applications for a higher use over applications for a lower use.[132]

Allocation of the Red River, which occurs by sub-basin, incorporates specific quantities of water with the operation of storage facilities. [133] It also includes provisions mandating changes in the allocation based on stream flow, which may be appropriate for use in response to climate change. [134] The requirements change as stream flows decline.[135]

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122 Belle Fourche River Compact, art. V(A), Pub. L. No. 78-236, 58 Stat. 94 (1944).

123 Yellowstone River Compact, art. V(A), Pub. L. No. 82-231, 65 Stat. 663 (1951).

124 *Id.* art. V(B).

125 Bear River Compact, art. V(A), Pub. L. No. 85-348, 72 Stat. 38 (1958).

126 *Id.* art. V(A)(1)-(4).

127 Pecos River Compact, art. III(a), Pub. L. No. 81-91, 63 Stat. 159 (1949). "The term '1947 condition' means that situation in the Pecos River Basin as described and defined in the Report of the Engineering Advisory Committee." *Id.* art. II(g).

128 Pecos River Compact, art. III(a), Pub. L. No. 81-91, 63 Stat. 159 (1949).

129 *Id.* art. VI(b).

130 Klamath River Basin Compact, art. III(A), Pub. L. No. 85-222, 71 Stat. 497 (1957).

131 *Id.* art. III(B)(1).

132 *Id.*

133 Red River Compact, art. 5.05(b)(1), Pub. L. No. 96-564, 94 Stat. 3305 (1980).

134 *Id.* art. 5.05(b)(2).

135 *Id.* art. 5.05(b)(3).

D. Administrative Allocation

A number of more contemporary compacts, such as the Delaware River Basin Compact, authorize an administrative entity to allocate interstate water resources on the basis of an approved plan or formula.[136] Similar authority is vested in the Susquehanna River Basin Commission, which has the "power from time to time as the need appears, to allocate the waters of the basin to and among the states signatory to this compact and impose related conditions, obligations, and release requirements."[137] Such administrative entities (often a compact commission or a state engineer) generally are empowered to adjust the interstate allocation[138] or to determine—usually on an annual basis—the quantity of water subject to compact allocation.[139] One

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[136] Delaware River Basin Compact, art. 3.3, Pub. L. No. 87-328, 75 Stat. 688 (1961). The Delaware River Basin Commission is also authorized to formulate and adopt "[a] comprehensive plan, after consultation with water users and interested public bodies; for the immediate and long range development and uses of the water resources of the basin . . . ." *Id.* art 3.2(a).

[137] Susquehanna River Basin Compact, art. 3.8(a), Pub. L. No. 91-575, 84 Stat. 1509 (1970). As with the Delaware River Basin Commission, the Susquehanna River Basin Commission is also authorized to formulate and adopt "[a] comprehensive plan, after consultation with appropriate water users and interested public bodies for the immediate and long range development and use of the water resources of the basin . . . ." *Id.* art. 3.3(1). Similar language is also contained in Article IX(A)(6) of the Arkansas River Basin Compact of 1970, Pub. L. No. 93-152, 87 Stat. 569 (1973) (The Arkansas-Oklahoma Arkansas River Compact Commission is to "[c]ooperate with federal and state agencies and political subdivisions of the signatory states in developing principles, consistent with the provisions of this Compact and with federal and state policy, for the storage and release of water from reservoirs, both existing and future within the Arkansas River Basin, for the purpose of assuring their operation in the best interests of the states and the United States . . . .").

[138] *See, e.g.*, Delaware River Basin Compact, art. 10, Pub. L. No. 87-328, 75 Stat. 688 (1961) (general authority of the Delaware River Basin Commission); Susquehanna River Basin Compact, art. 11, Pub. L. No. 91-575, 84 Stat. 1509 (1970) (general authority of the Susquehanna River Basin Commission); Bear River Compact, art. IV, Pub. L. No. 85-348, 72 Stat. 38 (1958) (authority of the Bear River Commission to review allocations in times of water emergencies); Rio Grande Compact, art. VI, Pub. L. No. 76-96, 53 Stat. 785 (1939) (authority of the Rio Grande Compact Commission to substitute new measures of water availability).

[139] *See, e.g.*, La Plata River Compact, art. II(3), Pub. L. No. 68-346, 43 Stat. 796 (1925) ("Whenever the flow of the river is so low that in the judgment of the state engineers of the state, the greatest beneficial use of its waters may be secured by distributing all of its waters successively to the lands in each state in alternating periods . . . in such manner, for such periods and to continue for such time as the state engineers may jointly determine."); Costilla Creek Compact, art. V(e), Pub. L. No. 88-198, 77 Stat. 350 (1963) (as amended) (requirement that the Costilla Creek Compact Commission "estimate each year the safe yield of Costilla Reservoir System and its component parts as far in advance of the irrigation season as possible, and shall review and revise such estimates from time to time as may be necessary"); Snake River Compact, art. III(b), Pub. Law No. 81-464, 64 Stat. 29 (1950) ("The amount of water subject to allocation . . . shall be determined on an annual water-year basis measured from October 1 of any year through September 30 of the succeeding year."); Yellowstone River Compact, art. V(C), Pub. L. No. 82-231, 65 Stat. 663 (1951) ("The quantity of water subject to the percentage allocations . . . shall be determined on an annual water year basis measured from October 1st of any year through September 30th of the succeeding year.").

provision of the South Platte River Compact expressly acknowledges that variable climatic conditions may necessitate such adjustments. [140]

[140] South Platte River Compact, art. IV(5), Pub. L. No. 69-37, 44 Stat. 195 (1926).