USING THE TRANSFER OF WATER RIGHTS AS A CLIMATE CHANGE ADAPTATION STRATEGY: COMPARING THE UNITED STATES AND AUSTRALIA

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I. INTRODUCTION

Water was the theme of the 2008 World Expo, hosted in Zaragoza, Spain. Along with showcasing the culture and products of its home country, each country's pavilion provided additional information about the water scarcity it faces, the solutions it devised, and the problems that still loom. From Qatar and Saudi Arabia, which demonstrated the water distribution methods vital to ensuring their desert countries' survival, to Caribbean countries that outfitted rooms with sensory technology to let visitors experience the effects of a hurricane, the theme of water's importance and scarcity was ubiquitous. Although the Expo's ironic main attraction was an outdoor waterfall in the hot and dry Zaragoza summer, visitors left with a greater understanding of the global nature of water scarcity.

The world is becoming increasingly aware of the imminent threat that global climate change poses, as evidenced by the awarding of the 2007 Nobel Peace Prize to the Intergovernmental Panel on Climate Change (IPCC) and former U.S. Vice President Al Gore, Jr. for their work in researching and publicizing the science of climate change.[1] To date, the IPCC has released its Fourth Assessment Report and is working on a fifth report, describing in ever-increasing detail the range and likelihood of the risks associated with the unavoidable global change.[2] World leaders met in Copenhagen in December 2009 and reached a three-page agreement, the Copenhagen Accord, which called for limiting global temperature increases and for investment in low-carbon energy systems; but the Copenhagen Accord was a non-binding agreement by 192 nations that "voted to merely 'take

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[1] Press Release, Norwegian Nobel Committee, "The Nobel Peace Prize for 2007" (Oct. 12, 2007), *available at* http://nobelprize.org/nobel_prizes/peace/laureates/2007/press.html.

[2] *See generally Climate Change 2007–Impacts, Adaptation, and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007), http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm.

note' of it."[3] However, the extent of popular understanding of the climate change problem, and the level of commitment to finding a solution, varies greatly across nations, and even across regions within nations.[4] Moreover, whether the legal institutions and policies of individual countries and international governmental bodies are prepared to meet the challenges that climate change will bring is highly uncertain and must be remedied.[5]

The connection between climate change and conventional energy consumption is well understood. As the world's energy-dependent economies continue to rely primarily on burning fossil fuels, the release of carbon dioxide into the atmosphere from this energy production is expected to overwhelm natural cycles, triggering a chain of events that have the potential for disaster.[6] But the interdependency of energy issues and water issues are less entrenched in the public mind, as are the drastic and upsetting impacts that climate change will have on the availability of water.

This note examines the role that climate change will play in creating a greater need for flexible and responsive legal institutions and mechanisms for the exchange of water, specifically within the western United States and Australia. These two regions provide a useful comparison as they share similar climates, large investments in water infrastructure to manage water scarcity, and the increasing use of water trading mechanisms in the reallocation of water rights. Part II of this article briefly describes water scarcity as a worldwide issue; Part III explores the various effects climate change is expected to have on water supplies; Part IV discusses the growing trend toward market-based solutions for achieving wise water management; Part V describes the legal systems governing water use in the western United States and Australia and legal barriers to the success of water transfers; and Part VI evaluates responses to climate change in the United States and Australia and the facility of water transfers to occur in each region.

II. WATER SCARCITY

Current water practices are fast depleting the sources of water available to communities across the world. Water-stressed[7] basins are located in northern

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[3] John M. Broder, *Climate Goal is Supported by China and India*, N.Y. TIMES, Mar. 9, 2010, *available at* http://www.nytimes.com/2010/03/10/science/earth/10climate.html.

[4] *See id.*

[5] *See, e.g.*, John M. Broder, *Climate Change Seen as Threat to U.S. Security*, N.Y. TIMES, Aug. 8, 2009, *available at* http://www.nytimes.com/2009/08/09/science/earth/09climate.html, (discussing "the prospect of military intervention to deal with the effects of violent storms, drought, mass migration and pandemics").

[6] *See generally* IPCC Fourth Assessment Report, *supra* note 2.

[7] Water stress is a concept to describe how people are exposed to the risk of water shortage. It is defined as either where per capita water availability is below 1,000 cubic meters per

Africa, the Mediterranean, the Middle East, the Near East, southern Asia, northern China, Australia, the USA, Mexico, north-eastern Brazil, and the west coast of South America.[8] The western United States and southern Australia provide examples of water scarcity in arid regions, while water scarcity also poses problems in areas with more abundant water resources.

A. Western United States

Water scarcity is an obvious issue in the desert regions of the American West. The average annual precipitation is less than twelve inches across most of Arizona, between ten and twenty inches across most of Colorado, between twelve and sixteen inches across most of New Mexico, and less than ten inches across southern California.[9] Past climate records based on Colorado River flows show that drought occurs frequently in the Southwest, and the Southwest has been home to some of the longest "megadroughts"[10] recorded in the world.[11] Excessive diversions from rivers and groundwater pumping have exacerbated water scarcity issues within the region. Such overuse has led to the drying of rivers and lakes, contamination of groundwater, and land subsidence.

The Southwest region's major rivers have been fully allocated, and in some cases, the water has been fully diverted. The mighty Colorado River, which once was capable of supporting ferries down its length to the Sea of Cortes, becomes a trickle by the time it reaches the Colorado River Delta due to the many large-scale diversions by all of the nearby states.[12] In fact, the Colorado River has been over-allocated, as claims on the river's water greatly exceed its average

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year or where the ratio of withdrawals to the long-term average runoff is greater than 0.4. Intergovernmental Panel on Climate Change, *Climate Change and Water: IPCC Technical Paper VI*, chapter 1.3.1 (B.C. Bates, Z.W. Kundzewicz, S. Wu, & J.P. Palutikof eds.) (June 2008), http://www.ipcc.ch/publications_and_data/publications_and_data_technical_papers_climate_change_and_water.htm.

[8] *Id.* Figure 1.1 of the technical paper shows a water stress map of the world pointing to examples of regions facing water issues.

[9] PRISM Precipitation Maps: 1962-90, WESTERN REGIONAL CLIMATE CENTER, http://www.wrcc.dri.edu/precip.html.

[10] The term "megadrought" refers to droughts lasting decades or centuries. *See, e.g.*, Richard Seager et al., *Tropical Pacific Forcing of North American Medieval Megadroughts: Testing the Concept with an Atmospheric Model Forced by Coral-Reconstructed SSTs*, 21 J. CLIMATE 6175, 6176 (2008), *available at* http://www.ldeo.columbia.edu/res/div/ocp/pub/seager/Seager_etal_megadroughts.pdf.

[11] *U.S. Global Change Research Program Scientific Assessments, Regional Climate Impacts: Southwest*, *in* GLOBAL CHANGE IMPACTS IN THE UNITED STATES 129 (2008), *available at* http://www.globalchange.gov/images/cir/pdf/southwest.pdf.

[12] Michael Cohen, *The Delta's Perennial Drought: Instream Flows for an Over-Allocated River*, 19 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 115, 115 (2006).

annual flow.[13] Riparian ecosystems, which thrive on flowing rivers, are threatened by the absence of flowing water.

Similarly, overpumping of groundwater has caused water tables to drop across the western states and has caused rivers to dry completely.[14] For example, in the 1940s and 1950s, large-capacity wells began pumping the vast Ogallala Aquifer, which spans an area from Texas and New Mexico northward to parts of South Dakota.[15] By 1980, the water table had dropped by more than 150 feet in some places, causing many domestic wells to go dry or be deepened in response and the decline continues.[16]

A reduced supply of groundwater in aquifers has effects on surface water supply, as groundwater often feeds rivers and lakes.[17] Many rivers in southern Arizona have gone dry as a result of sustained groundwater pumping: the Santa Cruz River, which in the 1940s supported a thriving riparian habitat of cottonwood trees and water-loving birds and animals, was a dry sand bed by the late 1980s due to the water demand of Tucson.[18] And the San Pedro River, which is a famed bird-watching destination for the great number of species using the area as a migratory resting point or breeding ground,[19] is threatened by the nearby city of Sierra Vista and sections of the river have gone dry.[20]

Excessive groundwater pumping has consequences for the land above the aquifers as the support for the land is removed.[21] Such consequences include sudden earth fissures in Arizona, sinkholes in Florida, and land subsidence in the San Joaquin and Coachella Valleys of California.[22] Areas near the ocean also face the threat of saltwater intrusion into the aquifer, contaminating the freshwater supply.[23] This intrusion has occurred in various places on both the Pacific and Atlantic coasts, and has caused areas near Los Angeles to implement a costly barrier well program to prevent further intrusion.[24]

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[13] *See id.*; *see also* JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES: CASES AND MATERIALS 799-808 (4th ed. 2006).

[14] *See* ROBERT GLENNON, UNQUENCHABLE: AMERICA'S WATER CRISIS AND WHAT TO DO ABOUT IT 105-134 (2009); *see generally* ROBERT GLENNON, WATER FOLLIES: GROUNDWATER PUMPING AND THE FATE OF AMERICA'S FRESH WATERS (2002).

[15] UNQUENCHABLE, *supra* note 14, at 123-124.

[16] *Id.*

[17] *Id.* at 124; GLENNON, WATER FOLLIES, *supra* note 14, at 39-45.

[18] GLENNON, UNQUENCHABLE, *supra* note 14, at 126; GLENNON, WATER FOLLIES, *supra* note 14, at 38-39, 45-49.

[19] GLENNON, WATER FOLLIES, *supra* note 14, at 53.

[20] GLENNON, UNQUENCHABLE, *supra* note 14, at 126.

[21] *Id.* at 131.

[22] *Id.*

[23] *Id.* at 133-34.

[24] *Id.*

B. Southeastern Australia

Australia has a climate similar to that in the western United States, and thus faces similar water issues. In fact, Australia represents the most extreme example of water scarcity, as it is the driest inhabited continent on the planet.[25] Only about 11% of rainfall runs off to supply surface water, and only a small fraction of 1% of the rainfall goes to recharge aquifers.[26] Thus, the remaining 89% returns directly to the atmosphere through evapotranspiration, which means that most of Australia's rainfall is unavailable for human use.[27] Frequent protracted droughts have plagued the continent for centuries, inspiring Australian folklore and poetry and causing severe recessions.[28] These periodic droughts are caused by El Niño, the weather pattern that causes torrential rains in South America while causing drought in Australia.[29] The El Niño cycle is irregular, arriving over intervals of two to seven years, and is of a similarly unpredictable duration.[30] The most recent El Niño drought in Australia ended in early 2007 with the arrival of normal rainfall levels.[31]

The historical development of land and water resources in Australia without national coordination or consideration of environmental impacts has led to a variety of environmental problems.[32] Large-scale clearing of lands for agricultural purposes has caused soil salinity, erosion, and acidification.[33] In turn, this has led to the deterioration of water quality as nutrients from the transformed soil run off or are eroded into waterways.[34] Changes in habitat, soil composition, and water quality have caused a loss in biodiversity.[35]

The Murray-Darling River is Australia's longest river system and drains a basin equal to the area of France and Spain together.[36] The Murray-Darling River basin provides water to many different states: South Australia and its capital, Adelaide, lie at the mouth of the river, while Victoria, New South Wales,

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[25] DESHENG HU, WATER RIGHTS: AN INTERNATIONAL AND COMPARATIVE STUDY 146 (2006); FEREIDOUN GHASSEMI & IAN WHITE, INTER-BASIN WATER TRANSFER: CASE STUDIES FROM AUSTRALIA, UNITED STATES, CANADA, CHINA AND INDIA 65 (2007).
[26] GHASSEMI & WHITE, *supra* note 25, at 65.
[27] *Id.*
[28] *The Big Dry–Australia's Water Shortage*, ECONOMIST, Apr. 28, 2007 (stating that the "Federation drought" of the late 1890s to early 1900s inspired Dorothea Mackellar to write of "a sunburnt country . . . of droughts and flooding rains").
[29] *Id.*
[30] *Id.*
[31] *Id.*
[32] GHASSEMI & WHITE, *supra* note 25, at 70-71.
[33] *Id.*
[34] *Id.*
[35] *Id.*
[36] *The Big Dry*, *supra* note 28.

and Queensland lie further upstream.[37] The river accounts for 85% of Australia's irrigation and provides water to 40% of its agriculture.[38] However, the river is degenerating and no longer contains enough water to flow to the sea as it once used to—mainly due to human uses.[39] The flow of the Darling, the longest tributary to the Murray River, is also subject to drastic variation due to the effects of El Niño, with yearly flows varying from 0.04% to 911% of the long-term average flow.[40] By 1994, 77% of the river's annual average flow, a figure higher than the total flow in dry years, was being consumed by human activity, including over-irrigation.[41] The accompanying effects on human health and the environment—effects that included increased water salinity, indigenous population failures, and toxic algae blooms[42]—led to legal reform,[43] which has mitigated some of the environmental effects.[44] However, problems continue to loom. There are many loopholes within the legal reforms that can undermine the reform goals,[45] and the growing Australian population will continue to add stresses to the system.

Most recently, Australia's droughts have resulted in palpable negative economic consequences. In 2007, the prior seven years of drought were estimated to have reduced Australia's annual GDP growth rate by one percentage point and caused the government to pay two million Australian dollars each day to farmers in drought relief.[46] The country's "worst drought on record,"[47] caused agricultural production to fall by almost one-quarter, and towns and cities had to enact drastic water restrictions.[48] The water levels in the Murray and Darling rivers were left strikingly low, even after normal rainfall resumed, because the drought had left the groundwater levels depleted and dried the soils of the basin.[49] The Australian Prime Minister John Howard warned that farmers would not be able to irrigate their crops at all if heavy rains did not occur.[50] Such a ban on irrigation would

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[37] *Id.*
[38] *Id.*
[39] *Id.*
[40] *Id.*
[41] *The Big Dry*, *supra* note 28.
[42] *Id.*
[43] Discussed *infra* Part V.B.
[44] *The Big Dry*, *supra* note 28 (stating these improvements in environmental quality include reduced river salinity to within the prescribed limits more than 90% of the time by the late 1990s, and the recovery of many native fish species). *See also infra* Part V.B.
[45] *See infra* Part V.B.
[46] *The Big Dry*, *supra* note 28.
[47] Kathy Marks, *Australia's Epic Drought: The Situation is Grim*, THE INDEPENDENT, Apr. 20 2007; *Leading Article: A Global Warning from the Dust Bowl of Australia*, THE INDEPENDENT, Apr. 20 2007 at 22.
[48] *Leading Article: A Global Warning*, *supra* note 47.
[49] *The Big Dry*, *supra* note 28.
[50] *Id.*; Marks, *supra* note 47.

have caused the water-dependent crops and trees to fail or die, ruining thousands of farmers.[51]

C. Non-Arid Regions

While the focus of this note is on the arid regions of the United States and Australia, it is important to note that the wetter regions of the world face water scarcity as well, in turn exacerbated by poor water quality. Within the United States, regions with high precipitation are currently dealing with water scarcity issues. Rockland County, New York, with rivers such as the Hudson as well as plenty of lakes nearby, declared drought emergencies three times between 1995 and 2002 due to insufficient water supplies.[52] Additionally, the rainy Portland, Ore. suburbs are "scrambling to find water" to support both the growing communities and endangered fish species,[53] the large Great Lakes are experiencing declining lake levels,[54] and the Ipswich River just outside Boston, Mass. has gone dry during most of the recent summers.[55]

There are many other water-stressed regions of the world. In China, the Huangzhe River has run dry due to increased irrigation and decreased precipitation.[56] In northern Africa, the area of Lake Chad is shrinking, and an extended dry season in Benin has affected rural water supplies.[57] Shrinking glaciers in the Andes have affected water supplies in northwest South America.[58] Thus, while this note focuses on the effects of water scarcity in the United States and Australia, the issue is critical for the rest of the world as well.

Water quality issues contribute to regions that are water-stressed. Arsenic and fluoride in the groundwater in India and Bangladesh have created huge drinking water availability problems in those regions.[59] Flood disasters in Bangladesh (in 1998, more than 70% of the country was inundated) have affected clean water supplies.[60] In northeast Brazil, erosion and sedimentation in reservoirs have reduced the available water supply.[61]

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[51] Marks, *supra* note 47. The water-dependent crops which would be severely damaged include rice, cotton, wine grapes, citrus, olives, and almond trees. *Id.* Many farmers took on large debt from the prolonged drought, and the rural suicide rate has soared. *Id.*
[52] GLENNON, UNQUENCHABLE, *supra* note 14, at 82.
[53] *Id.* at 93.
[54] *Id.* at 98.
[55] *Id.* at 126.
[56] IPCC Technical Paper IV, chapter 1.3.1, *supra* note 7, at fig. 1.1.
[57] *Id.*
[58] *Id.*
[59] *Id.*
[60] *Id.*
[61] *Id.*

Even in the United States, water quality issues have become increasingly important. Despite the existence of strong federal environmental quality legislation, such as the Clean Water Act and Safe Drinking Water Act, millions of Americans have been drinking water that does not comply with the federal guidelines, which have not been updated since 2000.[62] As a result, communities near Charleston, West Virginia have seen a marked increase in health problems including: skin rashes, skin burns, and eroded tooth enamel, due to a lack of enforcement of water quality standards.[63]

III. WATER SCARCITY AND CLIMATE CHANGE

A. Effects of Climate Change on Snowfall and the Hydrologic Cycle

Climate change is expected to exacerbate the water scarcity problems that arid regions already face by making those regions even drier and broader in range.[64] While the expected impacts may be difficult to quantify with certainty,[65] some scholars look to previous climatic events to show that the effects of climate disruption on water can be potentially dramatic due to the short timescale over which it will occur.[66]

Climate change "will make water more available in some areas and less available in other areas," placing more stresses on water management systems.[67] It is also expected to cause "substantial changes in mean annual streamflows, seasonal distributions of flows, and the probabilities of extreme high- or low-flow conditions"[68]—of which the impact on precipitation is likely to be largest.[69] For

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[62] Charles Duhigg, *Toxic Waters: That Tap Water Is Legal but May Be Unhealthy*, N.Y. TIMES, Dec. 16, 2009, *available at* http://www.nytimes.com/2009/12/17/us/17water.html?_r=1&em.

[63] Charles Duhigg, *Toxic Waters: Clean Water Laws are Neglected, at a Cost in Suffering*, N.Y. TIMES, Sept. 12, 2009, *available at* http://www.nytimes.com/2009/09/13/us/13water.html.

[64] Jonathan H. Adler, *Water Marketing as an Adaptive Response to the Threat of Climate Change*, 31 HAMLINE L. REV. 729, 730 (2008); Joseph W. Dellapenna, *International Water Law in a Climate of Disruption*, 17 MICH. ST. J. INT'L L. 43, 48 (2008).

[65] Adler, *supra* note 64, at 734.

[66] Dellapenna, *supra* note 64, at 46-47. Professor Dellapenna points to the most recent Ice Age, which changed the Middle East from a region with plentiful rainfall and free-flowing rivers to its more familiar desert landscape; the human inhabitants faced starvation or migration, leading to competition with other groups over resources and ultimately leading to the advent of irrigation. Similar adaptation occurred in other areas of the world. However, that dramatic climate change occurred over several millennia, while this current disruption is expected to occur only over a few centuries.

[67] Dellapenna, *supra* note 64, at 54.

[68] Adler, *supra* note 64, at 735 (quoting the 2001 report of the Intergovernmental Panel on Climate Change).

example, warmer temperatures will result in more precipitation falling directly as rain, rather than snow, which will run off to lower elevations more quickly.[70]

This impact on the timing of the hydrologic cycle has a variety of interrelated consequences.[71] While increased precipitation as rainfall means more water available immediately during the winter months, less water will form snowpack in the mountains, which serves as a natural system for rationing water to be delivered throughout the drier summer months, causing decreased water availability during an already scarce period.[72] As the flows shift to earlier in the year, streamflows will lessen during the main irrigation periods and impact agricultural success.[73] Increased winter rainfall will also worsen floods as all the water flows at once, causing corresponding economic consequences from the increased damage to homes and businesses.[74] A greater amount of water flowing through rivers will necessarily have to pass unused for electricity generation through dams unable to make use of such quantities, leaving them later unable to generate hydroelectric power for the peak electric demand summer months—an even greater loss when considering the push, via state renewable energy standards, to use renewable electricity sources.[75] While these timing issues have only recently come to the fore in economic analyses, they are becoming increasingly important in understanding the hydrologic and economic consequences of climate change.[76]

Climate change has impacts on the rest of the hydrologic cycle apart from precipitation and surface runoff, including seepage to aquifers and rates of evaporation and recharge from aquifers to streams.[77] Intense precipitation will be accompanied by more frequent droughts.[78] Other climate change-induced threats to coastal freshwater supplies come from the expected rise in sea level. First, as sea levels rise, saltwater will invade coastal aquifers, contaminating the area's freshwater supply.[79] Second, rising sea levels will increase the likelihood of the destruction of levees necessary to keep saltwater out of the water supply in regions where such a system is used, such as California's Sacramento-San Joaquin Delta.[80]

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[69] *See id.*
[70] Holly Doremus & Michael Hanemann, *The Challenges of Dynamic Water Management in the American West*, 26 UCLA J. ENVTL. L. & POL'Y 55, 58-59 (2008).
[71] *Id.*
[72] *Id.*; Adler, *supra* note 64, at 736.
[73] Doremus & Hanemann, *supra* note 70, at 58-59.
[74] *Id.*
[75] *Id.*
[76] *Id.*
[77] Adler, *supra* note 64, at 736.
[78] *Id.*
[79] Doremus & Hanemann, *supra* note 70, at 59.
[80] *Id.*

B. Effects of Climate Change on Water in the Western United States

In the western United States, the specific effects of climate change may vary across regions.[81] However, the most important result of climate change on the Southwest will be the impact on water resources.[82] Adequate water supplies are necessary to meet the ever-growing Southwest population's thirst, provide water for irrigation of major agricultural areas, provide power through dams, and support healthy ecosystems.[83] Extreme flooding and droughts caused by climate change will make it difficult to plan and maintain water supplies.

The arid and semi-arid areas are expected to experience more pronounced climate change effects, with most climate models converging on a loss in precipitation throughout the southwestern United States.[84] Although the effects on the summer monsoon season of the Southwest are uncertain, scientific consensus exists that the Southwest must prepare for a substantially drier future due to the effects of climate change.[85] At the same time, there is an increased risk of flooding in the Southwest due to decreased snow cover and winter precipitation being more likely to fall as rain rather than snow.[86] Such increased flooding poses a great risk to humans in overwhelming infrastructure built to contain water and keep it away from urban areas.[87] The Sacramento-San Joaquin River Delta system, forming the largest estuary on the west coast of North America, is particularly vulnerable to flooding events, as it currently stands below sea level and must be protected by a thousand miles of levees and dams.[88]

Some models estimate that the western United States could see a 30 to 70% reduction in snowpack by the end of the twenty-first century.[89] Even without a direct impact on precipitation, the loss in snowpack would cause increased variability in water flows in the West.[90] The regional tourism industry will experience an immediate economic impact from reduced snowfall or snowpack.[91] Ski resort operations will be negatively affected by shorter seasons. Additionally, later snows and earlier wet snow avalanches, which could cause decreases in snowpack from 40 to even 90% in some scenarios, could render entire ski resort operations unprofitable.[92]

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[81] *See* Adler, *supra* note 64, at 736.
[82] USGCRP, *supra* note 11.
[83] *Id.*
[84] Adler, *supra* note 64, at 737; Dellapenna, *supra* note 64, at 48.
[85] USGCRP, *supra* note 11, at 130.
[86] *Id.* at 133.
[87] *Id.*
[88] *Id.*
[89] Adler, *supra* note 64, at 737.
[90] *Id.*
[91] USGCRP, *supra* note 11, at 133.
[92] *Id.*

Droughts, a common occurrence in the Southwest, are predicted to become more frequent and more severe.[93] In the past 2,000 years, the Southwest has experienced decades-long "megadroughts" which greatly reduced the flow of the Colorado River and the Sierra Nevada headwaters, on which California relies heavily, and generally dried out the entire region.[94] The predicted effects of more extreme floods followed by extreme droughts have some pointing to proof that this is already occurring in the southwestern United States.[95] Decreased lake levels and river flows are already impacting water sports.[96] Additionally, winter precipitation in Arizona is already becoming more variable, causing both extremely dry and extremely wet winters.[97]

C. Effects of Climate Change on Water in Australia

The effects of climate change on Australia's drought-ridden arid regions are unsurprisingly similar to the effects described above for the western United States. Nationally, the Australian Government Bureau of Meteorology reports that Australian temperatures have risen on average by one-degree Celsius since the middle of the twentieth century, resulting in "an increase in the frequency of heatwaves and a decrease in the number of frosts and cold days."[98] This average temperature increase involves spatial variation across the continent; more warming is expected in northwest Australia and less warming in Tasmania and some coastal areas.[99]

Climate change will impact Australia's agricultural production, causing significant economic impacts.[100] Although it is suggested that increased carbon dioxide levels may benefit plant productivity, reductions in rainfall and available water will limit those potential benefits.[101] Specifically, wheat production may increase with higher carbon dioxide levels and a one to four degree Celsius rise in temperature if rainfall does not change; but production would decline with any higher temperatures if rainfall decreases as expected.[102] Fruit production and quality is vulnerable to increased temperatures, especially stone fruit and apples in southern Australia, as temperate fruits require winter chilling to properly form.[103]

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[93] *Id.* at 130.
[94] *Id.*
[95] Dellapenna, *supra* note 64, at 55.
[96] USGCRP, *supra* note 11, at 133.
[97] *Id.* at 132-33.
[98] Climate Change, AUSTRALIAN GOVERNMENT BUREAU OF METEOROLOGY, http://www.bom.gov.au/climate/change/ (last visited Oct. 9, 2010).
[99] GHASSEMI & WHITE, *supra* note 25, at 56-59.
[100] *See The Big Dry*, *supra* note 28; Marks, *supra* note 47.
[101] GHASSEMI & WHITE, *supra* note 25, at 56-59.
[102] *Id.*
[103] *Id.*

Even milk yields from cows are expected to decrease with increased temperatures.[104] Thus while climate change might have some beneficial impacts on Australia's agriculture, there are also many negative consequences.

In southern Australia, climate change will cause rainfall to decrease, leading to reductions in streamflow and causing water shortages, especially highlighting conflicts among the urban and agricultural users in southwestern Australia.[105] Northern Australia may experience increased summer rainfall and stream flow due to spatial variation.[106] An increase in frequent high-intensity rain in some areas may lead to beneficial groundwater recharge and dam filling, but will also increase the risk of flooding, landslides, and erosion.[107] Climate change will cause the Murray-Darling basin to heat up and dry out, and droughts like the current one are expected to become even more frequent.[108] The Commonwealth Scientific and Industrial Research Organization (CSIRO) has estimated that the Murray River's flow could reduce by 5% in twenty years and 15% in fifty years—but CSIRO has also provided a more catastrophic worst-case projection of a flow reduction by 20% in twenty years and 50% in fifty years.[109]

D. Climate Change and Water in Non-Arid Regions

Even more unnerving is the fact that water scarcity issues are cropping up in areas where one might expect an abundant water supply.[110] As discussed earlier, regions of the United States including New York, Oregon, Florida, and the Great Lakes have recently dealt with water scarcity.[111] These otherwise wet regions will not be immune from the effects of climate change on water availability; precipitation patterns will shift further, as they are already shifting, giving rise to the need for changes to current water management practices and law.[112] In fact, some of the drop in Lake Superior water levels has already been attributed to a changing climate, as warmer temperatures cause a reduced winter ice cover, in turn increasing evaporation from the lake surface.[113]

Climate change and resulting impacts on water will also further complicate water quality issues, as the ability of water to assimilate pollutants will be affected by reduced stock quantities available.[114] Although seldom discussed

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[104] *Id.*
[105] *Id.*
[106] GHASSEMI & WHITE, *supra* note 25, at 56-59.
[107] *Id.*
[108] *The Big Dry*, *supra* note 28.
[109] *Id.*
[110] *See generally* GLENNON, UNQUENCHABLE, *supra* note 14.
[111] *See supra* Part II.C.
[112] Dellapenna,, *supra* note 64, at 51.
[113] GLENNON, UNQUENCHABLE, *supra* note 14, at 101.
[114] Dellapenna,, *supra* note 64, at 52.

in literature, this aspect of the impact of climate change on water resources will become important.[115]

IV. WATER MARKETS

The ability to transfer property—in other words, to sell or lease property to another—is one type of right that can form the "bundle of rights" that characterize the meaning and scope of property rights.[116] Specifically, the ability to transfer water rights can be an important aspect of the property interest in water itself. Water markets can exist when transfers of water rights occur frequently or on large scales, and by the institutional structures in place to support them.[117] As prominent property rights and water law scholars observe, having a secure right in the ability to transfer water can promote desirable behavior in water users, encouraging uses and conservation which can effectively deal with scarcity issues.[118] Proponents argue that the ability to trade water rights can encourage efficient allocations and benefit the environment. However, opponents argue that trading can promote inter-basin water transfers causing environmental degradation and can create economic hardship to surrounding communities.

A. Economic Benefits of Water Markets

The main reason why many water and property rights scholars support the existence of water markets and the ability for the holders of water rights to be able to trade their rights with others is that trades can promote more efficient outcomes.[119] Although a legal system may originally assign property rights in water inefficiently among users, the ability to trade rights between users can achieve a more efficient reallocation of rights as those who value the resource more will pay more for the right to use it.[120] An increasingly scarce resource like water will undergo changes in value as the need for the scarce resource changes, and transfers between competing uses can allocate the rights where it is of highest value.[121]

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[115] *Id.*

[116] *See, e.g.*, J.E. Penner, *The Idea of Property in Law* (1997), *in* THOMAS W. MERRILL & HENRY E. SMITH, PROPERTY: PRINCIPLES & POLICIES 16-20 (2007). Other property rights forming this bundle can include the rights to use and enjoy the property, and to exclude others from its use. *Id.*

[117] Jedidiah Brewer, et al., *Transferring Water in the American West: 1987-2005*, 40 U. MICH. J.L. REFORM 1021 (2007).

[118] *Id.*

[119] Adler, *supra* note 64, at 739-42; GLENNON, UNQUENCHABLE, *supra* note 14, at 231-41.

[120] GLENNON, UNQUENCHABLE, *supra* note 14, at 231-41.

[121] *Id.*

Economists state that an efficient property rights system requires that rights be completely defined, exclusive, and transferable.[122] At the most basic level, the allocation of water rights without easy transferability can be described as one of a mismatch in the basic principles of supply and demand.[123] Transferability allows for efficient allocation of the resource to the users with the highest values, maximizing the benefit to society from the resource's use.[124] For example, highly consumptive irrigation used for the growth of low value crops can yield to a higher value use, such as a municipal drinking water supply or to produce electricity. This trade potential is especially high in the southwest United States, where the price paid by cities and industries for water is several multiples of the price farmers pay, due to federal agricultural subsidies.[125] Conforming to the higher value allocation will result in net benefits to both parties, as the users transferring their rights will be compensated financially.

The traditional legal framework of prior appropriation, which recognizes the priority of water rights based on a historical pattern of use, tends to favor the earliest established industries. As times and technologies change, what was once the highest value industry soon becomes only moderately valuable as new industries and water uses develop. Disallowing or discouraging the transfer of water rights does society a disservice by unduly favoring existing industries, retarding technological development, and reducing the region's ability to compete in an evolving economy.

B. Environmental Benefits of Water Markets

Many scholars argue that facilitating the transfer of water rights will be pivotal in supporting environmental goals, as well as in providing the economically efficient allocation of water resources.[126] If water rights were fixed in their allocation, without the option of transferability, the incentives for appropriators to waste, overuse, and race to acquire water rights would continue indefinitely, ultimately wreaking havoc on entire hydrologic and economic systems as rivers and aquifers run dry.[127] Thus, legally allowing for changes in purpose of use and the transfer of rights from one use to another could break the

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[122] Brewer et al., *supra* note 117, at 1024.
[123] *Id.* at 1023.
[124] Adler, *supra* note 64, at 740.
[125] Brewer et al., *supra* note 117, at 1023-24, 1032. For example, farmers in Pima County, Arizona pay about twenty-seven dollars per acre-foot for groundwater, while residents of the City of Tucson pay somewhere between a few hundred to a few thousand dollars per acre-foot of water. *Id.*
[126] GLENNON, UNQUENCHABLE, *supra* note 14, at 285-300.
[127] Adler, *supra* note 64, at 741-42.

endless cycle of water waste, and provide substantial incentives for conservation.[128]

Transfers of water rights also provide a mechanism for the creation of in-stream flow rights, where rights exist while water continues to flow in its source.[129] Environmental and conservation efforts recognizing the value of water remaining within its natural flow patterns have been relatively recent compared to the traditionally recognized value of agricultural and industrial use, and are usually handicapped in the priority systems governing water allocations compared to the diversions for consumptive agricultural or municipal use.[130] Thus, the transferability of water rights can allow water rights with significant priority status to be transferred to in-stream flow rights, retiring the old consumptive use and creating a right in the water remaining in its natural body. Oregon and Montana are places where this has occurred successfully.[131] The Oregon Water Trust, in operation since 1994, has bought up water rights from farmers and dedicated them to in-stream flows to protect the fish habitat and water quality of the rivers.[132] Using a variety of tools, including permanent purchases, short- and long-term leases, exchange and forbearance agreements, and conservation projects, the Oregon Water Trust has made a huge impact on the flows of small tributaries to large rivers.[133] Similarly, in Montana, the group Trout Unlimited has provided financial assistance to ranchers and farmers to undertake water conservation efforts on their land; in return, the rights to the conserved water are put toward in-stream flows, protecting local fish and wildlife.[134]

C. Criticisms of Water Markets

While market-based mechanisms offer solutions to some water usage and waste issues, scholars also believe that the application of a pure market system of private property is not appropriate for water, which is a public good as well as a vital resource.[135] One area in which treating water as a commodity is recognized as undesirable is in the privatization of water utilities. Examples abound where the privatization of water utilities has ended in disastrous failure and hardship for

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[128] *Id.*
[129] GLENNON, UNQUENCHABLE, *supra* note 14, at 285-95.
[130] *See infra* Part V (describing the legal systems governing water rights).
[131] GLENNON, UNQUENCHABLE, *supra* note 14, at 285-95.
[132] *Id.* at 285-90.
[133] *Id.* at 287.
[134] *Id.* at 290-295.
[135] *See, e.g.*, Joseph W. Dellapenna, *The Importance of Getting Names Right: The Myth of Markets for Water*, 25 WM & MARY ENVTL L. & POL'Y REV. 317 (2000) (arguing that the term "market" is not appropriate to describe water transactions).

residents.[136] Moreover, externalities such as environmental interests are not always well-served by a pure-market solution, a commonly recognized result of the failures of markets to guide themselves. Groups that are vigilant in efforts to protect habitats are typically the ones least able to compete financially because they individually profit nothing from habitat and species protection; instead, the benefits are spread out among the community as a whole.

One major criticism of the transfer of water rights is that it may continue the practice of inter-basin water transfers.[137] Inter-basin water transfers (hereinafter referred to as inter-basin water-diversions, to prevent confusion with the legal transfer of water rights) are the physical transfers of water from one hydrologically connected water basin to a completely different basin, which includes any diversion out of a basin of origin to supply water needs in another basin.[138] Inter-basin water-diversions are common around the world, having occurred as part of development projects to provide water to a growing population and facilitated by the construction of dams, canals, and pipelines.[139] Many of these projects are now criticized for the failure to take other factors into account, and for causing "significant social, economic and environmental impacts, which are now unacceptable."[140] These problems include "extensive negative impacts on rivers, watersheds and aquatic ecosystems," millions of displaced people, and unequal distribution of benefits among the populace.[141] To prevent such mistakes from occurring due to future projects, in 2000, the World Commission on Dams recommended that decision-makers consider the hydrology and geology of the area as well as receive public and stakeholder input when evaluating inter-basin water diversion projects.[142]

Australia provides many examples of current inter-basin water-diversions. The Snowy Mountains, in the state of New South Wales, are the site of the Snowy Mountains Hydro-Electric Scheme, which diverts flows from the Snowy River—in some parts diverting 99% of the flow—and Murrumbidgee rivers for water storage and electricity production.[143] The Snow River diversion changed the natural flow pattern, causing a variety of environmental impacts

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[136] The city of Atlanta, Georgia bought back its water system at great financial loss less than five years after privatizing it, hoping to improve service and limit costs. Joseph W. Dellapenna, *Climate Disruption, the Washington Consensus, and Water Law Reform*, 81 TEMPLE L. REV. 383, 408 (2008). Cochabamba, Bolivia, provides a more extreme example where the privatization of water services caused water rates to rise precipitously, angering local residents. *Id.* at 405.

[137] Christine A. Klein, *Water Transfers: The Case Against Transbasin Diversions in the Eastern States*, 25 UCLA J. ENVTL L. & POL'Y 249, 255 (2006-2007).

[138] *Id.* at 252.

[139] GHASSEMI & WHITE, *supra* note 25, at 22.

[140] *Id.*

[141] *Id.*

[142] *Id.* at 23.

[143] *Id.* at 91, 97-98.

including sediment deposition in channels, changes in water quality and temperatures, and changes in the frog and native fish populations.[144] A number of inter-basin water diversion projects have been proposed from the coastal basins of New South Wales to the inland basins, some for the purpose of adding to the Murray-Darling basin.[145] These proposed diversions would cause additional stresses to the coastal basins, have impacts on the health of coastal lakes and the oyster industry, and are unlikely to be approved by authorities.[146] Other projects that have been proposed in Australia include diversions from coastal catchments to supply agriculture in Queensland,[147] flooding of central lakes from seawater-diversions or groundwater extraction,[148] and pipelines to supply the cities of Perth and Adelaide with water from the northern part of Western Australia, which receives more rainfall than the rest of the country.[149] Many of these proposals, while motivated by the need to supply populated areas with more water, would impact the water bodies of origin, affect aboriginal heritage, require a great deal of energy causing a significant release of greenhouse gases, and would be too expensive to justify.[150] However, other expensive proposals—such as a desalination plant to provide water to Perth—have been implemented, demonstrating the extent of the need for water in Australia.[151] Major inter-basin water-diversion projects exist in the United States as well.[152] In California, the Los Angeles Aqueducts and Colorado River Aqueduct supply the city of Los Angeles; the Hetch Hetchy Aqueduct and the Mokelumne Aqueducts supply the city of San Francisco; and the All-American Canal transfers water from the Colorado River to agriculture in the Imperial Valley and the Coachella Valley.[153] Other projects diverting Colorado River water include the Colorado-Big Thompson Project and Fryingpan-Arkansas Project to Colorado; the San Juan-Chama Project to New Mexico; and the Central Utah Project to Utah.[154] As a result of these diversions, the Colorado River is no longer a river by the time it reaches the sea.[155]

Water transfers do have the potential to cause environmental damage when creating or continuing inter-basin diversions that harm ecosystems.[156] However, all of the environmental damage cannot be blamed on the water rights

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[144] *Id.* at 101.
[145] GHASSEMI & WHITE, *supra* note 25, at 107, 110.
[146] *Id.* at 110, 123.
[147] *Id.* at 125.
[148] *Id.* at 139.
[149] *Id.* at 151, 165, 180.
[150] *Id.* at 178.
[151] GHASSEMI & WHITE, *supra* note 25, at 178.
[152] *Id.* at 217.
[153] *Id.*
[154] *Id.*
[155] *See supra* Part II.A.
[156] *See supra* Part IV.B; *see also* Klein, *supra* note 137.

transfer if the status quo would have yielded the same environmental consequences. Economists stress that the true costs and benefits of a proposed or actual policy change must be weighed against the costs or benefits that would have occurred had the change not occurred.[157] In most cases, the transfer of water rights occurs from a highly consumptive agricultural use to a higher-value municipal use.[158] In the case of such a transfer, the original water basin is still lacking the quantity of water initially diverted from it for the agricultural use and is no better or worse off from the transfer to a municipal use. The transfer of water rights has not caused any additional environmental damage to the water basin.

In some cases, irrigation runoff from an agricultural diversion might allow some water to flow back into the local watershed, whereas transfer to a far away urban use would negate those runoff benefits. In this way, the transfer of rights would indeed cause greater damage to the environment. But, it is important to recognize that the transfer of rights in itself is not determinative of extra environmental damage and depends on the comparative damage caused by the previous and future use.

The criticism that the transfer of water rights can lead to more inter-basin water diversion projects is real, but can also be countered, as transfers have the potential to cause the opposite effect. The negative effects of inter-basin water transfers can be ameliorated by providing an opportunity for the transfer of water rights to improve on the previous use's environmental impacts. In a legal system where the government administratively approves changes in use of water rights, a rule can be created requiring that any inter-basin use adequately account for environmental damage which may occur. Thus, where previous water use may have involved an inter-basin water transfer that caused damage to the basin, the new transferred use may be able to rectify some of the existing damage.

If viewed solely from the perspectives of the parties involved in the transaction, the sale of water rights is an unqualified success, since the agreed price falls somewhere between where the seller values his own continued water use and where the buyer is willing to pay for water. However, there are often economic impacts to local communities, which are not captured by the simple market transaction between the buyer and seller of the water right. These negative externalities are created when industries are linked to one prevalent type of water use; for example, agricultural communities often support linked industries such as processing plants, seed and feed suppliers, and farming tool suppliers.[159] The

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[157] This is known as the "with or without principle." *See, e.g.*, JOHN B. LOOMIS, INTEGRATED PUBLIC LANDS MANAGEMENT 158-160 (2002). For example, if a certain policy change will create a number of jobs, the recorded net benefit of that change must not include any jobs that would have been created without the policy.

[158] *See* Adler, *supra* note 64, at 742.

[159] *See* GLENNON, UNQUENCHABLE, *supra* note 14, at 259-264. Glennon describes the Imperial Irrigation District's dilemma over whether to sell water rights to the public utilities supplying Los Angeles, San Diego, and surrounding cities. *Id.* The deal ultimately went

community surrounding the transferor of the water rights may suffer, for example, if a farmer no longer farms his land, he also no longer needs to buy farming implements or inputs, or to send his crops for processing.[160] In communities where agriculture and linked industries make up a dominant portion of the local economy, the loss of one portion of the chain can profoundly affect the entire economy.[161]

Economists have studied this phenomenon in an attempt to quantify the magnitude of the third-party economic impacts and determine the success or failure of efforts to mitigate such impacts. Such studies find different conclusions, depending on the cases, focus, and scale of the study. For example, a 1994 study of the 1991 California Drought Water Bank, which was an emergency water auction set up in response to a 1987-1991 drought crisis, attempted to quantify the direct and indirect costs and benefits to the regional economies.[162] The study found that, at the state level, emergency transfers produced net benefits by allowing rights to water to be sold to those with high demand and produced substantial net gain in employment and income; however, local agricultural economies did experience negative economic impacts.[163] The study also simulated the impacts of localized transfer restrictions to mitigate concentrated economic impacts and found that such restrictions would prevent job loss while trading off potential transfer benefits.[164]

A 2001 study on the third-party impacts of water transfers in California, focused instead on eight counties in the Sacramento Valley, simulated impacts on agricultural communities from a 25% reduction in surface irrigation water (perhaps due to a sale of water rights).[165] The study concluded that economic losses fall most heavily on counties highly reliant on agriculture; however, by optimizing the community's possible responses (switching crops, improving water efficiency, or simply using less water), such economic impacts could be minimized.[166]

These are only a few examples of studies seeking to quantify the local economic loss that can follow from the mass transfer of water rights out of an agricultural community. As a solution, legal systems can adopt transfer rules to

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through after the buyers set up a fund to compensate the region's agricultural economy for third-party impacts caused. *Id.*

[160] *Id.*

[161] *Id.*

[162] Richard E. Howitt, *Empirical Analysis of Water Market Institutions: The 1991 California Water Market*, 16 RES. & ENERGY ECON. 357 (1994).

[163] *Id.*

[164] *Id.*

[165] Hyunok Lee, Daniel A. Sumner, & Richard Howitt, *Potential Economic Impacts of Irrigation-Water Reductions Estimated for Sacramento Valley*, 55 (Part 2) CAL. AGRIC. 33-40 (March-April 2001), *available at* http://ucanr.org/repository/cao/landingpage.cfm?article=ca.v055n02p33&fulltext=yes.

[166] *Id.*

minimize such impacts. Twenty-two of California's fifty-eight counties have adopted water export restrictions as an attempt to deal with adverse third-party impacts.[167]

V. LEGAL SYSTEMS

Allowing for the rapid and flexible transfer of water rights may be a potential solution to water stressed communities, especially with the added factor of climate change. However, water institutions are not designed to allow for flexibility.[168] Rather, the systems we have created are designed for stability.[169] This search for stability provides economic benefits as insecurity in rights prohibits new investments,[170] but a focus on stable institutions and water rights regimes may hamper the ability to respond effectively to sudden climate change effects.[171]

As the scientific community continues to produce more refined estimates of the impacts that climate change will have on our natural systems, the task falls to the legal systems around the world to correspondingly take measures in response to the coming changes. These measures will involve both mitigation of the damage climate change will create and adaptation to the changes that are now unavoidable.[172] These potentially devastating effects on water supplies require that water managers and policymakers address water supply issues on an accelerated schedule, exploring changes to laws and institutions to make them more flexible and robust in the face of uncertainty.[173]

A. Water Law in the Western United States and Barriers to Transfer

The rights to water in the United States are mostly governed at the state level, although some federal laws do impact the distribution of water rights. The way that these rights are governed impacts how water is used and overused. For example, in many states, an artificial legal distinction is drawn between rights to surface water and rights to groundwater.[174] However, as scientific understanding of hydrology has progressed over time, it has become clear that surface water and groundwater are linked, and the use of one impacts the availability of the other.[175]

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[167] GHASSEMI & WHITE, *supra* note 25, at 234.
[168] Doremus & Hanemann, *supra* note 70, at 63.
[169] *Id.*
[170] *Id.* at 74.
[171] *See generally* Doremus & Hanemann, *supra* note 70.
[172] *Id.*; *See also* Adler, *supra* note 64, at 733-34 for benefits of adaptive measures.
[173] Adler, *supra* note 64, at 731.
[174] *See infra* Part V.A for more on the distinction between groundwater and surface water.
[175] Brewer et al., *supra* note 117, at 1027-28.

These differently defined rights can and do come into conflict with one another. This artificial distinction in the law provides an example of how the legal definition of rights to water can cause an impact on water use, and can promote or frustrate efforts to maintain water as a sustainable resource. Moreover, it can frustrate efforts to transfer water rights, where rights to surface water are useless to someone who can just obtain water by pumping groundwater. Other legal barriers to the transfer of water rights in the western United States include: ongoing water rights adjudications in the courts, the doctrines of beneficial use and salvage, the "no harm to juniors" rule, and the rules governing federal water rights which are capable of superseding state laws. With these legal barriers in place, transferring water rights becomes difficult and does not occur as often as desired for efficient outcomes.

Water law originally existed in the United States under a system of riparian rights, a system brought over by the English colonists.[176] A riparian holds the right to divert surface water only if he owns land adjacent to the flow.[177] Moreover, riparianism grants correlative rather than absolute rights, where one user's right is always determined in relation to other users of the water.[178] As a legal system, riparianism itself evolved through the years to grant rights favoring capitalism and development.[179] However, this riparian system was not well-suited to the more arid western states. Most western states never adopted riparianism, some explicitly rejecting the riparian system in their constitutions,[180] while some states have adopted a mixture.[181] Today only the eastern states continue to follow an essentially riparian system of water rights.[182]

Most of the western United States instead adopted a system of prior appropriation for surface water. Under this system, water users hold a right to use water for a specified amount, time, place, and purpose. These rights are ordered in priority from the earliest use of water to latest, creating a ranking system of

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[176] SAX, *supra* note 13, at 29.

[177] *Id.* at 27.

[178] *Snow v.Parsons*, 28 Vt. 459 (1856) ("The reasonableness of such use must determine the right, and this must depend upon the extent of detriment to the riparian proprietors below.").

[179] *See, e.g.*, Carol M. Rose, *Riparian Rights*, *in* THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 344 (Peter Newman ed., 1998). Under the clear and predictable rules of the earliest natural flow doctrine, any alteration of the stream's natural flow was prohibited and could be enjoined. This shifted to a priority system in which users of the water were awarded rights to use it based on seniority, while still operating within a riparian system. Finally, a reasonable use doctrine has evolved, which subjects users to a weighing of the values of one use against the other. Each shift in riparian doctrine was made to encourage more and higher value development to occur. *Id.*

[180] *E.g.*, ARIZ. CONST. art. XVII, § 1.

[181] SAX, *supra* note 13, at 13 (providing a map of the fifty states and their respective water law systems).

[182] *Id.*

junior appropriators whose rights are subordinate to the seniors.[183] The extent of the water right is much more certain under prior appropriation than under riparianism, although even prior appropriators may find they hold water rights that produce no actual water.[184]

Even though the prior appropriation system is theoretically capable of providing more certainty, in practice the extent of the water rights is still not very clear. The volume of competing claims within the prior appropriation system, with dates tracing back to before records were well kept, can cause confusion and conflict.[185] Many states undergo a lengthy process of general adjudications, in which all water claims are filed and evaluated in the courts, to add certainty to the water rights held.[186] However, certainty is only secured on the date of the decree, and the decree quickly loses efficacy as new claimants, with potentially superseding priority dates, enter the picture.

The lack of certainty leading up to the issuance of a decree from a general adjudication poses a barrier to the transfer of water rights.[187] Buyers may not be willing to purchase water rights if an unknown quantity is being sold.[188] Even after a decree is issued, the uncertainty in the water rights is not completely dispelled and further impedes transfers.

The beneficial use doctrine governs the ability of an appropriator's right to continue holding the water right indefinitely.[189] Beneficial use essentially means "use it or lose it", requiring that the appropriator continuously put their water to beneficial use or be subject to loss of the water right.[190] The loss of the right occurs through abandonment or forfeiture, if it can be proven that the appropriator did not use their full water right for a continuous period.[191]

Closely tied to the doctrine of beneficial use is the salvaged water doctrine, which varies across the western states.[192] Salvaged water refers to water that has newly been made usable due to conservation efforts; for example, lining a ditch so that more of the diverted water reaches the user instead of being lost to seepage or changing from flood irrigation to drip or sprinkler irrigation to reduce evaporative losses.[193] While some states give the right to the conserved water to

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[183] Brewer et al., *supra* note 117, at 1026.

[184] *Id.* Junior appropriators may find they have "paper" rights as opposed to "wet water" rights when river flow is so low that only senior appropriators are able to divert water. This situation is not uncommon, in many cases the rivers of the west are over-appropriated to begin with and the rights having been defined during rare periods of high flow. *Id.*

[185] SAX, *supra* note 13, at 132-33.

[186] *Id.*; Brewer et al., *supra* note 117, at 1027.

[187] Brewer et al., *supra* note 117, at 1027.

[188] *Id.*

[189] SAX, *supra* note 13, at 152-59.

[190] *Id.*

[191] *Id.* at 247.

[192] *Id.* at 182.

[193] *Id.*

the conserving user, other states treat the conserved water as new unclaimed water to be doled out to the appropriators next in line in the priority system.[194] Under the Colorado version, the doctrine has created an incentive for holders of water rights to forgo water conservation practices. Driven by the fear that any reduction in the amount of water used will lead to a reduction or loss in the water right, users are essentially encouraged to continue with wasteful uses.

The beneficial use and salvage doctrines pose a barrier to transfers by creating incentives for rights holders to continue inefficient or low value uses.[195] If a farmer seeks to improve the efficiency of his water use, the farmer does not gain the rights to the conserved water under the beneficial use doctrine, which could then be transferred to another for profit. Instead, the farmer must continue to use the water in the same way he always has in order to keep any of his water rights.

While transfers of water rights are generally permitted across western states, the "no injury" rule poses an additional legal restriction on when and how transfers may occur.[196] A party wishing to transfer water rights must show a prima facie case that existing diversions, even those of a junior priority, will not be negatively affected beyond a reasonable measure by the transfer.[197] A junior user may be negatively affected by a transfer where an upstream senior diverter's use involves subsequent runoff, which is then appropriated by a junior appropriator.[198] Thus even a holder with a senior priority date is restricted in his ability to transfer or even change the full quantity of his right.[199] As a direct limit on how transfers may occur, the "no harm to juniors" rule is one of the most significant barriers to the transfer of water rights.

The existence of a separate groundwater law in the western states makes matters more complicated. Groundwater doctrines developed separately from surface water law, a consequence of a lack of early understanding of the hydrologic cycle and the interconnectedness of all water, whether groundwater or surface water.[200] While some western states have since revised their water law to integrate surface and groundwater law, others have not yet legally recognized hydrologic reality.[201] The states that have integrated their groundwater and surface water law use a priority system for diversions and pumping equally.[202] However, some states treat groundwater as an open access resource. Texas retains a right of capture for groundwater, which is a property system that recognizes the

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[194] Brewer et al., *supra* note 117, at 1030. California is an example of the former while Colorado is an example of the latter. *Id.*
[195] *Id.* at 1027.
[196] SAX, *supra* note 13, at 270.
[197] *Id.* at 270, 274 n. 5.
[198] *Id.* at 270.
[199] Brewer et al., *supra* note 117, at 1029-30.
[200] SAX, *supra* note 13, at 393-94.
[201] *Id.*
[202] Brewer et al., *supra* note 117, at 1028.

resource belongs to the first one who takes it. Arizona and California have a reasonable use doctrine that allows unlimited pumping as long as it can be classified as for a "beneficial purpose," a standard that is easily satisfied.[203] These approaches encourage a race to acquire and use the groundwater, which ultimately has consequences for the surface water appropriators, as aquifers are able to provide less recharge to the river systems, instead drawing away water from rivers to replenish the aquifer.[204]

Arizona has attempted to address the unlimited pumping of groundwater. In 1980, it passed the Groundwater Management Act, which prohibited new wells without a state permit and required that developers within critical areas prove a viable water supply, setting the stage for the transfer of groundwater rights. However, the state later created an agency, which removed the burden of demonstrating an assured water supply from developers and reduced incentives to transfer.[205] Exemptions for small domestic wells have also allowed a circumvention of the goals of the Management Act.[206]

The disparate legal doctrines governing surface water and groundwater also pose a barrier to transfers of water rights. Because the doctrines are not integrated and groundwater pumping is unregulated in many states, anyone with a need for water rights may simply drill a well and begin pumping for water.[207] Thus, transferring water rights are of little to no value.[208] The lack of an integrated system unfortunately also exacerbates the negative environmental consequences from unlimited groundwater pumping by encouraging those who might otherwise buy a water right to sink a well instead.[209]

While rights to surface water are mostly determined by state law, there are instances in which federal rights to water may exist outside of a state's water apportionment system. For example, public rights to use water for recreational purposes may arise from federal government ownership of lands beneath "navigable waters" prior to the state's admittance to the Union.[210] Other federal water rights may be found to be impliedly reserved when federal lands are set to certain purposes, including national parks and forests and Indian reservations.[211] These rights may not be claimed within the state's appropriation system, but can be claimed with a priority date as of the date of reservation, even though the claim occurs years later. Disputes may occur over the quantity of water necessary to

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[203] *Id.* at 1028.
[204] *See generally* SAX, *supra* note 13, at 397-402 (describing briefly the hydrologic cycle and the interconnectedness of surface and groundwater).
[205] Brewer et al., *supra* note 117, at 1028-29.
[206] *Id.* at 1029.
[207] *Id.* at 1028.
[208] *Id.*
[209] *Id.*
[210] *See, e.g.*, Utah v. U.S., 403 U.S. 9 (1971).
[211] SAX, *supra* note 13, at 903-05.

satisfy the purpose of the reservation.[212] Finally, federal legislation, such as the Endangered Species Act, may enter the picture when certain species are listed as endangered, requiring amounts of water to be set aside for the species' recovery before other water uses may be allowed.[213]

The existence of federal water rights, which may or may not be accounted for within the state's water rights systems, adds a level of uncertainty to water rights which forms another barrier to the transfer of water rights.[214] Because unknown and unquantified federal rights may be claimed at any time, the water rights are not defined well enough to promote their transfer.

B. Australia

Australia's legal system governing water rights once contained barriers to trade similar to the United States. But after 1990's legal reforms, it has become much more encouraging of water rights transfers. The reforms created a regulatory arrangement to govern Murray-Darling water rights and their allocations each year. Now, there is a commission to oversee the Murray-Darling, water which may be safely used in a given year, and a commission to encourage the transfer of water rights while keeping environmental and social impacts to a minimum.

As in the United States, the ownership of water itself in Australia resides with the state or national governments, while individuals may possess the right to use the water.[215] Early Australian surface water rights took the form of riparian rights, modeling the legal regime of its European settlers, but were transformed into statutory water rights beginning with the State of Victoria in 1886.[216] These statutory water rights are defined by the number of diversions allowed per irrigation season.[217] In the early twentieth century, Australian states freely allocated statutory water rights to encourage farming settlements and the construction of water storage facilities and public irrigation works.[218] The resulting over-allocation of statutory water rights led to a demand in the 1980s for the ability to separate water rights from the land and trade rights among users, and water markets were established in all four states of the Murray-Darling basin by 1991.[219]

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[212] *Id.*
[213] Brewer et al., *supra* note 117, at 1033.
[214] *Id.* at 1033-34.
[215] R. Quentin Grafton, et al., *Markets–Water Markets: Australia's Murray-Darling Basin and the US Southwest* 3-4 (Int'l Ctr. Econ. Res., ICER Working Paper No. 15/2009, 2009), *available at* SSRN: http://ssrn.com/abstract=1437510.
[216] *Id.* at 5-6.
[217] *Id.* at 5.
[218] *Id.* at 6.
[219] *Id.*

The scarcity problems of the 1990s prompted a series of larger legal reforms in Australia,[220] which serve as an international example for river basin management and experiment in ecosystem revival, and possibly set international precedent.[221] In 1992, the national government and the four basin states agreed to the Murray-Darling Initiative, which led to the creation of the federal-state Murray-Basin Agreement.[222] The Agreement allocates the flow of the river among the basin states and is based on constantly updating scientific information to continually amend the Agreement.[223] The Agreement imposes more detailed land-use and water-management duties on the parties than an international treaty or U.S. interstate water-allocation compact.[224]

The reforms also led to the creation of the Murray-Darling Basin Commission, a joint federal-state commission overseen by a federal-state ministerial council and a stakeholder advisory board.[225] In December 2008, the commission became the Murray-Darling Basin Authority to facilitate integrated management of the basin, reporting to the Australian Minister for Climate Change and Water.[226] Essentially, the Murray-Darling Basin Authority runs the river and has the power to control releases from storage facilities upstream.[227] The two precedent-setting decisions that the commission made are the "adoption of an artificial base flow regime . . . and the imposition of the use reduction regime on existing users throughout the basin."[228]

To maintain flows for ecosystem restoration and agricultural production, in 1996 the commission created "the Cap," which sets yearly diversion limits on the basin states,[229] and other policies aimed at managing the scarce water resources, including "water trading, environmental flows and the security of property rights."[230] The Cap on surface water diversion has unfortunately caused a dramatic increase in groundwater use, which may not be regulated.[231]

In 2004, the Council of Australian Governments (COAG) reached a National Water Initiative Agreement and established a National Water

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[220] *The Big Dry*, *supra* note 28.
[221] A. Dan Tarlock, *Transboundary Freshwater Ecosystem Restoration: The Role of Law, Process and Lawyers*, 19 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 61, 69 (2006).
[222] *Id.*
[223] *Id.*
[224] *Id.*
[225] *Id.*
[226] *About the Murray-Darling Basin Authority*, MURRAY-DARLING BASIN AUTH., http://www.mdba.gov.au/about_the_authority.
[227] Tarlock, *supra* note 221, at 69.
[228] *Id.*
[229] *Id.* at 69-70.
[230] *Id.* at 70, (quoting the Murray-Darling Basin Commission, Annual Report 1998-1999, 24 http://publications.mdbc.gov.au/view.php?view=37).
[231] GHASSEMI & WHITE, *supra* note 25, at 70 (referring to Table 3.9).

Commission (NWC).[232] Key elements of the National Water Initiative (NWI) Agreement include defining water entitlements to promote security of entitlements along with a statutory basis for environmental benefits and ecosystem outcomes; facilitating the operation of water markets and trading of water rights while recognizing environmental needs and third-party impacts; ensuring proper pricing of water to encourage the sustainable use of water resources, pay for infrastructure, and promote pricing transparency; and to provide healthy and reliable water supplies.[233] The NWS assessed the progress of the NWI Agreement by undertaking biennial assessments and reported these conclusions to the COAG.[234] The NWI Agreement and NWC represent significant achievements in creating a comprehensive national Australian water policy.[235] However, there are a few possible impediments to the NWI Agreement's success in managing Australian water sustainably. For example, it lacks incentives for irrigators to return salvaged water to environmental purposes or trade with other users, which encourages users to maintain inefficient uses.[236] It also contains no mechanism to prevent third-party impacts from water trading, which can cause economic harm to agricultural communities.[237]

Individual states may have laws of their own governing water rights. The state of South Australia regulates the right to "take" water beyond a prescribed quantity through the issuing of licenses.[238] A license may be obtained either for a water-taking allocation, in which the license holder may take a determined quantity of water from the designated source, or for a water-holding allocation, in which the license holder is not allowed to take water, but may request that the Minister for Environment and Conservation convert the allocation to a water taking allocation.[239] The Natural Resources Management Act of 2004 allows the Minister to refuse a license application if it conflicts with the water allocation plan, poses a health risk, or for "any other reasonable ground[s]."[240] A license, once granted, is still subject to regulation. The particulars may be varied by the Minister for reasons including: to account for changes in the allocation plan, to meet the objectives of the River Murray Act 2003, or to prevent damage to the River Murray; the license may also be terminated in compliance with law.[241]

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[232] *Id.* at 84.
[233] *Id.*
[234] *Id.* at 85.
[235] *Id.*
[236] *Id.*
[237] GHASSEMI & WHITE, *supra* note 25, at 85.
[238] HU, *supra* note 25, at 153.
[239] *Id.* at 154.
[240] *Id.*
[241] *Id.* at 155.

The transfer of licenses is permitted in South Australia.[242] In fact, South Australia was the first state to introduce trading of water on the Murray River in 1983.[243] Transfers may be absolute or for a temporary period, after which the license reverts back to the original holder.[244] These transfers are subject to approval by the Minister for Environment and Conservation, who may choose to reject a transfer application for the same reasons as rejecting the granting of a license above, if the transferee has violated the Natural Resources Management Act of 2004, or if the licensee has violated terms of the existing license.[245] Four types of transfers may occur:

> (a) transfer of a license, including the water allocation, from a licensee to another person;
> (b) transfer of a whole or part of a water allocation from a licensee to another licensee or to the Minister;
> (c) transfer of a license or the whole or part of a water allocation to or by South Australian Water; and,
> (d) transfer of a license or the whole or part of a water allocation from a licensee to another person or to the Minister under an Interstate Water Entitlements Transfer Scheme.[246]

South Australia recognizes water rights for environmental purposes.[247] A 1996 document adopted by national Australian and New Zealand resource councils—the National Principles for the Provision of Water for Ecosystem—provided for twelve principles of water management to recognize, protect, and maintain the water levels necessary for water-dependent ecosystems.[248]

Both Australia and South Australia, on a smaller scale, have legal systems that explicitly spell out the ways in which water transfers are allowed to proceed, with checks on their negative impacts, which can hinder the transfer of water rights. The level of definition provided to methods of water transfers in legislative acts demonstrates the focus paid to ensuring that water transfers occur in an environmentally and economically beneficial manner. Moreover, the clarity given to how transfers may occur provides increased certainty to water rights holders, which can promote the use of transfers.

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[242] *Id.* at 156.
[243] *Id.* at 152.
[244] HU, *supra* note 25, at 156.
[245] *Id.*
[246] *Id.*
[247] *Id.* at 160.
[248] *Id.* at 159-60.

VI. CLIMATE CHANGE AND WATER: WHAT IS BEING DONE?

Society often changes its views on a resource issue—as well as its legal and political approach towards managing that resource—when it becomes apparent that a crisis is at hand.[249] However, the delay between the recognition of the crisis and the ultimate resolution through changes in the legal institutions causes inefficiencies and allows further degradation of the resource.[250] Many experts in natural resource law and economics believe that assigning property rights to natural resources is the best way to manage and preserve those resources in the long term.[251] Typically, the resource is first merely regulated through uniform rules to constrain behavior, and then assigned property rights as the resource value rises and the rules prove unable to prevent undesired externalities.[252] Case studies have shown such waste occurs in the transition from prescriptive governmental regulation to the assignment of formal property rights for open-access resources such as fisheries, oil, and gas deposits under public lands and air pollution.[253] Transferability is an important property right that has allowed for the correction of these resource issues.[254]

Although water is not an open-access resource and property rights are assigned to govern its use, it is generally viewed as under-valued. It therefore attains the results of the open-access resource: the creation of inefficiencies and waste due to its availability in some sectors as a nearly-free resource.[255] The next section will examine how Australia and the western United States have responded to the recognition of a crisis in water and to the impending impacts of climate change on that resource.

A. Responding to Climate Change

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[249] Gary D. Libecap, *Open-Access Losses and Delay in the Assignment of Property Rights*, 50 ARIZ. L. REV. 379, 380 (2008).

[250] *Id.* For example, a classic article describing the waste of open-access fisheries was written in 1954, but it was not until 32 years later that the first property rights system in fisheries was created in New Zealand. *Id.* at 381.

[251] *See, e.g.*, The Property and Environment Research Center (PERC), http://www.perc.org/ (last visited Oct. 1, 2010), a research institute promoting free-market environmentalism.

[252] Libecap, *Open-Access Losses and Delay in the Assignment of Property Rights*, *supra* note 249, at 380.

[253] *See generally* Libecap, *Open-Access Losses and Delay in the Assignment of Property Rights*, *supra* note 249.

[254] *See infra* Part IV.A.

[255] Gary D. Libecap, *The Tragedy of the Commons: Property Rights and Markets as Solutions to Resource and Environmental Problems*, 53 AUSTRALIAN J. AGRIC.& RES. ECON. 129 (2009), *available at* http://www.perc.org/files/Aust_Libecap.pdf.

Australia's public and government have embraced the concept of climate change in recent years. Although Australia was the only developed nation besides the United States to resist joining the Kyoto Protocol,[256] in 2007 the Australian public elected the current Prime Minister Kevin Rudd in large part due to his approach to climate change, acknowledging it as a problem Australia must address.[257] Rudd signed onto the Kyoto Protocol immediately after his election.[258]

Climate change functions are entrusted to several entities across the Australian government. The government actively tracks and analyzes climate data and trends through the Australian Government Bureau of Meteorology.[259] There is even a Department of Climate Change, established after Rudd's election in 2007 as part of the Prime Minister and Cabinet Portfolio.[260] The Department's goals include reducing Australia's emissions of greenhouse gases, adapting to unavoidable climate change impacts, and helping to create a global solution.[261]

The Australian public is now more aware of the impacts of climate change. This awareness increased due to a combination of the movie *An Inconvenient Truth*, the release of the IPCC report, and continuation of the prolonged drought.[262] Importantly, in a country where drought is a relatively frequent occurrence, the public is now more likely to attribute the prolonged nature of the droughts to the early effects of climate change.[263]

Although lawmakers in the United States have been slow to appreciate the urgency of climate change and the need to prepare for mitigation and adaptation, there is a sense that the science can no longer be ignored.[264]

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[256] Marks, *supra* note 47; *Leading Article: A Global Warning*, *supra* note 47. Then Prime Minister John Howard was a vehement climate doubter until the end of his term, when it became clear that the public opinion was in favor of stronger action on climate change. *Id.* Howard even refused to meet with Al Gore as Gore visited Australia promoting his film, *An Inconvenient Truth*. *Id.*

[257] *The Big Dry*, *supra* note 28; Michael Sullivan, *Australian Prime Minister Backs Climate Change*, NPR (Dec. 12, 2007), http://www.npr.org/templates/story/story.php?storyId=17158964.

[258] Sullivan, *supra* note 257.

[259] *See generally* Climate Change, *supra* note 98.

[260] *About Us*, AUSTRALIAN GOVERNMENT DEPARTMENT OF CLIMATE CHANGE AND ENERGY EFFICIENCY, http://www.climatechange.gov.au/about.aspx (last visited Sept. 27, 2010); *see generally* AUSTRALIAN GOVERNMENT DEPARTMENT OF CLIMATE CHANGE AND ENERGY EFFICIENCY, http://www.climatechange.gov.au/ (last visited Sept. 27, 2010).

[261] These are the three pillars of the Department of Climate Change's Corporate Plan, which guides the Department's "roles and priorities in delivering the Australian Government's climate change framework." *About Us*, *supra* note 260.

[262] Sullivan, *supra* note 257.

[263] *Id.* (quoting Dr. Michael Fullilove, Program Director, Global Issues Program, Lowy Institute: "The difference is that, whereas in the past, people might have looked at a drought and said, oh, bloody drought. Now, they look at it and say, bloody global warming.").

[264] *See, e.g.*, John M. Broder, *Obama Affirms Climate Change Goals*, N.Y. TIMES, Nov. 18, 2008, *available at* http://www.nytimes.com/2008/11/19/us/politics/19climate.html.

Regarding water, some believe that awareness does exist of the impact climate change will have on water supply.[265] At the national level, the federal government under President Obama has renewed interest in climate change science and in developing solutions to meet energy demand without exacerbating the environmental consequences of energy production.[266] The lack of federal legislation on climate change has caused the U.S. Environmental Protection Agency to proceed in initial regulation of greenhouse gas emissions.[267]

At the regional level, the southwestern approach to dealing with climate change is somewhat heartening, but faces struggles. In January 2009, scholars from various disciplines organized a Southwestern Adaptation Conference in Tucson, Arizona, to "examine the landscape of probable climate change impacts and their environmental and social costs," specifically focusing on the southwestern United States.[268] Governors of several western states and the Premiers of many western Canadian provinces met in February 2007 to form the Western Climate Initiative, a regional greenhouse gas emissions reduction program with plans for regional emissions trading.[269] However, in February 2010, Arizona announced it was pulling out of the program, citing budget difficulties.[270] Soon after, many Utah lawmakers indicated their desire for their governor to follow Arizona out of the program as well, noting that Utah is highly dependent on fossil fuels for power generation.[271] It thus appears that efforts to address climate change, despite regional efforts, will remain an issue that must be tackled at the federal level.

B. Focusing on Water and Trading Rights

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[265] GLENNON, UNQUENCHABLE, *supra* note 14, at 320.

[266] Broder, *Obama Affirms Climate Change Goals*, *supra* note 264.

[267] *See, e.g.*, Robin Bravender, *EPA Issues Final "Tailoring" Rule for Greenhouse Gas Emissions*, N.Y. TIMES, May 13, 2010, *available at* http://www.nytimes.com/gwire/2010/05/13/13greenwire-epa-issues-final-tailoring-rule-for-greenhouse-32021.html.

[268] Conference participants included legal and scientific scholars, lawmakers, and administrators. *See Adaption to Climate Change in the Desert Southwest: Impacts and Opportunities*, THE UNIVERSITY OF ARIZONA, JAMES E. ROGERS COLLEGE OF LAW (January 22-23, 2009), http://www.law.arizona.edu/adaptationconference/index.cfm for conference proceedings.

[269] *History*, WESTERN CLIMATE INITIATIVE, http://www.westernclimateinitiative.org/history (last visited Sept. 27, 2010).

[270] Sindya N. Bhanoo, *Arizona Quits Western Cap-and-Trade Program*, N.Y. TIMES, Feb. 12, 2010, *available at* http://www.nytimes.com/2010/02/12/science/earth/12climate.html?hpw.

[271] Brandon Loomis, *House Seeks to Leave Western Climate Initiative*, SALT LAKE TRIBUNE, Feb. 24, 2010, *available at* http://www.sltrib.com/news/ci_14465421.

In Australia, the management of the water in the Murray-Darling river basin is done with an eye to the effects of climate change, as the Murray-Darling Basin Authority lists "tackling climate change" as the foremost of its four priorities.[272] Moreover, the National Water Initiative[273] specifically focuses on the trading of water rights to facilitate the structural adjustment of water allocations as part of Australia's water reform and seeks to improve trading opportunities.[274] Ideas have been proposed to facilitate trading even further from lower value agricultural uses, recognizing the transaction costs imposed by trading limits to prevent negative economic impacts to agricultural areas.[275] Beyond these transactions, other market-based options to encourage irrigators to return water to the Murray River include voluntary buybacks of water entitlements for environmental purposes, compulsory buybacks of water entitlements, and more.[276] The degree of planning Australia has shown in using water transfers and other market mechanisms is highly encouraging, and demonstrates its understanding of climate change's impacts on water resources.

In the United States, the expected impact on the timing of the hydrologic cycle has become one factor behind California Governor Schwarzenegger's 2007 proposal to start building large dams on the San Joaquin and Sacramento rivers.[277] Major dams have not been built in California for more than thirty years;[278] and, the national trend regarding dams is toward decommissioning them to allow environmental flows to restore endangered fish populations and natural canyons.[279] Lester Snow, director of the California Department of Water Resources, believes that building dams will provide storage infrastructure to control floods that will worsen with climate change, and retaining the water that will no longer be naturally stored as snowmelt, for future agricultural and municipal uses.[280] As with most modern proposals to build more dams, there is significant opposition, based on the environmental damage the dams will create,[281]

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[272] *About the Murray-Darling Basin Authority*, MURRAY-DARLING BASIN AUTHORITY, http://www.mdba.gov.au/about_the_authority (last visited Oct. 1, 2010).
[273] *See supra* Part V.B.
[274] J.C. McColl & M.D. Young, Australian Commonwealth Scientific & Research Organization, *Managing Change: Australia's Structural Adjustment Lessons for Water* 24 (Sept. 2005), http://www.law.arizona.edu/adaptationconference/PDFs/YoungManagingChange.pdf.
[275] *Id.* at 24-25.
[276] *Id.* at 26-29.
[277] GLENNON, UNQUENCHABLE, *supra* note 14, at 109-10.
[278] *See id.* at 111.
[279] *See id.* at 118.
[280] *Id.* at 110.
[281] *See id.*

as well as the large price tag of building the dams and associated transportation infrastructure.[282]

The construction industry also shows awareness of climate change's projected impacts on water supply. In November 2009, the U.S. Green Building Council held its annual conference in Phoenix, Arizona.[283] Styled as Greenbuild, the conference offered a week filled with exhibits by vendors from various sectors of the green construction industry, lectures and panels by industry leaders and policymakers, and even featured Al Gore as the keynote speaker.[284] At one of the panels, entitled "Sustainable Infrastructure: A Key Component of Green Communities," panelists from sustainable construction consulting firms demonstrated their understanding of the energy-water nexus and the associated impacts climate change would have on water supply from the connection to energy alone.[285] They highlighted the importance of ensuring the long-term viability of water supply and treatment in construction of new communities and proposed a movement towards using distributed water infrastructure.[286] Similar to the idea of distributed generation in the energy context, distributed infrastructure for water would involve the localization of waste treatment systems within communities, to minimize the costs of transporting water far away for treatment, as generally occurs in conventional development.[287]

The California Emergency Drought Water Bank of 1991, discussed in Part IV.B above, can serve as a starting model for more institutions to facilitate temporary transfers of water rights.[288] The Bank's existence was able to help various municipalities meet their customers' water needs, and higher value farms to continue operations, by allowing for the quick transfer of water rights to where it was most needed during a drought.[289] Following this example will help other water-stressed areas in the United States meet their variable demands when required. As described earlier, encouraging the transfer of water rights can serve

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[282] *Id.* at 113. A 2008 estimate of the cost of the dams were $10.3 billion, and $2 to $3 billion for a canal to transport the water to users, with costs likely to rise as construction progresses. *Id.* at 110-13.

[283] Press Release, U.S. Green Building Council, USGBC's Greenbuild Conference Opens with a Plenary Celebration at Chase Field in Phoenix: USGBC President & CEO Rick Fedrizzi, Vice President Al Gore and Singer Sheryl Crow Open to a Packed Field (Nov. 13, 2009), http://www.usgbc.org/Docs/News/Opening%20Plenary%2011.12.09.pdf.

[284] *Id.*

[285] Panel on Sustainable Infrastructure: A Key Component of Green Communities, Greenbuild 2009 (Nov. 12, 2009). Specifically citing the energy needed for the conveyance of water, one panelist stated that water distribution systems accounted for up to 13% of electricity use in the United States. *Id.*

[286] *Id.*

[287] *Id.*

[288] Jedediah Brewer, Michael A. Fleishman, Robert Glennon, Alan Ker & Gary Libecap, *Law and the New Institutional Economics: Water Markets and Legal Change in California, 1987-2005*, 26 WASH. U. J.L. & POL'Y 183, 190 (2008).

[289] *Id.*

environmental interests and promote efficient uses of scarce water resources. Legal barriers in western United States water law should be minimized to allow water transfers to occur more frequently, although regulations may be crafted with an eye toward reducing negative impacts of transfers.

VII. CONCLUSION

It is clear that Australian law encourages water transfers as a potential solution to exacerbated water scarcity due to climate change. While water marketing has the potential to negatively impact the environment and local economies, laws and regulations can correct for these externalities and create trading institutions that minimize negative impacts. The United States will need to address the many identified legal barriers to the development of robust water markets. Temporary and permanent water banks to facilitate the transfer of water rights between parties, the integration of surface water and groundwater rights, and the ability for rights holders to retain the rights and economic benefit to water conserved are first steps that the western states can take to encourage transfers of water rights. This, in turn, will promote the highest value economic uses of water, help preserve the environment, and prepare for the unexpected shocks of climate change on water supply.