WESTERN WATER ASSESSMENT WHITE PAPER

The Effect of Changing Hydrographs on Compact Apportionments in the Western United States: A Preliminary Analysis of Potential Trouble-Spots

Western Water Assessment Working Paper:
Water Rights and Climate Change Project
2007

THE EFFECT OF CHANGING HYDROGRAPHS ON COMPACT APPORTIONMENTS IN THE WESTERN UNITED STATES: A PRELIMINARY ANALYSIS OF POTENTIAL TROUBLE-SPOTS

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Introduction

Several studies demonstrate that the hydrographs of many western rivers are changing in response to climate change, with one of the most pronounced changes being earlier runoff (e.g., see Stewart et al., 2005; Regonda et al., 2005).[1] This trend is most pronounced in low elevation basins. For example, in many basins of the Pacific Northwest, annual spring snowmelt is now occurring more than 20 days earlier than a half-century ago. This trend is less evident in high elevation watersheds, but even in those locations, continued global warming is expected to eventually modify streamflow patterns. Coincident with these changes are shifts in the timing and magnitude of water demands.

The "water rights and climate change" project of the Western Water Assessment is focused on how changes in the timing of spring snowmelt (i.e., earlier runoff) does or does not create problems in the administration of western (prior appropriation) surface water rights that are defined in part with respect to seasonal characteristics, either generally through terms such as "irrigation season" rights, or more specifically in rights that use explicit calendar dates to describe the start and end of diversion (or storage) seasons. The growing mismatch between dates found in rights and the shifting of the hydrograph has the potential to modify yields, demands, reliabilities, and other elements of water systems, with impacts resonating throughout the entire community of rightsholders and water users in highly case specific ways. To date, this issue has generally not been the subject of much scholarly inquiry[2] or dispute[3], but given projected trends in snowmelt, it is reasonable to expect that this issue will grow in salience.

The focus of this project is primarily upon the administration of rights defined under state laws, however, it is worthwhile to appreciate that a similar set of issues may exist at the interstate level. This paper provides a preliminary review of the issue of mismatched hydrographs and rights with respect to a special type of water allocation arrangement: rivers apportioned by the use of interstate compacts. At least 22 water apportionment compacts exist in the West; this review is limited to the following 16 compacts that have one of the eleven westernmost states as a signatory and that contain specific apportionment language:[4]

- Arkansas River Basin Compact of 1948 (CO-KS)
- Bear River Basin Compact of 1955, 1978 (ID-UT-WY)
- Belle Fourche River Basin Compact of 1943 (WY-SD)

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1 For more information, see the excellent summary by Udall and Bates (2007) and the other studies listed in the bibliography.

2 A search of the academic literature on this subject identifies no major studies that have examined this issue directly, although several acknowledge and touch upon the issue without providing additional analysis. A literature review has been prepared as part of this study, and is available upon request (Shapiro, Julie. 2007. "Climate Change and the Functioning of Water Rights: Results of Literature Search." Draft. June 20.)

3 Initial interviews with Colorado water professionals suggests that disputes may be emerging within many watersheds, primarily taking the form of operational controversies to be dealt with by local water commissioners. Perhaps the first wave of litigation associated with these disputes may involve better defining the rights and responsibilities of administrators in adjusting regimes of water rights to modified hydrologic conditions (e.g., see *North Sterling Irrigation Dist. v. Harold Simpson and James Hall*, 2005 CW 125 (Div. 1 Water Court), filed June 2005).

4 The states are: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming. Alaska and Hawaii are not considered in this review since only the states of the continental US have interstate borders (and thus interstate compacts). Note that the Animas-La Plata Project Compact (1946) is omitted from this analysis since it does not contain a new apportionment, but merely affirms the scope of the Upper Colorado River Compact to include the La Plata and Animas River systems.

- Canadian River Basin Compact of 1950 (NM-TX-OK)
- Colorado River Compact of 1922 (CO-NM-UT-WY-AZ-CA-NV)
- Costilla Creek Compact of 1944, 1963 (CO-NM)
- Klamath River Basin Compact of 1957 (OR-CA)
- La Plata River Compact of 1922 (CO-NM)
- Pecos River Basin Compact of 1948 (NM-TX)
- Republican River Compact of 1942 (CO-KS-NE)
- Rio Grande of 1938 (CO-NM-TX)
- Snake River Basin Compact of 1949 (WY-ID)
- South Platte River Compact of 1923 (CO-NE)
- Upper Colorado River Compact of 1948 (CO-NM-WY-UT)
- Upper Niobrara River Basin Compact of 1962 (WY-NE)
- Yellowstone River Basin Compact of 1950 (WY-MT-ND)

It is worth noting that 13 of these 16 compacts were signed by 1950 or earlier, and none originated later than 1962—well before global warming was a concern in the water management community (or elsewhere).

Treatment of Timing in the Western Compacts

The compacts reviewed contain a variety of approaches and language to describe the temporal qualities of the apportionment. In Table 1, this variety is summarized based on the following non-exclusive categories:

- **Key Spring Dates.** These are compacts that define apportionment periods (either for direct flow uses or storage), in part, by the use of a calendar date between March 21 and June 20. This is normally the start date of an apportionment or diversion season.

- **Key Fall Dates.** These are compacts that define apportionment periods (either for direct flow uses or storage), in part, by the use of a calendar date between September 23 and December 20. In many cases, these are apportionments that measure key hydrologic and water-use variables in terms of a water year.

- **Calendar Year Accounting.** These compacts either specify that apportionments and associated water accounting activities be measured by the calendar year (January 1 to December 31), or utilize terms such as "annual" to suggest such an accounting approach (in lieu of more specific guidance).

- **Multi-Year Accounting.** These compacts define apportionments and associated water accounting activities over scales greater than a single year.

- **No Time Element Needed.** This category is for compacts that, due to their structure, do not require the measurement of hydrologic variables over any time period. (The only example included is the Canadian River Compact, which is based on limiting the physical size of water storage facilities.)

Note that the assignment of compacts into these categories is based solely on the language found in the agreements and not on any additional agreements, either formal or informal, that may guide compact administration.[5] Compact administrators (such as State Engineers and/or compact commissions) are often delegated some professional discretion in determining how to measure and enforce apportionments, although most compacts do not offer useful language specifying the scope of these powers regarding timing issues.[6] Since any modification of compact terms or administration has the real potential to be zerosum (i.e., favoring one state at the expense of another) and may require a revision of compact terms (and re-ratification of the new agreement by the affected state legislatures and the federal government) or Supreme Court litigation, any confusion or ambiguity is a potentially significant problem.

The effort in Table 1 to explicit identify those compacts featuring spring and fall calendar dates is based on the premise that shifts in the hydrograph and in the start/stop of the demand seasons (esp. for irrigation) are most likely to be evident in these 2 seasons. Spring is of particular concern, as this is the season most directly affected by changes in the timing of snowmelt. Thus, the categories in Table 1 used to describe the use of calendar dates are ordered, left to right, with respect to their general likelihood of being problematic given current and growing shifts in snowmelt patterns. As a practical matter, determining which compacts will prove problematic on this and other points is much more complex and subject to case-specific conditions; nonetheless, all else being equal, compacts that rely heavily on specific spring dates, especially if they are associated with lowelevation watersheds, perhaps are most deserving of concern and further investigation.

Summary and Conclusions

This cursory review of western water allocation compacts is sufficient to suggest that a modified timing of snow-melt and spring flows is a potential concern in several regions due—if for no other reason—to inclusion of specific calendar dates. Of particular concern are the six of the 16 compacts reviewed that feature apportionments defined, at least in part, on specific spring dates. Eight states are signatories to these six compacts; Colorado is a signatory to four of them. (Appendix A provides further details on the compacts to which Colorado is a signatory.)

The identification of potentially problematic compacts by merely focusing on the presence/absence of calendar dates likely understates the issues associated with a growing mismatch between interstate water rights and hydrology. For example, even though the La Plata Compact does not feature spring calendar dates, it does require the maintenance of minimum summer flows—a challenge that is likely to grow in areas with earlier runoff and longer growing seasons. Additionally, climate change is likely to force attention on many other topics currently omitted from compacts. Of the 22 western compacts (including the 16 in this study) reviewed by Kenney (2002) in other research, none mention climate or climate change, only one mentions drought, only four mention fish or wildlife, only six mention water quality or pollution, only three mention groundwater, and only eight mention Native American water claims.[7] At some point, all of these issues will require examination, and climate change may be the stimulus.

5 It is worth noting, however, that ratified compacts have the force of both state and federal law, and almost all agreements and contracts devised following a compact are explicit in reinforcing and building upon the terms of the compact.

6 Note that four of the compacts reviewed (for the Belle Fourche, Colorado, Snake and Upper Niobrara Rivers) do not feature commissions established to oversee compact administration and to investigate potential problems.

7 Where these issues are mentioned, it is often merely to suggest that these issues are beyond the scope of the agreement.

Table 1. Timing Elements in Western Water Allocation Compacts.

Compact			Dates Used to Define Apportionment & Accounting Periods					Comments & Notes
Basin	Signatory States	year	Key Spring Dates	Key Fall Dates	Calendar Year Accounting	Multi-Year Accounting	No Time Element Needed	
Arkansas	CO, KS	1948	X	X				Defines winter storage season dates (Nov 1 to March 31) and summer storage season dates (April 1 to Oct 31).
Bear	ID, UT, WY	1955, 1978		X				Measures depletions over a water year from Oct 1 to Sept 30.
Belle Fourche	WY, SD	1943			X			Apportionments defined over a calendar year.
Canadian	NM, TX, OK	1950					X	Apportionment based on limiting storage capacity.
Colorado	WY, CO, UT, NM, NW, AZ, CA	1922				X		Apportionment based on 10-year moving averages.
Costilla Creek	CO, NM	1944, 1963	X	X				Defines irrigation season from May 16 to Sept 30; storage season from October 1 to May 15.
Klamath	OR, CA	1957			X			A few calendar year references; otherwise, no timing elements.
La Plata	CO, NM	1922		X				Defines a period of unrestricted use (Dec 1 to Feb 15) and apportionment period (Feb 15 to Dec 1).
Pecos	NM, TX	1948			X	X		Primarily a 3-year apportionment; measured over calendar years.
Republican	CO, NE, KS	1942			X			Apportionment defined by annual volumes.
Rio Grande	CO, NM, TX	1938	X	X	X			Most elements defined using a calendar year, however, some delivery obligations are tied to flows during April 1 to Oct 31 or Oct 1 to June 30.
Snake	WY, ID	1949		X				Apportionment based on annual water-year basis measured from Oct 1 through Sept 30.
South Platte	CO, NE	1923	X	X				Defines an irrigation season apportionment from April 1 through Oct 15.
Upper Colorado	WY, CO, UT, NM	1948		X				Measurements based on a water year extending from to Oct 1 to Sept 30.
Upper Niobrara	WY, NE	1962	X	X				Multiple storage seasons defined, beginning on Oct 1, and ending on either May 1, June 1, or Sept 30 depending upon the project and direct flow rights.
Yellowstone	WY, MT, ND	1950	X	X				Apportionment between MT and WY is based on annual water-year basis measured from Oct 1 through Sept 30, while the MT-ND apportionment runs from May 1 to Sept 30.

Appendix A: Calendar Date Requirements in Colorado's Water Compacts

The summaries below include the specific seasonal (i.e., calendar date) requirements found in the 8 water apportionment compacts to which Colorado is a signatory.[8] They do not include a review of the often voluminous agreements, decrees, and operating rules that typically evolve on and around compacts (e.g., the so-called "Law of the River" on the Colorado), nor does it include those rivers for which the rules of apportionment have primarily been established by the Supreme Court using principles of equitable apportionment.[9] These, admittedly, are significant omissions, but the intent here is not to provide a detailed or sophisticated analysis of any particular basin or situation. Rather, the goal is to provide an initial screening of basins, compacts, and language that could potentially prove problematic.

Table 2. Key Calendar Dates in Colorado's Compact Apportionments.

Compact	Some Specific Start/Stop Dates Listed
Arkansas River	March 31/April 1, October 31/November 1
Colorado River	N/A
Costilla Creek	May 15/May16, September 30/October 1
La Plata River	February 15, December 1
Republican River	N/A
Rio Grande	April 1, October 31, Oct 1, June 30
South Platte River	April 1, October 15
Upper Colorado River	N/A

8 Note that calendar date references to items such as the filing deadlines for annual reports are not included here or in the main report, as they are irrelevant to the functioning of the allocation system described in the compact.

9 For example, the Laramie River originates in Colorado before flowing into Wyoming to join the North Platte. The Laramie has been the subject of considerable litigation between Wyoming and Colorado, with the 1922 decree being the most salient decision (*Wyoming v. Colorado*, 259 U.S. 419 (1922), modified and rehearing denied, 260 U.S. 1 (1922), vacated, 353 U.S. 953 (1957)). Downstream, the North Platte has been a frequent source of litigation between Nebraska and Wyoming (and occasionally Colorado, given Colorado's interests on the Laramie). The initial North Platte decree was issued in 1945 in *Nebraska v. Wyoming*, 325 U.S. 589 (1945) and has been revisited since, including in *Nebraska v. Wyoming*, 507 U.S. 584 (1993). The case was settled and all claims dismissed in *Nebraska v. Wyoming*, 534 U.S. 40 (2001). In principle, the North Platte decree was not intended to modify, in any way, the arrangements on the Laramie; however, this has been an ongoing point of contention; e.g., see *Nebraska v. Wyoming*, 507 U.S. 584 (1993). This collective body of law does contain some elements based on the irrigation/non-irrigation season distinction, occasionally specified with calendar dates; thus, the potential for a mismatch between changing hydrographs and apportionment rules is a possibility on this combined system.

Arkansas River Compact of 1948 (CO-KS)

The Arkansas River is subject to 3 major apportionment compacts: one between Colorado and Kansas, one between Kansas and Oklahoma, and one between Oklahoma and Arkansas. The agreement between Colorado and Kansas primarily describes operation of John Martin Reservoir, and includes calendar dates to describe the winter and the summer storage seasons. Specifically, Article V(A) provides that the winter storage season will commence on *"November 1st of each year and continue to and include the next succeeding March 31st."* Summer storage, conversely, is defined in Article V(B) as commencing on *"April 1st of each year and continu[ing] to and include[ing] the next succeeding October 31st."* Summer storage is junior to decreed priorities (defined in paragraphs F and G) and to river flows demanded by Colorado (up to 500 c.f.s) and Kansas (750 c.f.s.).

No other significant references to calendar dates are included, however, it is worth noting that the 2 times periods specified, given their location in spring and fall, are potentially sensitive to any changes in the timing of snowmelt and the end of the irrigation season. Additionally, it should be remembered that this compact has been the subject of extensive litigation, both historically and recently, so assessing the importance of any compact provision should be done with an eye toward those agreements and decrees that now accompany the compact. Nonetheless, in sum, it would appear that this compact offers fewer concerns (regarding the timing of flows) than most.

Colorado River Compact of 1922 (CO-NM-UT-WY-AZ-CA-NV)

It is at least somewhat ironic that the most contentious compact in the region, and the one that is infamous for being based on a hydrological assumption that poorly fits actual conditions, is actually silent regarding provisions relating to calendar dates or anything related to timing of flows. Given the focus of the Colorado River Compact on flows measured in 10-year moving averages, however, this is not surprising. In this basin, as well as many others, to the extent that calendar dates play a role in water allocation, it is likely to be in delivery contracts and other elements of the Law of the River. Additionally, since many deliveries come from major (multi-year) storage facilities, calendar dates that do exist in delivery contracts are probably largely immune to perturbations associated with small timeshifts in the hydrograph, and even if such problems existed, they could likely be addressed administratively without any need to revisit the terms of the compact.

Costilla Creek Compact of 1963 (originally 1944) (CO-NM)

The Costilla Creek Compact uses calendar dates to distinguish between the "irrigation season" and the "storage season," the former extending from *"May 16 to September 30, inclusive"* (Article 2(q)) and the latter from *"October 1 of one year to May 15 of the succeeding year, inclusive"* (Article 2(r)). During the storage season, Article 5(c) provides that *"no water shall be diverted under direct flow rights unless there is water in excess of the demand of all operating reservoirs for water from Costilla Creek for storage."* This, presumably, restricts the movement of the irrigation season earlier (i.e., prior to May 16) and/or later (i.e., after September 30), provided that there is a demand to store water during these times.

La Plata River Compact of 1922 (CO-NM)

This compact uses calendar dates to describe two key time periods: a period of unrestricted uses for each state between *"the first day of December and the fifteenth day of the succeeding February"* (Article II(1)), and an apportionment period between *"the fifteenth day of February and the first day of December of each year"* (Article II(2)). During the apportionment period, use of water in each state is unlimited as long as the *"mean daily flow at the Interstate Station is one hundred cubic feet per second, or more"* (Article II(2)(a)). If this condition is not met, then *"the State of Colorado shall deliver at the Interstate Station a quantity of water equivalent to one-half of the mean flow at the Hesperus Station for the preceding day, but not to exceed one hundred cubic feet per second"* (Article II(2)(b)). In order to administer this formula, the compact requires the operation of *"suitable devices for recording the flow of water in said river at all times between the 15th day of February and the 1st day of December of each year"* (Article I).

At first glance, these temporal requirements do not appear to offer much likelihood of becoming problematic due to a modestly shifting hydrograph, as February 15 is unlikely to be near any obvious transition in the water demand season. What may prove more problematic is the minimum streamflow requirement, as one expected consequence of climate change in many basins is a reduction of flows in the summer.

Republican River Compact of 1942 (CO-KS-NE)

Much like the Colorado River Compact, the Republican River Compact has been the subject of considerable controversy in recent years, but not due to any calendar date provisions in the agreement. The compact features no mention of calendar dates or any text related to timing of flows, but rather apportions the river in terms of annual volumes.[10]

Rio Grande of 1938 (CO-NM-TX)

Several elements of the Rio Grande Compact contain provisions directly tied to calendar dates. Most key measurements (e.g., credits, debits, spills, delivery obligations) are defined and tabulated using a "common period of time," often a "calendar year," but this is generally not done in a way that is likely to be problematic given modest changes in the timing of streamflows, melt or irrigation seasons since the start of the calendar year (January 1) is not near any of the temporal elements of hydrologic thresholds (Article I). In Article III, most elements of Colorado's state-line delivery obligation to New Mexico are defined in terms of calendar years, with one notable exception. The delivery obligation is, in part, based on a Conejos Index Supply, which is defined with respect to *"the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of San Antonio River at the U.S.G.S. gaging station at Ortiz, both during the months of April to October, inclusive"* (Article III(1)). The obligation of New Mexico to maintain streamflows downstream (ultimately for the benefit of Texas) is based on a schedule tied to measured flows upstream but is *"exclusive of the months of July, August, and September"* (i.e., applicable only from October 1 to June 30) (Article IV). Procedures for modifying these schedules are provided to account for changes in (or problems with) gaging stations, depletions of natural runoff, and/or trans-mountain diversions, but it does not appear that a shift in the hydrograph was an anticipated change covered by the provisions listed or due to gaging station errors (Article IV(6) and Article V).

10 The key issue in this basin has been, and continues to be, managing the connection between surface water and groundwater.

South Platte River Compact of 1923 (CO-NE)

The South Platte River Compact is explicit in defining an apportionment based on an approximate measure of the irrigation season. Specifically, Article II(1) requires that flows near Julesburg be measured *"at all times between the first day of April and the fifteenth day of October of each year."* This time period corresponds to the irrigation season apportionment, during which *"Colorado shall not permit diversions from the Lower Section of the river ... to an extent that will diminish the flow of the river at the Interstate Station, on any day, below a mean flow of 120 cubic feet of water per second of time ..."* (Article IV(2)). During the rest of the year (i.e., the *"fifteenth day of October of any year and the first day of April of the next succeeding year"*) Colorado has the *"full and uninterrupted use and benefit of the waters of the river flowing within the boundaries of the State,"* with the exception that some water is reserved for use by Nebraska in a canal originating in Colorado (near Ovid), with diversions *"limited exclusively"* to the annual period between *"the fifteenth day of October of any year and the first day of April"* (see Article IV(1) and Article VI(2)(a-b)).

The reliance of the compact on the April 15 date is potentially problematic, as that date is relatively near the spring snowmelt season. The text of the compact makes some allowances for adjustments, although it is unclear if climate change would be a suitable justification for action. Article IV(5) states that *"variable climatic conditions, the regulation and administration of the stream in Colorado, and other causes, will produce diurnal and other unavoidable variations and fluctuations in the flow of the river at the Interstate Station, and it is agreed that ... minor or compensating irregularities and fluctuations in the flow at the Interstate Station shall be permitted"* as long as they are not a product of *"neglect, error or failure in the performance of duty by the Colorado water officials."*

Upper Colorado River Compact of 1948 (CO-NM-WY-UT)

The Upper Colorado River Compact does not prominently feature the use of calendar dates and thus does not appear directly vulnerable to problems caused by a changing hydrograph. The use of calendar dates is limited to the timing of some administrative matters, including the requirement that many measurements be based on a water year, defined as *"that period of twelve months ending September 30 of each year"* (Article II(k)).

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