Alternative Water Transfer Methods: Review of Colorado Experiences

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Abstract: Transfers of the right to use water can provide flexibility in regions where cities and farms compete for supplies. For example, the state of Colorado’s prior appropriation water law allows purchase and transfer of water among water users. During the last half century many cities have used this mechanism to buy water from agricultural water holders to satisfy their growing water demands. However, the transfer of water from rural to urban areas has left agricultural lands fallow and had negative effects on the economies and societies of rural communities. Colorado’s Water Plan addresses this problem by seeking alternative methods of transferring water so that the ownership of water rights stays in the agricultural sector but water saved on farms can be shared with urban areas. This paper reviews the alternative methods suggested in Colorado’s Water Plan, determines their capacities and shortcomings, and summarizes the efforts in the state to implement these methods. Lessons learned have important implications for improving the efficiency of water allocation in other dry regions. DOI: 10.1061/(ASCE)IR.1943-4774.0001401. © 2019 American Society of Civil Engineers.

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Introduction

As regions face water scarcity, they require new strategies to use existing resources better in different contextual situations. In semi-arid regions, urban growth may compete with agriculture for use of limited water supplies and without cooperative programs farmers might lose water to cities with more financial power. For example, in the state of Colorado, demand for water has increased at a fast pace due to urban growth and a newly developing oil and gas industry. Available fresh water supplies are limited and supply expansion does not adequately meet new demands (Tidwell et al. 2014). Therefore, cities are buying agricultural water rights to satisfy their growing demands. The agricultural rights are reliable and easy to use with existing urban infrastructure. This tactic may leave the land that lacks water fallow, hence the name buy-and-dry. Urban communities can afford the high prices of water rights, while farmers are often willing to sell their water rights and retire. So, in economic terms, this transfer is simply flow of a commodity (water) from a low value use (agriculture) to a high value use [municipal and industrial (M&I)] and may seem to be a win-win situation.

However, loss of water can cause agricultural economies to decline, leading to negative social and economic effects that impact the communities and local food security, as well as the environment (Ag Water NetWORK 2016). To avoid these undesirable outcomes, a middle ground is sought so that both agriculture and urban users can benefit from shared water resources. To create such a middle ground, Colorado’s Water Plan (CWCB 2015) proposes several alternative transfer methods (ATMs) in which the agricultural sector can participate to free up water for the M&I sector while remaining viable.

This paper categorizes the ATMs suggested in Colorado’s Water Plan, studies the current institutions in the state that uses them, and explains their functionality. By discovering the best paths to use ATMs in different situations, cities and farmers may cooperate in ways to increase resilience and economic outcomes in their shared regions. Colorado’s water transfer laws are complex, so the discussion starts with a historical overview of buy-and-dry in Colorado and a brief explanation of Colorado Water Law.

Background: Water Right Transfers and Their Impact

Water transfers occur in the context of state water laws, which include case law as well as statutes. In 1955, a famous case of major water transfer in Colorado occurred from the Otero Canal in the Arkansas River Basin to the city of Pueblo (McMahon and Smith 2012). This case institutionalized such transfers, and by the 1970s rapid population growth had forced more municipalities to follow this example and seek water from the agriculture sector. For example, by 1988, water had been removed from 59% of agricultural lands in the Arkansas River Basin (of southeast Colorado) leaving previously productive lands fallow (Sutherland and Knapp 1988). Municipalities were finding that senior agricultural water rights offer diversion security that is much needed during dry years and buy-and-dry was becoming a common strategy for cities.

More recent data from the South Platte River Basin shows continuing transfers of water rights from agriculture to cities. This is fueled by growth in M&I water use in the basin, which, according to the Statewide Water Supply Initiative report (CWCB 2010), is projected to increase from 254 million cubic meters (MCM) [206,000 acre-feet (AF)] in 2008 to between 428 MCM (347,000 AF) and 495 MCM (401,000 AF) in 2050. A large-scale water right purchase in the South Platte Basin occurred in 1986 when the city of Thornton secretly bought more than 7,000 hectares (ha) (17,750 acres) of land spread across 104 farms in Weld...
Larimer Counties (Young 2015). Strong opposition formed against this purchase when it was revealed the buyer was a municipality, exempt from land taxes (Baker 2016). In 1998, the Water Court ruled that Thornton had to minimize its impact on water rights of surrounding land owners. The city started to pay a voluntary payment in lieu of property taxes, convert dry farms to native grassland, and lease land and water to farmers (BizWest 2005). More recently, the city has started plans to construct a pipeline to convey the acquired water to its citizens by the mid-2020s, with a goal to transfer all the water to Thornton by 2060 (Young 2015).

Another example of water reallocation in Colorado is transfer of shares of the Colorado-Big Thompson (C-BT) Project, which was built to provide supplemental irrigation water. In 1957, M&I owned less than 20% of the shares, and by 2014 it owned more than 70%. Still, in 2016, the actual amount of water used in agriculture was 50% of C-BT water delivery (email communication with Roger Burns of Northern Water Conservancy District) because, during average to wet years, the M&I water right holders commonly lease their excess water to agriculture.

The following of land can have significant economic effects on rural areas. Thoralvdsen and Pritchett (2006) defined three kinds of potential effects on rural economies: (1) direct effects due to decreased revenue flow from the sale of irrigated crops, (2) indirect effects on businesses depending on agriculture due to reduced demand for agricultural inputs, and (3) induced impact due to change of demand for agricultural labor and decrease of employment. Schaffer and Schaffer (1984) expect the decline of farm income to reallocate wealth, resources, and population. They explain that migration out of rural areas has adverse impacts on local governmental and private services, eroding the rural infrastructure and social institutions.

There are also environmental concerns about agricultural lands that are left unirrigated. For example, after water right transfers in the Arkansas River Basin, where natural precipitation is inadequate for dryland farming, wind erosion increased drastically (Sutherland and Knapp 1988). In areas with more precipitation non-native plants take over the fallow lands, and serious dust storms create public safety issues. Now Colorado water court’s water transfer decrees require the revegetation of irrigated land to rangeland (Devine 2015). Revegetation is not required when water is rented out of a farm and the water right is not sold (DiNatale et al. 2013).

Howe et al. (1990) analyzed the economic impacts of agricultural to urban water transfers in the Arkansas River Basin and concluded that effects were not dramatic on the basin’s overall economy. However, the urban areas receiving water accrued the benefits while the costs were imposed on the rural areas. There were also third parties who were not directly involved in the transaction but have suffered from water transfers. Devine (2015) found transitional assistance to these third parties was opposed by municipal planners and rural leaders on philosophical grounds or grounds of efficacy.

Context: Colorado Water Law

Permanent water transfers occur under provisions of the Colorado water law and must be adjudicated by the state’s water courts. Colorado water law follows a strict prior appropriation system of water allocation (Jones and Cech 2009) or a first in time, first in right system. Senior water right holders can take their full allocated right before junior right holders can divert any water. This means in times of scarcity junior right holders may not receive their water allocation because the senior right holders have already diverted all the available water. For a share of surface water, users apply for water rights in court showing proof of a plan for beneficial use. The concept of beneficial use has a central role in Colorado’s water law. A water right holder must in fact use water for the specified beneficial use without being wasteful; otherwise the court can curtail the right. Beneficial use was commonly delineated for household, agricultural, and industrial purposes, but it has evolved to include environmental and ecological uses also (Hobbs 2004).

The court will adjudicate a water right decree specifying the priority date, its source of supply, amount, point of diversion, type and place of use, and conditions to protect against injury to other water rights. Currently, a new user can apply and acquire a water right but due to increasingly limited resources in parts of the state, in a normal year, no water is left after senior right holders divert their shares.

In Colorado, water rights are tradable and separable from the land (Goemans and Pritchett 2014), and a water user can buy a senior water right and gain the priority in water diversion. However, water right holders do not own the water; they can only use the appropriated water for the specific beneficial use stated in their adjudication (Article 16 § 5 Constitution of the State of Colorado). This means, for example, they cannot reuse their return flows and increase their consumptive uses. Where surface irrigation methods (e.g., furrow, flood, and basin) are used, much of the water is lost to groundwater and runoff at the tail end of farms. These losses become resources and rejoin the basin’s hydrologic cycle to be used downstream. Thus, any increase in irrigation efficiency or change in location of use may injure the water users who benefit from return flows. This leads to application of the concept of no injury in Colorado water law. Per this rule a change in a water right has to maintain the return flow as before the change in volume, location, and time [Colorado Revised Statute § 37-92-305(3)]. In water court proceedings, the historic rates of consumptive use and return flows are determined before a change in water use is decreed (MacDonnell 2015).

Efficient irrigation systems (center pivot or drip irrigation as compared to furrow or flood irrigation) can decrease irrigation losses and return flows. Per Colorado water law, water saved through efficiency improvement cannot be sold or reused. In agricultural lands, only the consumptive use can be sold or rented to other uses. In this way, Colorado water law discourages on-farm water savings through efficiency improvement.

Additionally, if water right holders fail to apply their allocated water to beneficial use for more than 10 years, they could have their rights forfeited through the judicial abandonment process. Although the water court has the provision of statutory protection for temporary abandonment, farmers can still be reluctant to save water in fear of losing their rights (Waskom et al. 2016). As indications of potential legislative remedies, House Bill 13-1248 and Senate Bill 15-198 would enable agricultural water right holders participating in an approved state pilot program to temporarily lease up to 30% of their consumptive water use annually to other users. Colorado HB16-1228 (Agriculture Protection Water Right Transfer Mechanism) allows landowners to change up to half of their consumptive use water to the newly created Agriculture Water Protection (AWP) water right. Once adjudicated through the water court, an AWP water right can be leased for one year to several different uses, including agricultural, municipal, industrial, recreational, and environmental. The remaining half of the original irrigation water right must remain on the land to be used for irrigation.

As is evident, water transfers in Colorado involve a long complicated process due to the no-injury rule. MacDonnell et al. (1990) describe it as a highly legalistic approach and found the procedure markedly slower than in the other states they studied.
Worldwide, water managers use different methods to avoid the undesirable effects of agriculture-to-urban water transfers. As the first step to reform water transfers, Turrall et al. (2005) recommended formation of adequate institutions to establish and enforce secure water rights. Water rights need to exist as shares, allocations, or entitlements (unbundled from land or independent of land ownership). Moreover, statutory water sharing plans need to ensure that resource use remains within sustainable limits. Howe et al. (1986) define six criteria for an effective method of water transfer: (1) flexibility in the allocation of existing water supplies; (2) security of tenure for established users to invest in water-using activities; (3) confrontation of users with the real opportunity cost of the resources available for their use (so the market-based value of resource is clear); (4) predictable outcomes of the process with minimum uncertainty; (5) public perception of the water allocation process as equitable or fair; and (6) reflection of public values that may not be adequately considered by individual water users such as environmental water requirements or water quality issues. Measures to mitigate negative impacts of water transfers include transfer of small amounts from many farms instead of plot abandonment, reinvestment of gains from water transfer in the rural communities and adequate compensation of water right holders and affected third parties (Turrall et al. 2005).

Colorado’s Water Plan expects the agricultural community to release at least another 62 MCM (50,000 AF) of water by 2030 to be used in urban areas. The governor’s November 2015 plan provides guidelines for new laws, regulations, and projects to help achieve the state’s goals related to water resources. The overall objective of the plan for agriculture is that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production. The plan does not set measurable objectives in supporting agriculture and fails to define specific measures for achieving the overall objective. Instead, it suggests possible ATMs to avoid buy-and-dry. ATMs proposed include lease-fallowing agreements, deficit irrigation, water banking, interruptible supply agreements, rotational fallowing, water conservation programs, and water cooperatives. They are different from buy-and-dry in that some ownership of the water rights stays in the agricultural sector, land is not permanently taken out of production, and water transfers are temporary (Kenney 2015).

The alternative methods have different scopes, and it is helpful to divide them into two categories: (1) on-farm methods to reduce consumptive water use, and (2) institutional frameworks to facilitate the transfer of water. Any water reallocation plan must include one method from each category to successfully conduct the transfer under Colorado’s water law. Crop water consumption needs to be reduced at the farm level using methods such as deficit irrigation, rotational fallowing, or other limited irrigation strategies. Transfer of water saved on individual farms does not necessarily provide enough water for urban water users, and larger entities such as ditch companies or irrigation districts use mechanisms such as water banks and interruptible supply contracts to reallocate water. Therefore, rather than categories, describing them as the two components of water transfer is more explanatory and relevant. Neither Colorado’s Water Plan nor the Statewide Water Supply Initiative (CWCB 2010) distinguish the functional differences of their suggested methods or define those methods.

Reducing On-Farm Consumptive Water Use

Crop water requirement is equal to the crop evapotranspiration (ET), which is partly compensated by precipitation during the growing season (Mahmoudzadeh Varzi 2016). Methods of reducing consumptive use that are suggested in Colorado’s water plan are discussed here.

Rotational Fallowing

Land fallowing is practiced by farmers as a strategy to cope with limited water. When available water is not enough to irrigate the entire farm, a part of it is left fallow. When water is continuously limited, the fallowed land is rotated each year. This method is suggested to provide additional water to meet new demands for water or to replace the existing yield of nonrenewable groundwater supplies (CDM Smith 2012).

With rotational fallowing, farm economic return is reduced because of less agricultural production, while fixed costs of land, equipment, and management remain constant. Moreover, as Colorado’s Water Plan (CWCB 2015) describes, revegetation protection, erosion control, and weed control become important considerations during fallowing. Therefore, when this method is used growers must be compensated for forgoing farming. On the other hand, by rotational fallowing crop consumptive use is reduced to zero consequently defining the reduction of farm consumptive use and associated return flows for a growing season adequately satisfies water court requirements. Therefore, this method is practical under Colorado water law. (See the next section for more details.)

Deficit Irrigation

The other strategy to cope with limited irrigation conditions is to under-irrigate an entire farm and avoid fallowing. In this practice, called deficit irrigation, farmers save water by accepting some yield reduction. The water saved can be diverted for other uses and increase net economic income, for example, due to increased land under cultivation or by leasing water to off-farm demands including Mi&I users. Advocates of deficit irrigation argue that with optimal water allocation to on- and off-farm activities farmers can increase their net return. They reason that the combination of the return from crop production plus the return from the water market will be larger than either one alone (English 1990; Fereres and Soriano 2007). The main objective of deficit irrigation is maximizing farm income by taking advantage of the opportunity cost of water when there is a market for water and the farm income can be improved by reallocating a part of its water.

Most literature on deficit irrigation determines the farm’s available water as the water diverted from a water source. However, Colorado water law only authorizes crop consumptive use or ET to be sold or leased. Therefore, crop water production functions, i.e., the relation between yield and crop ET, must be used in an optimization plan to determine the percentage of deficit irrigation. Modeling analysis has proved that crop water production functions must be concave for deficit irrigation to improve farm income (Mahmoudzadeh Varzi et al. 2019). Concave functions have decreasing marginal production, or production per unit of ET improves by reducing the amount of ET. But linear functions have a constant marginal yield and changes in production per unit of ET do not alter by changes of ET. Although recent studies (Trout and DeJonge 2017) found that corn crop water production functions are concave, most functions determined in experimental fields show a linear trend, which has been used in previous research to model crop water production (Mahmoudzadeh Varzi 2016). Therefore, for most crops deficit irrigation is not a useful option, but to maximize farm income, all available water needs to be allocated to the activity with larger marginal value. Moreover, to conform
to Colorado water law, for a deficit irrigation contract, farm return flows need to be monitored on a daily basis together with claimed reduction of farm consumptive use. This is a challenging process and currently is not used in Colorado as a method of reducing farm consumptive water use.

An easier-to-implement type of deficit irrigation is split-season fallowing, which is particularly suitable for hay crops. In this practice the land is not fallowed; it is irrigated during the first part of the growing season to obtain one or two cuts of hay (mainly alfalfa and grass). Then irrigation is stopped so the consequent cuts produce less hay or are completely lost. The water saved by forgoing late season irrigation can be used for other uses.

An example of partial fallowing is implemented along McKinley Ditch (in Cimarron on Colorado’s western slope). In 2010, the Western River Conservancy (nonprofit organization with environmental scope) bought a 79-ha (195-acre) grass pasture together with its water right from the McKinley Ditch to recover part of Cimarron River’s in-stream water requirements. Subsequently the Colorado Water Trust (another environmental nonprofit organization) acquired the water right (0.164 cubic meters per second) and pursued the Colorado Water Conservation Board (CWCB) to purchase it because CWCB is the only entity in Colorado that can own in-stream water rights. The water right will be used to irrigate the 79-ha pasture during the first part of growing season (June or July), then it will be released into the Cimarron River during the last part of growing season (late summer to October when water shortage is most severe in the river) (CWCB 2014). Note that this project required a water right purchase. Also, the water obtained is not transferred (it is either used in the original right holding land or left in the original source of water, the Cimarron River). In this respect the project used the traditional tactics of acquiring water rather than the newly suggested institutional frameworks (see the discussion that follows) and leasing markets. Regardless, CWCB and Colorado water experts consider this project as an example of successful ATM.

Institutional Frameworks for Water Transfer

In the context of Colorado’s water transfers, an institutional framework comprises the organizational arrangements and mechanisms to ensure legal and efficient transfer of water. Individual farmers can conserve water on their farms, but they do not have access to transfer mechanisms and the amount of water saved on one farm is usually not sufficient for municipal uses. Therefore, leasing water collaboratively among multiple farms is more efficient and effective without requiring a new water transfer application each time a water lease is desired.

The institutional frameworks suggested by Colorado’s Water Plan are water banks, interruptible supply agreements, and water cooperatives.

Water Banking

A water bank is a mechanism to store water credits for temporary reallocation (Goemans and Pritchett 2014). In this form of transfer, volunteer water right holders sell their water to interested water users. The ownership of a water right, however, will remain with the original right holders. Here a volume of water is sold, but not the water right itself. This transaction is possible through a bank that stores water either physically, as in using available space (reservoirs or groundwater storage), or as credits as in a freed-up portion of a canal’s water right (Singletary 1998).

As an example, the government of Australia has established a well-known and successful water bank in the Murray-Darling Basin to recover water for environmental purposes using irrigation water rights (Turrall et al. 2005). In the Murray-Darling Basin, the prior appropriation doctrine is not the base of water law, right holders own a percentage of available water, and therefore water shortage is shared equally among them. Moreover, there are no beneficial use obligations (Turrall et al. 2005). The proper solution for Colorado, therefore, will be different because the water banks need to comply with no-injury and anti-speculation rules.

In Colorado, the General Assembly authorized the first pilot water bank in 2001. The next year, the state engineer established rules for an Arkansas Basin water bank upon a request by the Southeastern Colorado Water Conservancy District. A few storage rights were deposited in the bank, but none were leased due to high prices ($0.65–$0.81 per cubic meter or $800–$1,000 per AF per year) and the absence of a storage facility (Castle and MacDonnell 2016). Another Water Bank Work Group was formed in western Colorado in 2014 as a pilot project for a future operational water bank in the Colorado, Gunnison, and Southwest basins (Godbout 2014). A study conducted for the Colorado River Water Conservation District (Colorado’s western slopes) perceives the form of the future water bank as follows (MW Americas 2012).

Willing senior water users from the agricultural sector will fallow or partially irrigate their lands and will be compensated for the water they are not consuming in agriculture. The water saved in this way will be available to users subscribed to the bank. The following is anticipated to be rotational among the irrigated lands of the three participating basins. Although the water bank could also store any extra water for subsequent years, the work group has excluded such a practice from its agenda.

An example of a partially functional water bank in Colorado is the Arkansas River Super Ditch, which is part of an initiative among seven ditch companies in the region (HDR Engineering 2007). In this pilot project in 2015, Catlin Canal provided 0.6 MCM (485 AF) of water to a few neighboring towns (Zaffos 2015). The other six ditch companies have not yet participated in the project due to regulatory problems. Under the terms of the agreement, the water-receiving communities can use water for three years in a ten-year period to supply homes and recharge their wells. No more than 30% of individual farm grounds can be fallowed in any year (Colorado House Bill 13-1248). During those years, the irrigators earn money from the leased water and rain-fed agriculture, in case they choose to practice it. In 2015, the company charged $0.41 for every cubic meter ($500 for every AF) of water transferred (Campbell 2015). The main purpose here is to keep rural communities viable, unlike buy-and-dry that forces farmers to leave their lands. The challenge remains for schemes like the Super Ditch to prove that their water supply is reliable for municipal users. Cities prefer not to rely on a new source of water every year, when a more permanent buy-and-dry tactic is accessible (Devine 2015), especially because the legal and administrative costs of leasing water can be as high as buying water rights (MacDonnell 2015).

The Super Ditch uses rotational fallowing to decrease on-farm water use, and then using the model of water bank, it transfers the saved water to the urban areas. Local news articles refer to this combination of methods as lease-fallowing agreements. Also, Colorado HB13-1248 is specifically issued to support this combination, which it refers to as fallowing-leasing. Perhaps for this reason, lease-fallowing agreements are mentioned in Colorado’s Water Plan as an alternative transfer method. However, there is no legal or practical obligation to combine these two specific methods in a transfer plan and hence presentation of such terms as a separate ATM in the water plan is misleading.

The Super Ditch and Water Bank Working Groups are supported by state grants, and research on their progress is ongoing.
The literature cited here represents a wide range of organizations from state authorities to academic and nongovernmental organizations, which reflects the interest of various entities on success of water banks in Colorado.

In Colorado, the concept of water banking has been used for purposes other than agriculture to M&I water transfers as well. In the San Luis Valley (southern Colorado), the Rio Grande Water Conservation District has initiated a plan to recharge the shallow unconfined groundwater aquifer within a portion of the area defined as the Closed Basin (Carswell 2013). Since water is not saved for transfer to M&I users, some experts do not consider this case as an example of ATM; however, this case is worth mentioning here because the plan uses the concept of water banking and is a voluntarily-formed institution. The district is in the process of forming six subdistricts composed of agricultural lands within the command area of ditches already managed together. In subdistrict No.1, the only operational subdistrict, well owners have the option to forgo irrigation and receive a monetary compensation per acre of fallowed land, or irrigate and pay a fee per AF of net water withdrawn plus a fee per acre of land cultivated (Rio Grande Water Conservation District, and Davis Engineering Service Inc. 2017). The objective is to encourage farmers to reduce groundwater consumption and recover falling groundwater levels. The first subdistrict (subdistrict No.1) was formed in 2006 partnering with other stakeholders such as USDA and the Colorado Division of Water Resources. Initially, the well owners willing to forgo irrigation had to commit to a 15-year fallowing program but since 2017 the subdistrict also offers fully funded shorter fallowing programs for up to 4 years (email communication with Cleave Simpson, general manager of Rio Grande Irrigation District). This project, however, is not self-sufficient and relies on the USDA’s Conservation Reserve Enhancement Program for approximately 80% of its costs. Other subdistricts have petitioned the District Court for formation and are now legal entities; subdistricts Nos. 2, 3, and 4 are actively working to finalize their own plan of water managements.

Interruptible Supply Agreements

Under interruptible supply agreements, the lessee pays a baseline fee, either a lump sum at the beginning or an annual fee over the course of the contract (Goemans and Pritchett 2014). The lessor guarantees to provide an agreed-on amount of water per year whenever the lessee requests. The lessees are normally municipal water users with water rights that are not sufficient during drought years. The lessors are the agricultural water right holders who are willing to interrupt their irrigation practices during drought years. The lessor also charges the lessee for the actual volume of water requested whenever water is transferred to the lessee. Colorado HB13-1130 allows three years of transfer in a single 10-year period, and the state engineer can reapprove an agreement up to two additional times. Before this bill interruptible water supply agreements were typically contracted for one year.

The city of Aurora and the Rocky Ford Highline Canal (in Arkansas River Basin) entered such an agreement in 2004 and again in 2005. Two sets of contracts were implemented, one with the ditch company for facilitating water transfer and the other with individual farmers who interrupted their irrigation practices to provide the water (CDM Smith 2012). In 2008, the city of Aurora and Highline Canal started a 10-year renewable interruptible supply agreement (CDM Smith 2012). In 2017, Larimer County sold part of its agricultural water rights to the city and county of Broomfield; the two parties also agreed on an interruptible supply contract. The contract was widely advertised as an innovative method for saving agriculture in Colorado and both sides were able to attract external funding, Larimer County, from CWCB and Broomfield, from the Gates Family Foundation (Larimer County Department of Natural Resources 2017). The North Sterling Irrigation District (NSID) in Logan County worked on a similar agreement to provide 8.4 MCM (6,800 AF) of water to BNN Energy, which supplies water to oil and gas development operations (Rice 2017). This is NSID’s second interruptible water supply agreement, the first being with Xcel Energy for 3.7 MCM (3,000 AF) in 2005 (WestWater Research LLC 2016). Xcel Energy, an electric services company, has not called for water yet (Rice 2017).

Water Cooperatives

Although Colorado’s Water Plan refers to water cooperatives as a distinct method of water transfer, they are another form of a water bank. Perhaps the term has entered the water plan because a new organization, called Northeast Colorado Water Cooperative, has started working along the Lower South Platte River. The members are mainly entities or individuals with agricultural water rights plus three small towns in the region. All members own decreed or pending water decrees for augmentation plans. On a given day, any member of a water cooperative may have more water credits than the member can use. Unused recharge credits primarily occur from proper use of augmentation plans. In 2008, for example, in the cooperative’s prospective command area the unused recharge credits summed up to 37 MCM (30,000 AF). This was almost 100 MCM (81,000 AF) for 2009 and 2010 (Brown and Caldwell, Vranesh and Raisch, LLP, and Phillips Law Offices LLC 2015). Meanwhile, other members may have less credit than they need. Members with extra water can supply water to members with unsatisfied water demand. The cooperative facilitates water sharing and transferring water credits among its members. Legal consultants determined that a cooperative will best suit such water sharing purposes. The cooperative considers leasing unused credits as another service it will provide to its members (Brown and Caldwell, Vranesh and Raisch, LLP, and Phillips Law Offices LLC 2015), but they do not discuss more detail.

Although the Water Cooperative has not facilitated any water exchange yet, it was able to produce a computer tool that evaluates the exchange capacity between various points of diversion on the South Platte River (Brown and Caldwell, Vranesh and Raisch, LLP, and Phillips Law Offices LLC 2015). When exchanges are conducted, this tool will be used together with data on location and priority of supplying and demanding members. As such the function of this cooperative is similar to a water bank and classifying it as a different method of water transfer will only create confusion.

Since many members of Northeast Colorado Water Cooperative are agricultural right holders the water does not necessarily leave the agricultural sector and the transfer may not be out-of-sector. Moreover, the cooperative will only be involved in reallocating augmentation credits, which requires no reduction of farm consumptive use. As such this project is hardly an example of an ATM. More importantly, preventing agricultural land dry-up is not the stated goal of this project. This may be why the water cooperative has not attracted much attention among scholars and policy makers, as is evident in the lack of published information about it. Although the cooperative received two grants through CWCB’s alternative agricultural water transfer grants, literature on its framework and function is scarce. Still, research on progress of this organization can produce valuable lessons for other water banks. This organization is especially interesting because the stakeholders felt it was required and formed it according to their needs. Moreover, the cooperative is considering rotational fallowing as a future plan.
to expand its water supplies (Brown and Caldwell, Vranesh and Raisch, LLP, and Phillips Law Offices LLC 2015).

Methods discussed so far, when paired properly, can serve as alternatives to buy-and-dry. Colorado’s Water Plan also mentions water conservation plans as another ATM. However, as it will be discussed presently, these plans cannot be considered as transfer methods but are defined here to complete the discussion.

Water Conservation Plans

Much statewide discussion is focused on reducing agricultural water consumption, but a number of utilities are implementing urban water conservation programs as well to reduce the demand for new water supplies. The CWCB supports these plans through “Water Efficiency Grants” (CWCB 2005). The CWCB defines water conservation as “any beneficial reduction in water loss, waste, or use . . . by implementation of water conservation or water efficiency measures.” Although this broad definition can include agricultural water conservation plans, the grant only covers entities that provide water to domestic, commercial, industrial, or public facility customers (CWCB 2005). For example, the municipalities of Ouray and Westminster and the Security Water District in Colorado Springs have used these grants to fund or develop their water conservation plans. As such, water conservation plans are not methods of reducing agricultural water consumption and their purpose is not freeing water for transfer. Therefore, conservation plans need to be regarded only as a way to decrease urban water consumption.

Discussion and Conclusions

Finding feasible ways to implement ATMs can help to increase available water supplies in semiarid areas, but how they can function will depend on the institutional arrangements in different states and other political jurisdictions. To illustrate the issues involved, an analysis of methods of ATMs as discussed in Colorado’s Water Plan was presented. These have two overarching requirements: (1) farm management methods to reduce agricultural consumptive use; and (2) institutional frameworks to facilitate the transfers. Each requirement must be addressed by a feasible water transfer plan and recognizing these components will help in gaining a more holistic view of the possibilities of water transfers.

Two methods of reducing agricultural consumptive use were reviewed: rotational fallowing and deficit irrigation. Deficit irrigation requires daily evaluation of consumptive use and is difficult to manage. Although methods to determine reduction of consumptive use on a daily basis are available, they are in preliminary stages of development and lack a user-friendly format as a computer tool or software package. This shortcoming is partly due to lack of specific regulations on deficit irrigation and how to measure consumptive use reduction. Water management specialists predict, even after overcoming the technical barriers, the administrative requirements of farm daily monitoring will be prohibitively expensive (Kenney 2015). Currently, using deficit irrigation to reduce farm consumptive use will only add to the inflexibility of water transfers. Pilot projects such as the Super Ditch Company practice rotational fallowing, although, returning the fallowed lands back to production is more difficult than irrigated land, and some level of maintenance is required (erosion and weed control) during fallowing. MacDonnell (2015) suggests focusing on rotational fallowing as a process to implement ATMs.

The two feasible institutional frameworks for ATMs are the water bank and interruptible supply agreements. Writers addressing Colorado’s buy-and-dry experiences call for more flexible regulations to facilitate both methods. The bills passed over the last decade (HB13-1130, HB13-1248, SB15-198, HB16-1228) were efforts to achieve this goal. So far, the water banks formed in Colorado are either in the initial stages of formation (Water Bank Working Group and Northeast Colorado Water Cooperative), rely on external funding (subdistricts of Rio Grande Water Conservation District), or still have problems attracting members and buyers (Super Ditch). Interruptible supply agreements that were created were able to function independently (contract between city of Aurora and Highline Canal). However, parties involved in more recent interruptible supply agreements (Larimer County and Broomfield) preferred to use external funding, which was attractive due to increasing interest in implementation of ATMs. In other words, Colorado is still experimenting with the possibilities provided by the new regulations.

In Colorado some agricultural water right holders still view leasing water as a risky practice. The common belief is that leasing water will prove the farm owns extra water and so the water court can curtail farm water rights due to inefficient use. Moreover, issues such as irrigating beyond point of use, diverting water out of priority, and expansion of use through extending irrigated land, may exist in farmlands, which will be discovered when the farm water right is reviewed for transfer. However, the examples of the Super Ditch and the agreement between Aurora and Highline Canal show supportive regulations can encourage the formation of leasing markets. Even municipalities have entered ATM contracts despite the fact that they prefer buy-and-dry tactics due to the more secured water right they provide. The few and limited water leasing markets have also helped to reflect the real opportunity cost of water. For example, in 2014, in South Platte Basin the leasing price of water was $0.06 per cubic meter ($80 per AF) when water was leased within the same ditch system (personal communication with Scott Williams of Water Colorado LLC). This is much lower than the prices in Arkansas valley ($0.41 per cubic meter) where water was leased from agriculture to municipalities (out of sector).

Both water banks and interruptible supply agreements have formed out of necessity and after the agricultural sector in a region had lost a considerable amount of water (Arkansas River Basin and South Platte Basin). The positive side of this trend is that most of these institutions are voluntary, and this characteristic can increase their public acceptability.

The water transferred to cities is water lost to agriculture even if not permanently. When the state’s food security, losses of third-party businesses, or reduced jobs in agricultural sector are considered, ATMs can only lighten the negative impacts but not eliminate them. The Colorado water plan and other policy documents do not discuss the reinvestment of gains from water transfer in the rural communities. Perhaps, the common understanding is that implementing ATMs will keep the benefits of water transfer within rural communities.

Public values such as environmental and water quality/quantity concerns had a small share in implemented ATMs. McKinley Ditch–Cimarron River project (stream flow restoration) is commonly considered as an environmental ATM although it used traditional methods of purchasing water rights and no water is transferred to new users. Implementation of this small-scale project (in terms of land under irrigation and amount of flow recovered) has local and limited impact, but proved Colorado water law, although not flexible, still has opportunities for sharing water between agriculture and other uses without land dry-up. Interestingly, the Saint Luis Valley subdistricts that focused on groundwater recharge (a public value) are not considered as ATMs although they utilize the concept of water banking. It appears, in Colorado, the term ATM is loosely applied to any effort to mitigate agricultural land dry-up (another example is water conservation plans).
In conclusion, in Colorado, the newly employed alternative water transfer methods from agriculture to urban areas mainly consist of reducing farm water consumption and leasing volumes of water to cities instead of selling water rights. Perhaps the key factor for the start of ATMs was a policy change from accepting buy-and-dry to preventing it. Several institutional arrangements have been created in Colorado to handle leasing contracts between agricultural water right holders and municipalities. However, these institutions still need to prove their efficacy to encourage more water users to use ATMs.

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