THESIS

UNDERSTANDING BELIEFS AND PREFERENCES OF IRRIGATORS TOWARDS THE USE AND MANAGEMENT OF AGRICULTURAL WATER IN THE COLORADO RIVER BASIN

Submitted by

Julie A. Kallenberger

Department of Human Dimensions of Natural Resources

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Master's Committee:

Advisor: Alan Bright

Rick Knight
James Pritchett

ABSTRACT

UNDERSTANDING BELIEFS AND PREFERENCES OF IRRIGATORS TOWARDS THE USE AND MANAGEMENT OF AGRICULTURAL WATER IN THE COLORADO RIVER BASIN

The agriculture sector in the American West is faced with multiple challenges including urbanization, drought, an aging producer population, and the prospects of climate change. As a result, the availability, use, and allocation of water throughout the West have become sources of both conflict and collaboration. Growing conflict emphasizes the need to identify and understand the diversity of beliefs of agricultural water users. This in turn, will help stakeholders better manage limited water resources and identify solutions for agricultural producers to deal with uncertainty and the pressures they are experiencing.

This study examines the findings from a survey of farmers and ranchers who use Colorado River water for agricultural purposes, including: the pressures they are experiencing on their water supplies, options for addressing pressures, their interest and involvement in water transfer arrangements, and their preferences for meeting future water demands. In addition, their beliefs towards water availability, the role of storage, water policy and law, and working together with other stakeholders to address water challenges will be discussed.

In brief, the results of this study indicate that agricultural water users face myriad number of pressures on their water supplies with drought and urban growth topping the list. The data indicates strong opposition towards agricultural water transfers, even those of temporary nature due to the concern of possibly losing their water right. A majority of participants agree that there will not be enough water for agriculture in their area or in the

Colorado River Basin and that further water storage is needed to address uncertainty; however, new storage projects should be expanded before initiating new projects. Overall, agricultural water users agree that they need to partner with other non-agricultural water users (preferably at the district or basin level) in order to address the challenges they face or will face in the future.

Multiple types of water stakeholders can benefit from the information found in this study by learning the differences, commonalities, viewpoints, and preferences of the agricultural sector and by using it to help gauge support for or against management decisions and policies, help predict and mitigate conflict among competing users, and to help develop approaches for working together collaboratively to address water issues in the Colorado River Basin.

Keywords: Colorado River Basin, water, agriculture, irrigation, transfer, Cognitive Hierarchy Model of Human Behavior

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Introduction

Research indicates that those who live in the Western United States (U.S.) think it is important to keep land and water in agriculture and that water transfers that create adverse impacts on rural communities should be limited (Fix, 2001; Western Governors' Association and Western States Water Council, 2012). Local food and fiber production, protecting open space and wildlife habitat, maintaining agricultural jobs and businesses, and preserving western heritage are among the reasons for ensuring that there is adequate land and water resources for agriculture production (Fix, 2001; J. Pritchett, Bright, A., Shortsleeve, A., Thorvaldson, J., Bauder, T., & Waskom, R., 2009). However, in order to better manage limited water resources and identify solutions for agricultural producers to deal with uncertainty and the pressures they may be facing, it is helpful to understand the underlying characteristics of human thinking and behavior by considering their basic beliefs, preferences, differences, and commonalities.

Based on data from a survey of farmers and ranchers who use Colorado River water for agricultural purposes, this thesis identifies: (1) the pressures agricultural water users are experiencing on their water supply; (2) beliefs held by agricultural water users regarding water availability, the role of storage, and water policy and law; (3) agricultural water users' preferences for meeting future water demands; (4) agricultural water users' interest and involvement in agriculture water transfers; and (5) agricultural water users' interest in working cooperatively with other stakeholders to address water challenges.

The purpose of this research is to explore beliefs and preferences of agricultural water users in the Colorado River Basin (CRB) regarding agricultural water use, management, and allocation. This information will: (1) help inform water managers, policy makers, and other key

stakeholders about their constituents' needs, preferences, and viewpoints towards the challenges that agricultural water users currently face; (2) help predict and mitigate conflict among competing users; and (3) help develop effective approaches for collaborative partnerships between water users.

Background

The Colorado River drainage, illustrated in Figure 1 (Glen Canyon Dam Adaptive Managment Program, 2009), is the most critical source of water in the West, traveling approximately 1,400 miles through Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming, and the northern states of Sonora and Baja California, Mexico. The Colorado River and its tributaries begin in the Rocky Mountains of Colorado and Wyoming and in the mountains of northeastern Utah. The river's main tributaries include Wyoming's Green River, the Duchesne River of northern Utah, and the Dolores, San Juan, Gunnison, and White rivers of Colorado. The CRB has

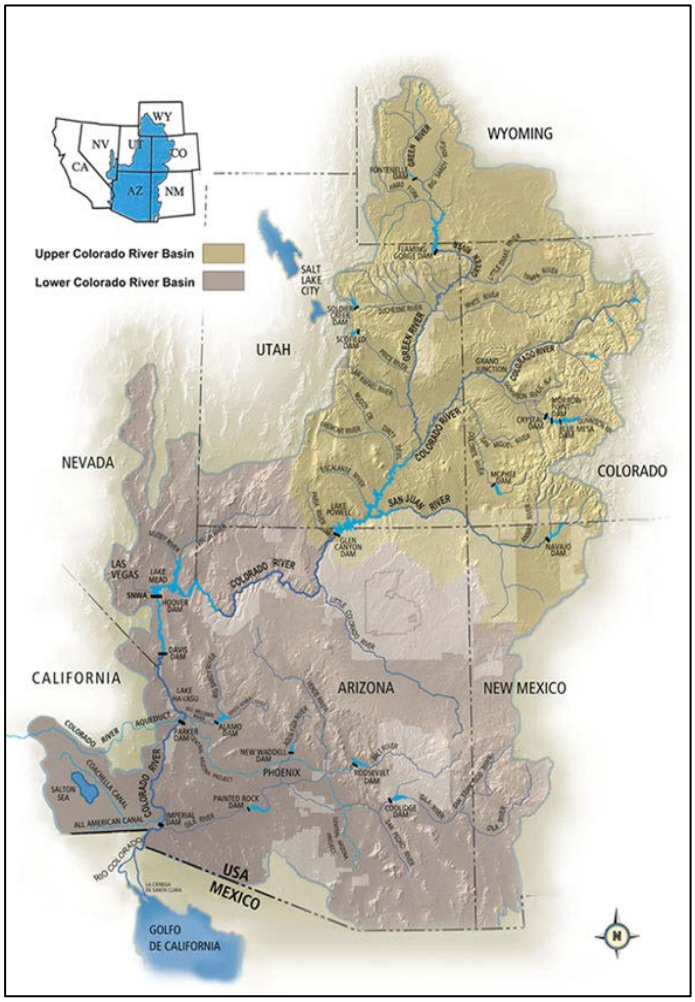

Figure 1. The Colorado River Basin. Source: Glen Canyon Dam Adaptive Management Program.

a drainage area of 246,000 square miles and the annual mean discharge of the river is approximately 15 million acre-feet (MAF) (Colorado River Water Users Association, 2007).

The Colorado River and its tributaries provide water to almost 35 million people (Cohen, 2011), supplies water to irrigate approximately three million acres of farmland (approximately 1.4 million acres the Upper Basin (including tributaries and transbasin lands) and another 1.4 million in the Lower Basin (including the Salton Sea Watershed), and serves 15 Native American tribes, seven National Wildlife Refuges, four National Recreation Areas, and 11 National Parks. In addition, the Colorado River is vital to Mexico's agricultural, environmental, and municipal needs (U.S. Department of Agriculture - National Agricultural Statistics Service, 2008; U.S. Department of the Interior - Bureau of Reclamation, 2011).

The waters of the Colorado River are apportioned according to the Colorado River Compact which was negotiated in 1922 among the seven CRB states. The watershed is divided into the Upper Basin (Colorado, New Mexico, Utah, and Wyoming) and the Lower Basin (Arizona, California, and Nevada), both of which are allocated 7.5 MAF of surface water per year, with the Lower Basin entitled to an additional one MAF ("Colorado River Compact," 1922). Mexico is entitled to 1.5 MAF per year (The Governments of the United States and Mexico, 1944).

Irrigated agriculture consumes the greatest portion of fresh water in the western U.S. (ranging from 75-85 percent). California has the largest number of irrigated acres of the seven basin states, with its largest user being the Imperial Valley, which irrigates about 500,000 acres. Nearly 900,000 acres of cropland are harvested each year in Arizona. In Colorado, there are over a million acres of agricultural land within the basin, plus another 900,000 acres outside of

the basin that are irrigated with transbasin diversions. The San Juan River (the Colorado River's largest tributary) irrigates nearly 100,000 acres in New Mexico. Nevada does not use water from the mainstem of the Colorado River for agricultural purposes, and in Utah and Wyoming, the Colorado River and its tributaries provide irrigation water for over 500,000 acres (Colorado River Water Users Association, 2007).

A wide variety of crops are grown in the CRB including: alfalfa, pastureland, grass hay, wheat, rice, sorghum, corn, beans, cotton, small grains, vegetables, fruit, nuts, and turf (Figure 2). Production of cattle, poultry, and sheep are also a large contributor to the CRB's agricultural output. Combined, crop and livestock production in the basin equal more than $1.5 billion a year in agricultural benefits. These benefits, measured at the farm gate, provide subsequent value-added activity and support industries which also thrive because of irrigation throughout the basin (Colorado River Water Users Association, 2007; U.S. Department of Agriculture - National Agricultural Statistics Service, 2009).

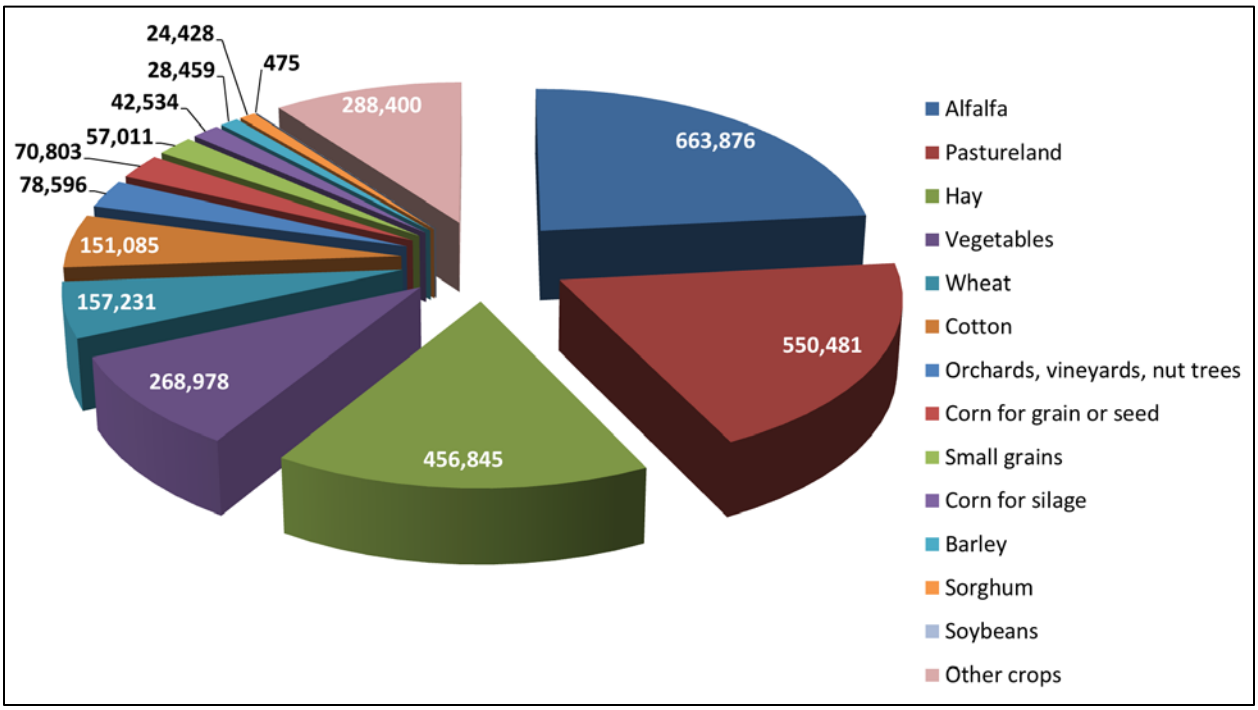

Figure 2. Crop distribution across the Colorado River Basin (irrigated acreage only). Source: USDA-NASS Census of Agriculture (2007).

Demands on the Colorado River

Rapid population growth, along with drought and the prospects of climate change, has increased the uncertainty of available water supplies and the agricultural economy in the CRB. Freshwater supplies are over allocated, and predictions include reduced surface water availability, diminished groundwater supplies, and a shift in the timing of water availability. According to a 2006 Western Governors' Report an estimated 25 million additional people are projected to be living in the West by 2030 (U.S. Department of the Interior - Bureau of Reclamation, 2005; Western Governors' Association, 2006). This will result in the need for an additional 48 billion gallons of water per year. Moreover, 14 of the 25 fastest growing cities in the U.S. are in Arizona, California, and Nevada (City Mayor Statistics, 2007). These urban areas

share water supplies with some of the most productive farmland in the CRB. In addition, water for the natural environment, industry, recreation, and energy also require dependable water supplies.

Climate models predict that annual water availability in the CRB will decline by 10 to 30 percent (Barnett, 2009) and the Southwest U.S. will experience more severe drought conditions. The historical annual flows of the river vary widely, ranging from 5 to 24 MAF (Colorado River Water Users Association, 2007) and precipitation in the Southwest U.S. is expected to decrease by 10 to 20 percent by the close of the twenty-first century (Intergovernmental Panel on Climate Change, 2007). The CRB Water Supply and Demand Study has been completed by the U.S. Bureau of Reclamation (U.S. BoR) to outline water supply and demand imbalances over the next 50 years, as well as assess the reliability of the system to meet the needs of the basin's resources and identify and prioritize strategies to resolve those imbalances. The study predicts that annual basin-wide temperatures will increase 1.3 to 2.4 degrees Celsius from 2011-2040 and 2041-2070 respectively. Snowpack is expected to decrease since more precipitation will fall as rain rather than snow. In addition, earlier snowmelt and reduction in streamflow will impact river discharge and the delivery time of irrigation water(U.S. Department of the Interior - Bureau of Reclamation, 2011).

Agricultural Water Transfers

Urbanization, aging irrigation infrastructure, and an aging producer population are among the challenges that the agricultural sector faces (Griffin, 2012). The U.S. BoR Water Supply and Demand Study (2011) estimates that one MAF of water will come from agriculture to meet non-agricultural water demands.

Water transfers are one strategy that CRB states can use to help secure water supplies for both agricultural and non-agricultural water uses. A water transfer is defined as "a voluntary agreement that results in a temporary or permanent change in the type, time, or place of use of water and/or a water right". Water transfers can be local or distant, a sale, lease, or donation; and they can move water among different types of water users (Western Governors' Association and Western States Water Council, 2012).

Water transfers from the agricultural sector are increasing. Sales are the primary transfer mechanism, though a greater volume of water has been transferred by way of leasing. Between 1988 and 2008, nearly 3,300 transactions, resulting in approximately 23.5 MAF of water were transferred between agricultural, environmental, and municipal users throughout the CRB. Agriculture was the primary source of the transactions (82 percent) and supplied nearly 16 MAF of the water that was transacted. The agriculture sector was also the most frequent receiver of such transactions; however, "agriculture-to-urban" water transfers are growing in number (Donald Bren School of Environmental Science and Managment, 2010; Pritchett, 2011). A majority of the transfer activity has been located in the lower basin states; however, considerations regarding voluntary market-based transfers and mechanisms such as water banking are occurring in the upper basin states as well (Griffin, 2012; Pritchett, 2011). The size and number of these transactions are highly dependent on local conditions, and as water continues to move from agricultural lands, these transfers lead to unanticipated impacts. Regardless of the type of water transfer arrangement, the process requires cooperative partnerships among the various stakeholders involved.

Stakeholder Cooperation

Some significant strides have already been made in understanding and documenting the opportunities of cooperative work among various stakeholders. Smith (2010) identifies incentives, barriers, tradeoffs, and specific examples for temporary water transfer arrangements in the West. Examples of the strategies include: agricultural rotational following, leasing of interruptible supplies for urban use during drought, split year leases with environmental needs, deficit irrigation, and improvement in irrigation efficiencies. The study outlines 11 case studies that illustrate collaborative efforts in working to solve both agricultural and non-agricultural water issues. For example, one of the case studies showcases the development of a 23,000 AF reservoir that provides multiple benefits for wildlife and fishes, recreation, and late season irrigation water for ranchers in the Little Snake River Basin, part of the Upper CRB in Wyoming. The different sectors were able to build a broad coalition and leverage funds from multiple sources, making this effort a template for how to bring stakeholders together for collective action. A second example from the Lower Basin explains farmers' use of surface water from the Central Arizona Project (CAP) by banking groundwater for urban growth. Under this particular arrangement, groundwater is able to recharge itself while farmers use water from CAP surface water supplies. Conversely, this arrangement is only temporary because eventually urban water needs will utilize all of the surface water supplies and farmers will return to groundwater pumping in order to support irrigated agriculture in the region. Nonetheless, this effort illustrates how water users can work together to meet current challenges even if it is a short-term solution.

The Human Connection

Human Dimensions is the area of investigation that attempts to describe, predict, understand, and affect human thought and action towards their natural environment. Examination of the literature shows that values, beliefs, and attitudes are considered valuable when it comes to water use, management, and decision making (Colorado Institute of Public Policy, 2006; Jacobs & Buijs, 2011; Vugteveen et al., 2010). A study led by the Colorado Institute of Public Policy discovered that western water issues are directly related to people's diverse beliefs, and by learning more about them, strategies can be identified to address current challenges in water management and predict future problems (Colorado Institute of Public Policy, 2006).

Recent efforts to understand public values, beliefs, and attitudes towards water issues were developed by an interdisciplinary team of researchers at Colorado State University. The focus of the study was to gauge various concepts by the general public in order to help facilitate water program coordinators, stakeholders, and decision makers in evaluating economic, social, and environmental issues related to water. The results of this study indicated that overall, the public sees irrigated agriculture production as a priority in the West, and they support practices to limit reallocation of agricultural water (J. Pritchett, A. Bright, A. Shortsleeve, J. Thorvaldson, T. Bauder and R. Waskom, 2009). Given that the public is a key stakeholder and has influence over water policy decisions, it is important to know if their attitudes, beliefs, and preferences parallel others, especially agricultural water users.

The Cognitive Hierarchy Model of Human Behavior (Figure 3), developed by Rokeach in 1973, is the fundamental framework for understanding key concepts believed to be at the root

of human thinking and behavior. The framework includes values, basic beliefs, attitudes and norms, behavioral intentions, and behaviors.

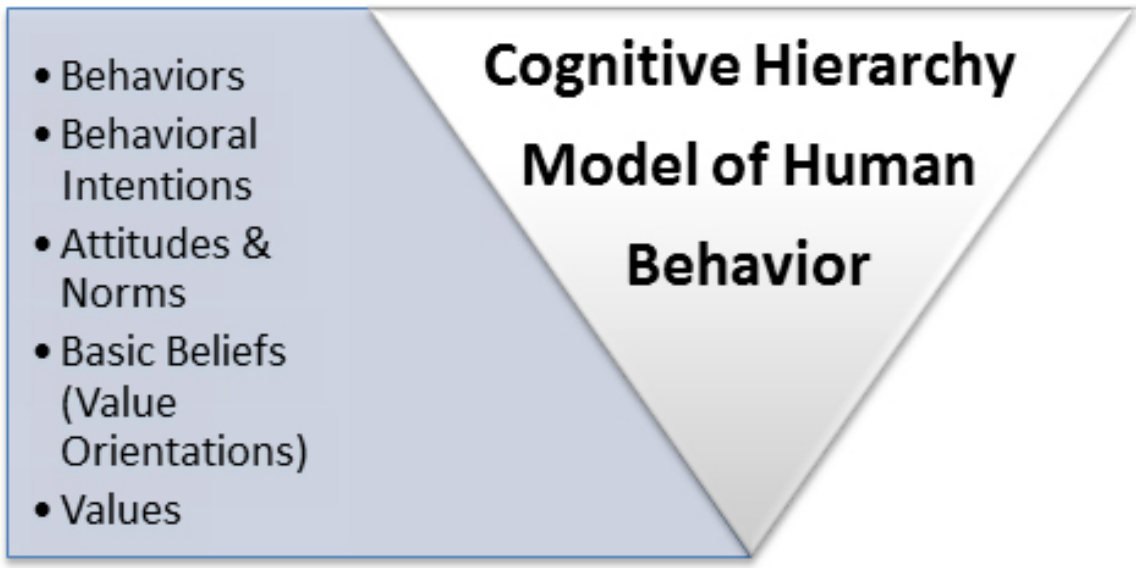

Figure 3. Cognitive Hierarchy Model of Human Behavior. Source: Rokeach (1973).

Values serve as the foundation of the framework, characterized as fundamental beliefs that are stable and enduring. They are formed early on in life and transcend specific situations (Schwartz, 1992). Values do not differ a considerable amount within the same culture, though they do vary across cultures. This distinctive characteristic explains why values are not likely to explain variability among particular attitudes and behaviors. The study of values is important because the research is able to explore the foundation of conflict, plan for the future, and understand the representation of diverse stakeholders (Rokeach, 1973).

Second order cognitions, basic beliefs, are considered to be more specific than an individual's values. Beliefs reflect thoughts about specific issues and objects and give meaning to abstract values (Vaske & Donnelly, 1999). Individuals may share common values, though

have very different basic beliefs about a specific issue or management decision (Bright, 2000; Fulton, 1996). The pattern of basic beliefs and their intensity determine a value orientation toward an issue, object, or behavior. “Basic beliefs have been found effective in orienting an individual’s fundamental values to more specific issues, which in turn, are of importance to resource managers” (Shortsleeve, 2009).

Basic beliefs serve as the basis for third order cognitions, attitudes. Attitudes are studied in order to understand, predict, and affect human behavior. Attitudes are considered to change over short periods of time and are usually context specific. Rokeach (1966) defines a change in attitude as “a change in predisposition.” Strong attitudes are those that are well-formed, resistant to change, and guide behavior. They are considered to be highly emotional if an individual is knowledgeable about an issue and feels the outcome of the situation will affect them personally (Krosnick, 1995).

Study Rationale

The number and type of stakeholders in water allocation, management, and use have increased over time, mainly due to competing demands over finite water supplies. Stakeholders include farmers and ranchers, local, state, and federal agencies, non-governmental organizations, tribes, legislators, researchers, and the general public. Agricultural water users themselves will be the most critical in establishing equilibrium between competing demands because, after all, they are the predominant water right holders and they are the most frequent supplier in water transfers. Consequently, understanding their basic beliefs and preferences towards agricultural water pressures, reallocation, and other associated challenges could help determine solutions to avoid the permanent dry-up of irrigated land in the CRB.

Thesis Organization and Purpose

The goal of this research is to explore the beliefs and preferences of agricultural water users in the CRB regarding agricultural water use, management, and allocation. This information will help inform water managers, policy makers, and other key stakeholders about their constituents' needs, preferences, and viewpoints towards the challenges that agricultural water users currently face, or will face in the future. In order to accomplish this goal, specific objectives have been established.

Objective 1: To identify the pressures Colorado River Basin agricultural water users are experiencing with regard to their water supply and the options most likely to be pursued to address the pressures.

Objective 2: To identify beliefs held by agricultural water users about:

a. water availability
b. water law and policy
c. the role of storage in meeting multiple needs

Objective 3: To identify agricultural water users' preferences for meeting future water demands in the Colorado River Basin.

Objective 4: To gather baseline data on agricultural water users' interest and involvement in agriculture water transfers.

Objective 5: To identify agricultural water users' interest in working cooperatively with other agricultural and non-agricultural stakeholders to address water challenges.

The research questions for addressing the project objectives include:

Question 1: What are the pressures that agricultural producers are experiencing on their water supply?

Question 2: What are the beliefs held by agricultural water users towards water availability, water law and policy, and the role of storage to meet water needs?

Question 3: What are farmers' and ranchers' preferences to meet future water demands in the Colorado River Basin?

Question 4: Are farmers and ranchers in the Colorado River Basin opposed to temporary water transfer arrangements?

Question 5: Are agricultural water users willing to collaborate with other stakeholders to address the challenges they are facing?

The outcomes resulting from this research may:

- inform water managers, policy makers, and other decision makers about the challenges and pressures agriculture faces, or will face in the future.
- identify areas of conflict and commonalities between stakeholders for communities to be more proactive in their water allocation, management, and use.
- further the use of basic belief dimensions in natural resources research.
- support the development and use of online surveys with farmers and ranchers.

Methodology

Data gathered from this survey is part of a larger research effort funded by the USDA-National Institute of Food and Agriculture (Agreement No. 2001-51130-31122). The project, titled *Addressing Water for Agriculture in the Colorado River Basin*, is being led by the Colorado

Water Institute (CWI) at Colorado State University in partnership with faculty and staff from the seven land-grant universities in the CRB. Appendix A provides a brief summary of the project team and its deliverables. Additional information about the project is available at www.CRBagwater.colostate.edu.

Study Area

Delta, Garfield, and Mesa counties in Colorado were selected as the study area because they have significant areas of agricultural land and their producers are predominantly served by Colorado River water (Figures 4 and 5).

Based on 2007 USDA-National Agricultural Statistics Service (NASS) county level data, there are 1,294 farms/ranches in Delta county, 623 in Garfield county, and 1,767 in Mesa county totaling over 960,000 acres of irrigated land. The average size of a farm/ranch in Delta county is 195 acres, and in Garfield and Mesa counties the average size is 538 and 211 acres respectively. Most operations in the three counties are between 10 and 49 acres in size. Delta county has 550 farms that fall into this category, Garfield county as 240, and Mesa county has 690. The average age of the primary operator is 58 years old in Delta and 57 years old in Garfield and Mesa counties. The study area includes females and operators of different races, and the principal operators are predominantly white males.

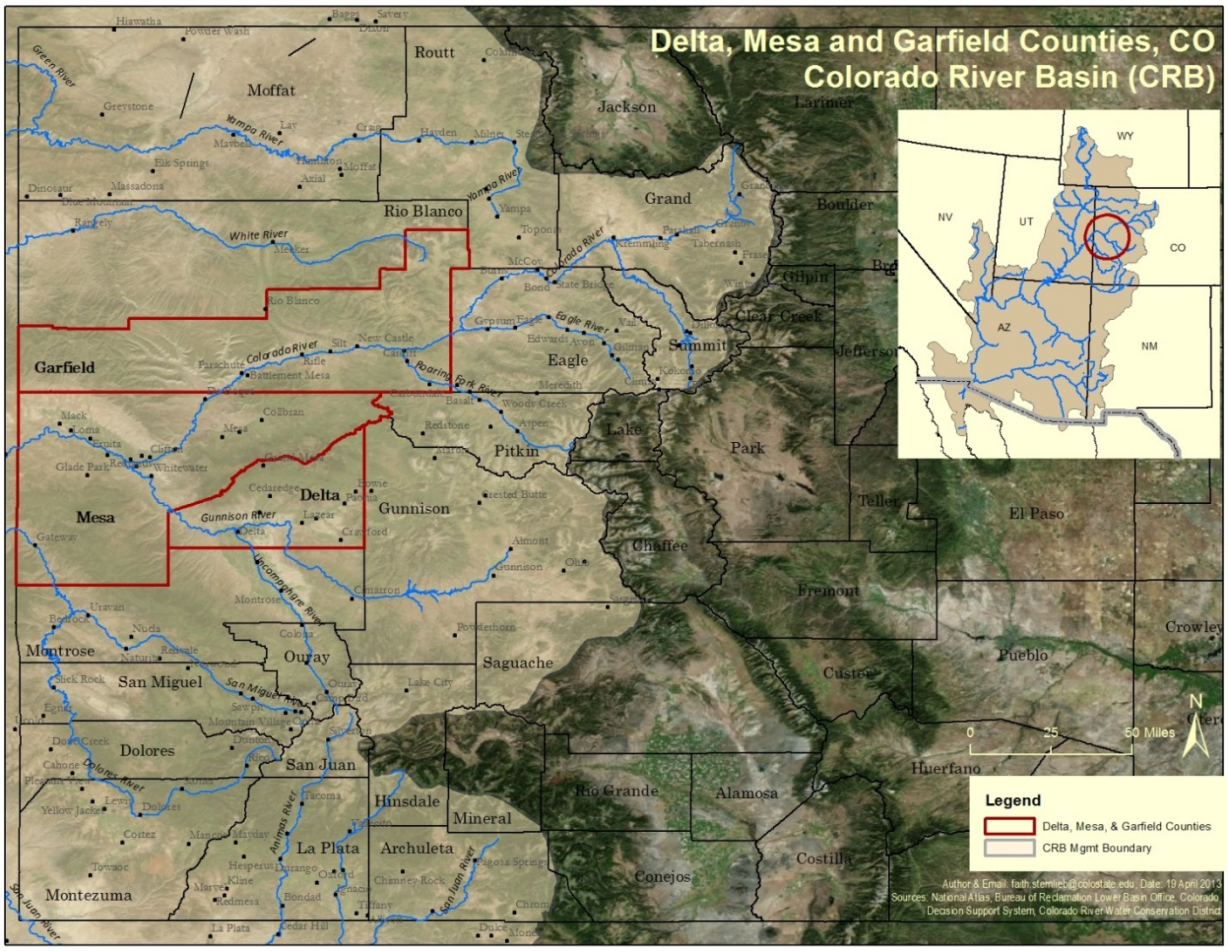

Figure 4. Map of study area: Delta, Mesa and Garfield Counties in Colorado. Sources: National Atlas, Bureau of Reclamation Lower Basin Office, Colorado Decision Support System, and Colorado River Water Conservation District. Author: Faith Sternlieb, Colorado Water Institute (2013).

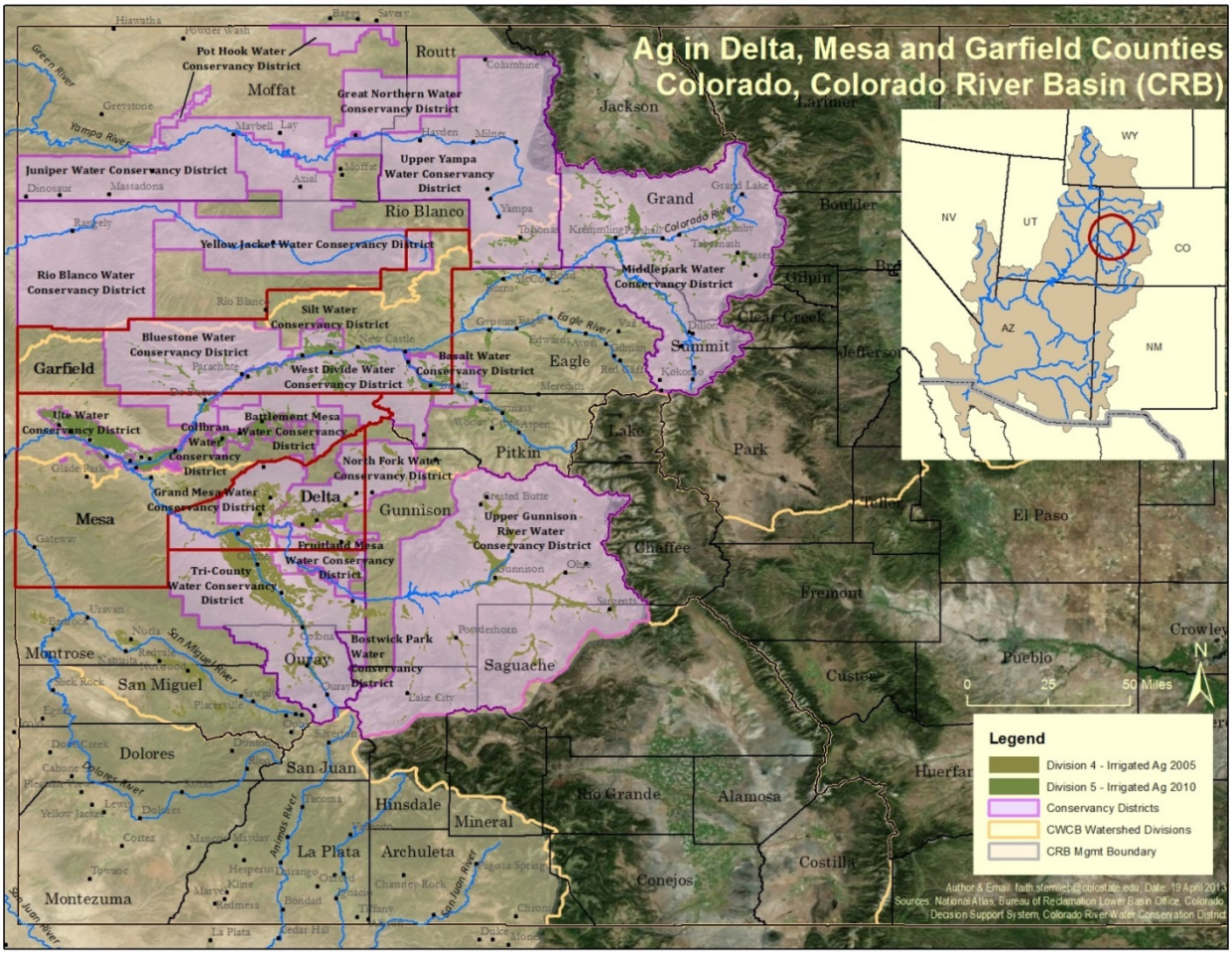

Figure 5. Irrigated agricultural in the Colorado River Basin within Colorado. Irrigated agricultural lands are based on data available through April 19, 2013. Sources: National Atlas, Bureau of Reclamation Lower Basin Office, Colorado Decision Support System, and Colorado River Water Conservation District. Author: Faith Sternlieb, Colorado Water Institute (2013).

Numerous types of crops and livestock are produced throughout the study area. The primary crop and livestock items for each county are listed in Table 1. Agriculture is important economically to the region. In 2007, Delta, Garfield, and Mesa counties generated over $130 million dollars from crop and livestock sales combined and the average market value of products sold per farm ranges from $34,652 to $36,167 (Table 2).

Table 1. Primary agricultural products produced in Delta, Garfield, and Mesa counties, Colorado. Source: U.S. Department of Agriculture – National Agricultural Statistics Service (2007).

	Delta	Acres	Garfield	Acres	Mesa	Acres
Top Crop Items	Forage - land used for all hay, grass, and greenchop	33,646	Forage - land used for all hay, grass, and greenchop	30,185	Forage - land used for all hay, grass, and greenchop	34,438
	Corn for grain	3,615	Wheat for grain	D[1]	Corn for grain	2,701
	Corn for silage	1,599	Sod	106	Wheat for grain	2,502
	Vegetables	1,135	Nursery stock	81	Corn for silage	1,841
	Apples	1,087	Apples	54	Peaches	1,806
Top Livestock Inventory Items	**Delta**	**Number**	**Garfield**	**Number**	**Mesa**	**Number**
	Cattle and calves	33,689	Cattle and calves	19,238	Layers	D[1]
	Sheep and lambs	10,293	Sheep and lambs	8,676	Cattle and calves	34,102
	Pheasants	9,624	Horses and ponies	3,723	Horses and ponies	5,375
	Horses and ponies	4,292	Colonies of bees	D[1]	Sheep and lambs	3,966
	Colonies of bees	D[1]	Layers	1,556	Goats	1,208

[1] Cannot be disclosed per USDA-NASS 2007 Agriculture Census data.

Table 2. Total market value of agricultural products sold in 2007 ($1,000) and average farm revenue for Delta, Garfield, and Mesa counties. Source: U.S. Department of Agriculture – National Agricultural Statistics Service (2007).

	Delta	Garfield	Mesa
Total value of agricultural products sold ($1,000)	$46,800	$22,203	$61,230
Value of crops including nursery and greenhouse ($1,000)	$20,158	$6,838	$30,262
Value of livestock, poultry, and their products ($1,000)	$26,642	$15,365	$30,969
Average market value of products sold per farm	$36,167	$35,639	$34,652

Table 3. Farms by value of sales in Delta, Garfield, and Mesa counties, Colorado. Source: U.S. Department of Agriculture – National Agricultural Statistics Service (2007).

Farms by Value of Sales	**Delta** (# of farms)	**Garfield** (# of farms)	**Mesa** (# of farms)
Less than $1,000	371	220	595
$1,000 to $2,499	153	72	254
$2,500 to $4,999	167	55	213
$5,000 to $9,999	159	62	208
$10,000 to $19,999	113	69	175
$20,000 to $24,999	25	24	42
$25,000 to $39,999	90	23	80
$40,000 to $49,999	37	12	27
$50,000 to $99,999	93	24	72
$100,000 to $249,999	60	37	55
$250,000 to $499,999	14	17	27
$500,000 or more	12	8	19

Sampling and Data Collection

In November 2012, an online survey was administered to 2,792 farmers and ranchers in Delta, Garfield, and Mesa counties who use Colorado River water for agricultural purposes. The sample population was assembled from the USDA-NASS database, which is populated from NASS's nationwide Census of Agriculture every five years.

The sample population was mailed a postcard announcement inviting them to participate in the survey. The postcard (Appendix B) provided brief description of the study and a link directing them to the survey. The initial mailing was followed by two additional mailings two weeks apart to help increase the response rate.

An Internet-based survey was chosen in order to reduce mailing costs, enable immediate data collection and analysis, and help quickly determine which addresses to send follow-up postcards. Survey Monkey software (Survey Monkey, 2013) was used to develop and deliver the survey.

Survey Instrument

The survey's audience and questions were informed by prior telephone interviews led by the *Addressing Water for Agriculture in the Colorado River Basin* project team. The interviews were conducted with 61 agricultural producers and water managers throughout the CRB (Appendix C).

The survey addressed 10 primary topics, containing nearly 50 supplementary questions (Appendix D). The topics included: pressures placed on agricultural water, water availability and management, meeting future agricultural water demands, water storage, barriers to water transfers, water law and policy, and agricultural water users' interest and involvement in

working cooperatively with other stakeholders to address the challenges they currently face, or will face in the future. The survey also collected information on demographic characteristics including age, years farming/ranching, type of irrigation method(s) used, water user type (i.e. surface and groundwater), types of crops and livestock produced, and gross value of agricultural products sold. The survey questionnaire and process were pre-tested with the project team members and select colleagues and revised according to feedback prior to administering to the sample population.

Statistical Analysis

Belief statements were measured on a five-point scale ranging from -2 (strongly disagree) to +2 (strongly agree). Age was measured in number of years and gross value of all agricultural products sold from the primary operation in 2011 was measured in dollars, ranging from $0.00 to over $1,000,000. Belief statements regarding water transfers and cooperation acted as dependent variables and were tested against age and gross value of products as the depending variables. Statistical Package for Social Scientists (SPSS) was used to analyze the data.

Results

The survey was completed by 299 individuals (N=2,792), resulting in an 11 percent response rate (Delta county = 11 percent response rate (n=107, N=1016); Garfield county = 10 percent response rate (n=45, N=430); and Mesa county = 11 percent response rate (n=147, N=1346)).

Demographics

The demographics based on the USDA-NASS 2007 Census of Agriculture county data were similar for age, income, and crop and livestock products grown; though, it would be difficult to generalize the survey participants' responses to the entire study area population because of the low response rate and absence of a non-response bias check. Conducting a non-response bias check would have included contacting a sample of non-respondents and asking them a subset of questions found in the survey. This process may have allowed the survey data to be generalized to the entire population. The non-response bias check was not performed for reasons including: (1) financial resources were not available for making phone or mail contact with non-respondents, (2) the complex nature of determining the population of non-respondents once the postcards were mailed, and (3) the unique situation each respondent faces with their water could make it difficult to generalize findings. Therefore, the following results are from only those who participated in the survey.

The survey results show that there were 190 males as primary operators and 32 females. Sixty-seven operations have both a male and female as the primary operator. Ten respondents did not report their sex. The mean age of the primary operator was 61 years old (range= 30-91). On average, respondents have been farming/ranching for 27 years (range= 1-70), while previous generations of their family have been farming/ranching for 54 years on average (range= 0-250). Sixty-five respondents reported that previous generations of their family have been farming and/or ranching for over 100 years.

Across all respondents, 18 percent make their living by farming, seven percent make their living by ranching, and 70 percent indicated that their farming/ranching operation

provides a supplemental income. Fifty-one percent of the respondents reported a gross value of all agricultural products sold from their primary operation in 2011 to be between $0.00 and $9,999. Only 23 percent reported a gross value of products sold above $50,000.

Ninety-six percent of respondents own their water rights or ditch company shares and 13 percent use rented or leased water for their operation. Fifty-nine percent of respondents are surface water users and 12 percent use groundwater as their primary source for irrigation.

Sixty-seven percent of respondents use furrow irrigation and 26 percent use surface flooding as their primary method of irrigation. Twelve percent use solid set and permanent systems, 13 percent use sideroll sprinklers or other mechanical move systems, 19 percent use drip, trickle, or micro irrigation (including sub-surface drip) systems, and eight percent use a center pivot system. Only three percent use a subirrigation method.

Grass hay, pasture, and alfalfa were the predominant crops grown (n=204, 165, and 158 respectively) by survey respondents. In addition, nearly 31 percent (n=94) produce some type of fruit, nut, or vineyard crop. Cow-calf production and keeping/raising horses are the main types of livestock operations found in the region (n=95, n=95 respectively). Thirty-two feeding/fattening cattle operations were reported, along with 27 poultry, 18 stockers and yearlings, 18 sheep (including ewes and lambs), 11 back-grounding heifers, and 11 hog and pig operations. No dairy operations were reported. Other types of livestock operations reported by respondents included: elk, alpacas, bison, and honeybees.

Study Findings

Overall, the survey respondents believe their services are valued by the general public (M=0.94 on a scale of -2 to +2) and 75 percent feel as though agriculture plays a central role in

their area. Almost half of the respondents indicated that there is a subsequent generation of their family with plans to continue their operation in the future (Table 4).

Table 4. Mean scores and percentages for beliefs about agriculture.

I believe …[1]	***M***[1]	**Disagree (%)**	**Neither (%)**	**Agree (%)**
my services as a farmer/rancher are valued by the general public	0.94	16	8	76
agriculture no longer plays a central role in my area	-1.05	75	4	22
the influx of new people in my area is influencing how I manage my water	0.50	22	19	59
there is another generation of my family that plans to continue farming/ranching in the future	0.33	24	29	47

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.
Overall percent (%) for Disagree, Neither and Agree may total more than 100% due to rounding.

At the p=.05 level, the number of years an operator has been farming/ranching is positively correlated with the likelihood that there is another generation of the family that plans to continue to farm/ranch in the future (r=.133, p=.048). The number of years that previous generations have been farming/ranching also indicates a positive correlation at the p=.01 level (r=.245, p=<.001) (Table 5). Both are considered to have a minimal practical significance (<.3).

Table 5. Correlation between subsequent generations planning to continue farming/ranching (dependent variable) and (1) the number of years the current operator has been farming/ranching and (2) the number of years previous generations have been farming/ranching (independent variables).

			Years Farming/ Ranching		**Years previous generations have been farming/ranching**	
	M	*SD*	*r*	*p*	*r*	*p*
There is another generation of my family that plans to continue farming/ranching in the future	0.35	1.402	.133	.048	.245	<.001

Objective 1: Study participants identified the different pressures they are experiencing on their agricultural water supplies. These included drought (88 percent of respondents), growing urban and suburban areas (65 percent), and local, state, and federal water policies and regulations (63 percent). The pressure that is being experienced the least is demand from the industry sector (20 percent), and 12 percent of respondents are not feeling any pressure on their agricultural water supply (Figure 6). Figure 7 illustrates the drought conditions during the time the survey was administered. Garfield and Mesa counties were experiencing extreme (stage D3) drought and Delta county was in a stage D2 (Severe).

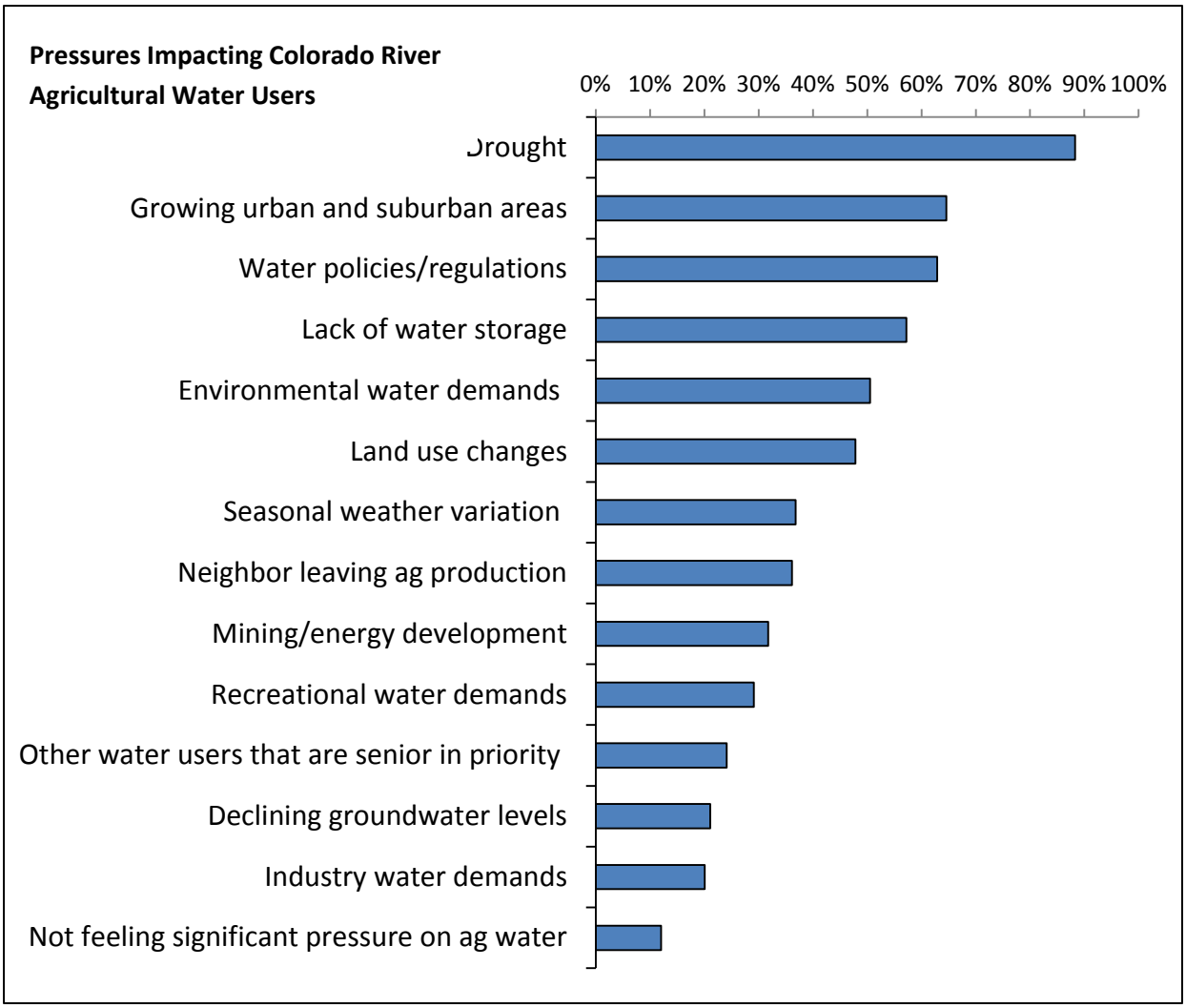

Figure 6. Percent of respondents indicating a particular pressure(s) is impacting the way they farm and/or ranch. Percent total is greater than 100% because survey respondents were allowed to indicate more than one selection.

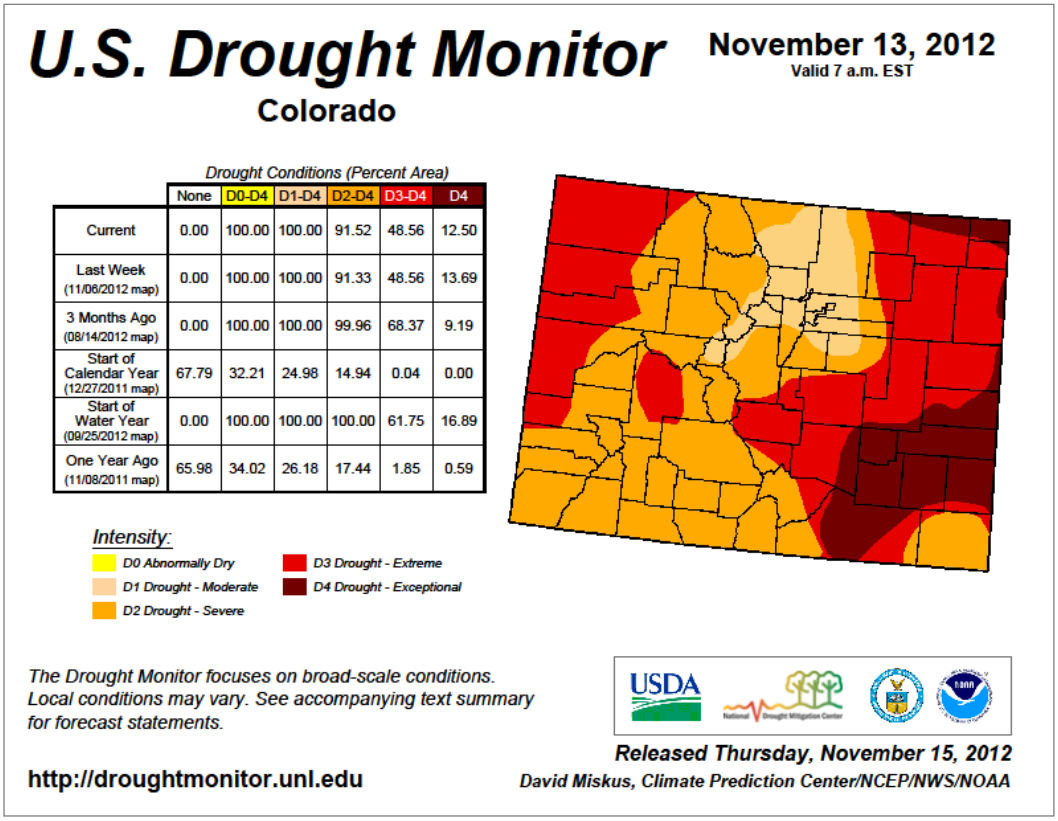

Figure 7. U.S. Drought Monitor from November 13, 2012 indicates stage D3 (Extreme) drought conditions in Garfield and Mesa counties and stage D2 (Severe) in Delta county. These conditions were present during the time frame when the survey was administered. Source: National Drought Mitigation Center http://droughtmonitor.unl.edu/monitor.html.

The most prevalent option for responding to these identified pressures is to leave their field(s) fallow (46 percent of respondents) in times when water is scarce. Secondly, producers would prefer to alter their water management practices (e.g., installing different irrigation equipment or implementing a new irrigation method). Thirty-eight percent of producers would retire as a means of addressing the pressures they face. The least popular response to dealing with the pressures water users are experiencing is to change their type of operation (Figure 8).

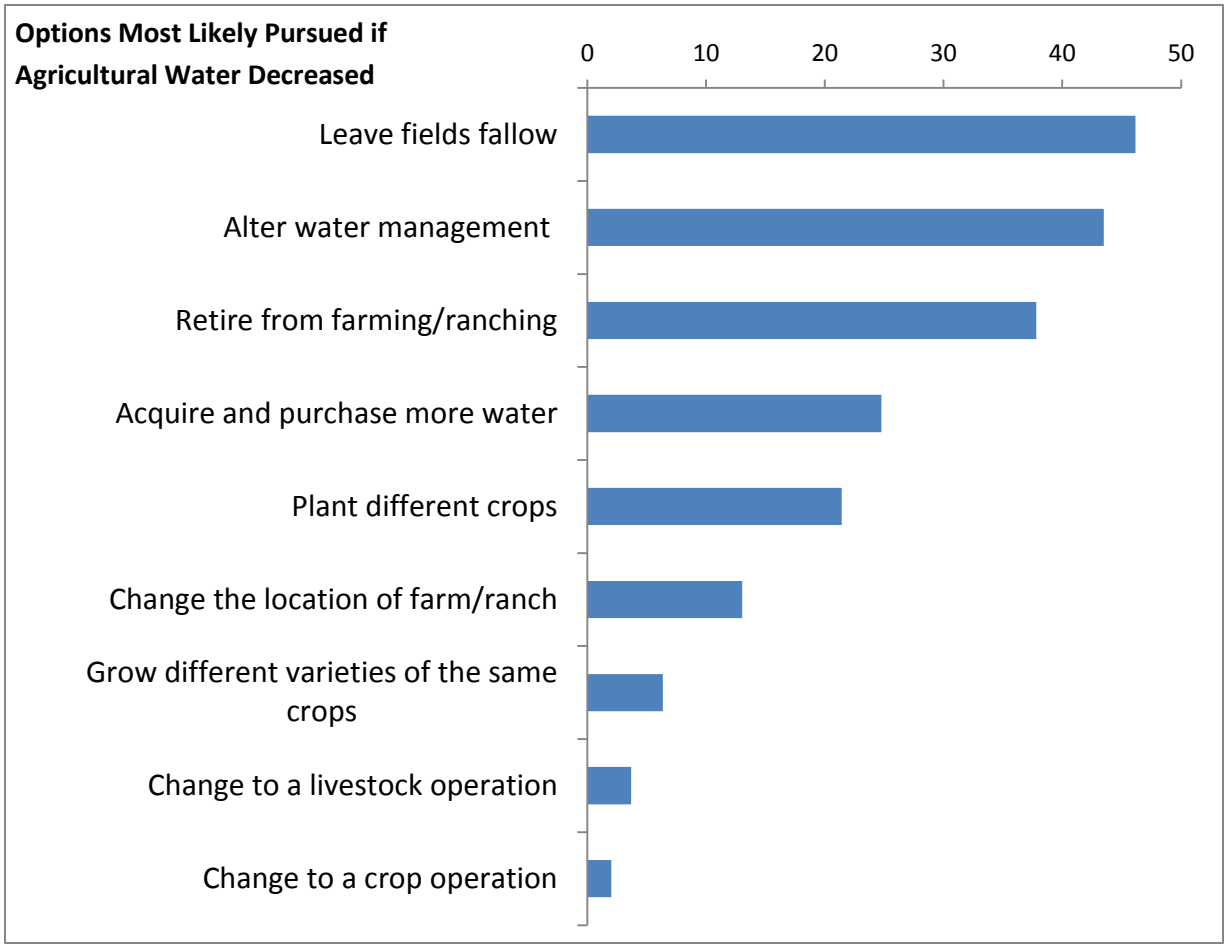

Figure 8. The options most likely pursued by survey respondents if their agricultural water availability were to significantly decrease due to drought or other pressures they might be experiencing. Percent total is greater than 100% because survey respondents were allowed to indicate more than one selection.

Objective 2a: Sixty-nine percent of survey respondents agreed that there will not be sufficient water for agriculture in the future in the CRB *(M*=0.76 on a scale of -2 to +2) and 58 percent feel as though there will not be enough water for agriculture in their area *(M*=0.43). However, only a quarter of respondents agree that they cannot plan ahead since their water supply is uncertain. Respondents only slightly disagree that water will not be affordable in the future to continue their operation (*M*=-.09), but moderately agree that it is too expensive to adopt improved irrigation management practices (*M*=.27) (Table 6).

Table 6. Mean scores and percentages for beliefs about water availability and management.

I believe …[1]	***M***[1]	**Disagree (%)**	**Neither (%)**	**Agree (%)**
there will not be enough water for agriculture ***in the CRB*** in the future [2]	0.76	21	10	69
there will not be enough water for agriculture ***in my area*** in the future [2]	0.43	29	13	58
water availability is not a concern on my farm/ranch at the present	-0.56	64	8	28
I hold senior water rights so I am not usually concerned about shortage of water	-0.31	47	25	28
I can't plan ahead since my water supply is too uncertain	-0.25	45	29	27
water will not be affordable in the future for me to continue my operation	-0.09	36	33	32
it is too expensive to adopt improved irrigation management practices	0.27	30	19	50
my water management is impacted by inadequate irrigation infrastructure	-0.03	39	22	39
the delivery time of my irrigation water is an issue I am concerned about	-0.10	39	29	33

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.
[2] Statement was reverse coded.
Overall percent (%) for Disagree, Neither and Agree may total more than 100% due to rounding.

Objective 2b: Sixty percent of survey respondents believe that policymakers do not understand the importance of agriculture in their area (*M*=-0.46 on a scale of -2 to +2). Almost half of respondents slightly agree that current water law and administration allow them to make the best choices for their operation (*M*=0.19) (Table 7). The sentiment that current water law in Colorado is sufficient was echoed by respondents when they were asked "if you could

change one aspect of water policy (at any level), what would it be"? Several respondents would like to see less federal involvement in the policy process from agencies including the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. Others agreed that policy needs to allow for water to remain in its basin of origin; specifically mentioned, was water transfers from the CRB to the East Slope of Colorado.

Table 7. Mean scores and percentages for beliefs about water policy and law.

I believe …[1]	***M***[1]	**Disagree (%)**	**Neither (%)**	**Agree (%)**
policymakers understand the importance of agriculture in my area	-0.46	60	7	33
current water law and administration allow me to make the best choices for my operation	0.19	29	24	47
there are too many water quality and quantity regulations already in place that make it difficult to manage my water	0.16	28	35	37

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.
Overall percent (%) for Disagree, Neither and Agree may total more than 100% due to rounding.

Objective 2c: Survey respondents were asked to agree or disagree with a series of belief statements regarding water storage. Seventy-two percent believe additional storage projects are needed and should be initiated in order to allow for better utilization of water resources. However, 58 percent feel as though existing storage should be expanded before initiating new storage. Three-quarters of respondents think it is possible for different sectors to work together to develop storage projects that meet multiple needs (Table 8).

Table 8. Mean scores and percentages for beliefs about water storage.

I believe …[1]	***M***[1]	**Disagree (%)**	**Neither (%)**	**Agree (%)**
there is adequate water storage in my area and additional projects are not needed	-0.91	72	11	16
new storage projects should be initiated to allow for better utilization of water	0.79	14	19	67
existing storage should be expanded before initiating new storage	0.63	13	29	58
it is possible for different sectors (such as agriculture, urban, and environmental) to work together to develop storage projects that meet multiple needs	0.84	13	13	75
storage projects are under appreciated for their value as a reliable year-round water supply	1.01	9	16	75
the return on investment is insufficient to pay for the costs of additional water storage	-0.25	43	30	27

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.
Overall percent (%) for Disagree, Neither and Agree may total more than 100% due to rounding.

Objective 3: Survey respondents shared their preferences for meeting future agricultural water supplies in the basin. Water conservation and efficiency were ranked the highest (79 percent) and working towards public policy that supports keeping land and water in agriculture was ranked second highest (76 percent). Alternative water transfer methods (e.g., dry year leases, purchase lease back arrangements, rotational fallowing, and water banking) and deficit irrigation were ranked the lowest (11 percent and five percent respectively) (Table 9).

Table 9. Preferences for meeting future agricultural water demands. Percent total is greater than 100% because survey respondents were allowed to indicate more than one selection.

Preference	**Percent (%)**
Water conservation and efficiency	79
Public policy that supports keeping land and water in agriculture	76
New storage infrastructure	46
Expansion of existing storage infrastructure	45
Improved agricultural management practices	39
Technological innovations	35
Alternative water transfer methods	11
Deficit irrigation	5

Objective 4: Survey respondents were presented with a series of belief statements about the permanent and temporary transfer of agricultural water to non-agricultural water uses. They were asked to indicate the extent to which they agreed or disagreed with the statements based on a scale of -2 (strongly disagree) to +2 (strongly agree). Results indicated that 87 percent of respondents are strongly opposed to the *permanent* transfer of water from agriculture to any other use and 76 percent are strongly opposed to the *temporary* transfer of water from agriculture to any other use. Ten percent have been involved in a permanent or

temporary transfer and only four percent are considering (or have considered) a transfer of their agricultural water right to a non-agricultural water user. Sixty-eight percent are concerned about the possibility of losing their water right, even in a *temporary* transfer arrangement (Table 10). The correlation was not statistically significant for any of the five belief statements regarding agricultural water transfers and a respondent's age (measured in years), or their gross value of agricultural products sold (measured in dollars from $0.00 to over $1 million in products sold from primary operation in 2011) (Table 11).

Table 10. Mean scores and percentages for beliefs towards water transfers.

I ...[1]	***M***[1]	**Disagree (%)**	**Neither (%)**	**Agree (%)**
am opposed to the ***permanent*** transfer of water from agriculture to any other use	1.47	8	5	87
am opposed to the ***temporary*** transfer of water from agriculture to any other use	1.07	13	11	76
have been involved in a permanent or temporary water transfer	-0.47	34	56	10
am considering (or have considered) a permanent or temporary transfer of my agricultural water right to a non-agricultural water user	-1.21	67	29	4
am concerned about the possibility of losing my water right, even in a temporary transfer arrangement	0.87	13	19	68

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.
Overall percent (%) for Disagree, Neither and Agree may total more than 100% due to rounding.

Table 11. Correlation between belief statements towards water transfers (dependent variable) and (1) age and (2) gross value of products sold in 2011 (independent variables).

			Age (years)		Gross Value of Products Sold ($)	
I…	*M*[1]	*SD*	*r*	*p*	*r*	*p*
am opposed to the ***permanent*** transfer of water from agriculture to any other use	1.46	0.998	-.087	.147	-.029	.649
am opposed to the ***temporary*** transfer of water from agriculture to any other use	1.07	1.151	-.086	.153	-.092	.144
have been involved in a permanent or temporary water transfer	-0.47	1.128	.068	.256	-.023	.716
am considering (or have considered) a permanent or temporary transfer of my agricultural water right to a non- agricultural water user	-1.20	1.053	-.022	.710	-.071	.259
am concerned about the possibility of losing my water right, even in a temporary transfer arrangement	0.82	1.244	-.008	.888	-.037	.552

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.

When the belief statements were treated as the dependent variable and age was sub-divided into five groups as the independent variable (Table 12), 30-40 and 40-50 year olds held a higher mean score of opposing transfers for temporary arrangements. Fifty-one to sixty year olds are less likely to consider a transfer, followed by the oldest age group. There was a statistical difference between age and "I have been involved in a permanent or temporary transfer arrangement" (F=2.55, p=.039, *Eta* = .19). When testing for homogeneity of variances, equal variances were not assumed. There was no statistical difference between age groups after running post-hoc tests.

Table 12. Belief statements towards water transfers (dependent variable) and age by group (independent variable).

	Age Group							
I…[1]	*30-40*	*41-50*	*51-60*	*61-71*	*71-91*	*F*	*p*	*Eta*
am opposed to the ***permanent*** transfer of water from agriculture to any other use	1.69	1.52	1.54	1.36	1.43	.603	.661	.092
am opposed to the ***temporary*** transfer of water from agriculture to any other use	1.31	1.18	1.08	1.11	0.79	.903	.463	.113
am concerned about the possibility of losing my water right, even in a temporary transfer arrangement	0.69	1.09	0.79	0.78	0.91	.511	.727	.086
am considering (or have considered) a transfer of my water right to a non-agricultural water user	-1.08	-1.00	-1.31	-1.17	-1.28	.649	.628	.096
have been involved in a permanent/temporary water transfer	-0.77	-0.19	-0.72	-0.29	-0.39	2.55*	.039	.19

* Significant at *p*=.05 level

[1]Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree).

The top three barriers to *temporary* water transfers between agricultural and non-agricultural water users are: (1) lack of information regarding the advantages and disadvantages of water transfers (49 percent), (2) state regulations, policies and/or laws (38 percent), and (3) a temporary transfer doesn't make sense for an overall financial or management perspective (36 percent) (Table 13).

Table 13. Identified barriers to *temporary* water transfers between agricultural and non-agricultural water users. Percent total is greater than 100% because survey respondents were allowed to indicate more than one selection.

Barrier	**Percent (%)**
Lack of information regarding the advantages and disadvantages of water transfers	49
State regulations, policies, and/or laws	38
A temporary transfer doesn't make sense from an overall financial or management perspective	36
Length and complexity of administrative process	33
Federal regulations, policies, and/or laws	31
The amount of money offered to farmers and ranchers for their water	30
High transaction costs (e.g., administrative fees, legal and engineering costs)	23
None of the above	9

Objective 5: Respondents indicated the extent to which they agreed or disagreed to a series of statements about their current level of involvement and willingness to partner with other agricultural and non-agricultural stakeholders (such as urban and environmental) to address agricultural water issues. The data indicate that a large portion of respondents (59 percent) believe agricultural water users need to coordinate with other sectors in order to stretch limited water supplies (Table 14). In fact, nearly 70 percent believe agricultural and environmental stakeholders share many of the same interests, such as preserving open space

and wildlife habitat, and think they need to find a way to work together to manage water supplies for mutual benefit. Fifty-four percent are active in making decisions in their local irrigation district/ditch company and over half of respondents feel as though farmers and ranchers in their area have been able to effectively organize and cooperate with each other to deal with existing and/or anticipated pressures on their agricultural water. Though, only 24 percent have been involved in some type of collaborative process with non-agricultural stakeholders.

Table 14. Mean scores and percentages for respondents' current level of involvement and willingness to work cooperatively with other agricultural and non-agricultural stakeholders.

I believe …[1]	***M***[1]	**Disagree (%)**	**Neither (%)**	**Agree (%)**
the agricultural sector should coordinate with other sectors to stretch limited water supplies	0.19	30	18	51
agricultural and environmental stakeholders share many of the same interests such as open space and wildlife habitat. We need to find a way to work together to manage our water supplies for mutual benefit.	0.43	23	23	54
farmers and ranchers in my area have been able to effectively cooperate with each other to deal with pressures on our agricultural water	0.36	28	14	59
I am active in making decisions in my local irrigation district/ditch company	0.72	20	12	69
I have been involved in some type of collaborative process with non-agricultural stakeholders	-0.30	41	36	24

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.
Overall percent (%) for Disagree, Neither and Agree may total more than 100% due to rounding.

Respondents who are active in making decisions in their local irrigation district/ditch company is positively correlated with gross value of products sold (r=.232, p=<.001). Other belief statements regarding cooperative partnerships were not found to be statistically significant with age or gross value of products sold (Table 15). Thirty to forty year olds feel most strongly that the agricultural sector should coordinate with other sectors to stretch limited water supplies and that agricultural and environmental stakeholders share many of the same interests and need to find a way to work together better to manage water supplies for mutual benefit. The oldest age group (71-91 year olds) were the least likely to have been involved in some type of collaborative process with non-agricultural stakeholders (Table 16).

Table 15. Belief statements towards cooperative partnerships with other stakeholders (dependent variable), age, and gross value of products sold in 2011 (independent variables).

			Age (years)		Gross Value of Products Sold ($)	
I believe…	*M*[1]	*SD*	*r*	*p*	*r*	*p*
the agricultural sector should coordinate with other sectors to stretch limited water supplies	0.18	1.167	-.017	0.787	-.057	.367
agricultural and environmental stakeholders share many of the same interests such as open space and wildlife habitat. We need to find a way to work together to manage our water supplies for mutual benefit.	0.40	1.212	-.041	0.507	.232*	<.001
farmers and ranchers in my area have been able to effectively cooperate with each other to deal with pressures on our agricultural water	0.41	1.191	-.026	0.674	-.004	.946
I am active in making decisions in my local irrigation district/ditch company	0.77	1.208	-.013	0.828	-.046	.468
I have been involved in some type of collaborative process with non-agricultural stakeholders	-0.31	1.225	-.051	0.407	.098	.122

* correlation is significant at the 0.01 level

[1] Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree). *M* reflects the mean score on a -2 to +2 scale.

Table 16. Belief statements towards cooperative partnerships with other stakeholders (dependent variable) and age by group (independent variable).

	Age Group							
I believe…[1]	*30-40*	*41-50*	*51-60*	*61-71*	*71-91*	*F*	*p*	*Eta*
the agricultural sector should coordinate with other sectors to stretch limited water supplies	0.92	0.44	0.24	0.47	0.4	1.104	.355	.126
agricultural and environmental stakeholders share many of the same interests such as open space and wildlife habitat. We need to find a way to work together to manage our water supplies for mutual benefit.	1.00	0.53	0.84	0.71	0.81	0.587	.672	.092
farmers and ranchers in my area have been able to effectively cooperate with each other to deal with pressures on our agricultural water	0.23	0.13	0.2	0.23	0.07	0.161	.958	.048
I am active in making decisions in my local irrigation district/ditch company	0.46	0.26	0.54	0.39	0.33	0.455	.769	.081
I have been involved in some type of collaborative process with non-agricultural stakeholders	-0.31	0	-0.43	-0.18	-0.52	-0.31	.293	.135

[1]Response ratings were coded on a 5 point scale ranging from -2 (strongly disagree) to +2 (strongly agree).

The three main barriers reported that prevent cooperation between different water users to develop solutions that address competing demands are: (1) diverse views about how water should be allocated or managed, (2) competition for resources (e.g., land, water, and

capital), and (3) conflicting federal, state, and local water policies (Table 15). A majority of the respondents agreed that cooperation between agricultural and non-agricultural water stakeholders is best accomplished at the water district or basin level (31 percent and 21 percent respectively). Only 12 percent agree that cooperation is most effective at the state level.

Table 17. Barriers to cooperation between different water users for developing solutions that address competing demands. Percent total is greater than 100% because survey respondents were allowed to indicate more than one selection.

Barrier	**Percent (%)**
Diverse views about how water should be allocated or managed	75
Competition for resources (for example, land, water, and capital)	52
Conflicting federal, state, and local water policies	37
Lack of effective leadership to get organized	35
Some parties end up resorting to litigation	34
Limited financial resources	33
Different types of water rights holders (for example, senior, junior)	33
Different types of irrigation and production practices	32
Different types of water users (for example, surface water, groundwater)	30
Location (in the state, basin, valley, etc.)	30
Limited time	18

Open Ended-Responses

Respondents were provided with the opportunity to offer comments throughout the survey. The following paragraphs include remarks towards the issues that were commonly mentioned.

The concern that was raised most frequently is that our society is not prioritizing the best use of our water resources. Is our priority to have a reliable and safe food supply and open space, or is it green lawns and golf courses? Respondents indicated that once non-agricultural sectors demonstrate that they are using their water in the most efficient and productive way, they will then be open to discussions regarding the use of agricultural water for other beneficial uses. One respondent stated "I know I will be pushed out of my ranch operation within the next 10 years if water is not allocated to farm and ranch operations BEFORE it is allowed to be used to water yards." A second respondent stated "When conservation measures (i.e. low flow toilets, xeriscaping, fixing the leaks, etc.) have been mandated, implemented and exhausted, then talk to me about transferring water. I am unlikely to be receptive to pleas for additional water to fill swimming pools and hot tubs, or to keep Kentucky Bluegrass alive in the desert."

Many respondents voiced their dissatisfaction towards environmental regulations and their hindrance to developing further water storage for agricultural purposes. Specifically mentioned were the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. They feel as though these agencies' policies should not undermine local decision making. A survey respondent stated "The environmental groups need to also be willing to work with us, and in my experience, that is simply not the case. They have a very extreme agenda and they are quite unwilling to compromise in the least."

Water transfers from the West Slope of Colorado to the East Slope of Colorado were mentioned several times by survey respondents. The concerns of transferring water out of its basin of origin are significant and the survey respondents are not supportive of this practice. Specific remarks include "I think Colorado has the best water laws in the USA. I think the policy of coveting western slope water, a resource that is already over appropriated, by the eastern slope needs to stop" and "I have lived in the Rifle, CO area all my life, my feelings are that if Denver needs more water, dry up the North Platte, not the Colorado River. The flow of the Colorado River continually gets less each year. I know that snow and rain fall has a factor, but Denver and the Front Range is the most contributing factor to this problem. The Colorado River is to flow to the West not the East".

A fourth concern that was expressed was the increasing demand of water used for oil and gas development and its potential impact on water quality. Some respondents feel as though water used for oil shale development could eventually consume the majority of water that is currently used for irrigation. Specifically mentioned by one survey respondent was "The biggest threat to our water is oil and gas development, followed closely by urban sprawl and attempts to buy water and move it from the western slope to the eastern slope. We need this to be stopped completely before it destroys agriculture in our area."

Water quality issues, mainly increased salinity and silt concentrations were additional concerns expressed by respondents. A survey participant stated "The salinity of the water is getting worse, with the drought, and the increased usage from the eastern slope. Since there is so much sulphur in the water from Glenwood Springs, and reduced flows in the river, we will

continually see the water quality go down and affect our agricultural practices in a negative way."

The comments provided regarding the future of agriculture in the CRB were wide-ranging from hopeful to doubtful. The following are comments received by survey respondents:

- The Colorado River Basin is in serious trouble. For far too long we've fooled ourselves about how much water was actually available for all the uses that are demanded on by numerous entities. The future looks very bleak without a day of reckoning that addresses actual water available versus water that is demanded or filed on and expected to be there upon demand."
- "Agriculture is paramount for the survival of the society. Until there are shortages and empty store shelves, the public will not fully appreciate this."
- "As a fruit producer I do not have many options, just devastation."
- "New people in my area do not understand the issues surrounding water in the West."

Discussion and Conclusions

In summary, the results of this study indicate that agricultural water users face a myriad of pressures on their water supplies with drought and urban growth topping the list. The data indicates strong opposition towards agricultural water transfers, even those of temporary nature due to the concern of possibly losing their water right. A majority of participants agree that there will not be enough water for agriculture in their area, or in the CRB. Most agree that more water storage is needed to address uncertainty; however, new storage projects should be expanded before initiating new projects. Overall, agricultural water users agree that they need to partner with other non-agricultural water users (preferably at the district or basin level) in

order to address the challenges they face or will face in the future. As a whole, there doesn't seem to be areas of strong disagreement among the survey population; though, as expected, there is some disagreement between individuals on a majority of the topics presented in the survey.

Implications

The implications of this study are threefold. First, the exploratory nature of this study is a good starting point to learn more about CRB agricultural water users' characteristics, differences, and commonalities. Knowing this information is important for developing a basic understanding of the issues and challenges they face and potential solutions. Furthermore, by sharing information about what agricultural water users are thinking and feeling with non-agricultural stakeholders, it can help educate and inform those who are not familiar with the viewpoints and preferences of the agriculture sector. For example, agricultural water users have indicated that they are not supportive of the temporary or permanent transfer of water to other uses. Consequently, there is an opportunity for future research and to share the advantages and disadvantages of transfers with various types of water users, including agricultural water users themselves. This information can help non-agricultural water stakeholders make informed decisions about how to meet their needs while avoiding the challenges that are associated with the permanent dry up of irrigated land. In addition, the farmer/rancher can benefit by minimizing uncertainties of limited water supplies.

Secondly, the data from this study illustrates that there are strong beliefs held by agricultural water users on various issues. When implementing changes in policy, water law, or developing cooperative partnerships with other water stakeholders, it will be extremely

important to consider their salient beliefs throughout the process. Salient beliefs held by agricultural water users who participated in the survey include:

- there will not be enough water in the CRB in the future
- their services are valued by the general public and agriculture still plays a central role in their area
- they are opposed to the permanent and temporary transfer of water from agriculture to any other use
- they are concerned about the possibility of losing their water right, even in a temporary transfer arrangement
- it is possible for water users to work together to develop storage projects that meet multiple needs
- agricultural and environmental stakeholders share many of the same interests, such as preserving open space and wildlife habitat, and they should find a way to work together to manage water supplies for mutual benefit

Thirdly, multiple types of water stakeholders can benefit from the information found in this study by using it for:

- gauging support for or against management decisions and policies
- predicting and mitigating conflict among competing users
- developing approaches for collaborative partnerships
- a basis for future research opportunities

Limitations

Like most studies, this project faced the challenges of limited time and financial resources. To help address these limitations, an online survey was chosen to minimize printing and mailing costs. However, a mail survey or a mixed methods approach (combined internet and mail delivery methods) may have improved the response rate. Nonetheless, the online survey format assisted with seamless data entry and transfer.

When the survey data is compared to the demographics of USDA-NASS 2007 Census of Agriculture county level data, there were areas where the sample was consistent. Though, the findings from the survey are not completely generalizable to the entire population in the study area due to the low response rate.

In addition to Delta, Garfield, and Mesa counties, the survey was also administered to 532 Colorado River water users in three counties in Arizona. The response rate from the Arizona population was approximately three percent. This low response rate may be due to 1) the sensitive nature of the subject, as the sample population may not want to share information related to their water to another state, 2) while the survey was administered during November and December, with hopes of avoiding harvest season, the time frame may have been a difficult for those in warmer climates to participate in the study, and 3) limited access or ability to use the Internet to complete the survey.

Moreover, the survey would have been more concise by eliminating unnecessary questions. Although only a few survey participants noted that the survey was too long, the survey did cover several topics and created confusion among participants and the research team. An approach that: (1) incorporated a single research goal and (2) identified the statistical

analysis needed to answer the research question(s) before administering the survey would have reduced confusion and improved the interpretation of the data. Moreover, a more systematic approach to developing the survey demographic questions would have improved their interpretation and applicability during data analysis.

Future Research

This study presented some interesting considerations for future research. First, exploring how East Slope Coloradoans feel about water transfers coming from the West Slope of Colorado would be of interest. Secondly, it would be worthwhile to survey agricultural water managers, along with other water users including the municipal, industrial, and environmental sectors to compare their beliefs and preferences and further expand on the 2006 Colorado Institute of Public Policy study findings.

Given that the data from this survey indicate that agricultural water users are not interested in temporary water transfers warrants further analysis and discussion. Since water for additional demands is projected to come from agriculture, it will be important to better understand the incentives, social, legal, economic barriers, and potential impacts of these transfers. Survey respondents expressed that they would like more information on the advantages and disadvantages of temporary water transfers; therefore, a need has been identified to provide this type of information. Furthermore, temporary water transfers do require cooperative partnerships. Survey data shows that agricultural water users are interested in working with others (environmental stakeholders were specifically identified) to better manage water supplies for mutual benefit. Continuation of the *Addressing Water for Agriculture in the Colorado River Basin* project is expected to identify opportunities for pilot

projects that focus on collaborative work between agricultural and non-agricultural water stakeholders.

The survey included a question concerning how land-grant universities (LGU) can best assist farmers and ranchers with the challenges they face. The data largely indicated that there is a need for LGUs to educate the general public about agriculture water use (83 percent) and to provide research, outreach, and assistance with agricultural water conservation (64 percent). In addition, over half of the respondents (56 percent) felt LGUs should increase their efforts to share what has been successful to collaboratively address water issues. These responses indicate a need for additional research, outreach, and education for *both* agricultural and non-agricultural water stakeholders.

Meanwhile, future research focused on the barriers of future generations pursuing careers in farming or ranching is critical. Almost half of the respondents indicated that the next generation of their family is planning to continue their operation in the future; however, in order to ensure subsequent generations continue the operation is of significant importance. Since there was a positive correlation between future generations continuing their family's operation and the number of years the operation has been in production, there is indication that agriculture will continue in the basin for years to come. However, new people exploring agricultural professions in the region may not be the case.

There is a lot of work to be done to address the challenges that the agricultural sector is facing, especially with regard to water allocation, its management, and use. This study is one step towards working with key water stakeholders to address the issues that can create undesirable impacts to irrigated agriculture in the CRB.

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Appendix A

Overview of Addressing Water for Agriculture in the Colorado River Basin Project

Addressing Water for Agriculture in the Colorado River Basin
Planning for Water Research, Extension, and Education

USDA Planning Grant Project 2011-2013
Led by Colorado Water Institute at Colorado State University
Project Team: Water institute directors and university faculty from the 7 U.S. Colorado River Basin States

A two year planning grant funded to CSU by USDA-NIFA
Intended to prepare the way for subsequent funding for identified pilot projects and other initiatives

The purpose of this grant is to:

- **Understand what agricultural water users and managers in the CRB think and how they feel about the status of water for agriculture.** Is it under pressure? If so, from where, and what do they want to do about it? Are they interested in working with other sectors to help other sectors get their needs met as a means of reducing the pressure on ag water? If so, under what terms?
- **Identify potential partners and opportunities** to help agricultural water users and managers meet their goals for their water.
- **Identify promising pilot projects or other initiatives** that could help ag water users and managers address obstacles (legal, institutional, technical, social and other) that may stand in the way of identified opportunities.
- **Prepare a subsequent multi-year project proposal or multiple smaller proposals** to implement identified pilot projects or initiatives.

Project Objectives/Corresponding Deliverables

Objective 1: Gain understanding and identify concerns, opportunities and impediments via **interviews, survey, and workshops**

Objective 2: Develop **GIS layers pinpointing the institutional framework** for agricultural water management via extensive data collection and participatory mapping exercises

Objective 3: Foster communication via interactive **website**

Objective 4: Prepare a **multi-year proposal (or smaller proposals) to implement pilot projects** or initiatives and provide an integrated approach to research, teaching, outreach and policy engagement

Project Director is Reagan Waskom, Colorado Water Institute, CSU. He will lead the Project Team assisted by CWI research associates Julie Kallenberger, MaryLou Smith and Faith Sternlieb.

Other members of the Project Team include:

- Troy Bauder, **Colorado** State University
- Sam Fernald, **New Mexico** Water Resources Research Institute
- Dave Kreamer, University of **Nevada**, Las Vegas
- Melinda Laituri, **Colorado** State University
- Mac McKee, **Utah** Center for Water Resources Research
- Sharon Megdal**,** Water Resources Research Center, University of **Arizona**
- Ginger Paige, University of **Wyoming**
- Doug Parker, **California** Institute for Water Resources, University of California
- Peter Taylor, **Colorado** State University

Appendix B

Survey Recruitment Announcement

Addressing Water for Agriculture in the Colorado River Basin

What do Agricultural Producers Think about the Future of Water for Irrigated Agriculture?

Access Survey at: www.CRBagwater.colostate.edu

Please participate in this survey and let your voice be heard!

Colorado Water Institute
PO Box 150969
Lakewood, CO 80215-9915

Address Service Requested

Addressing Water for Agriculture in the Colorado River Basin

FIRST-CLASS MAIL
PRESORTED
US POSTAGE PAID
Golden, CO
PERMIT NO. 896

You have been randomly selected to participate in a survey of producers who use Colorado River water for irrigated agriculture. Your insights are important to better understand the future of water for agriculture in the Colorado River Basin.

Simply type the following link into your Internet browser to access the survey:

www.surveymonkey.com/s/CRBwater

Please respond immediately to include your opinions in this survey

This project is funded by the USDA and is led by the following land-grant universities: Colorado State University, University of Arizona, University of California, University of Nevada, New Mexico State University, Utah State University, & University of Wyoming

Appendix C

Stakeholder Interview Questionnaire

Interview Guide for Addressing Agricultural Water in the Colorado River Basin Project

1. First, we would like to talk to you a bit about your own agricultural operations. Can you describe to us what kind of farming or ranching you do and how you get the water you need for those activities?

2. On the basis of your experience, what would you say are the most important changes that have occurred in recent years or are now occurring in farming and ranching in your area? What implications do these changes have for how you use water?

3. To what extent have you or other farmers in your area been able to organize and cooperate with each other to deal with the changes we've been talking about?

4. To what extent have you or other farmers in your area been able to organize and cooperate with other groups, such as urban, environmental, recreational and others, to deal with these changes?

5. How do you see the future of your own farm operation and agriculture more generally in your area, especially with respect to water?

6. Given the kinds of agricultural and water issues we've been talking about, what needs to happen, in your view, to make it possible for farmers and ranchers in your area to make the decisions related to water that are best for their farms and for their communities?

7. On the basis of your experience, how might land-grant universities such as [fill in participating state land-grant institution] be supportive of farmers and ranchers and their water-related needs in your area?

(Note: these broad questions may be reordered in any interview, according to the circumstances and the interviewee's interests.)

Probing and Follow-Up Questions

(Note: not all of these sub-questions will be asked. They will be used as relevant and necessary, depending on where the discussion goes in each interview.)

1. First, we would like to talk to you a bit about your own agricultural operations. Can you describe to us what kind of farming or ranching you do and how you get the water you need for your activities?

A. What crops/animals and other products do you produce?

B. To what extent do you irrigate? Where (and from whom) does your water come from?
C. How long have you been farming/ranching in this area?

2. On the basis of your experience, what would you say are the most important changes that have occurred in recent years or are now occurring in farming and ranching in your area? Do those changes have implications for how you use water?

A. What changes have you seen or are seeing in your production operations and where have those changes occurred? (market conditions, profitability issues, land values, other)
B. Would you say that your agricultural water is under pressure? What are these pressures and where are they coming from?
C. Have you seen important demographic changes in your area, with new kinds of people moving in?
D. Do these new groups have an impact on how you operate your farm/ranch and how you use your water?
E. Would you say that there have been important cultural changes in your area that affect how you operate your farm/ranch and how you use your water?

3. To what extent have you or other farmers in your area been able to organize and cooperate with each other to deal with the changes we've been talking about?

A. Are you active in your local irrigation district/ditch?
B. Do you know if your irrigation district/ditch company has been active in helping farmers/ranchers do with the changes we've been talking about? What strategies have they been pursuing?
C. How successful have farmers/ranchers been in working together cooperatively with each other to deal with important changes in agriculture in your area?
D. What challenges have farmers and ranchers faced in working cooperatively with each other? What brings people to the table and what keeps them away? (Upper and Lower basin, Colorado West Slope/Colorado Front Range; Junior/Senior water rights holders; groundwater/surface water users; different production strategies; full-time/part-time etc.)
E. At what level or scale do you think such cooperation might be most appropriate? (District, ditch, lateral, sub-basin, basin, statewide?)
F. Do you see any opportunities for cooperation among agricultural producers that aren't really being used much yet?

4. To what extent have you or other farmers in your area been able to organize and cooperate with other groups, such as urban, environmental, recreational and others, to deal with these changes?

A. Have there been efforts in your area to sell, exchange, lease, or share water between agriculture/ranching and other groups, such as urban utilities, environmental or

recreation groups? Who have you cooperated with (what groups or government entities have you worked with or hope to work with in the future? From your perspective, how have those efforts worked out?

B. Have there been any efforts in your area to coordinate water management cooperatively with other water user groups? From your perspective, how have those efforts worked out?
C. From your perspective, to what extent do you think effective cooperation between agriculture and other water user groups can be successful? What might be the most important barriers to such cooperation, or reasons why it's hard for such cooperation to be successful? What brings people to the table and what keeps them away?
D. At what level or scale do you think such cooperation might be best appropriate? (District, ditch, lateral, sub-basin, basin, statewide?)
E. Do you see any opportunities for cooperation across different sectors that aren't really being used yet?

5. How do you see the future of your own farm operation and agriculture more generally in your area, especially with respect to water?'

A. Do you feel that your production operation is likely to change, either for better or for worse?
B. Do you or your children plan to continue your farming in future or do you think that you may want to retire and do something else?
C. Do you think how you are able to use water in your production operation is likely to change in the future?
D. What does the future hold, from your perspective, for agriculture and water more generally in your area?
E. Are you optimistic about the future, or pessimistic? How do you see the future?

6. Given the kinds of agricultural and water issues we've been talking about, what needs to happen, in your view, to make it possible for farmers and ranchers in your area to make the decisions related to water that are best for their farms and for their communities?

A. Would you say that certain things need to happen to help farmers/ranchers stay in agriculture?
B. Would you say that farmers/ranchers need to be able to sell their land and operations for a fair price, if they choose to leave farming/ranching?
C. What kinds of policy or legal, and/or administrative support are needed for farmers/ranchers?
D. What kinds of changes might be necessary in how water is handled to support farmers/ranchers appropriately?

7. On the basis of your experience, how might land-grant universities such as [fill in participating state land-grant institution] be supportive of farmers and ranchers and their water-related needs in your area ?

A. What kinds of research, education and/or outreach might be most helpful to you and other farmers/ranchers in your area?
B. Are there pilot activities or experimentation that you think universities might carry out that would be helpful to you and other farmers/ranchers?
C. Could land grant universities provide education and training that would be useful to you and other farmers/ranchers?
D. Do you think land-grant universities could be a place where different agricultural water stakeholders might come together to discuss issues that both unite and separate them?
E. Have there been any land-grant University activities in your past experience that have been particularly interesting and helpful? For example?

Appendix D

Survey Instrument

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Welcome

Dear Agricultural Water User,

We would like your help. You have been randomly selected from a national agricultural statistic database to provide your insights on the future of water for agriculture in the Colorado River Basin. The USDA has funded this study to better understand:

- what you think about the current and future state of your water supplies and the associated challenges you are or might be facing
- your opinions as how to address competing water demands and whether there might be opportunities to find solutions with other stakeholders
- what changes in water policy would help you to make decisions that are best for your operation and community
- your interest and involvement in temporary water transfers or other mechanisms that may be useful in keeping irrigated agriculture viable in the Colorado River Basin
- whether you feel land-grant universities can better assist you with the agricultural water challenges you confront

The respondent to this survey should be the person responsible for making water management decisions on your farm/ranch. If you are not this person, we kindly request that you pass it along to the appropriate person in your operation. No personal or identifiable information will be collected and your responses will be summarized with others' responses in our reports.

The survey will take no more than 30 minutes to complete. You are encouraged to complete the entire survey; however, you may choose to skip any questions that you do not wish to answer. Results from this survey will be summarized and posted on the project's website www.CRBagwater.colostate.edu in the spring of 2013.

Thank you in advance for your time and participation.

Sincerely,

Dr. Reagan Waskom
Director, Colorado Water Institute
Colorado State University
reagan.waskom@colostate.edu

Dr. Sharon B. Megdal
Director, Arizona Water Resources Research Center
University of Arizona

Julie Kallenberger
Research Associate, Colorado Water Institute
Colorado State University
julie.kallenberger@colostate.edu

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

If you have questions about your rights as a participant in this study, please contact Janell Barker, CSU Institutional Review Board Coordinator at 970-491-1655 or at janell.barker@colostate.edu

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

1. Does your operation use water from the Colorado River system for agricultural purposes?

◯ Yes

◯ No (by selecting 'No' you will be able to exit the survey upon clicking the NEXT button below).

◯ I don't know

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Opinions About Irrigated Agriculture

2. Your opinions about agriculture on your farm, in your community, and throughout the Colorado River Basin are important to address agricultural water challenges. Please indicate the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
As a farmer/rancher, I believe my services are valued by the general public	○	○	○	○	○
Agriculture no longer plays a central role in my area	○	○	○	○	○
The influx of new people in my area is influencing how I manage my water	○	○	○	○	○
There is another generation of my family that plans to continue farming/ranching in the future	○	○	○	○	○

Please share any comments you may have regarding agricultural water or agriculture in general

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Pressures on Agricultural Water

3. Please check any of the following boxes that identify pressures you believe may be impacting the way you farm/ranch.

- ☐ Local, state, and/or federal water policies and regulations
- ☐ Lack of water storage
- ☐ Drought
- ☐ Seasonal weather variation (for example, earlier planting of crops, changes in the time of water delivery)
- ☐ Land use changes
- ☐ Growing urban and suburban areas
- ☐ Mining and energy development
- ☐ Industry water demands
- ☐ Recreational water demands (for example, fishing and rafting)
- ☐ Environmental water demands (including endangered species)
- ☐ Declining groundwater levels
- ☐ Neighbor farmers/ranchers leaving agricultural production
- ☐ Other water users that are senior in priority to me
- ☐ I am not feeling significant pressure on my agricultural water

Other (please specify)

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

4. If your agricultural water availability were to significantly decrease due to drought or other pressures you might be experiencing, which of the following options would you most likely pursue (you can select more than one)?

- ☐ Plant different crops
- ☐ Grow different varieties of the same crops
- ☐ Leave fields fallow
- ☐ Alter water management (for example, through different irrigation equipment or method)
- ☐ Explore opportunities to acquire and purchase more water
- ☐ Change to a livestock operation
- ☐ Change to a crop operation
- ☐ Change the location of farm/ranch (buy or lease/rent land elsewhere)
- ☐ Retire from farming/ranching
- ☐ None of the above

Other (please specify)

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Opinions About Irrigation Water Security and Management

5. Please share your opinions about your irrigation water security and management by indicating the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
There will be enough water for agriculture in the Colorado River Basin in the future	○	○	○	○	○
There will be enough water for agriculture in my area in the future	○	○	○	○	○
At present, water availability is not a concern on my farm/ranch	○	○	○	○	○
I hold senior water rights so I am not usually concerned about a shortage of water	○	○	○	○	○
I can't plan ahead since my water supply is too uncertain	○	○	○	○	○
Water will not be affordable in the future for me to continue my operation	○	○	○	○	○
It is too expensive to adopt improved irrigation management practices	○	○	○	○	○
My water management is impacted by inadequate irrigation infrastructure	○	○	○	○	○
The delivery time of my irrigation water is an issue I am concerned about	○	○	○	○	○

Please share any comments you may have regarding the security of your irrigation water

6. What water management improvements have you made (if any) at your operation within the past five years (for example, new/different irrigation scheduling, equipment, diversion structures, or monitoring devices)?

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Meeting Future Water Demands

7. When you think about future agricultural water supplies in your area, what mechanism(s) do you think farmers/ranchers should most rely on to help keep irrigated agriculture viable?

- ☐ New storage infrastructure
- ☐ Expansion of existing storage infrastructure
- ☐ Water conservation and efficiency
- ☐ Deficit irrigation
- ☐ Public policy that supports keeping land and water in agriculture
- ☐ Alternative water transfer methods (for example, dry year leases, purchase lease back arrangements, rotational fallowing, water banking)
- ☐ Technological innovations
- ☐ Improved agricultural management practices
- ☐ None of the above

Other (please specify)

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Opinions About Water Storage

8. Please share your opinions about water storage by indicating the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
There is adequate water storage in my area and additional projects are not needed	○	○	○	○	○
New storage projects should be initiated to allow for better utilization of the water	○	○	○	○	○
Existing storage should be expanded before initiating new storage	○	○	○	○	○
It is possible for different sectors (such as agriculture, urban, and environmental) to work together to develop storage projects that meet multiple needs	○	○	○	○	○
Storage projects are under appreciated for their value as a reliable year-round water supply	○	○	○	○	○
The return on investment is insufficient to pay for the costs of additional water storage	○	○	○	○	○

Please share any comments you may have regarding water storage

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Opinions About Water Transfers

9. Please share your opinions about the permanent or temporary transfer of agricultural water to non-agricultural water uses by indicating the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
I am opposed to the permanent transfer of water from agriculture to any other use	○	○	○	○	○
I am opposed to the temporary transfer of water from agriculture to any other use	○	○	○	○	○
I have been involved in a permanent or temporary water transfer	○	○	○	○	○
I am considering (or have considered) a permanent or temporary transfer of my agricultural water right to a non-agricultural water user	○	○	○	○	○
I am concerned about the possibility of losing my water right, even in a temporary transfer arrangement	○	○	○	○	○

Please share any comments you may have regarding water transfers

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

10. What do you think are the main barriers to temporary water transfers between agricultural and non-agricultural water users?

- ☐ State regulations, policies, and/or laws
- ☐ Federal regulations, policies, and/or laws
- ☐ High transaction costs (for example, administrative fees, legal and engineering costs)
- ☐ Length and complexity of administrative process
- ☐ Lack of information regarding the advantages and disadvantages of water transfers
- ☐ The amount of money offered to farmers and ranchers for their water
- ☐ A temporary transfer doesn't make sense from an overall financial or management perspective
- ☐ None of the above

Other (please specify)

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Opinions About Water Banks

11. Transfer of water among agricultural and non-agricultural users can also be accomplished through a water bank. For purposes of this study, water banks are broadly defined as arrangements that facilitate the temporary and voluntary transfer of various types of surface, groundwater, and storage entitlements based on market conditions.

Please indicate the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
I am familiar with the concept of a water bank	◯	◯	◯	◯	◯
I am interested in learning more about water banks	◯	◯	◯	◯	◯
I would be willing to participate in a water bank	◯	◯	◯	◯	◯
I have been involved in a water bank	◯	◯	◯	◯	◯
I am concerned about the possibility of losing my water right if I were to participate in a water bank	◯	◯	◯	◯	◯
I am concerned that agriculture in my area would be jeopardized if other farmers/ranchers were to participate in a water bank	◯	◯	◯	◯	◯

Please share any comments you may have regarding water banks

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

12. What would keep you from participating in a water bank?

- ☐ State regulations, policies, and/or laws
- ☐ Federal regulations, policies, and/or laws
- ☐ High transaction costs
- ☐ Length and complexity of administrative process
- ☐ Loss of market share for commodities
- ☐ Lack of information regarding the advantages and disadvantages of water banks
- ☐ I do not want to depend on the market to get the best price for my water
- ☐ I farm high value perennial crops
- ☐ I do not want to move water out of agriculture
- ☐ None of the above

Other (please specify)

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Water Law and Policy

13. Please share your opinions about water policy, law, and administration and how they affect the decisions you make about your water by indicating the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
Policymakers understand the importance of agriculture in my area	○	○	○	○	○
Current water law and administration allow me to make the best choices for my operation	○	○	○	○	○
There are too many water quality and quantity regulations already in place that make it difficult to manage my water	○	○	○	○	○

Please share any specific examples you may have of regulations impacting your ability to exercise your water rights

14. If you could change one aspect of water policy (at any level), what would it be?

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Working with Other Stakeholders

15. Please share your opinions about working with other agricultural and non-agricultural stakeholders (such as urban and environmental) to address agricultural water issues. Indicate the extent to which you agree or disagree with each of the following statements.

	Strongly Disagree	Moderately Disagree	Neither	Moderately Agree	Strongly Agree
Farmers and ranchers in my area have been able to effectively organize and cooperate with each other to deal with existing and/or anticipated pressures on our agricultural water	○	○	○	○	○
I am active in making decisions in my local irrigation district/ditch company	○	○	○	○	○
The agricultural sector should coordinate with other sectors (such as municipal, industrial, and energy) to stretch limited water supplies	○	○	○	○	○
Agricultural and environmental stakeholders share many of the same interests, such as preserving open space and wildlife habitat. I think we need to find a way to work together better to manage our water supplies for mutual benefit.	○	○	○	○	○
I have been involved in some type of collaborative process with non-agricultural stakeholders	○	○	○	○	○

Please share any comments you may have regarding working with other agricultural and non-agricultural stakeholders

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Working with Other Stakeholders

16. What do you think are the main barriers preventing cooperation between different water users for developing solutions that address competing demands?

- ☐ Conflicting federal, state, and local water policies
- ☐ Limited time
- ☐ Limited financial resources
- ☐ Lack of effective leadership to get organized
- ☐ Competition for resources (for example, land, water, and capital)
- ☐ Diverse views about how water should be allocated or managed
- ☐ Different types of water users (for example, surface water, groundwater)
- ☐ Different types of water rights holders (for example, senior, junior)
- ☐ Different types of irrigation and production practices
- ☐ Location (in the state, basin, valley, etc.)
- ☐ Some parties end up resorting to litigation
- ☐ None of the above

Other (please specify)

17. At which level do you think cooperation between agricultural and non-agricultural water stakeholders would be most effective?

- ◯ Ditch
- ◯ District
- ◯ Valley
- ◯ Basin
- ◯ State

Other (please specify)

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Working with Land-Grant Universities

18. We would like to know how you think land-grant universities (such as the University of Arizona and Colorado State University) can best assist farmers/ranchers with the challenges they are facing, or will be facing with their water. Please check one or more of the following that you think your land-grant university may be able help with.

- ☐ Organize focused discussion groups with other agricultural and non-agricultural stakeholders
- ☐ Share what has been successful to collaboratively address water issues
- ☐ Provide research, outreach, and assistance with alternative water transfer arrangements between agricultural and non-agricultural water users (i.e. dry year leases, purchase lease back arrangements, deficit irrigation, rotational fallowing, water banks)
- ☐ Provide research, outreach and assistance with agricultural water conservation
- ☐ Educate the public on agricultural water use
- ☐ None of the above

Please specify other ways in which you feel your land-grant university researchers, educators, Extension agent/staff can assist you with your agricultural water

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Background Information About You and Your Operation

Lastly, we would like to know a little more about your background to better understand your opinions. You may skip any of the following questions that you do not feel comfortable answering.

19. Please check one or more of the following that best describe what type of water user you are.

- ☐ I own the water rights or ditch company shares I use to farm/ranch
- ☐ I use rented/leased water to farm/ranch
- ☐ I am a surface water user
- ☐ I am a groundwater user

Other (please specify)

20. Please check one or more of the following irrigation methods you currently use.

- ☐ Surface flood
- ☐ Controlled flood (between borders or within basins)
- ☐ Furrow irrigation
- ☐ Center pivot sprinkler
- ☐ Solid set and permanent systems
- ☐ Sideroll sprinkler or other mechanical move systems
- ☐ Drip, trickle, or micro-irrigation, including sub-surface drip
- ☐ Subirrigation (water seepage, or use of a drainage system to maintain aquifer table at a predetermined depth)

Other (please specify)

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Background Information About You and Your Operation

21. Please check each crop type you typically grow.

- ☐ Alfalfa
- ☐ Grass hay
- ☐ Pasture
- ☐ Wheat
- ☐ Beans
- ☐ Corn for grain or seed
- ☐ Corn for silage
- ☐ Sweet corn
- ☐ Cotton
- ☐ Rice
- ☐ Sorghum
- ☐ Other small grains (barley, oats, rye, etc.)
- ☐ Vegetables (onions, carrots, potatoes, melons, etc.)
- ☐ Fruit, vineyards, and nuts
- ☐ Trees/ornamental/turf
- ☐ I do not grow crops

Other (please specify)

22. Please check each commercial livestock enterprise that you typically operate.

- ☐ Cow-calf
- ☐ Backgrounding heifers
- ☐ Dairy
- ☐ Stockers and yearlings
- ☐ Feeding/fattening cattle
- ☐ Feeding/fattening lambs
- ☐ Sheep (ewes and lambs)
- ☐ Hogs and pigs
- ☐ Goats
- ☐ Poultry (all types)
- ☐ Keep/raise horses
- ☐ I do not participate in a livestock enterprise

Other (please specify)

Background Information About You and Your Operation

23. Over the past few years, what percent (%) of your land has typically been under some form of irrigation?

Irrigated land owned	
Irrigated land rented or leased from others (including federal, state, and railroad land)	
Irrigated land rented or leased to others (including federal, state, and railroad land)	

24. Over the past few years, what percent (%) of the following land types have been under some form of irrigation?

Cropland	
Pastureland	
Orchard	
Other	

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Background Information About You and Your Operation

25. The primary work that provides income for my family is (select all that apply):

- ☐ Farming
- ☐ Ranching
- ☐ My farm and/or ranch activities provide a supplemental income and are not the source of my primary income

Other (please specify)

26. What was the gross value of all agricultural products sold from your primary operation in 2011?

- ◯ $0-$9,999
- ◯ $10,000 - $24,999
- ◯ $25,000 - $49,999
- ◯ $50,000 - $99,999
- ◯ $100,000 - $249,000
- ◯ $250,000 - $499,999
- ◯ $500,000 - $999,999
- ◯ Over $1,000,000

ADDRESSING WATER FOR AGRICULTURE IN THE COLORADO RIVER BASIN

Background Information About You and Your Operation

27. What is the zip code and county of your operation that uses water originating from the Colorado River for agricultural purposes?

Zip code

County

28. About how may years have you been farming/ranching your operation?

Years you have been farming/ranching

Years previous generations of your family have been farming/ranching

29. What is the age of the primary operator of your farm or ranch?

Age of primary operator

Age of additional primary operator

30. Is the primary operator(s) of your farm/ranch male or female (select all that apply)?

- ☐ Male
- ☐ Female

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Additional Thoughts

31. We sincerely appreciate the time and effort you have put into completing this survey. If you have any additional thoughts or comments about the questions or topics addressed in this survey, please provide them in the space below. They can be specific to your farming/ranching operation, state, sub-basin, or the Colorado River Basin as a whole.