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Tribal Economies: Water Settlements, Agriculture, and Gaming in the Western U.S.

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Abstract: This paper examines patterns in water rights quantification, agriculture, gaming, and economic characteristics across selected Native American nations in the United States (U.S.) to provide a perspective across tribal nations and regions. A unique set of data was analyzed, drawing from the U.S. Census Bureau, U.S. Department of Agriculture, court decrees, water rights data, and other sources. Fifty-one tribal nations are included in this study, based on availability of data on agricultural and economic indicators. Data analysis indicates the following: 1) tribes with quantified water rights also have higher agricultural revenue, 2) tribes which have quantified their water rights are more likely to also operate a casino, 3) tribes which have quantified their water rights tend to be more commonly located close to major cities, and 4) tribes which operate at least one casino have notably higher annual household income compared to tribes which do not. A number of interesting regional differences are observed: 1) Northwest tribes have significantly higher rates of water quantification than other regions, 2) Midwest tribes have the highest prevalence of casino operations compared to the other areas, and 3) the Southwest has the smallest proportion of tribes with casino operations. This paper identifies patterns across multiple tribal nations and across regions, and does not focus on establishing cause-and-effect. Causal relationships among tribal water quantification, farming, gaming, income levels, and unemployment will vary by location and tribe. Identifying cause and effect among different components of tribal economic development warrants further inquiry. The examination of patterns presented here illuminates interesting differences among tribal nations and regions, and provides a broad context for tribal leaders how best to cultivate sustainable, resilient economies and water resource management.

Keywords: *economic development, water rights, quantification, farming, casinos, water leasing*

Native American nations have legal entitlements to water resources in the United States (U.S.) and engage in active on-reservation water use and off-reservation water leasing. More than 50 tribes have secured over 10 million acre-feet per year (afy) of water through negotiated water settlements and/or through litigation (Landry and Quinn 2007). Tribal water rights were formally recognized by U.S. courts in 1908, when an irrigation project was being developed by the Fort Belknap Indian Reservation in Montana. During dry periods, the tribal project could not access water and the U.S. government sued upstream water users on behalf of the tribe in *Winters v. U.S.* (Landry and Quinn 2007). The Supreme Court affirmed that tribal nations have the right to use and manage water in order to fulfill the purposes of their land reservations. While tribes have strong legal entitlements to water, the quantification of those rights and provision of water supplies to tribal nations has been slow, costly, and painstaking, and continues as an ongoing process.

Over the last 50 years, many tribal nations have engaged in water settlement negotiations to quantify their water entitlements and secure funding for reservation water projects and economic development. A water settlement agreement typically involves negotiations between a tribal nation, federal agencies, states, water districts, and other water users in the area where the tribe is quantifying their water rights. Negotiated water settlements aim to resolve

conflict among water users by allowing parties to specify water allocations, provide water supply assurances, and reduce litigation. Many settlements explicitly authorize tribal nations to lease tribal water for use off-reservation (Colby et al. 2005; Stern 2015).

This article focuses upon three potential components of tribal economic development which are particularly relevant for tribal nations in the U.S.: water rights quantification and leasing, agriculture, and gaming. Sustainable economic development and effective policies are important in tribal nations' efforts to decrease poverty and unemployment rates. On average, a large disparity still exists between households in the national U.S. economy and households located on tribal reservations. Census data indicate that tribal households experience double the U.S. average unemployment rate and earn only 60 percent of the average U.S. household income (Rancier 2012; Davis et al. 2015; American Factfinder 2017).

Decisions by tribal nations to quantify water rights, to lease tribal water, and/or to develop infrastructure to deliver water to tribal homes, businesses, and farms provide one potential pathway for promoting tribal economic development (Waton 2015). In the U.S., tribal communities need to be federally recognized as tribal governments to formally claim water rights, so this option is not currently available to tribal communities which do not have this federal recognition.

In addition to facilitating access to water for reservation households and businesses, many Native American water settlements authorize off-reservation tribal water leasing. Tribal water leasing generally must be approved by the Secretary of the Interior, and state governments impose various conditions on tribal leases to protect state interests (Landry and Quinn 2007). Water quantification and leasing can offer tribes a valuable revenue source (Colby et al. 2005; Colby 2006; Cosens 2006; Landry and Quinn 2007; Killoren 2012; Bovee et al. 2016). Previous research has not systematically examined the interplay of tribal water rights quantification and tribal economic indicators. The economic effects of water rights quantification and leasing are not well understood.

This paper examines patterns across tribal nations in water quantification, agricultural earnings, and operation of casinos. Income levels and unemployment rates are accessible economic indicators for tribal economies and are used to identify patterns across selected U.S. tribal nations. The tribal nations included in this study were selected based on availability of relevant data. Data were collected from the U.S. Census Bureau, U.S. Department of Agriculture (USDA), water specialists, court decrees, news articles, and scholarly papers. Data were available for both 2010 and 2015 on tribal nations located in 12 states (Arizona, Idaho, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming). The USDA agricultural data that are critical to this study are only available for 41 tribal nations in 2010 and 51 tribal nations in 2015. Therefore, the complete dataset consists of 92 tribal nations over the two time periods. Analysis is conducted using t-tests to detect statistically meaningful differences across tribal nations, regions, and time periods.

This overview and comparative analysis across tribal nations and regions provides a broad perspective that can assist tribal decision-makers in considering policies to further sustainable economies, resource governance and management, and resilience to pressures of climate change. This study is not intended to identify specific cause and effect relationships between tribal water rights quantification, agriculture, gaming, and economic indicators. Causality and interrelationships among these factors can best be understood by focused site specific studies.

Reservation Economies, Tribal Water Settlements, and Off-Reservation Leasing

Native American nations govern tribal reservations which are limited compared to tribes' pre-European land bases. Nevertheless, reservations provide a base from which tribal nations exercise sovereign governmental powers over natural resources and economic development (Tsosie 2006).

Not all tribes in the U.S. are federally recognized, nor do they all have a land reservation. Some tribes govern themselves and seek to preserve cultural traditions without either federal recognition or

a reservation land base. There are 567 federally recognized tribes across the U.S. (NCSL 2018). Tribes develop their economies through a wide range of activities, including agriculture, mining, and tourism. Some tribal nations pursue economic development by quantifying their water rights, developing infrastructure to deliver water, and leasing tribal water to earn revenue. Tribal reservation lands have unusual and sometimes complex ownership patterns. Reservation land is held "in trust" by the federal government and not available to serve as collateral for commercial loans. Tribal members and non-tribal members hold private land allotments within reservation boundaries in many tribal nations, posing complications for cohesive governance and management of reservation natural resources (Wood 2003).

Tribal nations' right to govern their water resources is affirmed through a long history of jurisprudence and Congressional action which traces back to the landmark 1908 *Winters v. U.S.* U.S. Supreme Court decision. To make effective use of their water, many tribal nations have elected to quantify their water rights through costly and lengthy litigation or through negotiated water settlements. Over 50 tribes in the western U.S. have quantified their water rights and more tribes are in the process of negotiating water settlements (see extensive reference list accompanying Table 3). The Ak-Chin Indian Community of the Maricopa Indian Reservation, the Confederated Tribes of the Colville Reservation, and the Spokane Tribe of the Spokane Reservation were some of the first tribes to quantify their water rights in the 1970s (Colby 2006; Rancier 2012; Chief et al. 2016; Cosens and Chaffin 2016; Tribal Water Uses in the Colorado River Basin 2016).

In many settlement agreements, the federal government and other parties provide funds to tribal nations for economic growth, community development, wildlife restoration, water acquisition, and water projects. Most settlements are partially funded by the federal government and involve in-kind contributions from tribes, states, cities, and other water users. In some cases, water is transferred or exchanged with non-Indian water users to provide adequate water to tribes. Each settlement is unique. In the San Luis Rey settlement, the state, local, and tribal parties shared the cost to provide water, while in the Animas-La Plata Project case the water users and the tribe shared the cost. The only two settlements fully funded by the federal government were the Ak-Chin Indian Water Rights Settlement (1984) and the Northern Ute Indian Settlement (1992) (Colby 2006; Rancier 2012).

Monetary payments to tribes can occur as part of settlement packages for various reasons: 1) as compensation for past damages to tribal resources, 2) in lieu of providing larger quantities of water to tribes, and 3) to aid in water infrastructure and economic development on tribal lands. Tribal nations persevere over many years to secure their water allocations and carefully weigh tradeoffs between water and money in settlement negotiations (Colby et al. 2005; Colby 2006).

Tribal water leasing occurs in various parts of the western U.S., particularly in the Colorado River Basin. The Colorado River Basin includes 20 tribal nations, portions of seven U.S. states, and parts of two Mexican states (National Water Census 2018). Urban areas concerned about future water shortages lease tribal water to meet growing demands. Tribes also lease water to off-reservation water users to improve water quality and reliability, and to support natural habitats (Nyberg 2014).

In 2016, tribal water leasing was estimated to transfer about 260,000 afy, with $19 million revenue annually (Bovee et al. 2016). As drought becomes more persistent, short-term and intermittent water leases may be attractive for tribes and non-Indian parties. These types of drought-triggered intermittent leases allow tribes to exercise their water rights and earn revenue while providing water to non-Indian users during dry periods (Colby 2006; Bovee et al. 2016).

While water leasing offers tribes access to revenue, it is only one of many options for generating economic activity and revenue. Tourism, gaming, resort development, fishing, ranching, farming, and mining are all methods by which tribes generate income from their land and water (Fletcher 2004; Rosser 2005; Navajo Nation Sales Tax 2006). In some cases, water rights quantification and leasing can support tribal economic development, livelihood opportunities on tribal lands, and tribal adaptation to effects of

climate change on tribal natural resources and communities (Marsh and Smith 2015; Stern 2015; Chief et al. 2016; Cosens and Chaffin 2016).

Methodology

Data

This study utilizes data from USDA's Agricultural Census Survey, the Census Bureau, and other sources. Data were analyzed for 41 tribes in the U.S. in 2010 and 51 tribes in the U.S. in 2015. Tribal nations included in these surveys have reservations located in 12 U.S. states across three regions (Southwest: Arizona, New Mexico, and Utah; Northwest: Idaho, Montana, Oregon, Washington, and Wyoming; and Midwest: Kansas, Nebraska, South Dakota, and North Dakota).

Most western states allocate state-governed water under the doctrine of prior appropriation, with senior water rights being the last to be cut off in times of shortage. Tribes are typically senior water right holders because water rights of tribal nations date back to the date their land reservation was established. This seniority gives tribal water entitlements a higher degree of reliability during drought and an added financial value in water leasing.

Irrigation is an important method of farming in the arid western U.S., and crop irrigation accounts for a large share of the nation's water use (Schaible and Aillery 2013; USDA Economic Research Service 2017). In order to focus on agriculture as part of tribal economies, this study only includes those tribes in the U.S. which had agricultural data available in the 2010 and 2015 USDA Agricultural Census Surveys. Economic data were collected from the Census Bureau and gaming data were collected from the National Indian Gaming Commission. Geographic and water data were collected from various sources to create a unique data set across selected western U.S. tribal nations.

A total of nine variables are examined in this paper: 1) *Value of Agricultural Products Sold*, 2) *Unemployment*, 3) *Income*, 4) *Education*, 5) *Population*, 6) *Proximity to Major City*, 7) *Casino*, 8) *Water Rights*, and 9) *Year*. Refer to Table 1 for reference to the variables used in this study, their definitions, and data sources. All dollar figures in this article have been adjusted to 2015 dollars, to be consist with the most recent (2015) financial data used in this study. The next subsections of this article discuss the data in detail.

Agricultural Data. The USDA National Agricultural Statistics Service released data from the Agricultural Census Survey in 2010 and 2015. The data were collected by mailing surveys to tribes in 2007 and 2012, respectively. The USDA mailed surveys to every tribal nation, aiming to obtain survey responses from every tribe (USDA 2011; USDA 2017). However, incomplete survey responses reduced the USDA tribal data to 41 western U.S. tribes in 2010 and 51 in 2015.

The USDA data provide the *Value of Agricultural Products Sold* variable, defined as the market value of agricultural products sold for each tribe. This represents the gross value of all agricultural products sold, before taxes or production expenses (see Table 2). The data have been adjusted for inflation to 2015 dollars. On average, across the tribes included in this study, tribal nations received about 59 million dollars a year from agricultural products between 2010 and 2015, with wide variation across tribes.

Population, Education, and Economic Data. Data for tribal reservations were collected in the U.S. Census Bureau American Community Survey (ACS). The ACS began data collection with tribal nations in 2006 and collected data for over 60 months. Data are available for 2010 and 2015, with 2010 data gathered from 2006 - 2010, and 2015 data gathered from 2011 - 2015. For simplicity, we refer to the first data period as 2010 and the second period as 2015.

To analyze U.S. Census Bureau economic data alongside the USDA agricultural data, this study places 2010 USDA Agricultural Census data (collected in 2007) with 2010 Census Bureau data (collected from 2006 to 2010) and 2015 USDA Agricultural Census data (collected in 2012) with 2015 Census Bureau data (collected from 2011 to 2015). The two time periods (2010 and 2015) provide information for a total of 92 observations; 41 tribes for 2010, with an additional ten tribes having necessary data for 2015. Table 2 reports the averages of the variables examined in this study.

Income and unemployment data, collected from the U.S. Census Bureau, are used as economic

Table 1. Variable names, definitions, and sources for data analyzed on tribal nations.*

Variable Name	N	Definition	Source
Value of Agricultural Products Sold	92	The gross market value of all agricultural products sold before taxes or production expenses in $1000. It is the total number of sales regardless of who received the payment i.e., partners, landlords, contractors, etc.	United States Department of Agriculture, Census of Agriculture
Unemployment	92	The percentage of the population 16 years and over who are actively seeking a job.	Census Bureau
Income	92	The mean family income in inflation-adjusted dollars for the year examined.	Census Bureau
Education	92	The percentage of the population who are high school graduates or higher.	Census Bureau
Population	92	The total population of the reservation.	Census Bureau
Proximity to Major City	92	If a reservation's address or it's tribal headquarters' address is located less than 50 miles of driving distance from a major city (Proximity=1) or if not (Proximity=0). A major city is defined as one of the top three most populous cities in one of the western states selected for this study, or one of the top ten most populous cities with at least 100,000 residents.	Address: Tribal website or Google Population of cities in each state: Demographics by Cubit Driving distance to major city (miles): Google Maps
Casino	92	If a tribe operates at least one casino (Casino=1) or if not (Casino=0).	National Indian Gaming Commission
Water Rights	92	If a tribe has quantified its water rights (Water Rights=1) or if not (Water Rights=0).	Various Sources
Year	92	If data were observed in 2010 (Year=0) or if data were observed in 2015 (Year=1).	-

*The names and locations of tribal reservations were established through the Census Bureau and the Bureau of Indian Affairs.

indicators in this study. The *Income* variable used in this study is the sum of all forms of earnings received per tribal household in inflation-adjusted dollars, for the years examined. The income data collected for 2010 are adjusted to 2015 dollars to be compared to income data in 2015. Census Bureau data indicate, on average, a household in the tribal nations included in this study earns about $48,000 a year.

The *Unemployment* variable shows the percent of individuals over the age of sixteen who are actively looking for a job, divided by all individuals currently in the labor force. The average unemployment level in the tribal nations included in this analysis was 17.27 percent between 2010 and 2015.

Education may help tribes increase household income and support job opportunities (Hopi Education Endowment Fund 2007). Education data were also collected from the Census Bureau and the *Education* variable is defined as the percent of individuals with at least a high school diploma. About 81 percent of individuals on the reservations examined in this study received a high school diploma.

Table 2. Variable means in 2010 and 2015.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Water Right (%)	92	40.22	49.30	0	100
Casino (%)	92	73.91	44.15	0	100
Unemployment (%)	92	17.27	7.52	5.00	40.00
Income ($)	92	48,013	9,457	24,723	79,576
Education (%)	92	80.65	8.15	55.80	97.20
Value of Agricultural Products Sold ($1000)	92	58,566	77,334	22	571,100
Population (%)	92	11,012	25,018	59	173,822
Proximity to Major City (%)	92	21.74	41.27	0	100

Population data were also collected from the Census Bureau. *Population* variable is the estimated total population on a tribal reservation. The Census Bureau contacts representatives of tribal governments to identify boundaries of tribal nations from the list maintained by the Bureau of Indian Affairs (U.S. Census Bureau 2018). For many tribal nations, a large portion of tribal members live off of the reservation and are not counted in tribal reservation populations by the Census Bureau (U.S. Census Bureau 2018).

Geographic Data. Geographic data were collected to examine how water rights quantification is affected by the proximity of a tribe to a major city. This study created the *Proximity to Major City* binary variable to investigate the relationship. A major city is defined by the authors as one of the top three most populous cities in a state, or one of the top ten most populous cities with at least 100,000 residents. The zip code for the tribal nation was found from the listed physical address on the tribe's website. Driving distance was calculated from the city's zip code to the tribal nation's zip code. If the distance to a major city was less than 50 miles driving, the tribe was assigned a one, and if greater than 50 miles, a zero was assigned.

Casino Data. Tribal nations take diverse pathways in considering and adopting gaming as part of their economic development strategy. In the 1970s, the development of card rooms and bingo halls began to emerge among tribal nations as a means to bring revenue and job opportunities. However, local and state governments were concerned with potential negative effects of gaming and posed various obstacles to tribal gaming. Today, tribal nations decide upon opening a casino and then work with nearby local governments and state government to consider impacts. Tribes sometimes pay for mitigation to open a casino. Casinos have caused some disparities and conflicts within tribal communities (Peters et al. 2015; Savio 2016).

Data on casinos were collected from the National Indian Gaming Commission's Gaming Tribes Report. To determine if the tribe had opened a casino after 2010, we examined the tribe's gaming ordinance date. The Indian Gaming Regulatory Act requires each tribe to have its gaming ordinance approved by the Commission before opening a casino. No tribe in this study had a gaming ordinance approval date after 2010, so the same casino data were used for both 2010 and 2015. The *Casino* variable is a binary variable where a one was assigned if the tribe operated at least one casino and a zero, if not. Seventy-three percent of all tribes included in this study have at least one casino. Data on the size of a tribal casino (such as the number of slot machines or the number of employees) would have been useful in this work. However, such data were not available (NIGC 2018).

Water Data. Water rights data were gathered from multiple sources: media articles, court decrees, settlement documents, scholarly papers, and interviews with tribal water rights specialists (Stone 2017). Water rights quantification through court rulings and by settlements approved by Congress are accompanied by public records and news coverage. If no information about a tribal nation's water rights could be found after an extensive search, we assumed the tribe did not quantify its water rights. The *Water Rights* variable is a binary variable. A one was assigned if the tribe quantified its water rights by the year indicated, and a zero if not.

Despite extensive searching, a comprehensive centralized data base on tribal water right quantification does not appear to be available. Table 3 summarizes data on tribal water rights, casinos, and proximity to major city for the tribes covered in this study to create a broad data set. About 43 percent of the tribal nations included in this study have quantified their water rights.

Analytic Methods

The data available to examine the economic development components of interest for this study are limited. Data on size of casinos, tribal water use patterns, and number and size of tribal businesses were not readily available. Moreover, the data exhibit only minor changes between 2010 and 2015. Proximity to a major city and casino is static during the two data periods. T-test analyses are utilized to examine patterns across tribal nations and to account for variables of interest that could not be observed due to absence of data.

T-test analyses in the paper examine difference in means in *Water Rights*, *Casino*, and *Proximity to Major City*. This analysis is used to indicate a statistically meaningful difference between groups of tribal nations and between regions.

First, we analyze the difference between tribes which have quantified their water rights and those which have not. This analysis assesses whether other variables examined in this paper systematically differ with water quantification, i.e., 1) *Value of Agricultural Products Sold*, 2) *Unemployment*, 3) *Income*, 4) *Education*, 5) *Population*, 6) *Proximity to Major City*, and 7) *Casino*. We compare based on the *Water Rights* variable, where one group of tribal nations is defined by having quantified water rights (*Water Rights*=1) and the other is defined by not having quantified water rights (*Water Rights*=0).

Second, we look at the difference in means between tribes which have no casino (*Casino*=0) and tribes that have at least one casino (*Casino*=1). This t-test looks at tribes' 1) *Value of Agricultural Products Sold*, 2) *Unemployment*, 3) *Income*, 4) *Education*, 5) *Population*, 6) *Proximity to Major City*, and 7) *Water Rights*. Lastly, we test whether differences exist between tribes who are located within 51 miles to a major city versus those who are not. We note differences that are statistically significant at a 90, 95, and 99 percent level. A statistically significant t-test result is determined by several factors, such as sample size.

Results

Patterns in Gaming, Water Rights Quantification, Agriculture, and Location

Analysis of data compiled for this study indicates tribes which have quantified their water rights are more likely to also operate a casino. Twenty-one of the tribal nations in this study have quantified their water rights through a formal litigation or settlement process, and 37 of the tribal nations in this study operate at least one casino. In 2010, the first period of this study, 20 tribes had quantified their water rights while 31 had not. By 2015, there was one new tribal water quantification, the Blackfeet Nation of Montana, bringing the total to 21 tribes which had quantified their water rights.

Figure 1 illustrates various combinations of activities in which the tribes included in this study are engaged. Only 5 of the 51 tribes in this study quantified their water rights without also operating a casino. Of the 51 tribes, 21 tribal nations operate at least one casino and have not quantified water rights. Nine tribes have neither quantified water rights nor operate a casino. Sixteen tribes have both quantified their water rights and operate at least one casino. Of the 16 tribes with both quantified water rights and a casino, half of them quantified water rights first and then opened a casino. The causal mechanisms for the relationship between water quantification and casinos vary from tribe to tribe. Further understanding of the patterns requires location-specific research. The analysis in

Table 3. Water rights quantification, casinos, proximity.

#	Tribal Nation	[1]Water Rights Document Name	Document Type	Passed	# of Casinos**	Proximity to Major City (miles)****
1	Blackfeet	Blackfeet Water Rights Settlement Act of 2015	Settlement	2015	2	111
2	Burns Paiute				0	132
3	Cheyenne River				1	322
4	Coeur d'Alene				3	34.8
5	Colorado River	*Arizona v. California*	Court Decree	1963	1	155
6	Colville	*Colville Confederated Tribes v. Walton*	Court Decree	1978	3	113
7	Crow	Crow Tribe Water Rights Settlement Act of 2010	Settlement	2010	2	80.7
8	Crow Creek				1	172
9	Flandreau Santee				1	42.9
10	Flathead	Salish and Kootenai Water Rights Settlement Act of 2016	Settlement	2016	2	68.6
11	Fort Belknap	Fort Belknap-MT Compact of 2001	Settlement	2001	1	78
12	Fort Berthold				4	374
13	Fort Hall	Fort Hall Indian Water Rights Act	Settlement	1990	0	12.3
14	Fort Mojave	*Arizona v. California*	Court Decree	1963	0	96
15	Fort Peck	Fort Peck-Montana Compact of 1985	Settlement	1985	0	169
16	Fort Yuma-Quechan	*Arizona v. California*	Court Decree	1963	0	181
17	Gila River	Gila River Indian Community Water Rights Settlement Act, Arizona Water Rights Settlement of 2004	Settlement	2004	3	16.8
18	Havasupai				0	235
19	Hopi				0	190
20	Hualapai				0	138
21	Lake Traverse				3	96
22	Lower Brule				1	185
23	Lummi	*U.S. and Lummi v. Washington Department of Ecology*	Court Decree	2007	1	102
24	Navajo Nation	(NM only) Navajo Nation San Juan Basin in New Mexico Water Rights Settlement Agreement of 2010	Settlement	2010	4	100
25	Nez Perce	Nez Perce Tribe - Snake River Water Rights Act of 2004	Settlement	2004	2	12.8
26	Northern Cheyenne	Northern Cheyenne Indian Reserved Water Rights Settlement Act	Settlement	1991	1	98.6
27	Omaha				2	79

Table 3 Continued. Water rights quantification, casinos, proximity.

#	Tribal Nation	[1]Water Rights Document Name	Document Type	Passed	# of Casinos	Proximity to Major City (miles)
28	Pine Ridge				0	338
29	Pueblo de Cochiti				0	22.1
30	Pueblo of Isleta				2	33
31	Pueblo of Jemez				0	35.5
32	Pueblo of Santo Domingo				0	32.3
33	Pueblo of Zuni	Zuni Indian Tribe Water Rights Settlement Act of 2003	Settlement	2003	0	150
34	Rocky Boy's	Chippewa Cree Tribe of the Rocky Boy's Reservation Indian Reserved Water Rights Settlement Act	Settlement	1999	0	28.1
35	Rosebud				1	219
36	Sac and Fox				2	81
37	Salt River Pima-Maricopa	Salt River Pima-Maricopa Indian Community Water Rights Settlement Act	Settlement	1988	2	4.5
38	San Carlos Apache	San Carlos Apache Tribe Water Rights Settlement Act	Settlement	1999	1	91.4
39	Santee Sioux				1	126
40	Spirit Lake				1	157
41	Spokane	*United States v. Anderson*, U.S. Ct. of Appeals, 9th Cir, 1984	Court Decree	1984	2	48.7
42	Standing Rock				2	300
43	Tohono O'odham	Arizona Water Rights Settlement of 2004	Settlement	2004	4	74.6
44	Tulalip				3	12.2
45	Turtle Mountain/ Trenton Indian Service Area				3	250
46	Umatilla				1	184
47	Warm Springs	Confederated Tribes of the Warm Springs Reservation Water Rights Settlement Agreement	Settlement	1997	1	67.1
48	Wind River	Wind River, Arapahoe, Shoshone, and Big Horn Litigation	Court Decree	1992	4	35.4
49	Winnebago				3	84.5
50	Yakama	Acquavella Adjudications	Court Decree	2006	1	180
51	Yankton				2	115

[1]Document references listed by # at the end of the References section.

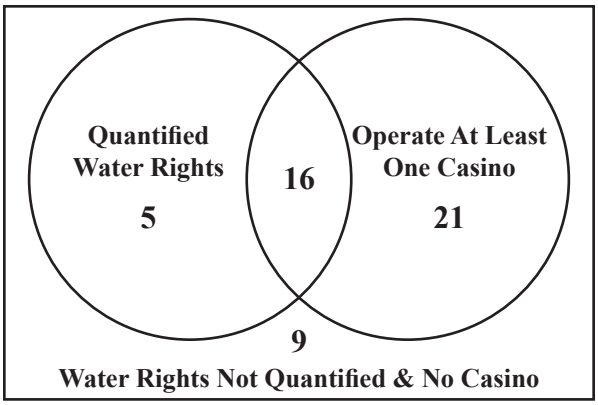

Figure 1. Diagram indicating number of tribal nations with quantified water rights and/or casinos, 2015. Total number of tribes = 51.

this paper examined patterns across multiple tribal nations and does not focus on establishing cause-and-effect.

Tribal nations with quantified water rights exhibit statistically significant differences from those without quantified water rights in terms of education, value of agricultural production, location relative to cities, and reservation population. Table 4 summarizes these results. Tribes with quantified water rights have an average of $47 million more in annual agricultural revenue than tribes without quantified water rights. Causal mechanisms need to be investigated on a location-specific basis. Some tribal nations may choose to quantify their water rights because they want to increase their agricultural production, and in other cases tribes which already have high agricultural production may quantify their water rights in order to protect their water access for farming. Future case-specific research can address these questions.

Tribes with quantified water rights tend to be more commonly located close to major cities than their counterparts without quantified water rights, at a 5 percent statistical significance level (Table 4). As tribal nations have larger populations, they are also more likely to have quantified their water rights. While the reasons for these patterns will differ by location, competition for water due to tribal lands proximity to cities may increase the likelihood of water rights quantification (Mauer 2016).

Another set of statistical tests compares tribal nations with a casino versus those without a casino, indicated in Table 5. The t-value test on income level for those with a casino is statistically significant at a one percent level. Tribes which operate at least one casino have a higher annual household income level by about $7,000, compared to tribes which do not. Also, tribes with at least one casino have higher population than tribes without a casino. There are no statistically significant differences in water rights quantification, unemployment, education, value of agricultural products sold, and proximity to major city between tribes which operate at least one casino and those which do not.

Casinos affect tribal economies by offering employment and increased revenue. Other unexamined factors may be contributing to the observed higher income. From 1988 to 2013, the number of tribal nations with casinos has increased. There are more than 440 tribal gaming operations in 31 U.S. states. Gaming revenue has increased from $100 million to $28 billion (Akee et al. 2015). Some researchers observe that gaming funds help improve life on reservations and help tribal governments move closer to fiscal independence (Mauer 2016; Douglas 2017). Over the past two decades, Akee et al. (2015) found that income increased overall for Native Americans living on reservations (both reservations with and without casinos) as more females entered the labor force, unemployment rates fell, and reservation housing quality rose. The Akee study used data from the 2011 U.S. Census which included Native Americans living on reservations in 48 contiguous states.

The last set of statistical analyses examines differences among tribal nations based on *Proximity to Major City* (Table 6). Tribes located close to a major city have significantly higher rates of quantifying their water rights and have higher unemployment levels than tribes located on more isolated reservations. Tribes located close to a major city are 21 percent more likely to have quantified their water rights. This could be due to more competition for limited water sources near cites, and that proximity to cities can make it more feasible to engage in water leasing to those cities.

Regional Differences

The regional location of tribes creates distinctive patterns related to several variables in this study. The tribal nations in this study are in 12 states that are grouped into three regions: Southwest (Arizona, New Mexico, and Utah),

Table 4. Water rights quantification - difference in means in 2010 and 2015.

Variable	Water Rights Not Quantified (N=55)	Water Rights Quantified (N=37)	Difference	t-value
[1]Casino (%)	72.73	75.68	-2.95	-0.31
[2]Unemployment (%)	16.56	18.31	-1.75	-1.10
[3]Income ($)	49,491	45,817	3,674	2.02**
[4]Education (%)	82.91	77.28	5.63	3.23***
[5]Value of Agricultural Products Sold ($1000)	39,593	86,768	-47,174	-2.51***
[6]Population	6,257	18,080	-11,823	-1.88*
[7]Proximity to Major City (%)	14.55	32.43	-17.89	-2.06**

Significance levels: *α = 0.1, **α = 0.05, and ***α = 0.01.
[1]Casino is the percentage of tribes with a casino.
[2]Unemployment is the percentage of people over the age of 16 who are actively seeking a job.
[3]Income is the mean annual household income.
[4]Education is the percentage of people who have attained a high school diploma or higher.
[5]Value of Agricultural Products Sold is the gross market value of all agricultural products sold before taxes or production expenses in $1000. It is the total number of sales regardless of who received the payment i.e., partners, landlords, contractors, etc.
[6]Population is the number of tribal members living on a reservation.
[7]Proximity to Major City is the percentage of reservations located less than 50 miles of driving distance from a major city, a city with population over 100,000.

Northwest (Idaho, Montana, Oregon, Washington, and Wyoming), and Midwest (Kansas, Nebraska, South Dakota, and North Dakota).

Figure 2 shows the regions compared with one another. Table 7 compares water rights quantification, casino, income, unemployment, education, and value of agricultural products sold across the regions. While the regions have similar unemployment levels, tribal education levels are statistically different from one another across all three regions. Southwest tribes have the lowest revenue from agricultural products (statistically significant at a one percent level). Northwest tribes have significantly higher rates of water quantification than the other regions (at a one percent level). Southwest tribes have the next highest rates of water quantification (significant at a one percent level).

The Midwest tribes have the highest prevalence of casino operations compared to the other areas. Over 90 percent of the tribes in the Midwest group operate at least one casino. The Southwest has the smallest proportion of casino operations, with less than 50 percent of tribes operating at least one casino. Differences between the Midwest and the Southwest related to casino operations are statistically significant at a one percent level. The Midwest region, which has no tribes in this study with quantified water rights, has the highest rates of casino operations. These regional differences likely involve political and economic factors not analyzed in this study. For example, higher rainfall in the Midwest leads to less dependence on securing irrigation water to sustain reservation agriculture, hence less pressure to quantify water rights. Tribal nations in different regions have

Table 5. Casino operation - difference in means in 2010 and 2015.

Variable	No Casino (N=24)	Casino (N=68)	Difference	t-value
[1]Water Rights Quantified (%)	37.50	41.18	-3.68	-0.31
[2]Unemployment (%)	19.30	16.55	2.75	1.55
[3]Income ($)	42,987	49,787	-6,801	-3.18***
[4]Education (%)	78.83	81.29	-2.46	-1.28
[5]Value of Agricultural Products Sold ($1000)	44,465	63,543	-19,078	-1.01
[6]Population	5,007	13,131	-8,124	-2.22**
[7]Proximity to Major City (%)	29.17	19.12	10.05	1.02

Significance levels: *α = 0.1, **α = 0.05, and ***α = 0.01.
[1]Water Rights is the percentage of tribes who have quantified their water rights.
[2]Unemployment is the percentage of people over the age of 16 who are actively seeking a job.
[3]Income is the mean annual household income.
[4]Education is the percentage of people who have attained a high school diploma or higher.
[5]Value of Agricultural Products Sold is the gross market value of all agricultural products sold before taxes or production expenses in $1000. It is the total number of sales regardless of who received the payment i.e., partners, landlords, contractors, etc.
[6]Population is the number of tribal members living on a reservation.
[7]Proximity to Major City is the percentage of reservations located less than 50 miles of driving distance from a major city, a city with population over 100,000.

faced different political dynamics with respect to both gaming and water rights.

Discussion and Summary

Tribal nations consider various economic strategies to bring jobs and improved income to tribal members and reservation economies, identifying their nation's comparative strengths and the potential role of their tribal natural resources (Harvard Business School 2018). In the western U.S., tribal nations often have senior water rights and valuable agricultural and gaming opportunities. Water rights quantification, agriculture, and gaming operations appear to be linked among the tribal nations examined in this study. The reasons for this linkage likely vary from tribe to tribe, and may reinforce areas of tribal specialization and emerging cluster strength for economic development on reservations (Harvard Business School 2018).

For the tribal nations in this study, those tribes which have quantified their water rights have significantly different characteristics than tribes which have not quantified their water rights. Tribes with quantified water rights had an average of $48 million more annual agricultural revenue than tribes without quantification. Tribal nations with quantified water rights also had higher population levels, greater proximity to cities, lower education levels, and lower income levels. Casino operations increase average household income for tribes, with a high level of statistical significance.

Across the 51 tribes examined in this study, there is a consistent relationship between tribal water rights quantification and higher agricultural revenue. Many tribal nations with active farming choose to pursue quantification, knowing that

Table 6. Proximity to major city - difference in means in 2010 and 2015.

Variable	Not Located Close to a Major City (N=72)	Located Close to a Major City (N=20)	Difference	t-value
[1]Water Rights Quantified (%)	34.72	60.00	-25.28	-2.06**
[2]Casino (%)	76.39	65.00	11.39	1.02
[3]Unemployment (%)	17.95	14.83	3.12	1.66*
[4]Income ($)	47,210	50,903	-3,693	-1.56
[5]Education (%)	80.38	81.60	-1.22	-0.59
[6]Value of Agricultural Products Sold ($1000)	62,542	44,254	18,288	1.17
[7]Population	11,866	7,939	3,927	1.08

Significance levels: *α = 0.1, **α = 0.05, and ***α = 0.01.
[1]Water Rights is the percentage of tribes who have quantified their water rights.
[2]Casino is the percentage of tribes with a casino.
[3]Unemployment is the percentage of people over the age of 16 who are actively seeking a job.
[4]Income is the mean annual household income.
[5]Education is the percentage of people who have attained a high school diploma or higher.
[6]Value of Agricultural Products Sold is the gross market value of all agricultural products sold before taxes or production expenses in $1000. It is the total number of sales regardless of who received the payment i.e., partners, landlords, contractors, etc.
[7]Population is the number of tribal members living on a reservation.

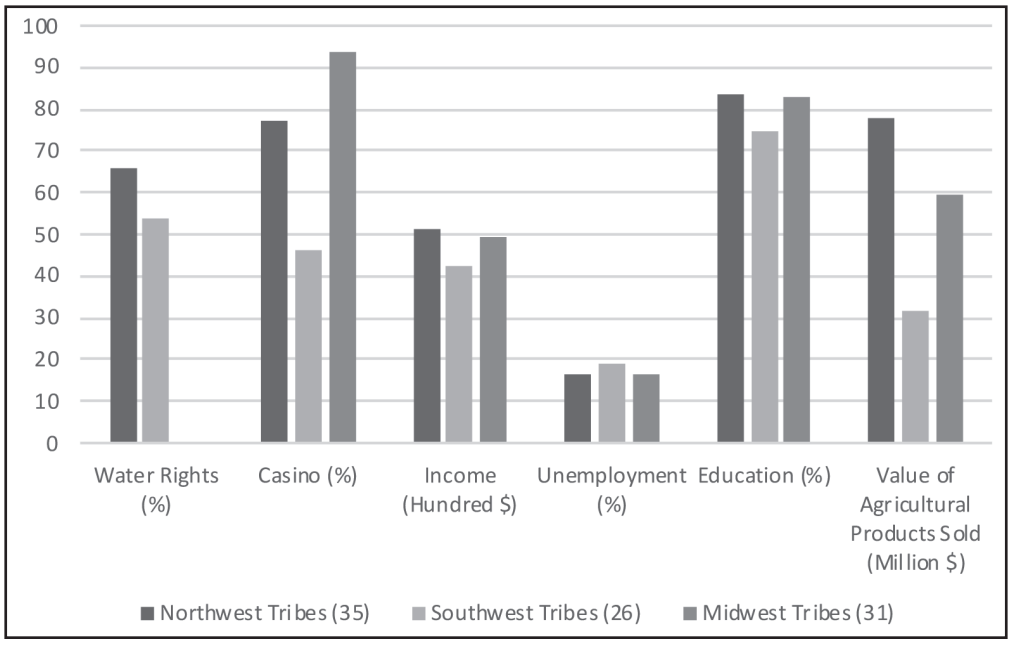

Figure 2. Variables differentiated by regional location of tribal nations.

Table 7. Variables differentiated by region in 2010 and 2015 (92 observations).

	Northwest Tribes (N=35)	Southwest Tribes (N=26)	Midwest Tribes (N=31)
Water Rights (%)	65.71***	53.85*	0.00***
Casino (%)	77.14	46.15***	93.55***
Income (Hundred $)	51.16***	42.28***	49.28
Unemployment (%)	16.68	19.27	16.26
Education (%)	83.43***	74.37***	82.77**
Value of Agricultural Products Sold (Million $)	77.96	31.68***	59.22

Significance levels: *α = 0.1, **α = 0.05, and ***α = 0.01.

secure access to significant quantities of water are essential for their irrigated farming. Also, tribes engaged in irrigated farming may be more likely to quantify their water entitlements because the Practicably Irrigable Acreage (PIA) standard (used for many years by the courts to quantify tribal water entitlements) is readily applicable to tribes with irrigated farms. The PIA standard quantifies tribal water rights based on the amount of acreage on the reservation that is feasible for irrigated agriculture (Colby 2006; Brougher 2011).

In this study, tribes located less than 50 miles of driving distance to a major city had significantly higher percentage employment rates and average household income. Reservations located closer to cities are more likely to quantify their water rights. This may be due to a number of interrelated factors. Water rights quantification is costly and time consuming. For tribes located closer to cities, there may be greater regional demand on limited water resources. This competition for water may stimulate both the tribes and nearby cities to quantify tribal water rights in order to provide more certainty in regional water supply planning.

Statistical comparison found that Midwest tribes included in this study have a higher proportion of reservations operating casinos, but a lower proportion of tribal nations with quantified water rights, compared to the other two regions. Northwest and Southwest tribes examined in this study have similar percentages of water rights quantification and casino operation. Understanding the direction of causality requires site-specific analyses. It is uncertain whether water rights quantification encourages tribes to operate a casino, or tribes which desire to operate casinos seek water rights quantification. Water rights quantification and gaming operations for tribal nations are linked to economic development opportunities. These two activities may stimulate one another and jointly increase business activity on tribal nations.

Each tribal nation faces a unique set of factors that influence tradeoffs between pursuing water rights quantification, gaming, and agriculture. The patterns across tribes summarized in this article reflect the diversity of these pathways. A few more examples are highlighted here. The 2004 Arizona Water Settlements Act includes quantification of Gila River Indian Reservation and the Tohono O'odham Nation water rights and leasing provisions with nearby cities for mutual economic benefits (Tohono O'odham Settlement 2003; Bark 2009; USBR 2018). Both tribes operate a casino and are engaged in commercial agriculture. Years after quantifying water rights in the 1990 Fort Hall Indian Water Rights Agreement, in 2014 the Shoshone-Bannock Tribe negotiated agreements with junior-water rights holders to address water supply shortfalls for non-Indian water users. In addition to gaming and farming enterprises, the Shoshone-Bannock Tribe is implementing a tribally managed water bank to address Snake River

instream flow and groundwater replenishment needs of concern throughout the area (Bovee et al. 2016). Similar lease agreements and water management innovations are active or under negotiation with other tribal nations to provide water for environmental needs, urban growth, and agriculture.

While the data set assembled in this study provides an opportunity to look broadly across tribal nations at water rights, farming, gaming, and reservation economies, much more research on these themes is warranted. Due to absence of more widespread data, only 51 tribal nations were included in this study and patterns observed in this study cannot be assumed to extend to a broader set of tribes. Causal relationships between water quantification and reservation economies are complex, location-specific, and require more exploration. Figure 3 highlights multiple economic inter-relationships that need to be considered.

Results from comparisons among the tribal nations and regions included in this study highlight the complexity of relationships between water, gaming, farming, and reservation economic development. Consideration of these patterns can help tribes design policies to create sustainable tribal economies and to protect and manage tribal land and water. We hope those examining these important themes in the future will have access to more comprehensive data that includes many more tribal nations, and data generated through collaborations which recognize tribal governments as sovereign managers of information and natural resources.

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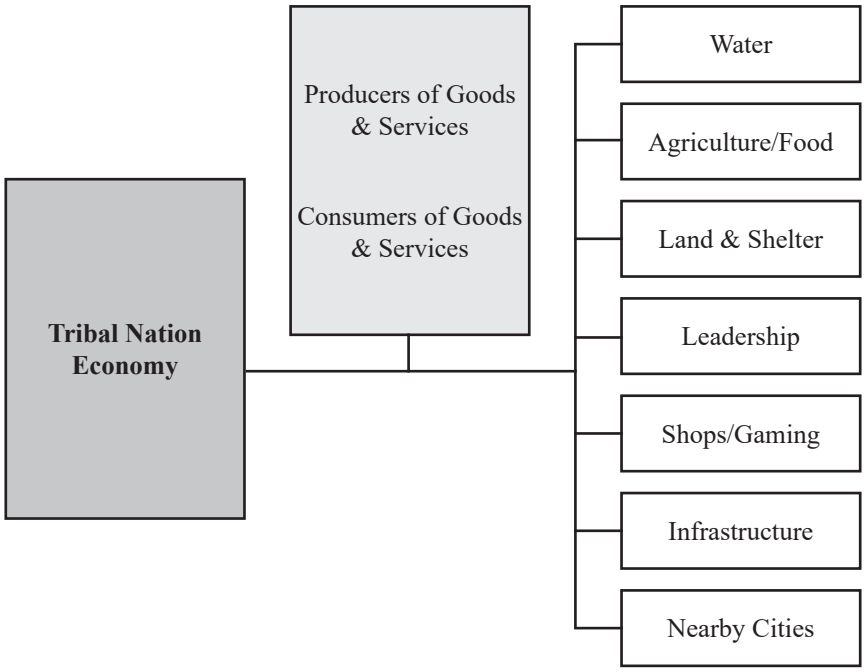

Figure 3. Components of tribal economic development.

books, including *Negotiating Tribal Water Rights*.. She may be contacted at bcolby@email.arizona.edu.

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