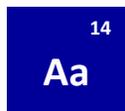


THE ECONOMIC IMPORTANCE OF WATER AVAILABILITY IN KANSAS



FINAL REPORT
September, 2015



APPARET
Analytics LLC

EXECUTIVE SUMMARY

- This study examines the economic importance of water availability in the State of Kansas in the future.
- A modified IMPLAN input-output model is used to estimate the potential economic losses associated with constrained water availability in calendar year (CY) CY2062 in seven areas of the State defined by the Southwest Kansas Groundwater Management District No. 3 (GMD3), compared to a baseline of unconstrained water availability.
- The economic impacts are estimated based on three assumptions:
 - Reduced water availability in Areas 1-5 in CY2062 due to groundwater depletion and silting rates of reservoirs;
 - The non-substitutability of water to compensate for the loss; and
 - The non-adaptation of producers and consumers to compensate for the water loss.
- Three measures of economic impact are assessed for each area of study and the State of Kansas as a whole. These are: Gross State Product (GSP),¹ employment,² and labor income.³
- Water availability estimates for CY2062 are supplied by GMD3.
- The following Table compares the availability of water in each of the seven study areas in CY2012 with the GMD3 estimates for CY2062.

Total Water Availability by Area (Actual and Estimated)

GEOGRAPHY	CY2012 Base Data (AF)	CY2062 Estimated Availability (AF)
Area 1	663,793	376,119
Area 2	1,229,397	1,027,642
Area 3	2,188,548	903,726
Area 4	189,624	170,491
Area 5	714,540	645,985
Area 6	1,276,563	1,276,563
Area 7	75,553	75,553
All 7 Areas	5,674,225	4,099,960

Source: GMD3 (2015)

¹ GSP represents the dollar value of all goods and services produced for final demand in a state. It is often used as a key measure of the health of a specific state's economy.

² Employment is a count of full- and part-time jobs for one full year.

³ Labor income includes employee compensation (wages and benefits) and proprietor income.

- The potential **total** economic losses associated with GMD3's reduced estimated water availability in the study areas in CY2062 compared with unconstrained water availability and trend economic growth in Kansas is detailed in the following Table.

Estimated Economic Losses by Area Associated with the Constrained Water Scenario for the State of Kansas in CY2062

GEOGRAPHY	GROSS STATE PRODUCT Billions 2015 \$	EMPLOYMENT Job Years	LABOR INCOME Billions 2015 \$
Area 1	2.5	38,441	1.3
Area 2	1.4	20,116	0.7
Area 3	10.4	123,961	5.3
Area 4	2.6	36,842	1.4
Area 5	1.4	21,348	0.7
Area 6	-	-	-
Area 7	-	-	-
Total Estimated Economic Losses	18.3	240,708	9.4

Source: Apparet Analytics

- The potential economic losses for five of the study areas is estimated to range from \$1.4 billion GSP for Areas 2 and 5 to \$10.4 billion GSP for Area 3 in CY2062 (both 2015 \$).
- Two of the study areas are not estimated to suffer any economic losses, as GMD3 does not anticipate reduced water availability in the areas by CY2062.
- An estimated \$18.3 billion (2015 \$) in GSP could be lost in the State of Kansas in CY2062 compared with the baseline if GMD3's constrained water scenario in Areas 1-5 is realized. This equates to a loss of approximately 10.1% GSP for the State as a whole in CY2062.
- Agriculture, Forestry, Fishing and Hunting (\$3.6 billion) and Real Estate and Rental (\$3 billion) are estimated to experience the greatest shortfalls in statewide GSP contributions if GMD3's CY2062 water availability estimates for the seven study areas hold true (both 2015 \$).
- Government and non-NAICs; Health and Social Services; Wholesale Trade; Transportation and Warehousing; and Professional, Scientific and Technical Services are also estimated to each contribute over \$1 billion less (2015 \$) to the State economy under GMD3's constrained water scenario in CY2062.
- Almost 241,000 public and private sector jobs would not be created statewide if GMD3's reduced water availability scenario holds true in Areas 1-5 in CY2062. These estimated job losses could equate to a \$9.4 billion (2015 \$) loss in statewide labor income in CY2062.

- Healthcare and Social Services (13.4% of job losses); Agriculture, Forestry, Fishing and Hunting (12.8% of job losses); and Professional, Scientific and Technical Services (8.8% of job losses) are estimated to experience the largest employment potential losses in absolute terms in CY2062.

CONTENTS

EXECUTIVE SUMMARY ii

INTRODUCTION 1

METHOD AND DATA SOURCES 2

 Data Inputs..... 2

 Economic Impact Method..... 5

ESTIMATED RESULTS..... 7

CONCLUSIONS & RECOMMENDATIONS 13

APPENDIX A – NAICS CODES 15

LIST OF TABLES

Table 1: Total Water Availability by Area (Actual and Estimated) 4

Table 2: Estimated Economic Losses Associated with the Constrained Water Scenario for the State of Kansas in CY2062 7

Table 3: Estimated Economic Losses by Area Associated with the Constrained Water Scenario for the State of Kansas in CY2062 8

Table 4: Estimated GSP Sector Losses by Order of Magnitude in CY2062 in the State of Kansas..... 11

LIST OF FIGURES

Figure 1: State of Kansas Areas of Study..... 3

Figure 2: Estimated GSP Losses by Area in CY2062..... 9

Figure 3: Estimated Job Losses by Sector in CY2062 in the State of Kansas 11

INTRODUCTION

In May 2014, Governor Sam Brownback placed more than half of all counties in the State of Kansas in an emergency drought status.⁴ The U.S. Geological Survey (USGS) also acknowledges that water demand often outstrips availability in the State of Kansas.⁵ This is due in large part to the extensive development of groundwater for irrigation water use. There's also been a steady decline in the High Plains Aquifer - a key water source for farmers in Western Kansas; and aquifers beneath many areas of central Kansas contain water that is too salty for domestic and agricultural usage.

Kansas' water availability could significantly impact the future economic development and prosperity of the State; and a *Vision for the Future of Water in Kansas* has gathered stakeholder input from farmer, ranchers, municipalities, and other water users to form a comprehensive, 50-year vision for water.

The purpose of this initial study is to estimate the extent to which the State of Kansas economy could be impacted by a reduction in water availability in calendar year (CY) 2062.

Using data supplied by the Southwest Kansas Groundwater Management District No. 3 (GMD3), the current study compares the projected size of the economy in CY2062 if water is freely available with a scenario in which the total level of water availability is constrained within seven areas of the State of Kansas. These seven areas represent 63 counties, and have been identified for analysis by GMD3. Five of the seven areas are estimated by GMD3 to experience a water deficit by CY2062, primarily based on the depletion of groundwater supplies and silting. The other two areas are estimated to experience a reduction in water availability post-2062. No assumptions are made about the impact of climatic conditions on water availability (including droughts) within the analysis.

Using a modified IMPLAN input-output model in conjunction with trend (10-year average BEA sector-specific) growth projections for the State of Kansas, economic impacts are estimated based on:

- The reduced availability of water in Areas 1-5 in CY2062;
- The non-substitutability of water to compensate for the loss; and
- The non-adaptation of producers and consumers.

The results are intended as a preliminary assessment of the economic importance of water in the State, and as such could be used in subsequent research, commissioned separate to this current study – for example, a partial net economic analysis of the development of a new aqueduct project in Kansas, taking into account the construction, operational and economic development benefits, alongside a thorough analysis of the costs and financing mechanism(s).

⁴ Source: Kansas Office of the Governor, (2014). *Governor Sam Brownback Updates Drought Emergency, Warnings and Watches in Kansas Counties*, May 21, 2014, available at:

http://www.kwo.org/reports_publications/Drought/Governor%20Updates%20Drought%20Status%20Issues%20Executive%20Order%20May%202014.pdf

⁵ Source: USGS (date unknown). *U.S. Geological Survey Programs in Kansas*, available at: <http://pubs.usgs.gov/fs/FS-017-96/fs-017-96.pdf>

METHOD AND DATA SOURCES

Water availability is a critical input in the production and consumption activities of any economy.

Data Inputs

Water data for the current study has been supplied by GMD3, who have divided the State of Kansas into distinct areas, which:

- Are consistent with county boundaries to allow for the use of county level data; and
- Enable use of previous groundwater modeling for supply decline data.

Focusing on both the current and projected available supply of water, and using 2012 water availability as the base year, GMD3 has identified seven areas within the State that could potentially experience a water deficit by 2112. These seven areas represent 63 counties, as illustrated in Figure 1. Each deficit projection is primarily based on the depletion of groundwater supplies and silting of reservoir storage space. No assumptions are made about climatic conditions such as droughts within the analysis, aside from the fact that the base year (2012) for the economic modeling is itself a drought year.

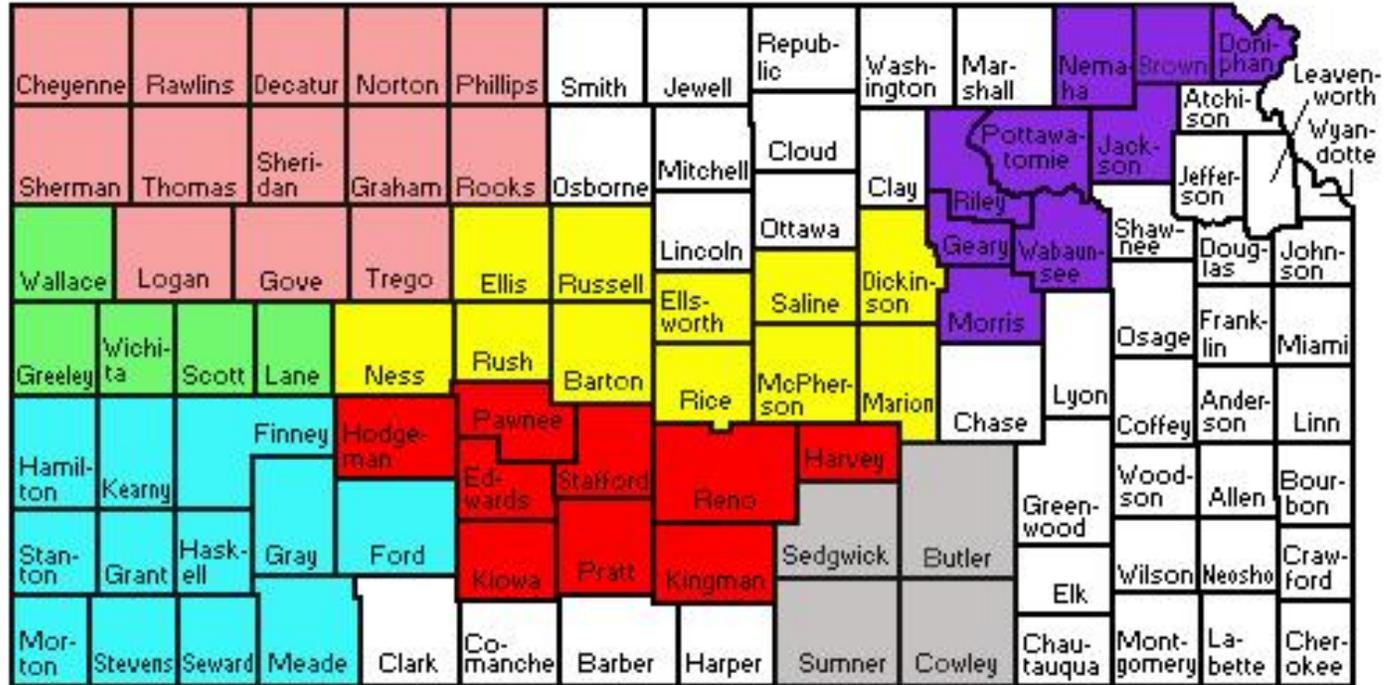
Table 1 illustrates the base data supplied by GMD3 for each of the seven areas in 2012, along with the estimated water availability in CY2062.

Three types of water availability have been supplied by GMD3. Agricultural use refers to the water needed to meet the irrigation requirements of crops, maintain feedlots and dairies. Municipal use is the water required to meet urban and rural residential and commercial needs. Industrial water use includes such purposes as fabricating, processing, washing, diluting, cooling, or transporting a product; incorporating water into a product; and sanitation needs within manufacturing facilities. To quantify the economic importance of water in these seven areas in CY2062, Apparet Analytics combines municipal and industrial water into a single category prior to conducting the analysis.

Table 1 shows that the water deficit for two of the GMD3-defined study areas is not projected to occur within the 50-year time horizon of the current study. However, the water supply models and other data sources accessed by GMD3 to provide county level data estimate that the availability of water will decline in the other five areas featured in this study by CY2062.

In summary, total water availability in the seven study areas identified by GMD3 is estimated to fall 27.7% by CY2062.

Figure 1: State of Kansas Areas of Study



Key:

- Area 1
- Area 2
- Area 3
- Area 4
- Area 5
- Area 6
- Area 7

Table 1: Total Water Availability by Area (Actual and Estimated)

GEOGRAPHY	AGRICULTURAL		MUNICIPAL & INDUSTRIAL		TOTAL	
	2012 Base Data (AF)	2062 Estimated Availability (AF)	2012 Base Data (AF)	2062 Estimated Availability (AF)	2012 Base Data (AF)	2062 Estimated Availability (AF)
Area 1	650,244	368,442	13,549	7,677	663,793	376,119
Area 2	1,207,950	1,009,715	21,447	17,927	1,229,397	1,027,642
Area 3	2,130,583	879,790	57,965	23,936	2,188,548	903,726
Area 4	148,858	133,838	40,766	36,653	189,624	170,491
Area 5	664,083	600,369	50,457	45,616	714,540	645,985
Area 6	1,102,670	1,102,670	173,893	173,893	1,276,563	1,276,563
Area 7	30,851	30,851	44,702	44,702	75,553	75,553

Source: GMD3, (2015). Southwest Kansas Groundwater Model; Northwest Kansas Groundwater Model (GMD4); KS Dept. of AG/DWR; KS Water Office; KS Geological Survey

Economic Impact Analysis Method

Economic impact analysis traces the full impact - direct, indirect and induced - of an economic activity on jobs and incomes in a defined economy.

The availability of water in the State of Kansas affects the maximum level of production possible in each sector, and therefore the number of people directly employed by all firms operating in those sectors. These are known as direct economic impacts. Indirect effects arise, for example, through supplier purchases placed by firms as part of their production process. Induced effects occur when workers either directly or indirectly associated with the level of production spend their incomes in the local economy, when suppliers place upstream demands on other producers, and when governments spend new tax revenues. The total jobs and incomes associated with the productive activity made possible by the availability of water in the State are a multiple of the initial direct production.

To estimate the economic importance of water in the State of Kansas, Apparet Analytics uses a modified version of an IMPLAN input-output model. IMPLAN is widely used for economic assessments and can provide detailed estimates of secondary expenditures and income generated as a result of a business investment or operation for a finite period of time (typically one full calendar or fiscal year). Input-output analysis is an economics term that refers to the study of the effects that different sectors have on the economy as a whole, for a particular nation or region.

Apparet Analytics' method for estimating the economic value of water consists of four fundamental steps:

1. **Prepare a baseline estimate of the size/nature of the economy for a defined geography:** This Business as Usual (BAU) case consists of an input-output table for the year of study, in which the intermediate demand and final demand for the areas of study is described, and a distinction made between the use of water as a primary input to the production process of each industry or sector, and other water supplies that are directly consumed.
2. **Develop a policy scenario:** This policy scenario assumes the reduced availability of water in CY2062 for each sector listed in the input-output table. It also assumes that no other sources of water are available to compensate for the loss of water deliveries in CY2062, and the non-adaptability of producers and consumers.⁶
3. **Compute the baseline and policy scenario forecasts.**
4. **Produce the "delta" results:** Differences between the BAU and policy scenario values for each sector provide the incremental economic potential of the State of Kansas, assuming an appropriate water supply can be sourced. This produces economic impact estimates for GSP, employment, and labor income for the reduced water availability scenario.

⁶ Apparet Analytics acknowledges the unlikelihood of the complete non-substitutability of water to compensate for the reduction in water availability, and also the unlikelihood of the non-adaptability of producers and consumers. However, this type of scenario represents the best way to arrive at a comprehensive estimate of the importance of water for the State of Kansas economy.

Three variables are provided to illustrate the economic importance of water in the current analysis. These are:

- **Gross State Product (GSP):** this is synonymous with value added. It represents the dollar value of all goods and services produced for final demand in a state or county. It excludes the value of intermediate goods and services purchased as inputs to final production. It can also be defined as the sum of employee compensation (wages, salaries and benefits, including employer contributions to health insurance and retirement pensions), proprietor income, property income, and indirect business taxes.
- **Employment:** this is a count of full- and part-time jobs. It includes both wage and salary workers, and the self-employed. In the current study, employment is measured in job years. A job year is equivalent to one person having a full-time job for exactly one year.
- **Labor Income:** this includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income.⁷

Using a modified IMPLAN input-output model in conjunction with 10-year average BEA sector-specific growth estimates for the State of Kansas, economic impacts are estimated based on:

- The reduced availability of water in Areas 1-5 in CY2062;
- The non-substitutability of water to compensate for the loss; and
- The non-adaptation of producers and consumers to reduced water availability.

All results are provided for one full calendar year – namely, CY2062.

All dollar amounts are expressed in current 2015 dollars (2015 \$).

The estimates of economic importance presented in this study are based on the flow of dollars around the specific areas defined by GMD3 based on data availability, similar economic and water supply regions of Kansas. They do not take into account any transactions made with agents located outside the geographic boundaries of the study area - that is, when goods and services are purchased from individuals and firms located in other parts of Kansas, states and nations; or when residents and business pay federal taxes. These latter transactions are described as “leakages” in economic impact analyses, to reflect the fact that dollars are leaking out of the economy of the individual state or counties of study into the economies of other states or nations. One major determinant of the size of leakages in economic impact analyses is the size of the study area - the bigger the geographical area of study, the less the potential for leakages because less transactions take place with entities outside of the area analyzed.

⁷ Labor income is also included in GSP.

ESTIMATED RESULTS

Table 2 provides estimates of the statewide economic losses associated with a reduction in the availability of water in five of the seven areas identified by GMD3. The estimated reduction in water availability in CY2062 is primarily based on the depletion of groundwater supplies and silting rates of reservoirs. No assumptions are made about the impact of climatic conditions on water availability (including droughts) within the analysis.

The estimated metrics (where appropriate) are expressed in 2015 dollars (2015 \$), and assume both non-substitutability and non-adaptation. That is, no other sources of water are assumed to be available to compensate for the loss of water in the Areas 1-5 in CY2062 (the study year); and producers and consumers are assumed to be unable to adapt to the water shortfall.

The first line of Table 2 estimates the anticipated direct losses for the State of Kansas economy if GMD3’s estimated reduction in total water availability holds true in CY2062.⁸ These losses are estimated at \$12.3 billion GSP, approximately 158,000 jobs, and \$6.3 billion labor income (2015 \$).

The second line of Table 2 estimates the indirect losses sustained by the State of Kansas economy if GMD3’s estimated reduction in total water availability holds true in CY2062.⁹ This is estimated at \$3 billion GSP, over 35,000 jobs, and \$1.4 billion labor income (2015 \$).

Table 2: Estimated Economic Losses Associated with the Constrained Water Scenario for the State of Kansas in CY2062

	GROSS STATE PRODUCT <i>Billions 2015 \$</i>	EMPLOYMENT <i>Job Years</i>	LABOR INCOME <i>Billions 2015 \$</i>
Direct Losses	12.3	157,764	6.3
Indirect Losses	3.0	35,047	1.4
Induced Losses	3.0	47,897	1.7
Total Estimated Economic Losses	18.3	240,708	9.4

Source: Apparet Analytics

⁸ Direct effects refer to any activity directly associated with the availability of water in the seven study areas. They are usually defined in terms of the maximum level of production or output possible in each sector, and the number of people directly employed by all firms operating in each sector.

⁹ Indirect effects capture the impact on the firms that directly and indirectly engage in production and employment as a result of the availability of water in the seven study areas; for example, through supplier purchases placed as part of the production process.

The third line of Table 2 estimates the induced losses sustained by the State of Kansas economy if GMD3’s estimated reduction in total water availability holds true in CY2062.¹⁰ This is estimated at \$3 billion GSP, approximately 48,000 jobs, and \$1.7 billion labor income (2015 \$).

The total impact of GMD3’s estimated reduction in total water availability in the study areas in CY2062 for the State of Kansas economy is estimated at \$18.3 billion GSP, almost 241,000 jobs, and \$9.4 billion labor income (2015 \$). To put this into perspective, an estimated 10.1% of the State of Kansas’ annual GSP could be lost if GMD3’s estimated reduction in total water availability for residents, businesses, industry, and agriculture located in the seven areas of study in CY2062 holds true.

Table 3 estimates the **total** (that is, direct, indirect, and induced) economic losses for each of the study areas identified by GMD3.

Table 3: Estimated Economic Losses by Area Associated with the Constrained Water Scenario for the State of Kansas in CY2062

GEOGRAPHY	GROSS STATE PRODUCT <i>Billions 2015 \$</i>	EMPLOYMENT <i>Job Years</i>	LABOR INCOME <i>Billions 2015 \$</i>
Area 1	2.5	38,441	1.3
Area 2	1.4	20,116	0.7
Area 3	10.4	123,961	5.3
Area 4	2.6	36,842	1.4
Area 5	1.4	21,348	0.7
Area 6	-	-	-
Area 7	-	-	-
Total Estimated Economic Losses	18.3	240,708	9.4

Source: Apparet Analytics

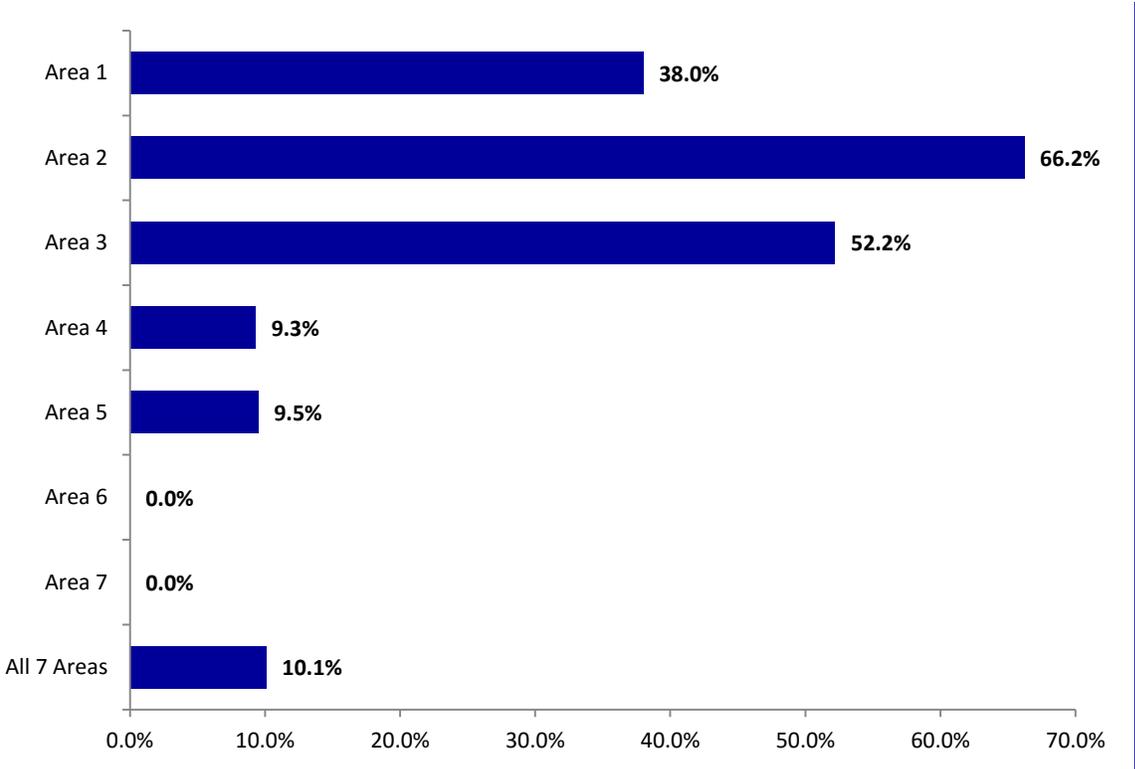
Table 3 estimates that the study area affected the greatest in absolute terms by GMD3’s shortfall in water availability in CY2062 is Area 3. This area consists of Finney, Ford, Grant, Gray, Hamilton, Haskell, Kearny, Meade, Morton, Seward, Stanton, and Stevens counties. Area 3’s total economic losses are estimated at \$10.4 billion GSP, approximately 124,000 jobs, and \$5.3 billion labor income (2015 \$).

Areas 6 and 7 are not anticipated to experience any economic losses, as GMD3 estimates that their water availability in CY2062 will remain unchanged compared to 2012 (the base year for the economic modeling).

¹⁰ Induced effects occur when workers either directly or indirectly associated with the level of production spend their incomes in the local economy, when suppliers place upstream demands on other producers, and when governments spend new tax revenues.

Figure 2 summarizes the estimated GSP losses by study area arising from GMD3’s constrained water scenario in CY2062. This suggests that in percentage terms, Area 3 could lose 52.2% of GSP in CY2062 as a result of GMD3’s estimated reduction in water availability. However, the hardest hit area in percentage terms could be Area 2. This latter area consists of 5 counties – Greeley, Lane, Scott, Wallace, and Wichita. Area 2’s estimated \$1.4 billion loss in GSP in CY2062 due to GMD3’s reduced water availability scenario equates to a 66.2% loss in the area’s GSP in that year.

Figure 2: Estimated GSP Losses by Area in CY2062



Source: Apparet Analytics

Table 4 estimates the total statewide GSP losses at a sectoral level in the State of Kansas, compared to a Business as Usual (BAU) scenario in which water availability is unconstrained. The GSP estimates encompass direct, indirect, and induced losses. The sectors are categorized according to the North American Industry Classification System (NAICS).¹¹ An explanation of the categories of business activity included within each NAICS sector is provided in Appendix A.

Two private sector establishment categories are each estimated to contribute over \$3 billion less to GSP (2015 \$) in the State of Kansas if the best available regional data provided for CY2062 holds true. These sectors are Agriculture, Forestry, Fishing and Hunting; and Real Estate and Rental. Five additional public

¹¹ NAICS is the standard used by Federal statistical agencies to classify business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

and private sector categories listed in Table 4 could each contribute over \$1 billion less (2015 \$) to the State of Kansas economy as a result of GMD3’s constrained water scenario in CY2062. This includes an estimated loss of \$1.67 billion from the Government sector and all non-NAICs classified businesses.

Table 4: Estimated GSP Sector Losses by Order of Magnitude in CY2062 in the State of Kansas

SECTOR	GROSS STATE PRODUCT Billions 2015 \$
Agriculture, Forestry, Fishing & Hunting	3.604
Real Estate & Rental	3.012
Government & Non NAICs	1.666
Health & Social Services	1.660
Wholesale Trade	1.226
Transportation & Warehousing	1.142
Professional, Scientific & Technical Services	1.121
Finance & Insurance	0.988
Retail Trade	0.964
Information	0.696
Administrative & Waste Services	0.537
Manufacturing	0.422
Accommodation & Food Services	0.298
Electricity, Natural Gas, Water, Sewage & Other Treatment/Delivery Systems	0.238
Educational Services	0.202
Management of Companies	0.194
Mining	0.119
Other Services	0.110
Arts, Entertainment & Recreation	0.078
Construction	0.052
Estimated Total GSP Losses¹²	18.328

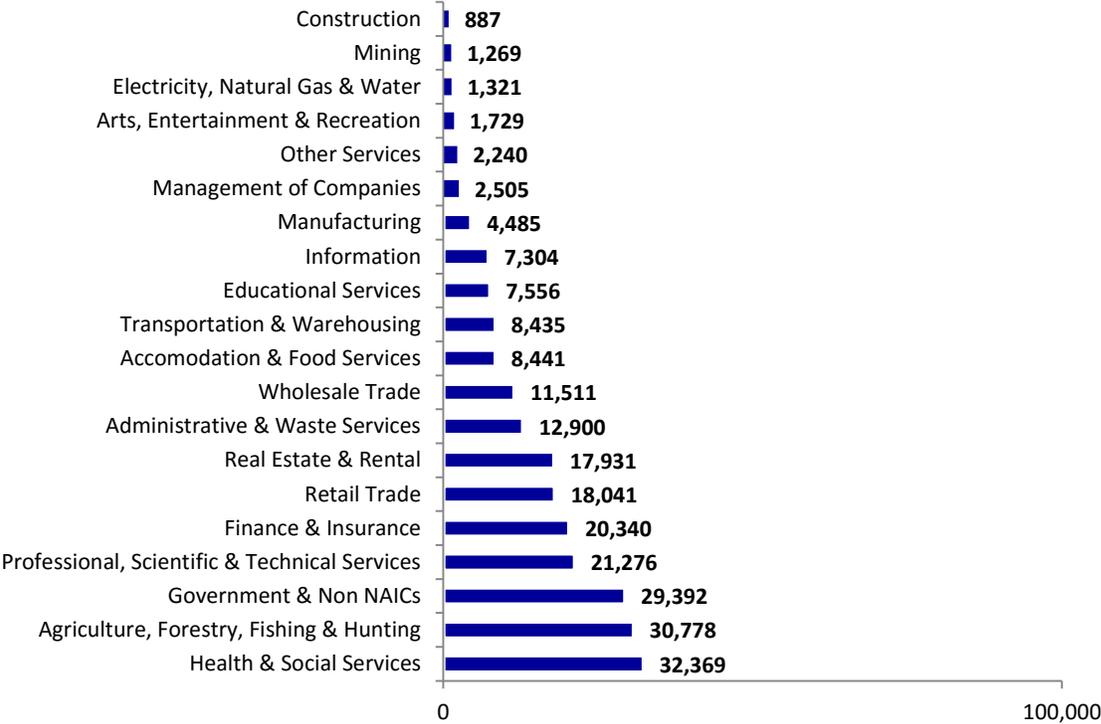
Source: Apparet Analytics

Figure 3 estimates the total statewide employment losses at a sectoral level in CY2062 in the State of Kansas if GMD3's water availability estimates for the seven study areas holds true. The estimates consist of direct, indirect, and induced full-time (or equivalent) job losses in CY2062 alone.

The Top 3 private sectors estimated to experience the largest losses in absolute terms in statewide employment in CY2062 are: Healthcare and Social Services (13.4% of job losses); Agriculture, Forestry, fishing and Hunting (12.8% of job losses); and Professional, Scientific and Technical Services (8.8% of job losses). Figure 3 also estimates that Government and all non-NAICs classified employment could account for 12.2% of statewide job losses in CY2062.

¹² Numbers may not tally exactly due to rounding.

Figure 3: Estimated Job Losses by Sector in CY2062 in the State of Kansas



Source: Apparet Analytics

CONCLUSIONS & RECOMMENDATIONS

The purpose of this study is to calculate the economic importance of water availability to the State of Kansas.

Based on an assumption of constrained water availability in five of seven study areas in CY2062 estimated by GMD3 under normal climatic water supply conditions, a customized IMPLAN input-output model is used to estimate Gross State Product (GSP), employment, and labor income losses in CY2062.¹³

Central to this analysis are two additional assumptions:

- The non-substitutability of water to compensate for the estimated loss of water availability in Areas 1-5; and
- The non-adaptability of producers and consumers to this estimated water loss.

Conclusions

The direct losses for the State of Kansas economy if GMD3's estimated reduction in total water availability in the seven areas of study holds true in CY2062 are estimated at \$12.3 billion GSP, approximately 158,000 jobs, and \$6.29 billion labor income (2015 \$).

The indirect losses sustained by the State of Kansas economy if GMD3's estimated reduction in total water availability in the seven areas of study holds true in CY2062 are estimated at \$3 billion GSP, over 35,000 jobs, and \$1.4 billion labor income (2015 \$).

The induced losses sustained by the State of Kansas economy if GMD3's estimated reduction in total water availability in the seven areas of study holds true in CY2062 are estimated at \$3 billion GSP, approximately 48,000 jobs, and \$1.7 billion labor income (2015 \$).

The total impact of GMD3's estimated reduction in total water availability in the seven areas of study in CY2062 for the State of Kansas economy is estimated at \$18.3 billion GSP, almost 241,000 jobs, and \$9.4 billion labor income (2015 \$). This equates to an estimated 10.1% loss for the State of Kansas' GSP in CY2062.

Area 3, which consists of Finney, Ford, Grant, Gray, Hamilton, Haskell, Kearny, Meade, Morton, Seward, Stanton, and Stevens counties, is estimated to potentially suffer the greatest economic losses in absolute terms due to GMD3's projected shortfall in water availability in CY2062. Area 3's total economic losses are estimated at \$10.4 billion GSP, approximately 124,000 jobs, and \$5.3 billion labor income (2015 \$).

Area 2, which consists of Greeley, Lane, Scott, Wallace, and Wichita counties, is estimated to potentially suffer the greatest economic losses in percentage terms due to GMD3's shortfall in water availability in

¹³ Apparet Analytics recognizes that the non-substitutability and non-adaptability assumptions are unlikely. However, it is the best way to arrive at a comprehensive estimate of the economic importance of water for State of Kansas economy.

CY2062. Area 2's total economic losses are estimated at \$1.4 billion GSP, over 20,000 jobs, and \$0.7 billion labor income (2015 \$).

Areas 6 and 7 are not projected to experience any economic losses in CY2062 as GMD3 does not estimate any shortfall in water availability in either geography.

Agriculture, Forestry, Fishing and Hunting (\$3.6 billion) and Real Estate and Rental (\$3 billion) are estimated to experience the greatest shortfalls in statewide GSP contributions if GMD3's water availability estimates for the seven study areas hold true (both 2015 \$).

Healthcare and Social Services (13.4% of job losses); Agriculture, Forestry, Fishing and Hunting (12.8% of job losses); and Professional, Scientific and Technical Services (8.8% of job losses) are estimated to experience the largest employment losses in absolute terms in CY2062 if GMD3's water availability estimates for the seven study areas hold true.

Apparet Analytics' economic analysis therefore clearly demonstrates the economic importance of water for the State of Kansas economy today and for a year envisioned 50 years in the Kansas future.

Recommendations for Further Study

The results presented in this study offer a snapshot of potential losses associated with constrained water availability for a single calendar year (2062). Apparet Analytics therefore recommends a multi-year analysis to estimate the cumulative economic losses associated with reduced water availability in the State over a 50-year time horizon.

Apparet Analytics also recommends GMD3 revises the study areas to more closely align with groundwater management districts and/or the newly formed 14 regional Planning Areas under the Kansas 50 year water vision initiative prior to the commission of a more detailed study.

Finally, Apparet Analytics recommends the commissioning of a benefit-cost analysis to explore the options for increasing water availability throughout the State. The leading water strategy identified by the benefit-cost analysis could then be used in a partial net economic analysis that takes into account the construction, operational and economic development benefits, investment/financing costs, and the resulting economic value of increased water availability for residents, agriculture, business, and industry.

APPENDIX A – NAICS CODES

The North American Industry Classification System (NAICS) is used by U.S. government and businesses to classify business establishments according to type of economic activity (process of production). The NAICS numbering system consists of two to six digits. The first two digits designate the largest business sector, the third digit designates the subsector, the fourth digit the industry group, the fifth digit the NAICS industries, and the sixth digit the national industries. A list of the 2012 two-digit NAICS categories, general descriptions, and examples of the type of firms or entities is shown below:

NAICS 2012 Sectors and Examples

SECTOR #	DESCRIPTION	EXAMPLES
11	Agriculture, Forestry, Fishing, and Hunting	Crop Production; Animal Production and Aquaculture; Forestry and Logging; Fishing, Hunting and Trapping; Support Activities for Agriculture and Forestry
21	Mining, Quarrying, and Oil and Gas Extraction	Oil and GAS Extraction; Mining (except Oil and Gas); Support Activities for Mining
22	Utilities	Electric Power Generation, Transmission and Distribution; Natural Gas Distribution; Water, Sewage and Other Systems
23	Construction	Construction of Buildings; Heavy and Civil Engineering Construction; Specialty Trade Contractors
31-33	Manufacturing	Food Manufacturing; Beverage and Tobacco Product Manufacturing; Textile Mills; Textile Product Mills; Apparel Manufacturing; Leather and Allied Product Manufacturing; Wood Product Manufacturing; Paper Manufacturing; Printing and Related Support Activities; Petroleum and Coal Products Manufacturing; Chemical Manufacturing; Plastics and Rubber Products Manufacturing; Nonmetallic Mineral Product Manufacturing; Primary Metal Manufacturing; Fabricated Metal Product Manufacturing; Machinery Manufacturing; Computer and Electronic Product Manufacturing; Electrical Equipment, Appliance, and Component Manufacturing; Transportation Equipment Manufacturing; Furniture and Related Product Manufacturing; Miscellaneous Manufacturing
42	Wholesale Trade	Merchant Wholesalers, Durable Goods; Merchant Wholesalers, Nondurable Goods; Wholesale Electronic Markets and Agents and Brokers
44-45	Retail Trade	Motor Vehicle and Parts Dealers; Furniture and Home Furnishings Stores; Electronics and Appliance Stores; Building Material and Garden Equipment and Supplies Dealers; Food and Beverage Stores; Health and Personal Care Stores; Gasoline Stations; Clothing and Clothing Accessories Stores; Sporting Goods, Hobby, Book, and Music Stores; General Merchandise Stores; Miscellaneous Store Retailers; Non-store Retailers

48-49	Transportation and Warehousing	Air Transportation; Rail Transportation; Water Transportation; Truck Transportation; Transit and Ground Passenger Transportation; Pipeline Transportation; Scenic and Sightseeing Transportation; Support Activities for Transportation; Postal Service; Couriers and Messengers; Warehousing and Storage
51	Information	Publishing Industries (except Internet); Motion Picture and Sound Recording Industries; Broadcasting (except Internet); Telecommunications; Data Processing, Hosting, and Related Services; Other Information Services
52	Finance and Insurance	Monetary Authorities - Central Bank; Credit Intermediation and Related Activities; Securities, Commodity Contracts, and Other Financial Investments and Related Activities; Insurance Carriers and Related Activities; Funds, Trusts, and Other Financial Vehicles
53	Real Estate, and Rental and Leasing	Real Estate; Rental and Leasing Services; Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)
54	Professional, Scientific, and Technical Services	Publishing Industries (except Internet); Motion Picture and Sound Recording Industries; Broadcasting (except Internet); Telecommunications; Data Processing, Hosting, and Related Services; Other Information Services
55	Management of Companies and Enterprises	Establishments holding the securities of, or equity interests in, companies and enterprises to own a controlling interest or influence management decisions; Non-Government establishments administering, overseeing, and managing establishments that normally undertake strategic and organizational planning or decision-making
56	Administrative and Support, and Waste Management and Remediation	Administrative and Support Services; Waste Management and Remediation Services
61	Educational Services	Elementary and Secondary Schools; Junior Colleges; Colleges, Universities, and Professional Schools; Business Schools and Computer and Management Training; Technical and Trade Schools; Other Schools and Instruction; Educational Support Services
62	Healthcare and Social Assistance	Ambulatory Health Care Services; Hospitals; Nursing and Residential Care Facilities; Social Assistance
71	Arts, Entertainment, and Recreation	Performing Arts, Spectator Sports, and Related Industries; Museums, Historical Sites, and Similar Institutions; Amusement, Gambling, and Recreation Industries
72	Accommodation and Food Services	Accommodation; Food Services and Drinking Places
81	Other Services (except Public Administration)	Repair and Maintenance; Personal and Laundry Services; Religious, Grantmaking, Civic, Professional, and Similar Organizations; Private Households
92	Public Administration	State and Local Government; Military

**Apparet Analytics LLC
4704 West Barko Lane
Phoenix
AZ 85087**

**Tel: (480) 363 1480
Email: apparet14@gmail.com**