Evaluation of the impact of end gun removal on wateruse within GMD 5 under its 2010 AWEP

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Summary: To evaluate likely wateruse savings of end gun removal under GMD5's LEMA concept (i.e. removal of end guns without any specific accountability), KDA-DWR evaluated water use for 45 systems that removed end guns within the proposed LEMA under the 2010 Agricultural Water Enhancement Program (AWEP). KDA-DWR's evaluation is based on methods recently developed to estimate water use based on climate factors [1, 2] and KDA-DWR's use of the resulting climate-based water-use estimator tool to evaluate changes in water-use behavior with changing management. See e.g. its application to the Sheridan 6 LEMA in "*A climate-based method to estimate water use and evaluate water savings,*" presented at the 2018 Governor's Water Conference, which demonstrated significant reductions in water-use behavior between pre- and post-LEMA conditions.

These methods were used to evaluate water use before (2000-10) and after (2012-17) gun removal. A 5.0 % reduction in irrigated acres was reported with a 4.8 % reduction in reported wateruse. However, when adjusted for climate, the reported water use and predicted water use were nearly the same. This suggests that the irrigated area reduction under AWEP had no discernable impact on water use in Zone A.

Evaluation

Under AWEP, USDA Natural Resources Conservation Service (NRCS) in Kansas provided at least $570,000 to GMD5 for fiscal year (FY) 2010 to "…reduce water use by removing end guns from center pivot systems and returning those irrigated acres under the end gun to non-irrigated acres…[for the Rattlesnake Creek subbasin within GMD5 for five years]." [source: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ks/programs/?cid=nrcs142p2_032842]. End guns were removed for 45 systems under the program.

A climate-based water use estimator was developed for the AWEP rights within Zone A based on years 2000-2010 [3]. Fig. 1 plots estimated vs. reported water use for this estimator, which shows a coefficient of determination (r-squared value) of 98.5 percent. Fig. 2 compares reported and estimated use for 2000-2017 using the estimator based on the wateruse pattern from years 2000-2010. Reported use in 2011, an extreme year, was less than estimated, likely due to a combination of water right limitations and/or pumping limitations - being unable to keep up with crop demands.

Table 1 compares reported use and acres as well as estimated water use for three periods (1) 2000-2010 (baseline), (2) 2011-2017, and (3) 2012-2017. Line 4 compares fractional differences between periods 2012-2017 and 2000-2010. Finally, the table displays the expected reported use which would represent a 5% and 10% savings from end gun removal under the climate for the 2012-17 period (6,030 AF and 5,713 respectively). Reported use and acres both decreased approx. five percent. The estimator predicted a decrease of five percent in water use between the two periods in terms of acre-feet based on climate factors.

Comparing reported and estimated use for the post-AWEP years 2012-2017 in Table 1 shows that the averages for reported and estimated water use are nearly the same: the difference is only 26 ac-ft. That is to say, the reported use for 2012-2017 is almost exactly what would be predicted by the estimator based on past use, and shows no apparent impact of the irrigation reduction under AWEP.

Thus in contrast to the Sheridan 6 LEMA which showed a definite change in behavior with the LEMA implementation, this analysis can find no savings with the removal of end guns under AWEP.

In a separate analysis, KDA-DWR found that the average use and use patterns of the AWEP and non-AWEP files within the Zone A were essentially identical.

Table 1. Comparison of reported and estimated water use

	(A)	(B)	(C)	(D)	(E)
	time period	rep. use acft/yr	reported acres	est. use acft/yr	change in behavior reported vs estimated
(1)	2000-2010	6,693	5,740	6,692	Baseline
(2)	2011-2017	6,676	5,458	6,848	-2.58%
(3)	2012-2017	6,374	5,453	6,348	0.41%
(4)	row (3-1)/1	-4.76%	-5.00%	-5.15%	
(5)	with 5% reduction			6,030	-5.00%
(6)	with 10% reduction			5,713	-10.00%

Row (1) is the time period that was used to develop the relationship between climate and pumping, so it is called “Baseline” in cell (E)(1).

Row (2) shows the reported water use and acres along with the estimates of water use over 2011-2017 given by the “Baseline” relationship. Cell (E)(2) reports that the reported water use was 2.58% less than what was predicted by the Baseline relationship. This is likely due to the extremely dry conditions in 2011 that saw water use limited by authorized quantity and in some cases by the inability of some irrigation systems to provide the rate needed to keep up with crop demand.

Row (3) removes 2011 from the data set. Again, it shows the reported water use and acres along with the estimates of water use over 2012-2017 given by the “Baseline” relationship. Cell (B)(3) is average reported use for 2012-2017. Cell (D)(3) is average use/yr estimated from the baseline relationship for 2012-2017.

The Baseline relationship does not consider acres – or said another way, the Baseline relationship makes no assumptions about acres or irrigation practices and depends only on climate data.

As cell (C)(3) shows, the average number of irrigated acres 2012-2017 is 5% less than in the Baseline period (C)(1). Any water savings caused by that reduction in acres would cause a deviation from the estimated use. Instead what we see is that the estimated use (D)(3) is almost the same as the reported use (B)(3). If the 5% reduction in acres between the Baseline period and the 2012-2017 period had resulted in a 5% savings in water use, then the reported use would have been the value in (D)(5). Likewise, a 10% savings in water use would have resulted in (D)(6) reported water use.

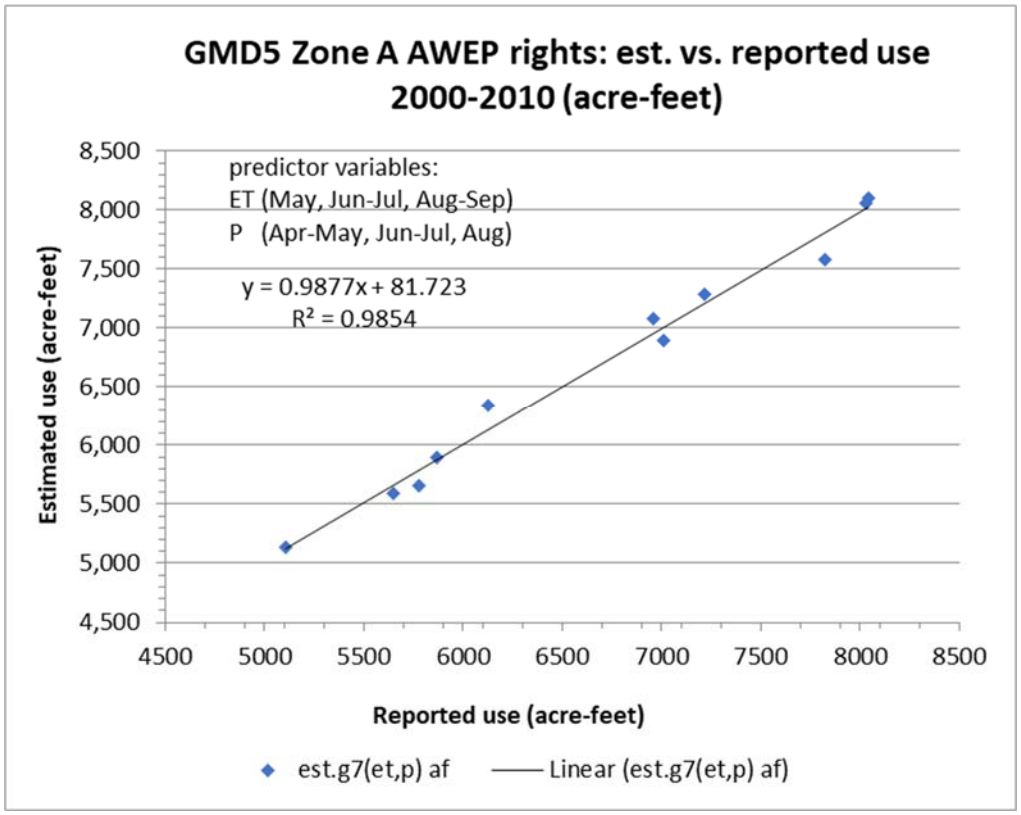

Fig. 1. Estimated vs. reported use for AWEP rights in Zone A, 2000-2010 (inches).

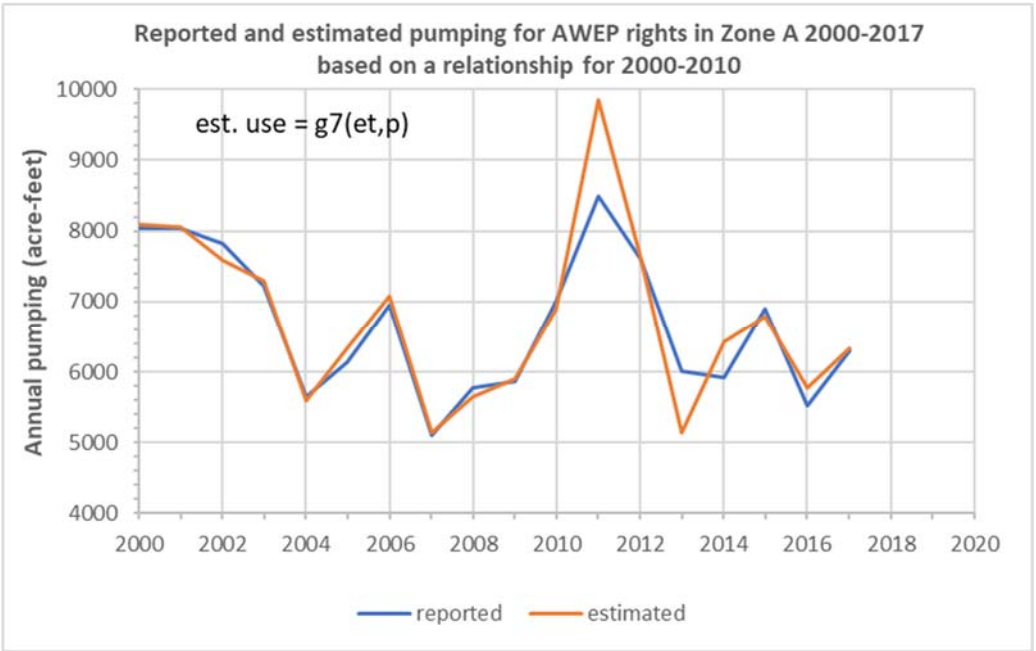

Fig. 2. Comparison of reported and estimated use 1991-2017. Estimator is based on data for years 2000-2010.

References

[1] KDA-DWR Memo Jan 9, 2018, Regression relationship of groundwater irrigation water use to precipitation and ET in GMD5. [PRISM-based data and regression with GMD5 gw irrigation_spp_2018_0110.docx]

[2] KDA-DWR Update to Memo of Jan 9, 2018: an improved water use estimator for GMD5 Zone A and related work. [Memo_wateruse_estimate_regression_model_update_2018_1218.docx]

[3] Water use estimate Excel file GMD5_ZoneA_AWEP.xlsm [source for T. 1 and Figs. 1 and 2]:
T.1: sheet ZoneA_AWEP!F42:K4, Fig. 1: sheet ZoneA_AWEP at P125, Fig. 2: sheet ZoneA_AWEP at P105.