Kansas v Nebraska & Colorado
No. 126, Orig., U.S. Supreme Court

Rebuttal Report Prepared

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Rebuttal of the Expert Report and Deposition of Dr. David Sunding

Professor David Sunding raised a number of issues in his expert report[1] and in his deposition[2] that had not been anticipated in our initial expert reports[3]. This report is intended to rebut these additional issues.

1. Use of Market Data

Professor Sunding's expert report makes a major issue of the supposed superiority of using actual "market" data and "measured" data rather than the supposedly "hypothetical" models we use in our report. Unfortunately most of what he characterizes as market data and measured data are not really that, and his approaches to using that data fall short of his claims.

He advocates the use of land sale price and rental rates as a method of isolating the contribution of water to land value. He makes use of land rental and sales data published by Kansas State University[4] and a similar report published by the University of Nebraska[5], which he cited as references 35 and 49 to his report. He fails to recognize the importance of the cautions included prominently on page 1 of both reports. In the Kansas publication:

> "The average prices in this guide encompass parcels of land that vary widely in productivity. Additionally, prices are based on survey respondents' estimates of prices as opposed to actual market sales. Thus, these data are more appropriate for analyzing trends than for establishing market value or rental rates for specific tracts of farmland." (Dhuyvetter and Taylor, page 1, first paragraph)

And from the Nebraska publication:

> "The reader is cautioned, however, to use this information primarily for trend analysis and not to assume that the information provided is accurately depicting values and cash rents of a local agricultural land market, let alone a particular parcel of land. If more specific information is deemed necessary, we highly recommend seeking the services of a certified agricultural real estate appraiser." (Johnson, Van NewKirk and Rosner, page 1, third paragraph)

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[1] David Sunding, "Assessment of Kansas Damages and Nebraska Unjust Enrichment Resulting from Nebraska's Overuse of Republican River Water in 2005 and 2006", March 15, 2012.
[2] Deposition of David Sunding, April 13, 2012.
[3] Joel R. Hamilton and M. Henry Robison, "Economic Analysis of Kansas Losses from Overuse of Republican River Water by Nebraska in 2005 and 2006", November 18, 2011.
Joel R. Hamilton and M. Henry Robison, "Economic Analysis of Nebraska Benefits from Overuse of Republican River Water by Nebraska in 2005 and 2006", November 18, 2011.
[4] K.C. Dhuyvetter and M. Taylor, "Kansas Land Prices and Cash Rental Rates", Department of Agricultural Economics, Kansas State University, Farm Management Guide MF-1100, November 2011.
[5] B. Johnson, S. Van NewKirk and T. Rosner, "Nebraska Farm Real Estate Market Highlights 2010 – 2011", Department of Agricultural Economics Report No. 189, June 2011.

Obviously this is survey data, not real market data, and not measured data, and is data that was recognized as questionable by its authors.

There are a number of other reasons to question the relevance of this data in this case:

- Both of these sources contain survey estimates of cash rental rates. In fact in KBID, and probably in Nebraska, most land rentals are based on crop-share leases rather than cash rental leases. Also, many of the transactions are within-family, rather than arms-length.
- Land prices and cash rental rates will reflect buyers' expectations of the long term profitability from buying or leasing that land. This might have little relationship to the short term value of water or impact of water shortage in a particular year.
- In focusing on cash rent and sales Dr. Sunding is addressing only the value of water to the land owner or proprietor. Thus he is missing some major pieces of the value of water to a state. He is missing the value of water to farm labor, the value to farm input suppliers and the value to the wider regional economy.

The one report that Dr. Sunding cites that actually uses real market land sales price data is the report by Schultz and Schmitz[6] This is a paper that was presented at a professional meeting and as such would not have been formally peer reviewed. If I had peer reviewed this paper I would have had a number of critical comments:

- The authors did not discuss some likely econometric problems with the hedonic regression. First, the fit of the regression was only fair with an R^2 of 0.64. Second, multicolinearity, or correlation among the independent regression variables, is very common in this kind of work. The report does not discuss or display a correlation matrix, which would have allowed assessment of this problem. If other independent variables are correlated to the variables representing irrigation, this would reduce the significance of the water variables, and could reduce the estimate of the value of water.
- The gallons per minute or the pumping level variables used in this analysis are likely to be correlated with the irrigation variables (% gravity and % pivot)
- The translation of % gravity and % pivot variables into irrigation value per acre required some questionable assumptions.
- The resulting estimate of water value is at best an average, not a marginal value and represents the buyers' long-term estimates of profitability, not the value of water in a dry year – which is the issue in this case.
- Again, by relying on this paper, Dr. Sunding is addressing only the value of water to the land owner or proprietor. Thus he is missing some major pieces of the value of water to Kansas or Nebraska. He is missing the value of water to farm labor, the value to farm input suppliers and the value to the wider regional economy

For these reasons the Schultz and Schmitz paper, the only instance Dr. Sunding cites which use real observed market data, is of little relevance to this case.

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[6] S. Schultz and N. Schmitz, "The Implicit Value of Irrigation Through Parcel Level Hedonic Price Modeling", Paper presented at the joint meeting of the AAEA, CAES and WAEA, Denver, July 2010.

Another way that Dr. Sunding tries to shift the focus to the supposed superiority of market data is by selective reference to some market-like transactions that didn't occur in KBID:

> "For example in 2011 KBID offered to sell farmers an additional 6" of water at $33 per acre-foot if needed. However, no farmers ended up opting to purchase additional water at that price. The relatively low marginal value of water is also reflected in KBID's decision to sell irrigation water for drought assistance in 2005. In that year, the district chose to forgo diversion of 1,200 acre-feet of water in exchange for a $12,000 payment." (Sunding Expert Report, page 20)

The 2011 value relates to a standing offer from the District to sell water in excess of the 15" allocation to any takers. This typically occurs late in the season (Nelson Deposition. pages 92-94). After farmers had already taken their expected quota of water, an additional 6" of water would be expected to have little marginal value, so they declined to take more. The marginal value of water would have been much higher if it had meant adding 6" of water to the 6" they actually got in 2005 or 2006 versus adding 6" to the 15" they actually got in 2011. (It is a truism of water resource economics that the marginal value of an additional increment of irrigation water declines as you add more.)

The second transaction cited by Dr. Sunding refers to drought assistance from USBR, through the Kansas Water Office, to KBID in consideration for leaving water in Harlan County Reservoir for the season. This is water that would have been left in the reservoir anyway, because the water supply was too low that year to call for water (Nelson deposition, pages 98-100 and 104-106, He notes that water was not used because of low supply). The agreement was signed by the District on August 8, 2005 (Nelson Exhibit 12). Because the farmers above Lovewell had made alternative plans to adjust to the lack of water in 2005, and because the small amount of water would have been almost impossible to convey through the irrigation system without prohibitive losses, an infusion of late-season water would have had little value to irrigators, and was more valuable carried over to the next year.

While Professor Sunding chooses to highlight these water transaction opportunities that were declined by KBID farmers, he chooses to ignore information on water purchases that actually did occur in Nebraska in 2006. These transactions are documented in table R1, extracted from a memo written by Ann Bleed (KS arbitration exhibit 44). All three of these transactions (Frenchman Valley, NBID and Riverside) are further documented in memoranda of agreement (KS arbitration exhibits 50, 51 and 52).

The three transactions that actually happened in 2006 had an expected total water yield of 23,518 acre feet and cost $3.5 million. The cost per expected acre foot ranged from $50 to $198 and averaged $149. These three transactions actually yielded 22,690 acre feet, making the actual average cost of this water $154 per acre foot.

We conclude that Professor Sunding has chosen to draw selective attention to some Kansas transactions which because of their circumstances are not relevant to our analysis. At the same time he has chosen to ignore some water transactions that occurred elsewhere in the Republican River Basin at very high prices per acre foot.

By citing the low asking prices of the KBID water offered for sale in 2005 and 2011, Dr. Sunding is implying that the water Kansas did not receive in 2005 and 2006 was not worth even that low value. By not citing actual water sales that did occur in Nebraska in 2006, Dr. Sunding is ignoring market-based evidence that water in that water-short year was actually worth much more.

Our analysis documents that the true value of the water that Kansas should have received (but did not) was somewhere in between. Table R2 shows our results. We show direct on-farm value added (from table 44 of our Kansas losses expert report) as the value of the water to the farmer without considering secondary effects. This is directly comparable to the water value to farmers which is presumably reflected in the Nebraska water sales. Dividing this by water delivered to farmers gives a water value of $55 per acre foot delivered in 2005 and $69 per acre foot in 2006. Alternatively if one selects the water flow deficit at the state line (a measure of diversions) as the denominator, this gives a water value of $31 per acre foot diverted in 2005 and $39 per acre foot in 2006.

Our estimate of the value of the water that Kansas was deprived of because Nebraska exceeded its share, is well below the water value substantiated by actual 2006 water market transactions in Nebraska. Our analysis is conservative. If we had used water values such as those demonstrated in the Nebraska water market, our Kansas loss claim would have been much larger.

2. Irrigated Acreage Regressions

Professor Sunding developed a regression approach to explore the relationship between KBID irrigated acreage and water supply. He estimates the regression separately for above and below Lovewell Reservoir. His regression equation hypothesizes that KBID irrigated acres is a function of KBID water diversions and acres planted in north central Kansas.

Dr. Sunding asserts the superiority of this approach over ours by saying that

> "Other aspects of Kansas' analysis can be evaluated by examining market data." (Sunding Expert Report, page 20, paragraph 4)

We see no reason why data on KBID irrigated acres, KBID water diversions, and acres planted in North Central (NC) Kansas should be considered to be market data. The KBID data come from KBID project records. The NASS data is the result of a process that surveys local experts, and thus is neither measured data nor market data.

Our approach, which relies on historic KBID acreage data, and doesn't rely on some market shibboleth or statistical procedure, is better grounded in the available relevant data.

Dr. Sunding does not make an adequate defense of the formulation of his acreage regression model. It is obvious that KBID irrigated acreage should be a function of the KBID water supply. However it seems that water deliveries might make a better explanatory variable than water diversions. Moreover, his defense of the acres planted in northcentral Kansas ("NC Kansas") variable is inadequate. He says

"This variable should capture any general trends in crop production, such as a government subsidy program or a spike in input prices." (Sunding Expert Report, page 20, paragraph 4)

The variable he uses is the total of both irrigated and dryland acres planted to corn, milo, soybeans and alfalfa in NC Kansas. The irrigated land in the region outside KBID is predominantly irrigated from wells, while the KBID irrigated land is provided with US Bureau of Reclamation project water. A very large portion of the acreage planted to these four crops in the NC Kansas region grows dryland crops without irrigation. Why Professor Sunding chose these particular regression variables is unclear.

Dr. Sunding did not provide the actual STATA computer output for his yield regressions as a supporting document, but only provided it after being pressed at his deposition. The computer output we produced using the STATA command file is shown in figure R1.

However, the goal for estimating these regressions is not to predict the log of acreage, or even to estimate the coefficients of the regression equation. Predictions of the log of acreage or and estimates of the regression coefficients themselves are essentially irrelevant to our task in this case which is to estimate the damages Kansas suffered from the water shortage. What are needed are predictions of the acreage (not the log of acreage) that should have been irrigated if the required water had been delivered. Tables R3 and R4 are spreadsheets that take Dr. Sunding's regression coefficient estimates and use them to predict acreage above and below Lovewell. These predictions based on Dr. Sunding's regression are then compared to the actual acres reported by KBID. The predicted and actual acres are also shown as graphs in figures R2 and R3 for above and below Lovewell. These graphs show clearly that Dr. Sunding's regressions fit the actual acreage numbers quite poorly..

In his deposition (pages 73 and 74) Dr. Sunding defended the use of statistical procedures such as regression because they allow estimation of confidence intervals and provide the tools to conduct hypothesis tests. However, the weak fit of Dr. Sunding's regression models is obvious even from the graphs. The calculations in tables R3 and R4 continue, computing the model errors for each year, squaring them, summing the results, dividing by the number of observations, and finally taking the square root. The result is the root mean square error (RMSE) for the regression – which is roughly equivalent to the standard error of the regression. The RMSE for the above Lovewell regression was 2,061 acres, and for the below Lovewell regression it was 2,272 acres. As Dr. Sunding indicated, a statistical regression can be used to construct confidence intervals. A confidence interval around Dr. Sunding's regression predictions would be computed as roughly plus or minus two standard errors. The resulting confidence interval is huge – over 8,000 acres wide. These results are summarized in table R5

Figures R2 and R3 show the resulting predictions of Dr. Sunding's regressions when we substitute the amount of water that Kansas says should have been delivered in 2005 and 2006 into the estimated regression. That is, how many acres should have been irrigated in those years? Dr. Sunding's results confirm that more land should have been irrigated in both years, and both above and below Lovewell. The figures also show the 8,000 acre-wide confidence bounds around Dr. Sunding's predicted acreage.

As Professor Sunding indicated in his deposition, the regression results can also be used to test hypotheses. The acreage numbers we used in our analysis to represent the acres that should have been irrigated in 2005 and 2006 lie well within two standard errors of the prediction from Dr. Sunding's model. Dr. Sunding's regression results are not significantly different from the irrigated acreage figures we used in our analysis. His regression results are consistent with the acreage numbers we used in our analysis. Professor Sunding's acreage regressions support, and do not discredit our analysis.

3. Yield Regression

In Dr. Sunding's expert report (page 20), he posits a similar regression equation where KBID corn yield is a function of KBID water diversions, corn yield in north central Kansas, and the product of these two variables used as an interaction term.

In his deposition (pages 125 and 126) Dr. Sunding again stated that this was the preferred form of his yield regression equation and that water diversion was the preferable variable to use in the regression as opposed to water deliveries. However, the STATA computer program command file KBID_analysis.do (figure R4) which Dr. Sunding submitted on his CD along with his expert report, indicates that he actually used the KBID water deliveries variable rather than water diversions variable in his regression. The yield regression that he actually ran does not agree with what Dr. Sunding indicated was the preferred form of the relationship.

We also note in our expert report that KBID irrigated crop yields taken from the KBID annual reports are not actual measured yields, but are the results of a voluntary annual crop survey conducted by the district. Thus we have misgivings about the accuracy of these numbers. Thus, the data used in his yield regressions is certainly not "market" data which Dr. Sunding seems to imply in his expert report.

The actual STATA computer output for Dr. Sunding's yield regression is also contained in figure R1, which was referenced above. Dr. Sunding used the Prais-Winsten transformation for estimation of models suffering from serial correlation problems. However, the goal for estimating these regressions is not to predict values of yield as altered by Prais-Winsten transformation or even to estimate the coefficients of the regression equation. As noted above for the acreage regressions, the predicted transformed yield numbers and the estimated regression coefficients themselves are essentially irrelevant to the task of quantifying Kansas damages from the water shortage. In order to estimate damages, we need predictions of actual (not transformed) KBID crop yields. Again we use a spreadsheet, shown as table R7 to take Dr. Sunding's regression coefficient estimates and use them to predict KBID yields. (We do this by applying a reversed Prais-Winsten transformation to the predictions of Dr. Sunding's regression.) These predictions are then compared to the actual yields reported by KBID. The predicted and actual yields are shown as a graph in figure R5.

The spreadsheet in table R7 proceeds as before to compute the root mean square error by which Dr. Sunding's yield regression predicts reported KBID yields. The calculated RMSE of 13.5 bushels is large, indicating a poor model fit to the reported yield. A confidence bound of plus or minus two RMSEs would be plus or minus 27.0 bushels from Dr. Sunding's model prediction, as shown in figure R5. For 2005 these bounds encompass (and thus fail to refute) all of the calculated corn yields derived from our yield modeling approach both for the yields with the actual restricted water available in those years and the yields if the required water supply had been available. For 2006 the error bounds include (and thus fail to refute) our calculated corn yields with the actual water supply (see table 14 in our Kansas expert report).

Note also that the fit of Dr. Sunding's yield regression is so poor that the reported 2005 corn yield is outside the error bounds. Dr. Sunding's regression can be used to refute the 187 bushel corn yield reported by KBID in 2005 – reinforcing our doubts about the accuracy of the survey-based KBID reported crop yields.

Clearly the yield regression approach proposed by Dr. Sunding performs too poorly to be an acceptable alternative to our agronomically-based crop yield models for the task at hand – which is to calculate the yield differences caused by water shortage in Kansas.

4. <u>Deep Water Horizon Standards of Documentation</u>

Dr. Sunding argues in his expert report (page 28) and in his deposition (pages 159-161) that a claim for damages from water shortage should be held to the same standard as were the private claims for damage from the private sector oil company that caused the Deepwater Horizon oil spill. That is, the affected party should have to present actual historic business record documentation to support a damages claim.

This approach is misguided for several reasons:

- This case is not about individual damages – like the individual resort on the gulf coast that lost business because guests were concerned about oil on the beaches. In this case the water that Nebraska wrongfully overused belonged to Kansas and the interest of the state is in recovering all of the lost income caused by that wrongful use even though the impact was spread across many of its citizens and businesses.
- In this case the interests of the state extend to the secondary impacts of the water shortage. That is, Kansas is concerned about the interests of farm labor, the interests of the farm input suppliers, the interests of the suppliers of the suppliers, and the wider interests of the affected communities. The impacts spread from a few primarily affected irrigators to a host of other parties who suffered only a small individual damage. The approach used by the private oil company in the Deepwater Horizon situation focuses only on those most immediately affected, but a large part of the total impact to Kansas citizens would be ignored if one focused narrowly on only the most directly impacted parties.
- Applying the restrictions used by the oil corporation in the Deepwater Horizon situation is not costless. Presumably the only individuals in the Gulf who applied for compensation were those for whom the expected compensation exceeded the cost of documenting an application. In the present case, the cost to the state of acquiring this kind of documentation would be extremely large -- and prohibitive. If one state can cause diffuse small damage to many citizens of another state, and require such a high level of documentation as to make a damage claim impossible, then the diffuse damage could continue with impunity.
- The answer is to rely on models as we have done in our expert report – crop yield models, crop budgets, and the use of the IMPLAN model to trace the impacts from the directly affected irrigators to the input suppliers, to farm labor, and to the local communities. This approach

was used in Kansas v. Colorado (the Arkansas River case) and was accepted by the Special Master and the Court.

- Our models were able to build on a key difference between the current case and the Deepwater Horizon oil spill. In the current case we know the magnitude of the water shortfall through the Accounting Procedures established by the Final Settlement Stipulation. This contrasts to the oil spill where the magnitude of the disaster could be known only through complaint.

Thus the Deepwater Horizon oil spill compensation procedure provides no useful guidance for computing damages in this case.

5. <u>Alleged Errors and Double Counting in the Secondary Impacts Analysis</u>

Professor Sunding focuses on our specific application of the 2006 Kansas IMPLAN secondary effects model and alleges that we made some miscalculation that results in a double counting of results (page 31 of his expert report and page 166 of his deposition). He does not pinpoint the specific multiplier or calculation in question, although our analysis provides all the multipliers and other component steps involved (see for example table 45 and 46 of our Kansas Report). Instead he proceeds to offer a curious simulation, inflating a select subset of data from our report and running these through IMPLAN. Below we show that his double counting claim stems from a mischaracterization of IMPLAN results. We also show the computer screenshots from the IMPLAN computer program input worksheet to demonstrate that the results in our expert report agree precisely with the output of the IMPLAN program.

Professor Sunding's simulation focuses on data from our illustration of secondary effects estimation shown in tables 45 and 46 of our Kansas report. These tables refer only to farms above Lovewell Reservoir and the 2005 damage year. Table 47 of our Kansas report is a summary table, collecting and displaying the total of value added impacts for both regions and both years. The attached table R8 repeats table 47 results for 2005 above Lovewell, and displays these in column (2). Column (1) simply breaks out secondary direct and indirect effects, and induced effects stemming from on-farm versus off-farm changes. These detailed effects can also be seen in table 46 of our Kansas report.

Professor Sunding's simulation is presented in tables 8 and 9 of his report. His table 8 presents an odd transformation of the changes in farm input purchases from table 45 of our report. As shown in the headings to his table 8, he took Kansas' estimated changes in purchases of farm inputs (his column 2), and added to each a proportionate share of the on-farm direct value added, the $632,505. We do not believe that he can attach any meaningful interpretation to these transformed numbers (his column 5). Professor Sunding goes on to run these curiously inflated farm input purchases through IMPLAN and thereby obtain what he calls the "direct," "indirect" and "induced" impacts shown in his table 9. Finally, he then re-labels results from our summary table 47 "direct," "indirect" and "induced" and implies that our "indirect" effect estimate looks suspiciously like a double-count. Professor Sunding's IMPLAN results appear in our table R8 column (4) aligned with our results shown in column (2).

What Professor Sunding has done is clearly a scrambled analysis. The value Professor Sunding labels "direct effect," $618,403, he compares to our on-farm direct value added effect, $632,505. But his figure ***is not*** on-farm direct. He obtained his figure by running a change, albeit an inflated change, in farm input purchases through IMPLAN. What this maneuver produces not a change in direct on-farm value added but rather an inflated change in the direct value added of these particular farm input suppliers. In our analysis, we would characterize these as the "secondary direct effect." Similarly, what he calls the "induced effect" and compares to our induced effect total, is actually only the off-farm portion of our induced effect total.

Column (5) provides the proper alignment of Professor Sunding's results according to the impact categories used in our analysis. Note the clearest conclusion from this realignment is to eliminate comparisons with on-farm effects, on-farm direct and on-farm induced. Nothing that Dr. Sunding did in his simulation could have generated direct on-farm value added effects, only effects stemming from farm input purchases. Dr. Sunding's alternative simulation analysis actually misses all income (i.e., value added) originating on farms as well as incomes induced by the spending of that income.

The two columns of our table R8 labeled simply "%" show the portion of off-farm multiplier effects from our analysis (column 3) and from Professor Sunding's (column 6). The similarity of these portions reinforce the fact that both are based on our original farm input purchase values, which Dr. Sunding reproduces and then blows-up in his table 8. The slight differences reflect apparent differences in the IMPLAN model assumptions made – our assumptions are conveyed through the deliberate transparency of tables 45 and 46 in our Kansas report, but his modeling assumptions are not clearly stated.

As additional documentation of our correct use of IMPLAN we have attached computer screenshots of the IMPLAN input and output screens (figure R6 and R7) that replicate exactly the results shown in our tables 45 and 46. Note the agreement of IMPLAN output screen values and those appearing for our analysis in our table R8.

This validates our IMPLAN results and our secondary impacts analysis. Dr. Sunding's charge that our analysis suffered from double counting is baseless.

6. <u>Allegation that Interregional Spillovers were not Properly Accounted for</u>

Professor Sunding offers a second attack on our secondary effects analysis, distinct from the alleged double-counting discussed above. To conduct our original analysis (presented in our Kansas and Nebraska expert reports), we constructed two separate IMPLAN models, one for Kansas and one for Nebraska. For selection of model regions, we followed established practice and examined state boundaries in relation to the regional trade hierarchy. The examination indicated that an analysis based on two independent state-level models was the appropriate course.

Professor Sunding argues that in fact these two state economies are significantly intermingled with cross-state trade, and that the degree of cross-state trade is so great that it negates most of our secondary Kansas damage estimate. Supporting his allegation, Professor Sunding employs a later-year IMPLAN model (beyond the 2005 - 2006 damage period) and employs a new multiregional modeling option not available for model years 2005 and 2006.

Countering Professor Sunding's cross-state spillover allegation requires a brief review of well-established spatial trade theory and consideration of two prominent third-party portrayals of the separate trade hierarchies that characterize the regions of Nebraska and Kansas. We also briefly review accepted protocol for building models where an interstate water dispute is the issue. Finally, we consider the IMPLAN technique Professor Sunding uses to estimate his spillovers. We find that his technique is 1) not available for the 2005-2006 damage years, 2) incapable of modeling the composite mix of changed farm input purchases required of our analysis and 3) perhaps most importantly the model is new and untested in the professional literature and thus is inherently experimental.

Regions can be defined in a number of ways, common political authority (e.g., states and counties), common climate (e.g., "the Sun Belt"), and others. Regional trade theory is built on a different view, focused on the internal structure of trade, or trade hierarchy, which is characterized in terms of a system of cities, towns and villages linked together by trade in goods, services and labor. Economic regions exhibit an internal economic cohesion stemming partly from the fact that most of the people who live in the region also work and shop in the region, and partly from that fact that businesses located in the region also exhibit a high degree of industry interconnectedness. Economic regions are alternatively called "functional economic areas," emphasizing the fact that they indeed function as economies. Economic impacts within regions flow "up" the hierarchy, from small, dominated, low-order places up to larger, dominant central places.

To avoid error, the proper region for input-output modeling is the functional economic area. In our Kansas expert report, we describe how a change in one or a composite collection of industries creates ripple effects in the form of secondary impacts that spread to other industries. Importantly, the process has a spatial dimension as well. A change in industry output in one place spreads to others according to the spatial structure of trade as indicated by the regional trade hierarchy. Functional economic areas are defined to capture and otherwise encompass regional trade hierarchies and thereby form the natural boundaries for input-output modeling.

Selecting the geographic boundaries for the input-output model in a water dispute case such as the present one can be complicated by an incongruence of economic and political boundaries. Impacts need to be reported for states. At the same time, however, impact model boundaries must reflect economic regions, thus the potential for conflict. A most pertinent example of this involved Texas and New Mexico and a dispute involving the Pecos River. Texas alleged overuse of Pecos River water as it flowed through the southeast corner of New Mexico. Texas sued New Mexico claiming, among other things, a share of the ill-gotten secondary benefits that allegedly accrued to New Mexico as a result of illegal water use. The issue was dropped after it was shown that the disputed area of New Mexico was actually part of a Texas-centered (El Paso) region rather than a New Mexico-centered economic region. The indication was that a significant portion of the secondary effects stream actually flowed to Texas rather than New Mexico.

The opposite conclusion was reached in the *Kansas v. Colorado* case (Arkansas River). Kansas experts verified the coincidence political and economic boundaries and were thus able to conduct their analysis by modeling the two states as separate economic entities. Together, these two cases point to a protocol for selecting the most appropriate input-output model boundaries in interstate water disputes.

The border separating Kansas and Nebraska shows a similar coincidence of economic and political boundaries. Applied researchers rely particularly on two sources for identifying economic regions:

The "Rand McNally Trading Areas" and the U.S. Department of Commerce, Bureau of Economic Analysis "BEA Economic Areas." The methodologies underlying both of these sources rely heavily on hierarchical trade theory and, not surprisingly, their boundaries show a general degree of agreement.

Figure R8, shows the Rand McNally trading areas superimposed on the political boundaries of Nebraska and Kansas. Rand McNally collapses the implicitly many-order trade hierarchy into two broad levels. The areas encompassed by the bold red borders capture the market reach of the highest-order places. Accordingly, most of Nebraska, and certainly all of the Republican River area where the present water dispute is focused, is trade-dominated by Omaha. Similarly the bulk of Kansas and the area of water dispute is trade dominated by Wichita. KBID is located in Jewell and Republic Counties in the northeast corner of the Wichita economic region.

At the next level of the Rand McNally hierarchy are a wide collection of smaller cities and towns, each dominating sub-areas of their own. These lower-order sub-regions are shown in figure R8 by the multiple colored areas. Other than distinguishing one area from another, there is no significance to particular colors. The single dominant city or town in each of these areas is labeled with its name, otherwise only member counties are shown. Salina, Kansas, is the dominant place in the sub-region containing KBID.

Note that a significant portion of western Nebraska, and a small portion of western Kansas, is trade dominated by Denver, Colorado, and much of eastern Kansas is trade dominated by Kansas City, Missouri. But the existence of these cross-state economic regions does not affect the present analysis. The important political boundary for the present analysis is the one separating Nebraska and Kansas, and this one appears everywhere coincident with the economic boundary except for the two small and rural western Kansas counties (Cheyenne and Rawlins Counties) indicated as dominated by McCook, Nebraska.

The BEA economic areas map shown as figure R9 presents a very similar picture. Here again the common border between Kansas and Nebraska is inviolate. All of northwest Kansas is in the Salina, Kansas, economic area (141) and all of the Nebraska Republican River Basin is in the Kearney, Nebraska, economic area (85).

Another set of maps reinforces the importance of political boundaries as separators of economic regions. Electricity to power irrigation wells and sprinkler systems is a very important production input purchased by Nebraska irrigators. In rural areas, the dominant source of electricity is from rural electric cooperatives. Figures R10 and R11 document the service areas of rural electric cooperatives in Nebraska and Kansas. Since the rural electric cooperatives are mostly organized on a state by state basis, it is hardly surprising to see that the service areas divide precisely at the political boundary between Kansas and Nebraska.

In selecting Nebraska and Kansas as the appropriate economic regions for our analysis, we considered both the Rand McNally and the BEA maps. The slight economic in-road to Kansas in the Rand McNally map, involving the two rural counties dominated by McCook, Nebraska is irrelevant to this case, because any spillovers from these two Kansas counties would be north into Nebraska, rather than the south-directed spillovers Dr. Sunding is trying to demonstrate. We thus selected as model regions the whole-state areas of Nebraska and Kansas.

Let us turn finally to Professor Sunding's use of the newly available multiregional IMPLAN model option. At the present time the settled method of choice in building regional input-output ("IO") models is an approach commonly called the "RPC technique", referencing the regional purchase coefficients used in the analysis. The technique, originally introduced in the 1980s, has dominated applied regional IO modeling ever since. IMPLAN refers to their application of the RPC technique as "Econometric RPCs."

Beginning in 2010, IMPLAN introduced an optional second method for constructing a regional model termed the "trade flows method." In this method trade flows are assumed to follow a "gravity flow" pattern, where big places dominate small places, irrespective of the very real effects that political boundaries actually do have. Note that the traditional econometric RPC approach is still the dominant method: Selecting the trade flows method requires an extended data set conveyed on an external hard-drive called the "IMPLAN Appliance."

We offer the following criticisms of Professor Sunding's estimation of cross-state spillovers using IMPLAN's trade flows option. First, he is not able to actually model the initial change in industry outputs that drives the present analysis, and that is the secondary impact of the changes in farm input purchases shown, for example, in our Table 45. To do this in his IMPLAN multiregional setting requires not only the portion of these purchases that occur in the small areas he designates as separate impact regions near the Republican River in both states, but as well the portion that occurs in the other areas of his multiregional model. And this information he does not have – it is simply not available. Instead, as surrogate, Professor Sunding models a change in a single sector -- IMPLAN's "grain farming" sector. In contrast our change in farm input purchases is a composite of changes in the crop mix, changes in irrigation status, and changes in cultural practices caused by the water shortage in Kansas. Comparing the input structure of the grain farming sector with the actual composite change in farm input purchases suggests that the grain farming sector provides a very flawed surrogate.

Second, in contrast to the ruling econometric RPC method for constructing models, we can find no peer reviewed literature supporting IMPLAN's new "trade flows" option. We conclude that the new technique is inherently experimental, and not appropriate for application to the case of interstate economic damages such as the present one.

Finally, the cross-state spillovers Professor Sunding generates with the new IMPLAN modeling option are so at odds with the character of the prevailing trade hierarchy indicated by Rand McNalley, the BEA and others, and this compels a high degree of skepticism.

For these reasons we reject Dr. Sunding's assertion that we missed significant interstate economic spillovers from Nebraska's excessive use of Republican River water, and we stand by our use of separate Kansas and Nebraska IMPLAN models in our analysis.

Rebuttal Tables

Rebuttal Figures

References

1. K.C. Dhuyvetter and M. Taylor, "Kansas Land Prices and Cash Rental Rates", Department of Agricultural Economics, Kansas State University, Farm Management Guide MF-1100, November 2011. (This report was cited in Dr. Sunding's expert report)
2. B. Johnson, S. Van NewKirk and T. Rosner, "Nebraska Farm Real Estate Market Highlights 2010 – 2011", Department of Agricultural Economics Report No. 189, June 2011. (This report was cited in Dr. Sunding's expert report)
3. S. Schultz and N. Schmitz, "The Implicit Value of Irrigation Through Parcel Level Hedonic Price Modeling", Paper presented at the joint meeting of the AAEA, CAES and WAEA, Denver, July 2010. (This report was cited in Dr. Sunding's expert report)
4. Memo from Ann Bleed, March 5, 2007. (This was arbitration exhibit 44)
5. Memorandum of Agreement between the State of Nebraska, Nebraska Department of Natural Resources, and Frenchman Valley Irrigation District in Nebraska, May 10, 2006. (This was arbitration exhibit 50)
6. Memorandum of Agreement between the State of Nebraska, Nebraska Department of Natural Resources, the Middle Republican Natural Resources District and Riverside Irrigation Company, Inc. May 10, 2006. (This was arbitration exhibit 51)
7. Memorandum of Agreement between the State of Nebraska, Nebraska Department of Natural Resources, and Bostwick Irrigation District in Nebraska, May 10, 2006. (This was arbitration exhibit 52)

Table R1: Nebraska Water Purchases in 2006

Irrigation District	Water Available	Cost			Benefit	
	AF	$	$/AF		AF	$/AF
Frenchman Valley	6,400	400,000	62.50		3,672	108.93
Riverside	2,000	100,000	50.00		1256	79.62
Bostwick	15,118	3,000,000	198.44		17762	168.90
Total/Average	23,518	3,500,000	148.82	*	22690	154.25

* Indicates a math error in the original that was corrected.

Source: Memo from Ann Bleed, 3/5/2007, KS arbitration exhibit 44.

Table R2: Kansas Losses per Acre Foot of Water not Delivered

	Total Direct On-Farm Value Added Loss	Total Loss AF Farm Delivery	Direct On-Farm Value Added per AF	Lost Cortland Canal AF at Stateline	Direct On-Farm Value Added per AF
Sources:	1	2		2	
2005	1,154,484	20,934	$55.15	37,776	$30.56
2006	1,241,191	18,079	$68.65	31,677	$39.18

Sources:

1 Hamilton-Robison, Kansas Losses Report, Table 44.
2 Spronk KBID Losses Report, Table A-1.

Figure R1: STATA computer output from Sunding Regressions

```
------------------------------------------------------------------------------------------------
      name:  <unnamed>
       log:  c:\school finance\kbid_regression 2 Apr 2012.log
  log type:  text
 opened on:   2 Apr 2012, 12:30:13

.
. gen corn_yield_interaction = deliveries_total * region_corn_yield

.
. reg kbid_corn_yield deliveries_total region_corn_yield corn_yield_interaction

      Source |       SS       df       MS              Number of obs =      41
-------------+------------------------------           F(  3,    37) =   15.47
       Model |  21149.5491     3  7049.8497            Prob > F      =  0.0000
    Residual |  16856.2327    37  455.573856           R-squared     =  0.5565
-------------+------------------------------           Adj R-squared =  0.5205
       Total |  38005.7818    40  950.144544           Root MSE      =  21.344

------------------------------------------------------------------------------
     kbid_corn_yield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------------+--------------------------------------------------------
    deliveries_total |   .0015633   .0013171     1.19   0.243    -.0011054     .004232
   region_corn_yield |   1.625782   .4669733     3.48   0.001     .6796043     2.57196
corn_yield_interaction |  -.0000152   .0000118    -1.29   0.205    -.0000391    8.68e-06
               _cons |  -37.50994   55.15746    -0.68   0.501    -149.2696    74.24969
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  4,    41) =  .5641668

.
. prais kbid_corn_yield deliveries_total region_corn_yield corn_yield_interaction

Iteration 0:  rho = 0.0000
Iteration 1:  rho = 0.7208
Iteration 2:  rho = 0.7650
Iteration 3:  rho = 0.7658
Iteration 4:  rho = 0.7658
Iteration 5:  rho = 0.7658

Prais-Winsten AR(1) regression -- iterated estimates

      Source |       SS       df       MS              Number of obs =      41
-------------+------------------------------           F(  3,    37) =   26.61
       Model |  16062.1685     3  5354.05618           Prob > F      =  0.0000
    Residual |  7445.34186    37  201.225456           R-squared     =  0.6833
-------------+------------------------------           Adj R-squared =  0.6576
       Total |  23507.5104    40   587.68776           Root MSE      =  14.185

------------------------------------------------------------------------------
     kbid_corn_yield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------------+--------------------------------------------------------
    deliveries_total |   .0015644   .0006958     2.25   0.031     .0001546    .0029742
   region_corn_yield |   1.450547   .2345518     6.18   0.000     .9752997    1.925794
corn_yield_interaction |  -.0000128   6.72e-06    -1.90   0.065    -.0000264    8.38e-07
               _cons |  -26.83509    28.6352    -0.94   0.355    -84.85552    31.18534
---------------------+--------------------------------------------------------
                 rho |   .7658385
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    0.564167
Durbin-Watson statistic (transformed) 2.563226

.
. predict kbid_corn_yield_predict, xb

. li kbid_corn_yield_predict if year == 2005 | year == 2006

     +----------+
     | kbid_c~t |
     |----------|
 36. |  150.187 |
 37. | 118.4682 |
     +----------+

.
. preserve
```

Figure R1 Continued

```
. replace deliveries_total = 34985 if year == 2005
(1 real change made)

. replace deliveries_total = 36951 if year == 2006
(1 real change made)

. replace corn_yield_interaction = deliveries_total * region_corn_yield
(2 real changes made)

. predict kbid_corn_yield_predict2, xb

. li year kbid_corn_yield_predict2 if year == 2005 | year == 2006

     +------------------+
     | year   kbid_c~2  |
     |------------------|
 36. | 2005   150.2852  |
 37. | 2006   124.8642  |
     +------------------+

. restore

. gen region_acres_planted = region_corn_acres + region_milo_acres + region_soybean_acres + region_alf
> alfa_acres

. gen ln_region_acres_planted = ln(region_acres_planted)

. gen ln_diversions_above = ln(diversions_above)

. gen ln_diversions_below = ln(diversions_below)

. gen ln_acres_irr_total = ln(acres_irr_total)

. gen ln_acres_irr_above = ln(acres_irr_above)

. gen ln_acres_irr_below = ln(acres_irr_below)

. reg ln_acres_irr_above ln_diversions_above ln_region_acres_planted

      Source |       SS       df       MS              Number of obs =      41
-------------+------------------------------           F(  2,    38) =   76.09
       Model |  8.71602609     2  4.35801304           Prob > F      =  0.0000
    Residual |  2.17635314    38  .057272451           R-squared     =  0.8002
-------------+------------------------------           Adj R-squared =  0.7897
       Total |  10.8923792    40  .272309481           Root MSE      =  .23932

------------------------------------------------------------------------------
ln_acres_irr_above |   Coef.   Std. Err.    t    P>|t|    [95% Conf. Interval]
-------------------+----------------------------------------------------------
 ln_diversions_above |  .4708475  .0384466  12.25  0.000   .3930164   .5486787
ln_region_acres_planted | .1596725 .2433585 0.66 0.516 -.3329811   .6523261
             _cons |  2.459997   3.458333   0.71  0.481  -4.541032   9.461026
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  3,    41) =  1.736428

. preserve

. replace ln_diversions_above = ln(16851) if year == 2005
(1 real change made)

. replace ln_diversions_above = ln(18110) if year == 2006
(1 real change made)

. predict kbid_above_acres_predict, xb
```

Figure R1 Continued

```
. li kbid_above_acres_predict if year == 2005 | year == 2006

     +----------+
     | kbid_a~t |
     |----------|
 36. | 9.271881 |
 37. | 9.313342 |
     +----------+

. restore

. reg ln_acres_irr_below ln_diversions_below ln_region_acres_planted

      Source |       SS       df       MS              Number of obs =      41
-------------+------------------------------           F(  2,    38) =   14.16
       Model |  .371215493     2  .185607746           Prob > F      =  0.0000
    Residual |  .497933777    38   .01310352           R-squared     =  0.4271
-------------+------------------------------           Adj R-squared =  0.3969
       Total |   .86914927    40  .021728732           Root MSE      =  .11447

------------------------------------------------------------------------------
     ln_acres_irr_below |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------------------+-----------------------------------------------------------------
    ln_diversions_below |   .1243393     .049733     2.50   0.017     .0236601    .2250186
ln_region_acres_planted |   .5353646    .1146585     4.67   0.000     .3032505    .7674787
                  _cons |   1.280616    1.667585     0.77   0.447    -2.095233    4.656466
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  3,    41) =  1.236825

. preserve

. replace ln_diversions_below = ln(40677) if year == 2005
(1 real change made)

. replace ln_diversions_below = ln(43321) if year == 2006
(1 real change made)

. predict kbid_below_acres_predict, xb

. li kbid_below_acres_predict if year == 2005 | year == 2006

     +----------+
     | kbid_b~t |
     |----------|
 36. | 10.07561 |
 37. | 10.10871 |
     +----------+

. restore

. log close
       name:  <unnamed>
        log:  c:\school finance\kbid_regression 2 Apr 2012.log
   log type:  text
  closed on:   2 Apr 2012, 12:30:14
------------------------------------------------------------------------------
```

Table R3: Calculation of Errors and RMSE for Sunding Acreage Above Lovewell Regression

Regression Coefficients Above	
Constant	2.460
Diversions	0.471
Region Planted Acres	0.160

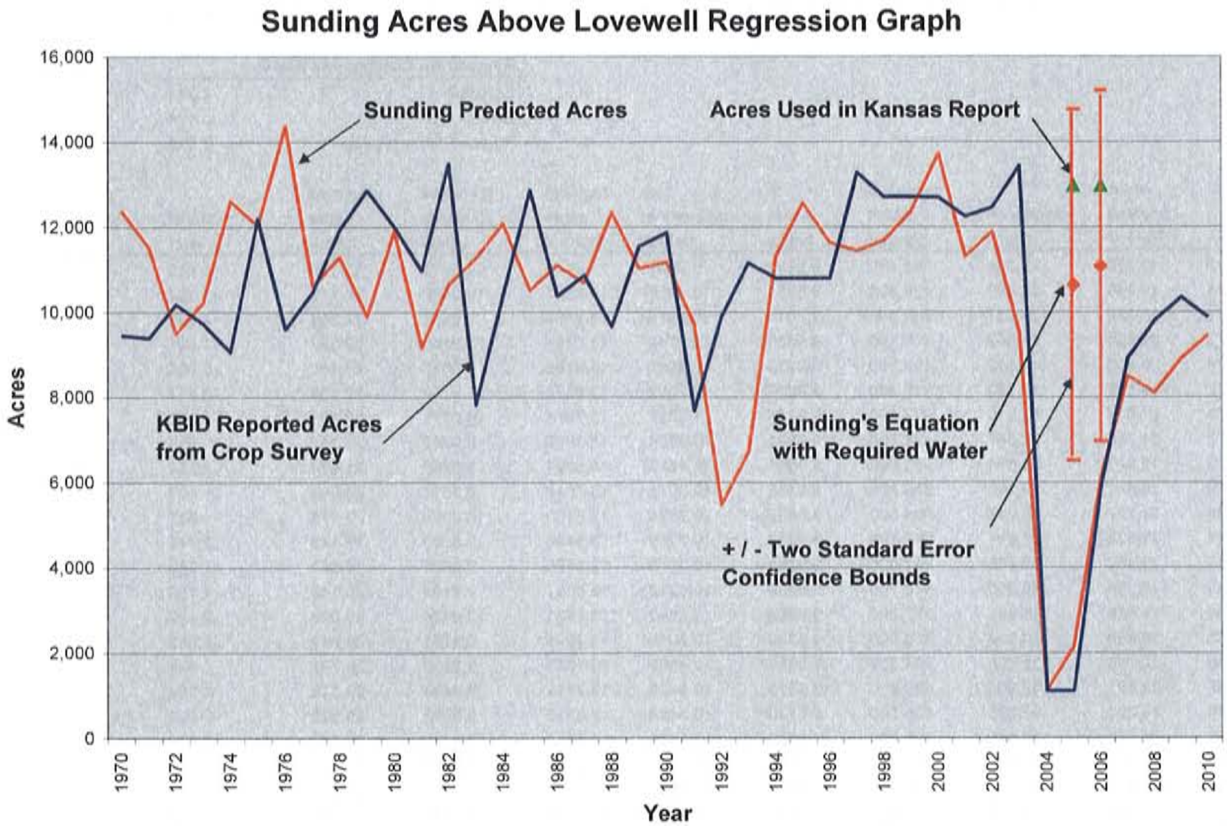
	acres irrigated above	diversions above	regional acres planted	ln acres above	ln diversions above	ln regional acres planted	predicted ln acres above	predicted acres above	model error	Sunding prediction w required water	acres used in Our analysis
1970	9,456	24,473	998,490	9.1544	10.1053	13.8140	9.4238	12,379	-2,923		
1971	9,388	20,147	1,128,820	9.1472	9.9108	13.9367	9.3518	11,519	-2,131		
1972	10,179	13,717	1,043,900	9.2281	9.5264	13.8585	9.1583	9,493	686		
1973	9,722	15,422	1,177,100	9.1821	9.6436	13.9786	9.2326	10,226	-504		
1974	9,052	24,533	1,108,500	9.1107	10.1078	13.9185	9.4416	12,602	-3,550		
1975	12,190	22,915	1,016,200	9.4084	10.0395	13.8316	9.3956	12,036	154		
1976	9,594	33,800	977,190	9.1689	10.4282	13.7924	9.5724	14,363	-4,769		
1977	10,459	17,723	991,300	9.2552	9.7826	13.8068	9.2707	10,622	-163		
1978	11,936	20,146	993,600	9.3873	9.9108	13.8091	9.3314	11,287	649		
1979	12,858	15,470	950,300	9.4617	9.6467	13.7645	9.1999	9,896	2,962		
1980	11,995	22,555	994,500	9.3922	10.0237	13.8100	9.3847	11,905	90		
1981	10,968	13,668	847,100	9.3027	9.5228	13.6496	9.1233	9,166	1,802		
1982	13,481	18,794	847,900	9.5090	9.8413	13.6505	9.2734	10,651	2,830		
1983	7,824	21,490	810,700	8.9650	9.9753	13.6057	9.3293	11,264	-3,440		
1984	10,390	23,417	977,800	9.2486	10.0612	13.7931	9.3997	12,085	-1,695		
1985	12,861	17,606	953,000	9.4620	9.7760	13.7674	9.2613	10,523	2,338		
1986	10,379	19,919	924,800	9.2475	9.8994	13.7373	9.3146	11,099	-720		
1987	10,864	18,383	929,000	9.2932	9.8192	13.7419	9.2775	10,695	169		
1988	9,660	25,823	835,500	9.1757	10.1590	13.6358	9.4206	12,340	-2,680		
1989	11,541	19,871	895,700	9.3537	9.8970	13.7054	9.3084	11,030	511		
1990	11,860	20,658	868,000	9.3809	9.9359	13.6739	9.3216	11,177	683		
1991	7,680	15,113	905,000	8.9464	9.6233	13.7157	9.1811	9,712	-2,032		
1992	9,880	4,474	901,000	9.1983	8.4060	13.7113	8.6073	5,471	4,409		
1993	11,153	6,860	918,000	9.3195	8.8335	13.7300	8.8115	6,711	4,442		
1994	10,792	19,816	1,062,000	9.2866	9.8942	13.8757	9.3343	11,319	-527		
1995	10,792	24,822	1,051,000	9.2866	10.1195	13.8653	9.4386	12,565	-1,773		
1996	10,792	20,412	1,156,000	9.2866	9.9239	13.9605	9.3617	11,635	-843		
1997	13,282	19,606	1,172,000	9.4942	9.8836	13.9742	9.3450	11,441	1,841		
1998	12,702	20,386	1,188,000	9.4495	9.9226	13.9878	9.3655	11,679	1,023		
1999	12,707	22,829	1,221,000	9.4499	10.0358	14.0152	9.4232	12,372	335		
2000	12,691	27,804	1,308,000	9.4486	10.2329	14.0840	9.5270	13,725	-1,034		
2001	12,248	18,743	1,246,000	9.4131	9.8386	14.0354	9.3336	11,311	937		
2002	12,458	20,772	1,259,000	9.4301	9.9414	14.0458	9.3836	11,892	566		
2003	13,433	13,294	1,166,000	9.5055	9.4951	13.9691	9.1612	9,521	3,912		
2004	1,107	144	1,138,000	7.0094	4.9698	13.9448	7.0266	1,126	-19		
2005	1,107	561	1,159,000	7.0094	6.3297	13.9631	7.6699	2,143	-1,036	10,635	12962
2006	5,925	5,154	1,215,000	8.6869	8.5475	14.0103	8.7216	6,134	-209	11,085	12962
2007	8,923	10,255	1,230,000	9.0964	9.2355	14.0225	9.0475	8,498	425		
2008	9,794	9,115	1,303,000	9.1895	9.1177	14.0802	9.0013	8,113	1,681		
2009	10,346	10,658	1,479,000	9.2444	9.2741	14.2069	9.0951	8,912	1,434		
2010	9,872	11,868	1,568,000	9.1975	9.3816	14.2653	9.1551	9,462	410		
								SSE	174,191,181		
								RMSE	2,061.2		

Predictions for 2005 and 2006 with Required Water

1,107	16,851	1,159,000	7.0094	9.7322	13.9631	9.2719	10,635
5,925	18,110	1,215,000	8.6869	9.8042	14.0103	9.3134	11,085

KS001178

Figure R2:



KS001179

Table R4: Calculation of Errors and RMSE for Sunding Acreage Below Lovewell Regression

Regression Coefficients Above	
Constant	1.281
Diversions	0.124
Region Planted Acres	0.535

	acres irrigated below	diversions below	regional acres planted	ln acres below	ln diversions below	ln regional acres planted	predicted ln acres below	predicted acres below	model error	Sunding prediction w required water	acres used in Our analysis
1970	18,280	44,654	998,490	9.8136	10.7067	13.8140	10.0074	22,190	-3,910		
1971	19,246	36,497	1,128,820	9.8651	10.5050	13.9367	10.0480	23,110	-3,864		
1972	16,336	26,571	1,043,900	9.7011	10.1876	13.8585	9.9667	21,304	-4,968		
1973	20,806	23,652	1,177,100	9.9430	10.0712	13.9786	10.0165	22,393	-1,587		
1974	20,400	44,612	1,108,500	9.9233	10.7058	13.9185	10.0632	23,465	-3,065		
1975	19,587	44,720	1,016,200	9.8826	10.7082	13.8316	10.0170	22,404	-2,817		
1976	21,054	62,239	977,190	9.9548	11.0387	13.7924	10.0371	22,860	-1,806		
1977	21,788	32,547	991,300	9.9891	10.3904	13.8068	9.9642	21,252	536		
1978	19,973	35,691	993,600	9.9021	10.4827	13.8091	9.9769	21,524	-1,551		
1979	20,671	29,960	950,300	9.9365	10.3076	13.7645	9.9313	20,564	107		
1980	21,237	45,248	994,500	9.9635	10.7199	13.8100	10.0069	22,179	-942		
1981	21,924	27,691	847,100	9.9953	10.2289	13.6496	9.8600	19,148	2,776		
1982	20,499	32,466	847,900	9.9281	10.3879	13.6505	9.8803	19,541	958		
1983	18,398	50,380	810,700	9.8200	10.8273	13.6057	9.9109	20,148	-1,750		
1984	19,658	46,921	977,800	9.8862	10.7562	13.7931	10.0024	22,078	-2,420		
1985	18,549	30,514	953,000	9.8282	10.3259	13.7674	9.9351	20,642	-2,093		
1986	21,706	35,605	924,800	9.9853	10.4802	13.7373	9.9382	20,707	999		
1987	22,721	37,905	929,000	10.0310	10.5428	13.7419	9.9484	20,919	1,802		
1988	20,202	51,296	835,500	9.9135	10.8454	13.6358	9.9292	20,522	-320		
1989	24,155	38,849	895,700	10.0922	10.5674	13.7054	9.9319	20,577	3,578		
1990	24,805	46,491	868,000	10.1188	10.7470	13.6739	9.9374	20,691	4,114		
1991	23,201	35,852	905,000	10.0520	10.4872	13.7157	9.9275	20,486	2,715		
1992	13,709	10,165	901,000	9.5258	9.2267	13.7113	9.7684	17,472	-3,763		
1993	22,705	12,335	918,000	10.0303	9.4202	13.7300	9.8024	18,078	4,627		
1994	24,141	34,186	1,062,000	10.0917	10.4396	13.8757	10.0072	22,186	1,955		
1995	24,141	44,334	1,051,000	10.0917	10.6995	13.8653	10.0340	22,787	1,354		
1996	24,141	44,785	1,156,000	10.0917	10.7096	13.9605	10.0862	24,009	132		
1997	25,703	44,036	1,172,000	10.1544	10.6928	13.9742	10.0915	24,136	1,567		
1998	25,784	44,909	1,188,000	10.1575	10.7124	13.9878	10.1012	24,371	1,413		
1999	26,080	45,569	1,221,000	10.1689	10.7270	14.0152	10.1176	24,776	1,304		
2000	28,067	56,372	1,308,000	10.2423	10.9397	14.0840	10.1809	26,395	1,672		
2001	26,925	41,182	1,246,000	10.2008	10.6258	14.0354	10.1159	24,733	2,192		
2002	26,991	41,903	1,259,000	10.2033	10.6431	14.0458	10.1236	24,925	2,066		
2003	23,027	28,831	1,166,000	10.0444	10.2692	13.9691	10.0360	22,835	192		
2004	23,034	24,470	1,138,000	10.0447	10.1052	13.9448	10.0026	22,085	949		
2005	23,439	22,232	1,159,000	10.0622	10.0093	13.9631	10.0005	22,037	1,402	23,757	25,417
2006	22,655	24,551	1,215,000	10.0281	10.1085	14.0103	10.0381	22,882	-227	24,556	25,417
2007	24,055	26,515	1,230,000	10.0881	10.1855	14.0225	10.0542	23,254	801		
2008	25,561	24,501	1,303,000	10.1488	10.1065	14.0802	10.0753	23,749	1,812		
2009	26,017	30,547	1,479,000	10.1665	10.3270	14.2069	10.1705	26,122	-105		
2010	26,886	36,340	1,568,000	10.1994	10.5007	14.2653	10.2234	27,540	-654		
								SSE	211,568,317		
								RMSE	2,271.6		

Predictions for 2005 and 2006 with Required Water

23,439	40,677	1,159,000	10.0622	10.6134	13.9631	10.0756	23,757
22,655	43,321	1,215,000	10.0281	10.6764	14.0103	10.1087	24,556

Figure R3:

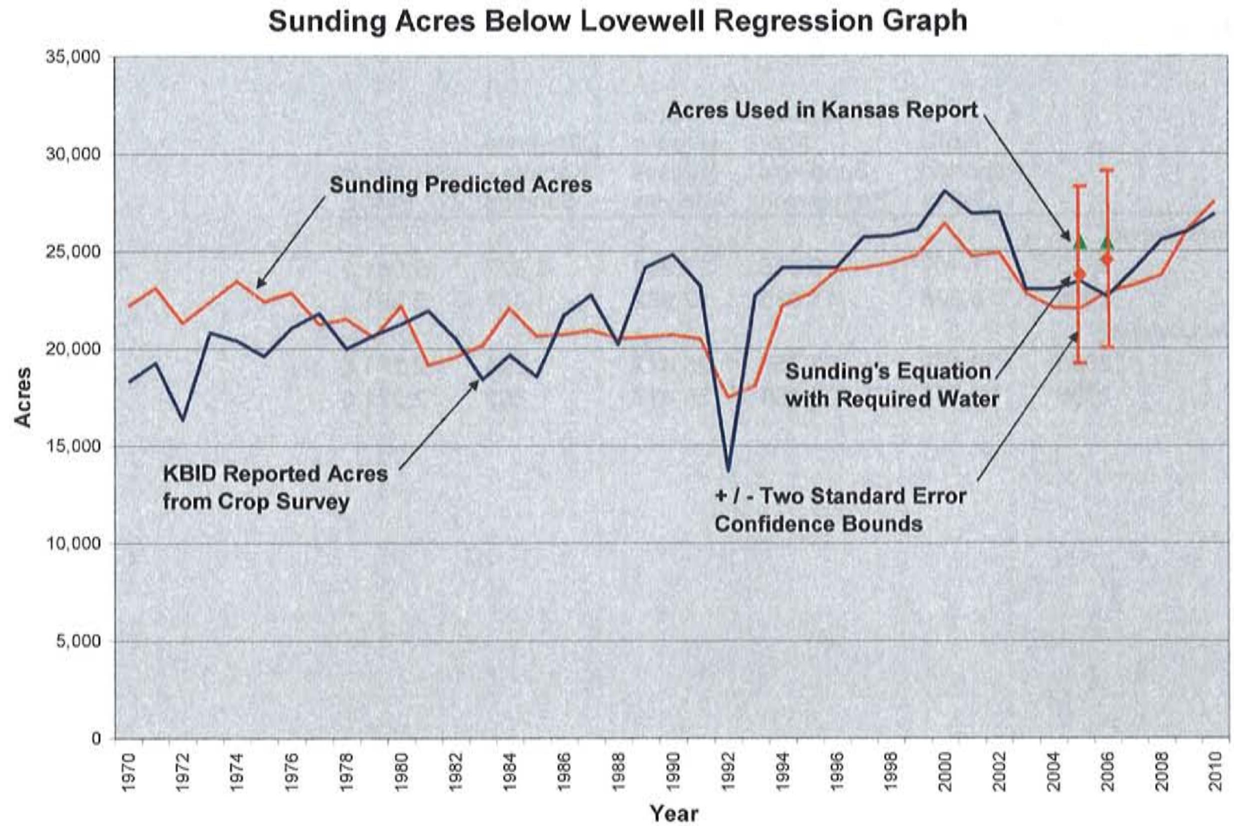


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Table R5:

Summary of Sunding Acres Regression Results

	KBID Reported Acres	Prediction from Sunding's Regression	Acres Used in Kansas Analysis	Difference Kansas v Sunding	Sunding's RMSE
Above Lovewell					
2005	1,107	10,635	12,962	2,327	2,061.2
2006	5,925	11,085	12,962	1,877	2,061.2
Below Lovewell					
2005	23,439	23,757	25,417	1,660	2,271.6
2006	22,655	24,556	25,417	861	2,271.6

Figure R4: Sunding's STATA regression instruction file

```
clear
set more off
capture log close

use KBID_Data

tsset year

log using "kbid_regression $S_DATE.log", replace

gen corn_yield_interaction = deliveries_total * region_corn_yield

reg kbid_corn_yield deliveries_total region_corn_yield corn_yield_interaction
dwstat

prais kbid_corn_yield deliveries_total region_corn_yield corn_yield_interaction

predict kbid_corn_yield_predict, xb
li kbid_corn_yield_predict if year == 2005 | year == 2006

preserve

replace deliveries_total = 34985 if year == 2005
replace deliveries_total = 36951 if year == 2006
replace corn_yield_interaction = deliveries_total * region_corn_yield

predict kbid_corn_yield_predict2, xb
li year kbid_corn_yield_predict2 if year == 2005 | year == 2006

restore

gen region_acres_planted = region_corn_acres + region_milo_acres + region_soybean_acres + region_alfalfa_acres

gen ln_region_acres_planted = ln(region_acres_planted)

gen ln_diversions_above = ln(diversions_above)
gen ln_diversions_below = ln(diversions_below)
gen ln_acres_irr_total = ln(acres_irr_total)
gen ln_acres_irr_above = ln(acres_irr_above)
gen ln_acres_irr_below = ln(acres_irr_below)

reg ln_acres_irr_above ln_diversions_above ln_region_acres_planted
dwstat

preserve

replace ln_diversions_above = ln(16851) if year == 2005
replace ln_diversions_above = ln(18110) if year == 2006

predict kbid_above_acres_predict, xb

li kbid_above_acres_predict if year == 2005 | year == 2006

restore

reg ln_acres_irr_below ln_diversions_below ln_region_acres_planted
dwstat

preserve

replace ln_diversions_below = ln(40677) if year == 2005
replace ln_diversions_below = ln(43321) if year == 2006

predict kbid_below_acres_predict, xb

li kbid_below_acres_predict if year == 2005 | year == 2006

restore

log close
```

Source: This material was submitted by Sinding as file "KBID_analysis.do" on his supplementary materials CD.

Table R6: Regression Data Submitted by Sunding

year	deliveries total	acres irrigated above	acres irrigated below	acres irrigated total	KBID corn yield	region corn yield	region corn acres	region milo acres	region soybean acres	region alfalfa acres	diversions above	diversions below	diversions total
1970	52522	9456	18280	27736	92	67	152000	628000	23490	195000	24473	44654	69127
1971	38115	9388	19246	28634	114	84	146000	767000	18820	197000	20147	36497	56644
1972	26141	10179	16336	26515	129	99	121000	721000	8900	193000	13717	26571	40288
1973	25116	9722	20806	30528	103	95	148900	819000	19900	189300	15422	23652	39074
1974	50981	9052	20400	29452	102	74	163900	762300	20900	161400	24533	44612	69145
1975	49119	12190	19587	31777	107	81	123000	715000	25900	152300	22915	44720	67635
1976	68636	9594	21054	30648	103	92	121200	683000	16990	156000	33800	62239	96039
1977	30688	10459	21788	32247	103	96	119000	702000	20300	150000	17723	32547	50270
1978	34050	11936	19973	31909	123.1	103	108900	698000	39700	147000	20146	35691	55837
1979	28776	12858	20671	33529	123.1	118	101000	648000	43600	157700	15470	29960	45430
1980	48857	11995	21237	33232	94.7	83	118000	666000	62000	148500	22555	45248	67803
1981	22804	10968	21924	32892	134.6	123	97000	521000	73000	156100	13668	27691	41359
1982	30710	13481	20499	33980	108	101	97000	499000	99000	152900	18794	32466	51260
1983	47751	7824	18398	26222	106.2	95	80000	496000	91000	143700	21490	50380	71870
1984	47725	10390	19658	30048	139	127	86000	641000	101000	149800	23417	46921	70338
1985	27991	12861	18549	31410	140.5	134	88000	655000	79000	131000	17606	30514	48120
1986	33802	10379	21706	32085	148.7	131	107000	594000	103000	120800	19919	35605	55524
1987	35718	10864	22721	33585	137.3	123	92000	577000	145000	115000	18383	37905	56288
1988	50596	9660	20202	29862	135.2	119	82000	527000	124000	102500	25823	51296	77119
1989	39012	11541	24155	35696	158.8	144	76000	575000	137000	107700	19871	38849	58720
1990	43514	11860	24805	36665	139	117.7	108000	500000	150000	110000	20658	46491	67149
1991	32352	7680	23201	30881	110.6	104.9	125000	555000	120000	105000	15113	35852	50965
1992	4248	9880	13709	23589	166	140.1	102000	575000	96000	128000	4474	10165	14639
1993	3299	11153	22705	33858	92	101.7	136000	545000	110000	127000	6860	12335	19195
1994	31330	10792	24141	34933	153.4	120	174000	615000	163000	110000	19816	34186	54002
1995	42474	10792	24141	34933	135.8	105	159000	622000	150000	120000	24822	44334	69156
1996	41249	10792	24141	34933	163.9	140	182000	720000	145000	109000	20412	44785	65197
1997	40705	13282	25703	38985	166.6	114	202000	650000	199000	121000	19606	44036	63642
1998	41192	12702	25784	38486	157.6	125	220000	600000	217000	151000	20386	44909	65295
1999	44613	12707	26080	38787	165.4	115	240000	567000	286000	128000	22829	45569	68398
2000	58016	12691	28067	40758	143.4	89	248000	609000	321000	130000	27804	56372	84176
2001	39234	12248	26925	39173	155	107	219000	599000	299000	129000	18743	41182	59925
2002	43952	12458	26991	39449	162	90	224000	597000	306000	132000	20772	41903	62675
2003	28865	13433	23027	36460	160.7	102	161000	625000	243000	137000	13294	28831	42125
2004	15600	1107	23034	24141	180.4	139	162000	530000	320000	126000	144	24470	24614
2005	12601	1107	23439	24546	187	122	245000	483000	319000	112000	561	22232	22793
2006	17963	5925	22655	28580	162.6	96	226000	467000	397000	125000	5154	24551	29705
2007	22953	8923	24055	32978	181.6	127	224000	523000	369000	114000	10255	26515	36770
2008	18000	9794	25561	35355	189.9	138	234000	508000	461000	100000	9115	24501	33616
2009	22931	10346	26017	36363	220.5	150	310000	500000	549000	120000	10658	30547	41205
2010	32563	9872	26886	36758	162.7	115.1	380000	380000	708000	100000	11868	36340	48208

Source: This material was submitted by Sinding as file "KBID_data.csv" on his supplementary materials CD.

Table R7: Calculation of Errors and RMSE for Sunding Yield Regression

	KBID Corn SurveyYield	Predictions from Sunding Prais Winsten Regression	Sunding Predicted Yields After Un-transformation	Model Error
1970	92.0	69.14	107.5	-15.5
1971	114.0	31.36	118.7	-4.7
1972	129.0	37.50	124.8	4.2
1973	103.0	24.35	123.1	-20.1
1974	102.0	20.32	99.2	2.8
1975	107.0	30.84	109.0	-2.0
1976	103.0	43.93	125.9	-22.9
1977	103.0	20.72	99.6	3.4
1978	123.1	36.99	115.9	7.2
1979	123.1	45.61	139.9	-16.8
1980	94.7	6.39	100.7	-6.0
1981	134.6	60.92	133.4	1.2
1982	108.0	12.12	115.2	-7.2
1983	106.2	29.60	112.3	-6.1
1984	139.0	56.78	138.1	0.9
1985	140.5	45.02	151.5	-11.0
1986	148.7	34.34	141.9	6.8
1987	137.3	29.18	143.1	-5.8
1988	135.2	32.09	137.2	-2.0
1989	158.8	57.95	161.5	-2.7
1990	139.0	15.34	137.0	2.0
1991	110.6	20.37	126.8	-16.2
1992	166.0	73.92	158.6	7.4
1993	92.0	-12.78	114.3	-22.3
1994	153.4	55.08	125.5	27.9
1995	135.8	21.42	138.9	-3.1
1996	163.9	63.63	167.6	-3.7
1997	166.6	15.04	140.6	26.0
1998	157.6	43.67	171.3	-13.7
1999	165.4	26.94	147.6	17.8
2000	143.4	16.60	143.3	0.1
2001	155.0	38.82	148.6	6.4
2002	162.0	17.69	136.4	25.6
2003	160.7	35.29	159.3	1.4
2004	180.4	72.96	196.0	-15.6
2005	187.0	18.88	157.0	30.0
2006	162.6	3.45	146.7	15.9
2007	181.6	65.29	189.8	-8.2
2008	189.9	50.26	189.3	0.6
2009	220.5	52.65	198.1	22.4
2010	162.7	3.27	172.1	-9.4
			SSE	7459.8
			RMSE	13.4887585

Figure R5:

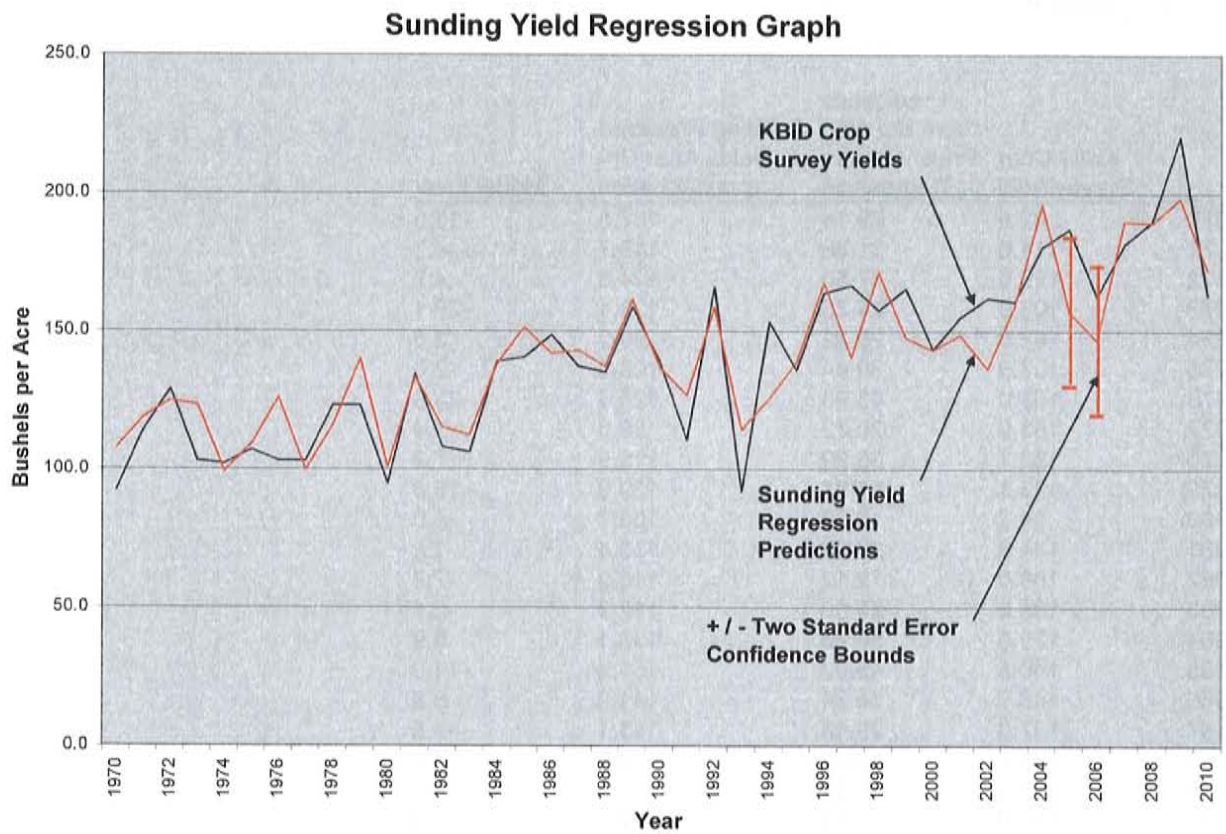
Sunding Yield Regression Graph
250.0
200.0
150.0
100.0
50.0
0.0
Bushels per Acre
KBID Crop Survey Yields
Sunding Yield Regression Predictions
+ / - Two Standard Error Confidence Bounds
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year

Table R8: Comparison of Value Added Results -- Kansas Expert Report and Prof. Sunding's Report

	From Our Report			What Sunding Implied	What Sunding Actually Did	
	(1)	(2)	(3)	(4)	(5)	(6)
			%			%
on-farm direct		$632,505		$618,403		
secondary direct and indirect						
direct	$291,549		57%		$618,403	54%
indirect	$121,877		24%		$280,468	25%
total		$413,426		$280,468		
secondary induced						
by farm income	$186,090					
by other income	$101,940		20%		$244,605	21%
total		$288,030		$244,605		
GRAND TOTAL		$1,333,961		$1,143,476	$1,143,476	

Figure R6: Screenshot of IMPLAN Input Screen Showing our Inputs for 2005 Above Lovewell

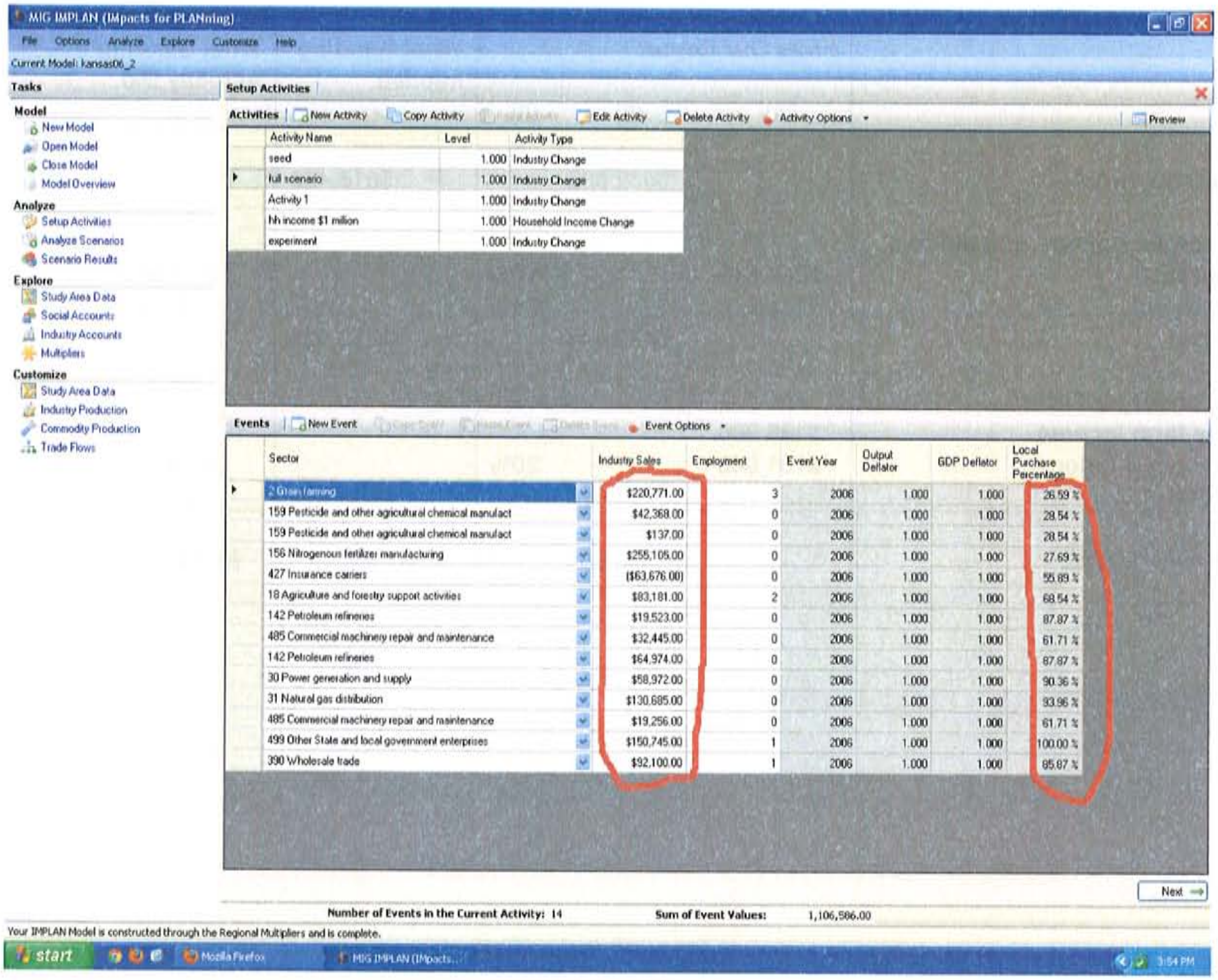

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Figure R7: Screenshot of IMPLAN Output Screen Showing our Results for 2005 Above Lovewell

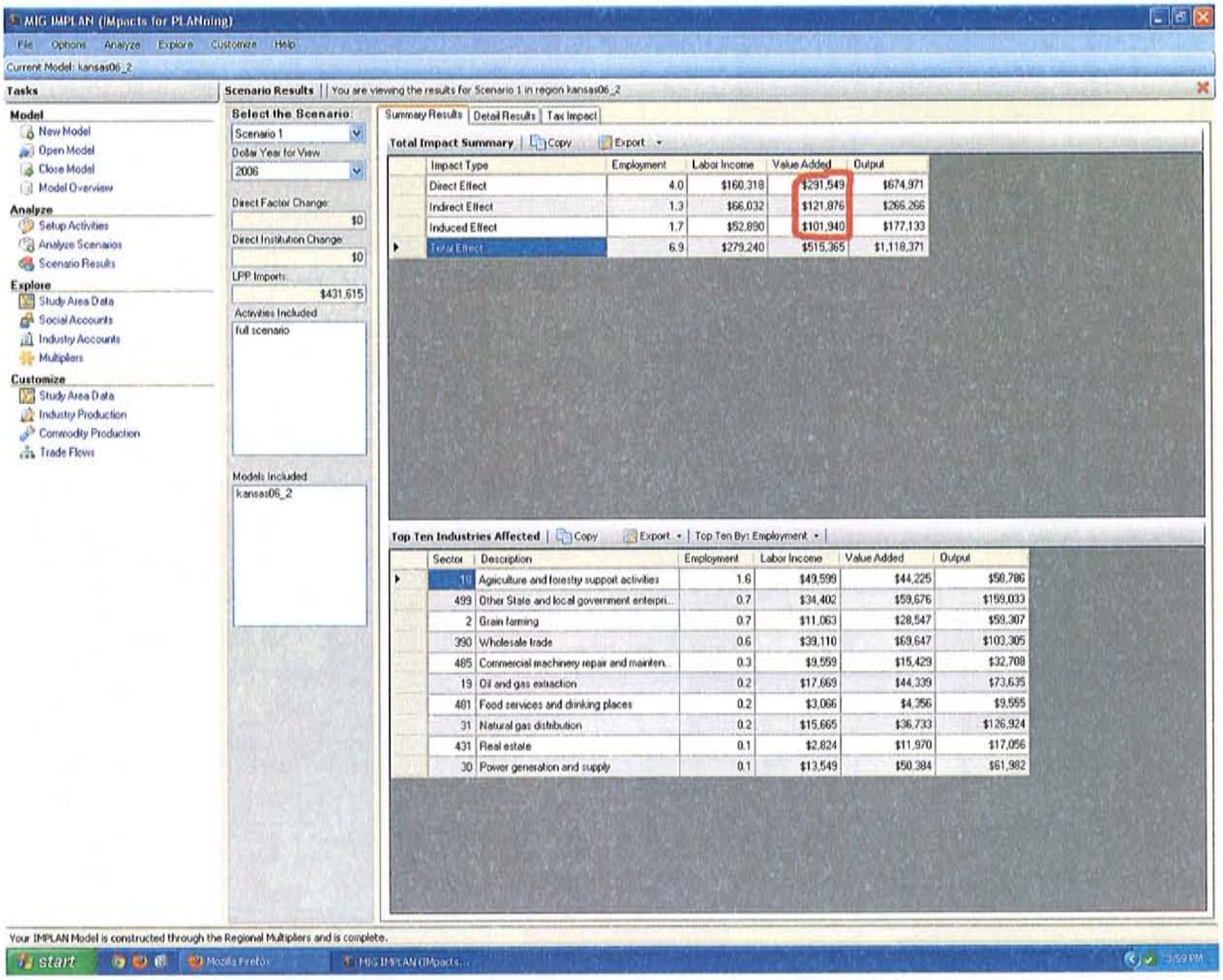
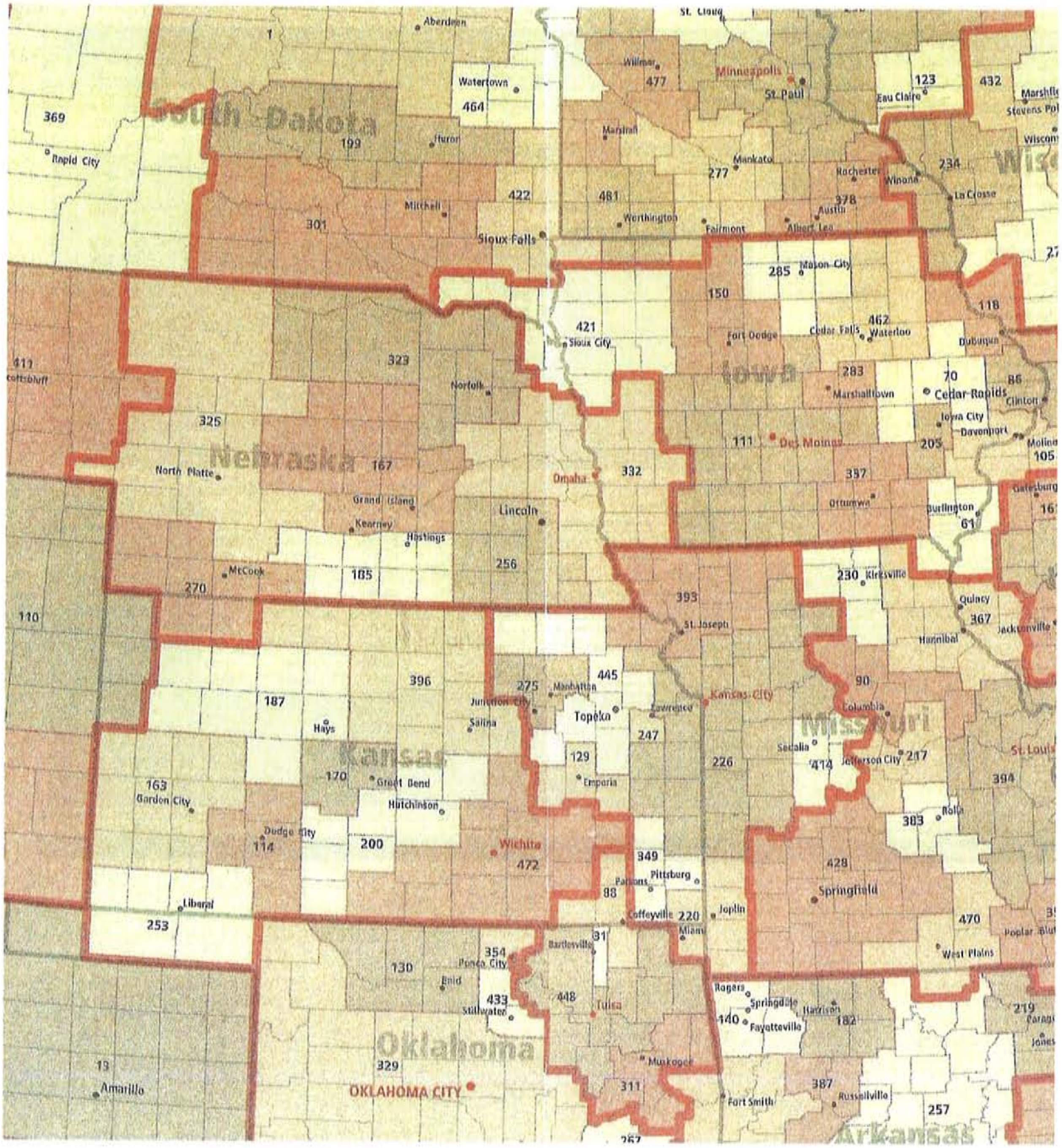
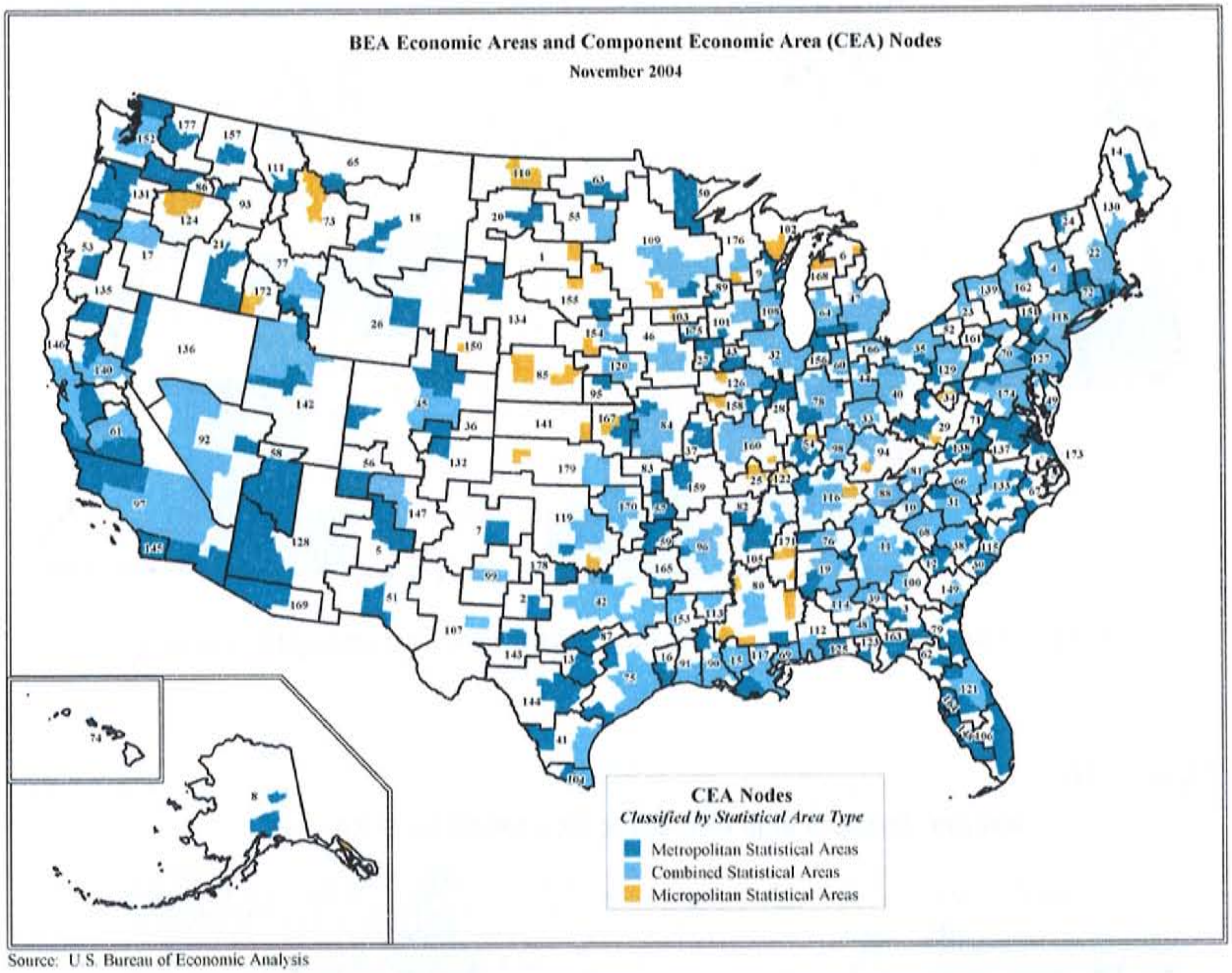


Figure R8: Rand McNally Trading Areas



Source: Commercial Atlas and Marketing Guide 2009, Rand McNally, Chicago, Illinois, page 23.

Figure R9:



Source: US Department of Commerce, Bureau of Economic Analysis,
http://www.bea.gov/regional/_images/ea/EconAreaMap_small.gif

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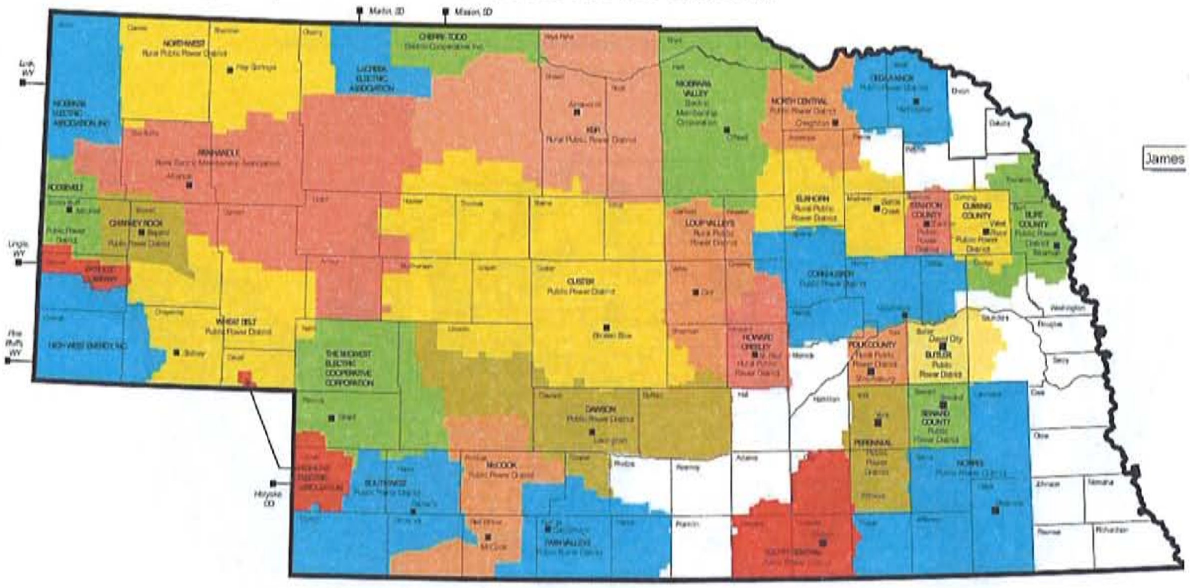
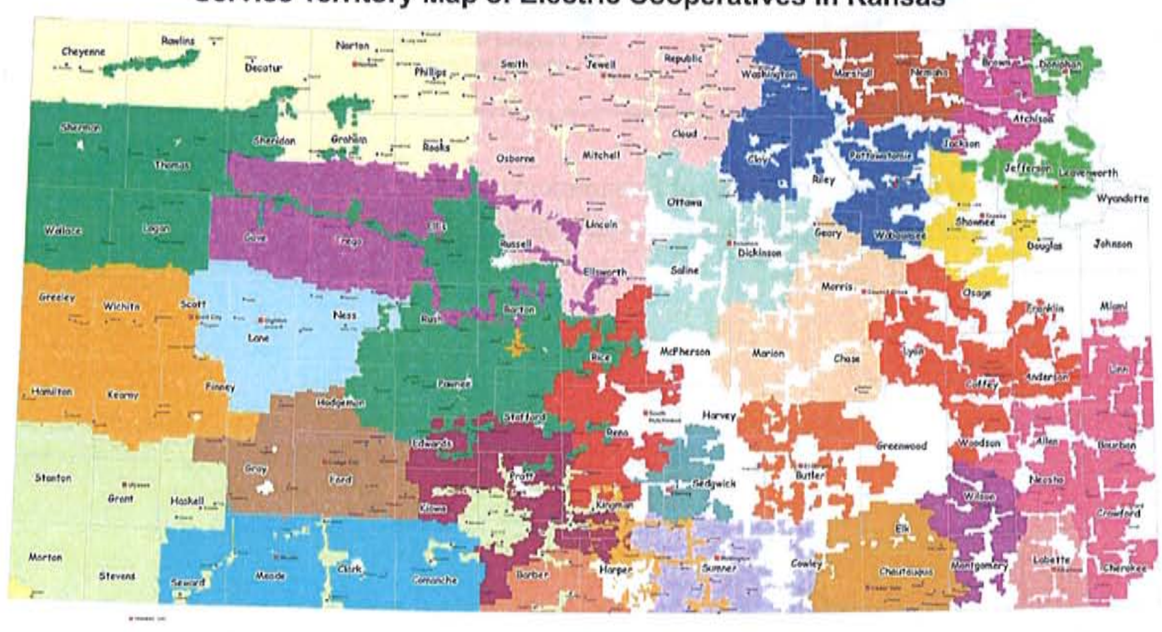
Figure R10:
Service Territory Map of Electric Cooperatives in Nebraska



Source: Nebraska Rural Electric Association, http://nrea.org/content/about-our-members

Figure R11:

Service Territory Map of Electric Cooperatives in Kansas



Source: Kansas Electric Cooperatives, Inc., http://www.kec.org/serviceareas.aspx

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