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Abstract

Statewide agricultural land values from 3,243 arms-length market sales in North Dakota between 2001 and 2004 were 6 percent higher than estimates derived from the June Agricultural Survey (JAS) of National Agricultural Statistics Service (NASS), and 9 percent higher than values from the North Dakota Land Value Survey (NDLVS). These survey-market sale differences varied substantially in particular regions and counties and over time. The geographic information system (GIS) technique of 'kriging' was used to interpolate point-based market and JAS land values statewide in a continuous (raster) format. Few counties contained homogenous land values and differences between market sales and the JAS were quite large in several specific (sub-county) areas. Opinion-based surveys are therefore considered reasonably accurate and useful for statewide or regional applications but are likely insufficient for county and more site specific valuation analyses unless such survey data is spatially interpolated (kriged) and disseminated using GIS technologies.

Differences Between Agricultural Land Value Surveys and Market Sales

By Dr. Steven Shultz

Introduction

Both federal and state governmental agencies regularly conduct opinion-based surveys of farm operators in order to estimate agricultural land values. This data can be time consuming and expensive to collect and is often used by policy makers, researchers, and the buyers and sellers of land, particularly in cases when formal agricultural land appraisals are too expensive or infeasible. It is therefore considered prudent to evaluate the accuracy of these survey-based land value estimates by comparing them with actual agricultural market sales at different levels of geography (statewide, regionally, in individual counties, and across continuous landscapes), and such comparisons should be made across different years.

To date, there has only been one other formal study of this issue: a 1995 study by Gertel which appeared in this same journal, and concluded that agricultural market sales were consistently higher than values from several different opinion-based surveys in both Illinois and Maryland. This present study can be considered a follow-up study to the earlier effort and will focus on another state (North Dakota) and include more site-specific levels of analysis, which is now possible with the use of Geographic Information System (GIS) technologies.

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The objective was to quantify differences between arms-length agricultural land market sales over the 2001 to 2004 time period and two sets of opinion surveys: the USDA-NASS June Agricultural Survey (JAS) which is a personal survey administered nationwide, and the North Dakota Land Value Survey (NDLVS) which is a telephone survey funded by the State of North Dakota but administered by the NASS North Dakota field office. Comparisons are first made at the statewide, regional, and county levels using 2001 to 2004 data, and then at a more site-specific levels with year 2002 data by spatially overlaying interpolated (continuous) land value maps representing both market and JAS land values in order to identify specific areas where they differ substantially.

Previous Research Comparing Opinion Surveys and Market Values

No previous studies have specifically compared the accuracy of land values from the June Agricultural Survey (JAS) or other land owner/operator land value surveys such as NDLVS. However, an article by Gertel (1995) compares actual land sales data with opinion-based land values surveys of landowners (an ERS-NASS survey) and other surveys of "local experts" in Illinois and Maryland. As well, an article by Roka and Palmquist (1997) evaluated the use of JAS land value data for hedonic analyses of farmland attributes in the five-state Corn Belt region of Illinois, Indiana, Iowa, Missouri, and Ohio.

The Gertel study (1995) compared actual land sales with several opinion survey-based land value estimates in both Illinois and Maryland. The surveys included: 1) An ERS survey of land/owner operators (conducted by NASS); 2) a survey of County Executive Directors by the Agricultural Stabilization and Conservation Service (ASCS); and 3) ERS/NASS survey of real estate brokers and lenders conducted prior to the existence of the JAS.

In Illinois, 19,847 arms-length agricultural sale transactions from 1983 through 1991 were averaged by counties (weighted by sale size) and then aggregated to the State level (weighted by number of sales in counties). These statewide average land values were then compared to land value data from each of the three alternative surveys. Although no statistical analyses of the Illinois data were made, it was noted that both actual sales and estimates of sales by brokers/lenders were similar, and in most years were higher than survey values from either ERS/NASS (landowners) or ASCS (County Executive Directors).

The magnitude of observed differences were not explicitly stated, but from the land values reported in the accompanying tables, the following differences in land value data over the 1983-1991 time period appear to have occurred: actual sales were 9 percent higher than landowner estimates, 15 percent higher than County Director estimates, and 2 percent higher than real estate broker/lender estimates. It should be noted that these land value differences varied considerably year by year. As well, it is suspected that these variations may not be consistent across counties or alternatively that the aggregation of land values at the state level of analysis masks what is occurring in individual counties.

In Maryland, 1,521 agricultural arms length sales from 1987 to 1991 in 23 counties were grouped into 17 strata and compared to land values from the 3 surveys after editing out statistical outliers associated with development sales or properties with unique amenities. Differences among land sale values and survey values were highly dependent on the region of analysis, the size of sold tracts, and nearby population densities. However, average sale values were 27 percent higher than landowner survey values, 19 percent higher than County Director estimates, and 10 percent lower than real estate broker/lender estimates.

Based on this 1995 study, differences between actual agricultural land values and opinion-based surveys, estimates of land values appear (at least in these two states and at the statewide level of analysis) to be smaller in agricultural areas than in developed areas near urban centers. Also, land differences from actual sales appear smaller with "expert" (agent/broker) surveys than with landowner surveys.

Roka and Palmquist (1997) evaluated the use of June Agricultural Survey (JAS) land value data for hedonic analyses of farmland attributes in the five-state Corn Belt region of Illinois, Indiana, Iowa, Missouri, and Ohio. Hedonic analyses involved studying market transactions in order to quantify how attributes of sold tracts impact sale prices and in this case a series of hedonic regression models were estimated with the dependent variable being agricultural land sale value (based on

JAS data on a per acre basis) from 1994 to 1996, while the explanatory variables were various subsets of farm and owner/operator characteristics, obtained from both the JAS and/or the USDA Natural Resource Inventory. The specific objective was to evaluate the appropriateness of JAS data for such studies in the hope that this nationwide data set could be used in lieu of more expensive and difficult to collect data on individual market sales.

It is important to note that in the model specifications for 1994 and 1995 the authors included a variable "SOLD": a binary measure of whether JAS respondents had actually sold property in the previous year. In 1994 and 1995, 1.4 percent of JAS respondents had actually sold property. In 1996, this market experience question was dropped from the JAS.

Based on the fact that the "SOLD" variable did not have a statistically significant impact on sale prices (in 1994 and 1995) the authors found "some evidence that the land value opinion given in the JAS match market opinions" with the caveat that imputed JAS values may have an impact on this match. A second indication of the reliability of the JAS land value data is that the estimated hedonic coefficients (marginal prices of land characteristics) were consistent (stable) across years. The fact that the best estimated model only explained one third of the variation in land values was attributed to the lack of detailed explanatory variables and in particular a lack of soil productivity data specific to JAS tracts, rather than the quality of JAS land value data itself.

Sources of Agricultural Land Value Estimates

Opinion-based land value surveys are generally administered to farm operators and/or absentee landowners who are asked to estimate the value of land that they own or operate or the value of nearby land owned and operated by others. Such surveys generally assume that these respondents are aware of recent market transactions in cases when they may not have recently bought or sold land themselves. In North Dakota there are two opinion-based land value surveys administered each year to farm operators: The June Agricultural Survey (JAS) and the North Dakota Land Values Survey (NDLVS).

The June Agricultural Survey (JAS) is funded and administered by the National Agricultural Statistics Service (NASS). It is a national effort that involves annually surveying all farm activity within approximately 10,000 segments across the country, each segment measuring roughly one square mile. Segment samples are on average 640 acres or 1 square mile in size, and are selected from the major land use strata across the contiguous 48 states with the goal of capturing all types of agricultural activities. All farmers operating within the selected segments are interviewed in-person and asked to describe very specific agricultural practices within the segments that they operate (NASS, 2005a).

Collected JAS data includes: ownership details, crop acreage and practices, livestock inventories, management activities and input costs, gross agricultural sales, and both land values and cash rents. More specifically in relation to land values, the JAS asks operators what they believe the market value is of their land inside the segment boundaries as well as the value and cash rental amounts for cropland, pasture, grazing and grassland acres. The JAS also asks operators questions about the entire farm they own or operate. In North Dakota there are approximately 420 segments surveyed by the JAS each year, representing a random sample of land uses throughout the State. However the data is only reported to the public at the State level of aggregation because there are often not enough sample points to accurately represent land values for particular counties, and to maintain the confidentially of all data provided by individual farm operators (NASS, 2005b).

In contrast, the NDLVS is a telephone survey of farm operators that is conducted in January or early February of each year by the North Dakota Field Office of NASS. It is funded by the North Dakota State Land Department, which requires agricultural land value data in each county of the State in order to assess the validity of sale prices and rents of land they control. The resulting land value estimates are also published on-line and in the corresponding annual North Dakota Agricultural Statistics Handbook by NASS, and these values are widely reported and cited.

Approximately 3,800 farm operators provide land value data to the NDLVS and both land values and cash rental values are collected for non-irrigated crop, pasture, and hay. For each county, the number of collected responses is reported along with minimum, maximum, most frequent (modal), and average values.

North Dakota allows sellers and/or buyers of land to maintain the confidentiality of real estate considerations (prices). However, in most counties of the State anecdotal evidence suggests that more than 70 percent of the agricultural land sales are not specified to be confidential and are hence available from public deed records in county courthouses. An exception to this trend is apparently occurring in some of the counties in the southwestern corner of the state.

The use of disclosed land sales for appraisals or other valuation studies requires that they be verified as being: arms-length (not between family members), not to have included substantial buildings or equipment, and to have been cash or cash equivalent transactions. Although North Dakota taxes agricultural land based on its productive value, the Office of the State Tax Commissioner in collaboration with county tax directors, regularly verifies and compiles all arms-length and land only agricultural land sales in the state as part of an "assessment ratio study" (which compares sale values with assessed taxable values). Normally this data is not released to the public, but all publicly disclosed agricultural market sales from the state and individual counties were provided for the purposes of this present study.

Another potential source of agricultural market sales are rural appraisers who assemble large numbers of agricultural sales for appraisal purposes. In many states, appraisers are surveyed by other appraisers (the case in North Dakota) or by university researchers (as done in South Dakota and Nebraska) in order to make annual estimates of agricultural land values. However, such appraiser surveys often only report ranges of land values, may be based on limited and possibly self selected samples, and in cases where means and standard deviations are actually reported, they are aggregated at county or regional levels of analysis.

Procedures

Comparisons between market sales and opinion-based survey estimates of agricultural land values were made at the state, regional, and county levels of analysis. Since JAS and NDLVS land value estimates were reported separately for crop and pastureland (and hay land for the NDLVS) an aggregate estimate of all agricultural land value was calculated by weighting reported mean crop, pasture, and hay land values for each county by the acres of each land use occurring the county. Market sales were excluded from the analysis if they were smaller than 40 acres.

For comparisons at more site-specific (sub-county) levels of analysis, maps of both market sale and JAS-based land value estimates were visually compared and spatially overlaid in order to identify regions of particular large differences. This first required that all market sales and JAS segment locations be digitized into a geographic information system (GIS) database. Sales were digitized using the legal description of the sales (township, range, section and quarter descriptions) along with common land unit boundaries of individual farm fields as developed by the Farm Service Agency (FSA). JAS segments were digitized using their reported latitude/longitude coordinates associated with the geographic center (centroid) or each segment. To maintain confidentiality agreements between NASS and surveyed landowners, it was necessary to work with JAS data only within NASS offices and to not produce of distribute any maps which would identify the location of specific survey sites.

Once sale and JAS locations were digitized and represented as points, the GIS technique of kriging was used to interpolate point data to a continuous (raster) surface by assuming that the distance and/or direction between sample points shows a spatial correlation that can be used to help describe the surface. The spatial estimation technique involves fitting a mathematical function to a specified number of points to determine the output value for each location and has been used mostly in the natural sciences when a spatially correlated distance of directional bias in the data is present (Chou, 1997).

Collected Land Value Data (2001-2004)

A total of 3,243 agricultural land sales over the 2001 to 2003 time period (an average 811 per year) were collected and utilized. The centroid location of these sales along with their relative values on a per acre basis are shown in Figure 1, which demonstrates the general trend of declining land values from east to west across the State (a direct relationship with declining soil productivity in a western direction). However, there are exceptions to this generalized land value trend: there are numerous cases of high valued land sale (denoted by red) in areas of the State otherwise dominated by relatively lower

(blue) values and vice versa (cases of low values sales in areas of generally high values). Similarly it can be clearly seen that in most parts of state, land values are not consistently homogenous within individual counties.

During this same time period, 3,935 JAS surveys were conducted in 420 segments of 1 square mile in size, which corresponds to approximately 985 surveys per year across the State (the exact number of segments vary each year). Again, due to NASS confidentiality agreements, it is not possible to display the actual locations of these survey segments.

Finally, between 2001 and 2004, a total of 8,642 NDLVS land value surveys were conducted with completed land value opinions, which corresponds to an average of approximately 2,160 surveys per year. This data is only aggregated at the county level of analysis and was therefore not included in any sub-county, GIS-based analyses.

State/Regional/County Differences Between Market Sales and Surveys

On a statewide level, land value estimates based on each of the two surveys were reasonably close to each other and to actual market sales: JAS estimates were six percent lower than market sales while NDLVS estimates were nine percent lower (Table 1). However, differences between the two surveys and market values were not constant over time and appear to be increasing in recent years. For example, in 2001 JAS values were two percent lower than market values while in 2004 they were nine percent lower. Similarly, NDLVS values were 6 percent lower than market sales in 2001 and 12 percent lower in 2004. Differences may be increasing in recent years due to rapidly increasing land values across the state in 2003 and 2004 and the fact that opinion surveys may not be picking up these land value changes as quickly as they are occurring.

Differences between the two land value surveys and actual market sales also do not appear constant across the distinct regions of the State: Both JAS and NDLVS numbers underestimate actual market sales most sharply in the southwest part of the State, while the JAS overestimate market sales mostly in the Southern Red River Valley and the northeastern part of the State (Table 2).

Similarly, as can be seen from Table 3 there are extreme variations on how the JAS and NDLV surveys differ from actual market sales in different counties throughout the State. In fact, in some counties differences between the JAS and market sales vary by as much as 44 percent, and almost 30 percent of counties have differences that exceed 20 percent. It appears that differences between the NDLVS estimates and market sales are not quite as extreme as with the JAS but again large differences in particular counties do exist (18% of counties have Market Sale-NDLVS differences that exceed 20%).

There do not appear to be any particular geo-spatial patterns associated with counties having high differences between market sales and the two surveys other than counties with the highest differences appear to be banded together around the Missouri River in the Southwestern part of the State (Figures 2 and 3).

Site-Specific Differences Between Market Sales and Surveys

The previous county level analyses comparing actual market sales with JAS survey estimates of agricultural land values are limited because they rely on the assumptions that land value and the characteristics that influence land values are constant or homogenous within counties, and that county-wide average values (single point estimates) accurately reflect the conditions throughout individual counties.

In contrast, continuous (kriging-based) estimates of market sales in the year 2002 (Figure 3 with 776 sales) were spatially overlaid with a kriged map representing 2002 JAS-based land values (Figure 5, based on 376 survey sites). Despite the much larger sample size, each of the two maps appear (at least visually) to estimate land values across the State in a relatively similar pattern: both portrays the widely known east to west value gradient present in North Dakota, but it also demonstrates that estimated land values are almost never homogenous within counties.

The areas where the land values from the two maps do not coincide appear in the overlay map shown in Figure 6 as dark red (indicating that JAS values are higher than market-based values) and in dark blue (indicating JAS values are less than market sales).

Conclusions

Similar to the previous study by Gertel (1995) nearly a decade earlier in Illinois and Maryland, this present study determined that agricultural market sale values in North Dakota are higher than land value estimates derived from opinion-based surveys, although the magnitude of the differences is not as large as observed in the earlier study. This indicates either that survey respondents are systematically under-valuing their agricultural land or perhaps, that land being sold is of higher quality than the land owned by survey respondents.

Since the differences between market sales and opinion-based surveys in North Dakota are relatively small, it can be concluded that these opinion surveys are reasonably accurate at least at the statewide or regional levels of analysis but that they are not sufficient for county or sub-county analyses. This is likely a result of the fact that land characteristics and values are not homogenous across county boundaries.

The use of the GIS technique of kriging to interpolate land value data points across a continuous surface appears to hold much advantage over traditional count level analyses as it appears that land characteristics and land values are not homogenous across county boundaries. The kriged land value maps presented in this study have demonstrated the high degree of variation in land values across counties that clearly would have been lost if the data is aggregated (averaged) at the county level of analysis.

By overlaying the kriged market sale and JAS land value maps, it was demonstrated that market values were overall (on a statewide basis) very similar to JAS estimates but again, that there were several distinct (site-specific) areas around the State where the land value estimates associated with the two data sources did differ substantially. Such a map which identifies these differences could be used to warn users of survey-based land value estimates that these data source may not be particularly reliable. Alternatively this same information could be used by NASS to increase the sample size of their JAS survey efforts in these particular areas of inaccuracy.

Finally, the use of kriging to represent land values should be further evaluated by NASS as an approach for releasing JAS land value data to the general public in contrast to their current policy of releasing only single (statewide) land value estimates. This GIS approach has the potential to provide reasonably accurate and site-specific agricultural land value estimates in many parts of the country where such data is clearly not available while maintaining the confidentiality of individual JAS respondents.

Acknowledgements

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Table 1. Differences in Land Values from Alternative Sources ($/Acre)

Source	2001	2002	2003	2004	(2001-04)*
Market Sales	$361	$375	$420	$459	$430
JAS	$384	$384	$406	$449	$406
(Vs Mkt. Sales)	(-2%)	(-5%)	(-14%)	(-9%)	(-6%)
NDLVS	$365	$377	$395	$432	$392
(Vs Mkt. Sales)	(-6%)	(-4%)	(-6%)	(-12%)	(-9%)

** Based on 3,243 market sales, 3,935 JAS surveys and 8,642 NDLVS surveys*

Table 2. Regional Differences in Land Values from Alternative Sources Over Time ($/Acre, 4 Year Average: 2001-2004)

	Market Sales	JAS	NDLV
Statewide	$430	$406 (-6%)	$392 (-9%)
North Red River Valley	$732	$751 (3%)	$725 (-4%)
South Red River Valley	$879	$933 (6%)	$936 (0%)
Northeast	$355	$374 (5%)	$368 (-2%)
Southeast	$398	$386 (-3%)	$382 (-1%)
Northwest	$328	$347 (6%)	$334 (-4%)
Southwest	$303	$276 (-9%)	$245 (-11%)

Table 3. Differences Between Land Value Survey Estimates and Market Sale Values Across North Dakota Counties (2001-2004)

	JAS Versus Market Sales	NDLVS Versus Market Sales
Range of Differences	-27% to +44%	-35% to +33%
Percentage of Counties with Differences > +10%	20%	9%
Percentage of Counties with Differences > -10%	22%	6%
Percentage of Counties with Differences > +20%	12%	10%
Percentage of Counties with Differences > -20%	8%	8%

Figure 1. Centroids of 3,243 Agricultural Land Sales in North Dakota (2000-2004)

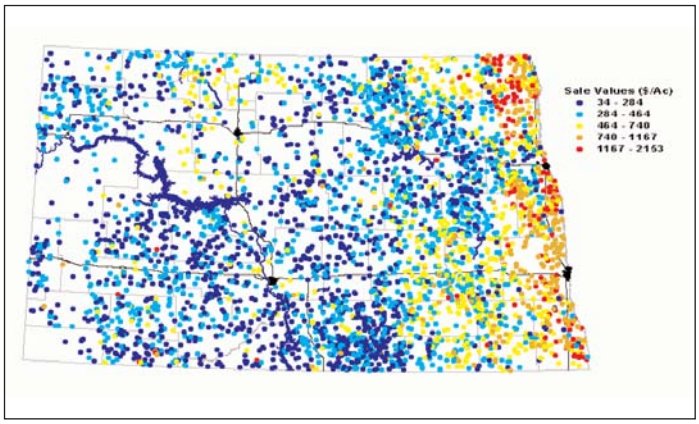

Figure 2. North Dakota Counties with Large Differences Between JAS Estimates and Market Sales (2001-2004)

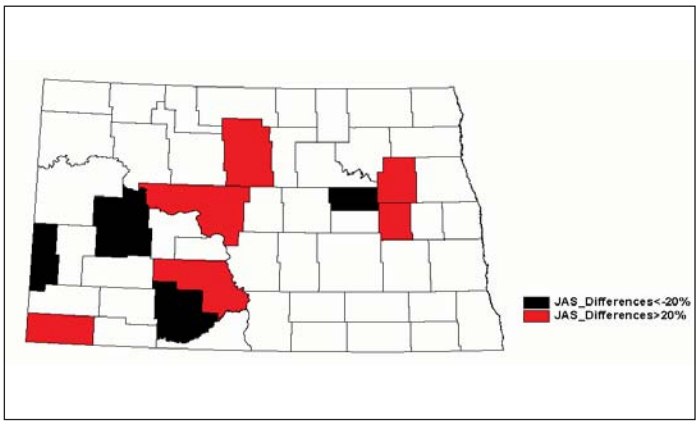

Figure 3. North Dakota Counties with Large Differences between NDLVS Estimates and Market Sales (2001-2004)

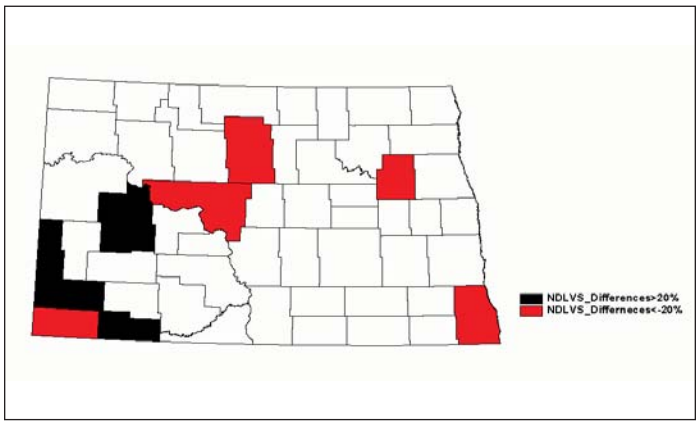

Figure 4. Kriged Market Sales, 2002 (n=776)

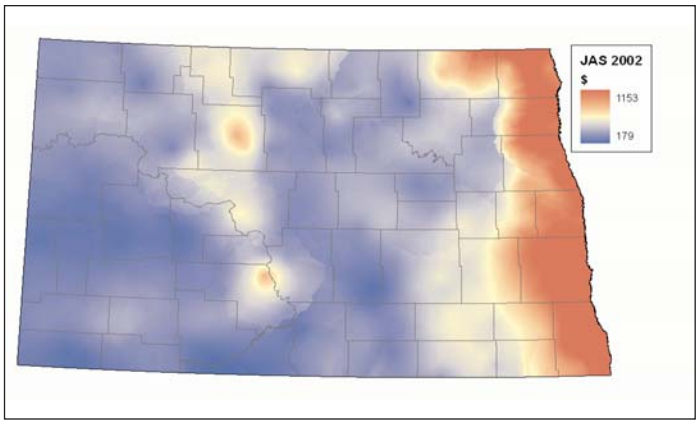

Figure 5. Kriged JAS Sales 2002 (n=376)

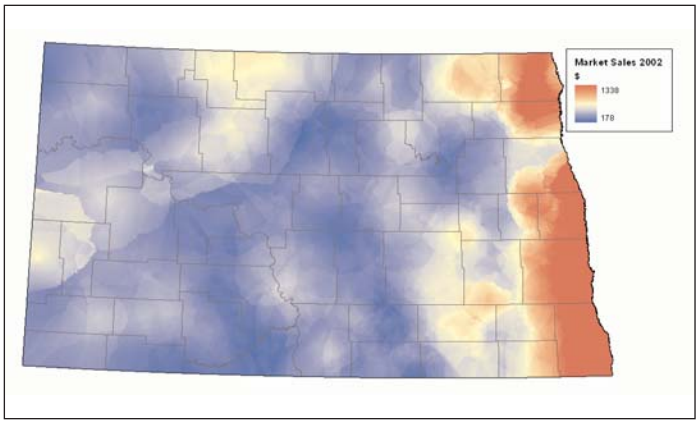
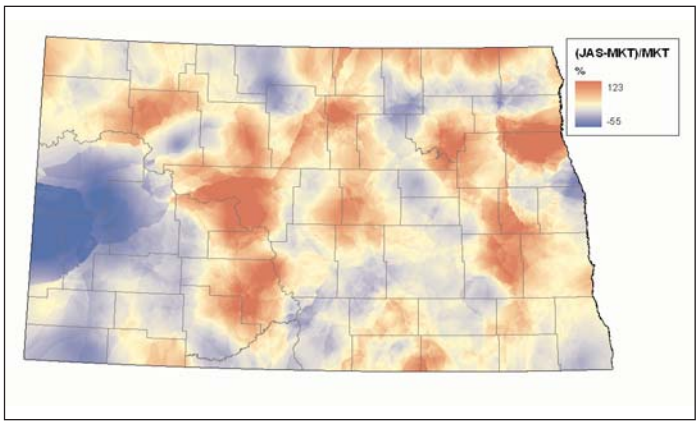
Figure 6. Differences Between Kriged 2002 JAS and Market Sale Values