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The purpose of this project was to examine graduation and dropout rates for high school students to determine if a correlation could be found with respect to the relative school distance from a military installation in the Pikes Peak region. Spatial analysis and Ordinary Least Squares analysis were used to build a linear regression model to predict student graduation and dropout rates. The results for the total student population for graduation rates and for dropout rates showed no statistically significant correlation with respect to the relative proximity to a military installation. Detailed analysis revealed that several minority and gender subgroups showed statistically significant correlations.

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University of Denver Department of Geography

Capstone Project

for

Master of Science in Geographic Information Science

June 2, 2011

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I. INTRODUCTION

Background

"Graduation rates are a fundamental indicator of whether or not the nation's public school system is doing what it is intended and funded to do: engage, enroll, and educate youth to be productive members of society" (Yeboah et al. 2010). High school graduation rates for Colorado are well below the national average (Donnel-Kay Foundation et al. 2010). Research shows that "…kids who don't graduate from high school struggle throughout their lives to keep up" (Dianda 2008). Students who don't graduate have limited employment options and earn an average of $10,000 less per year than workers who have graduated high school (Bali & Alvarez 2004).

From a monetary perspective the long-term costs of students not graduating is more than Colorado resources can support. Budgets at the federal, state, county, and school district levels are all dwindling. Finding ways to keep children in school through graduation could be a financial imperative. "They [dropouts] are twice as likely as high school graduates to slip into poverty from one year to the next (Bridgeland et al. 2006)."

Recent studies have reported that Colorado has the fourth highest high school dropout rate in the nation (Alliance for Excellent Education 2010). Colorado Department of Education defines a dropout as, "a person who leaves school for any reason, except death, before completion of a high school diploma or its equivalent, and who does not transfer to another public

or private school or enroll in an approved home study program (2010)." According to a report by the Colorado Graduate Initiative (CGI) *Answering the Call: A Report on Colorado's High School Dropouts and Best Practices for Improving Educational Outcomes* "Colorado would save more than $92,000,000 (per year) in reduced crime spending if the male graduation rate increased by 5% (Donnel-Kay Foundation et al. 2010)." A single dropout student costs Colorado in excess of $200,000 in public support over a lifetime, according to the President of the Colorado Children's Campaign (Colorado Children's Campaign 2011). Costs include things such as health care, rehabilitation, legal and remediation services, lost earnings and lost revenue from taxes (Colorado Children's Campaign 2011).

In Colorado, graduation rate and dropout rate do not add up to 100% (Donnel-Kay Foundation 2010). They are calculated using different cohorts and graduation rates do not include students who complete the GED (Donnel-Kay Foundation 2010). Logically, however, these two rates are inversely correlated.

Regional education boundaries are designated by the Colorado Department of Education (CDE). Graduation and dropout rates vary from region to region within the state. According to CDE the Pikes Peak region has one of the highest graduation rates and one of the lowest dropout rates in the state (2011). A unique characteristic of the Pikes Peak region is that it contains the only county in the nation (El Paso) that is home to five military

installations (Schroyer 2011). Given its relatively small footprint on the map, this is a high concentration of military industry, economy, and way of life. Is it possible that close proximity of high schools to these military installations is correlated with high school graduation rates? Similarly, are dropout rates correlated with close proximity of high schools to military installations? Spatial and statistical analyses are used to address these questions in the study. For the purpose of this research, "military installations" are defined as permanent, active-duty military reservations, e.g. Air Force bases and Army posts, located in the study area.

Importance of Research

In late 2010 the U.S. Department of Education's High School Graduation Initiative Program awarded a five year $15 million grant to improve graduation rates in 32 Colorado schools (CDE 2010). A portion of the funds are allocated to research into strategies that work for keeping students in school until successful graduation (CDE 2010). An investigation of possible factors that relate to higher graduation rates and lower dropout rates in the Pikes Peak area could contribute to the development of successful strategies. If factors can be identified and relationships are found between military installations and positive high school graduation rates and/or negative dropout rates, then educators and legislators may be able to nurture these factors in other regions to increase graduation rates and decrease dropout rates.

Once correlations are substantiated by research and statistical analysis, further investigation can be conducted to reveal insightful relationships which may then be used to develop meaningful actions and educational policies to help keep students in school through successful graduation. There are many steps involved in the process of determining correlations, showing cause and effect relationships, and then devising feasible actions to use those relationships for keeping our children in school. This study starts by analyzing the strength of correlations between high school graduation and dropout rates with the geographic proximity of high schools to military installations in the target area.

Thesis Statements

Variable 1. Graduation Rates

A strong inverse relationship exists between high school graduation rates and proximity of high schools to military installations located in the Pikes Peak Region of Colorado-- As distance from a military installation increases, graduation rates decrease.

Variable 2. Dropout Rates

A strong positive relationship exists between high school dropout rates and proximity of high schools to military installations located in the Pikes Peak Region of Colorado— As distance from a military installation increases, dropout rates increase.

**Note: An increase in graduation rates is desirable while an increase in dropout rates is not desirable.*

Literature Review

Spatial Studies

The use of GIS in educational research, planning, and policy is a relatively new phenomenon but its popularity is growing as researchers and educators discover the benefits of its ability to give statistical information a visual meaning (Cobb 2003). The educational community is using GIS to plan bus routes, determine new school locations, identify school of choice patterns, analyze student achievement, evaluate school equity, and examine school neighborhood demographics (Cobb 2003, Gulson & Symes 2007).

An article published in the Annals of the Association of American Geographers in 2001 examined spatial inequities related to school placement in three West Virginia counties (Talen). The study concluded that 3rd grade test scores were inversely related to lengthy school commutes (Talen 2001).

Lisa Piscoppo, Kidscount Director for the Colorado Children's Campaign, conducted her doctoral thesis at the University of Denver in 2005 on the relationship between Colorado test scores and various neighborhood demographic and school related variables (2005). Some specific variables she examined were educational attainment, race, income, teacher experience (measured in years), percent free lunch, and teacher salary (2005). She digitized school attendance boundaries, aggregated Census

neighborhood data, applied multivariate analysis to examine correlations at the regional, district, and school levels, and used GIS to display the results (2005). The percentage of students receiving free lunch was the most highly correlated variable at the school level scale (Piscoppo 2005). As the percentage of students receiving free lunch in a school increased, the test scores decreased. In this particular study it is important to note that correlation does not equal causality. Eliminating free lunch would not necessarily increase test scores.

A similar study conducted in St Louis, Missouri, also discovered a strong negative correlation between MAP (Missouri Assessment Program) science scores and the percent of students within a district receiving free lunch (Hogrebe et al. 2008). The percentage of teachers with master's degrees had a strong positive correlation with MAP science scores in the area (Hogrebe et al. 2008). GIS was used to display the correlations. Another study conducted by the same research group in St. Louis compared access to resources, graduation rates, and dropout rates among the de-accredited St. Louis City school district and other districts located nearby (2007). The research discovered significant differences between graduation and dropout rates for the St. Louis City school district and the neighboring districts.

In 2004 the Colorado Children's campaign published geographic research results depicting graduation rates and student demographics in Colorado school districts. The research concluded that graduation rates for

male students were lower than females, graduation rates were lower for minority students than non-minority students, and graduation rates for impoverished students are lower than their affluent classmates (CCC 2005).

GIS has proven to be a helpful method for visually demonstrating and analyzing educational statistical trends across geographic areas which is why it is used to represent the findings of this research.

Statistical Analyses

Multivariate analysis has been applied extensively to educational data in order to delineate possible relationships between student achievement, graduation rates, and dropout rates and various demographic and school related factors.

In a study published in the 32nd edition of the *Policy Studies Journal* in 2004, Valentina A. Bali and R.M. Alvarez use multivariate analysis to develop a model for predicting black, Hispanic, and white student achievement for grades 1-4 in the Pasadena Unified School district in California. Their research supported the theory of "racial gaps" in student achievement. "Racial gaps" are significant differences in test scores at different times in educational attainment between black, Hispanic, and white students (Bali & Alvarez 2004). The research concluded that family related factors have a strong effect on the test scores of black students while neighborhood factors tend to have a strong effect on white and Hispanic students' test scores (Bali & Alvarez 2004).

The U.S. Dept. of Education has conducted statistical studies concerned with predicting dropout and graduation rates by gender, race, and socio-economic level nationwide through the year 2016 (Hussar & Bailey 2007).

Martha Abele Mac Iver, Robert Balfanz, and Vaughn Byrnes conducted an extensive bivariate analysis of indicators related to graduation and dropout rates in five school districts in Colorado (2009). They found that course failure, attendance, and behavioral issues were the strongest indicators.

A study performed by Robert Balfanz and Nettie Ledgers in 2004 led to the development of a measure called "promoting power" intended to quantify the ability of a school to graduate its students. Promoting power "compares the number of freshman at a high school to the number of seniors four years later (or the number of tenth graders to seniors three years later in schools with a 10-12 grade span)" (Balfanz & Ledgers 2004). They used this measure to determine schools across the nation that had low promoting power and thus low graduation rates and high dropout rates (Balfanz & Ledgers 2004).

A study conducted on a national scale examined total graduation rates for all students, and then divided the rates into subgroups of race and gender (Greene and Winters 2006). The research concluded that females are more likely to graduate high school than males (Greene and Winter

2006). Greene and Winters stated that a key finding of the study was that, "The gender gap in graduation rates is particularly large for minority students."

Goals of the Study

This study is intended to examine two key educational metrics, high school graduation rate and dropout rate, in the spatial context of distance to military installation gates (access/entry points). Previous studies have looked at other educational factors, such as the relationship of test scores with respect to the free lunch program (Piscopo, 2005). Piscopo also examined racial and gender factors on pre-graduation high school test scores. The primary goal of the current study is to perform an in-depth geospatial analysis of the Pikes Peak region graduation and dropout rates as they relate to the geographic closeness of high schools to local military installations. Secondary goals of this research are to analyze racial and gender subgroups within the Pikes Peak region high school populations for the same geospatial correlations.

II. STUDY DESIGN

Study Area

The subject area selected for this research is the Pikes Peak region of Colorado. It is in central Colorado, approximately 70 miles south of Denver. It is located in an area just east of the Front Range Mountains which generally divide the state into an eastern half and a western half. The majority of the state's population resides along the Front Range.

The most populated county in the Pikes Peak region is El Paso (at 500,000 people). Like neighbors to its north and south, El Paso County has similar geographic characteristics. A major difference, however, is that five of the state's six permanent military installations are located in El Paso County. It is for this reason that the Pikes Peak region, which includes El Paso County, is chosen as the area of interest in this study. Located within the region are 41 public non-charter and non-alternative high schools.

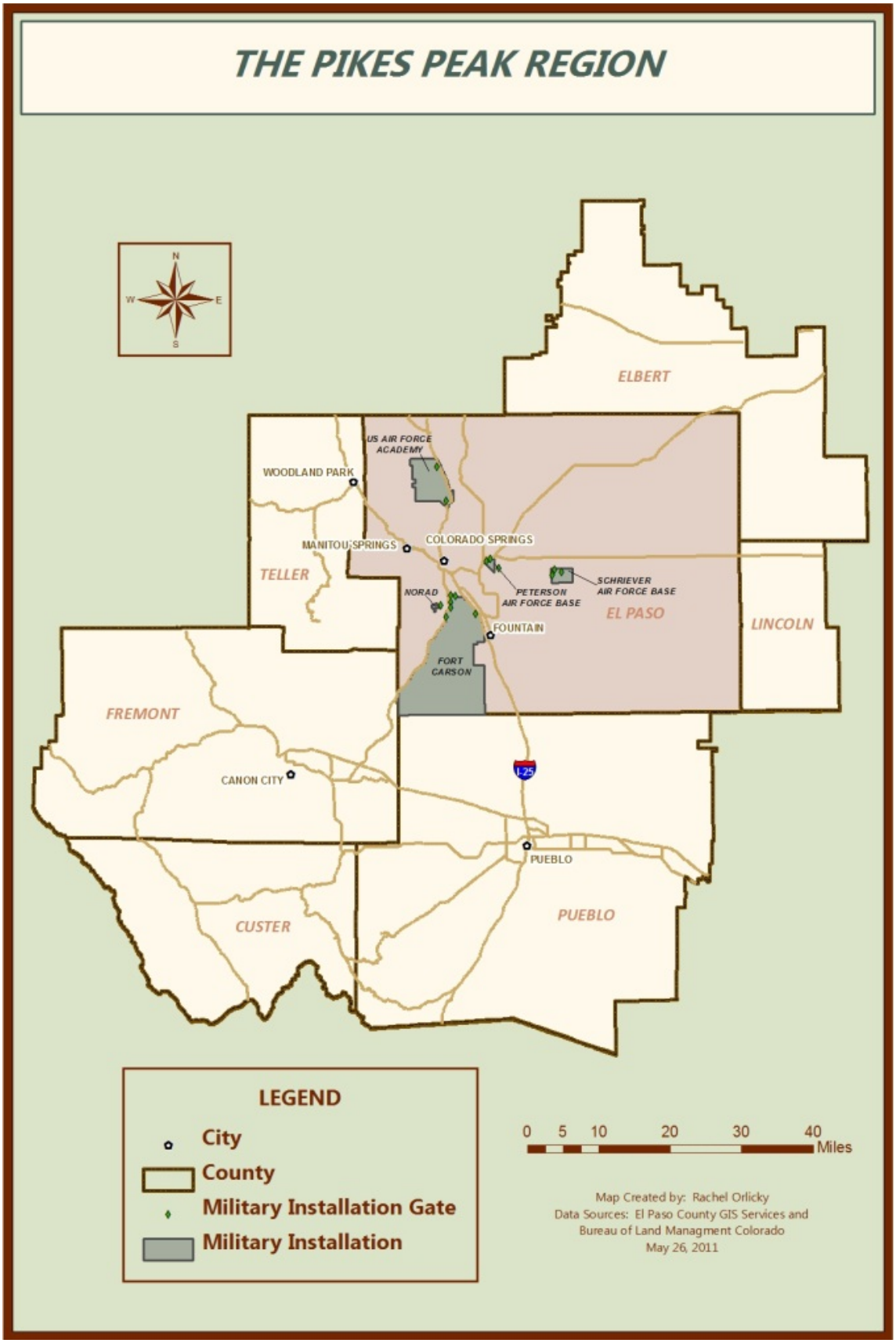

Figure 1. Map of the Study Area: The Pikes Peak Region

Data

A base map was constructed with shapefiles of Pikes Peak region characteristics, including county boundaries, highways, military installation boundaries, high schools, and cities. All layers were projected in UTM Zone13N, GCS NAD83.

The Colorado counties shapefile was clipped to include only counties located within the Pikes Peak region as defined by CDE (2011). These counties are El Paso, Teller, Elbert, Lincoln, Pueblo, Custer, and Fremont (CDE 2011). The county boundaries were then dissolved to produce a single polygon shapefile of the Pikes Peak region for use in additional data manipulation.

The military installations shapefile was created by selecting Department of Defense owned land from a statewide layer of land ownership. The selection was then clipped to the boundary of the Pikes Peak region polygon.

Military gates are the entry points for military installations so the locations for each gate were gathered with a Garmin Global Positioning System model 60 unit with accuracy of +/- 10 feet. This Garmin model was chosen due to its availability and cost-effectiveness. The accuracy required for this study was +/- 1 mile. Military installation coordinates were verified using Google Earth software. The recorded coordinates were imported into ArcMap and exported to a point shapefile.

A Pikes Peak public high schools shapefile was derived from a Colorado public school shapefile obtained from Geocommons. The "Select by attributes" function was used to select the high schools (high_grade field value equal to "12"). Alternative high schools and charter high schools were removed from the data because examination of data trends revealed that alternative and charter school student population numbers were significantly smaller than traditional public school populations. Removing these schools removed significant data outliers that would have skewed the results. The high schools shapefile was then clipped to the Pikes Peak region boundary yielding a total of 41 high schools in the target area. Excel spreadsheets of high school graduation and dropout rates were imported and joined to the high schools shapefile.

Examination of the graduation and dropout data by school revealed that some high schools did not have certain minorities of students. The graduation and dropout rates for these high schools were misleading: Examples are as follows:

Example 1.

Calhan High School did not have any Native American students who were eligible to graduate- thus the graduation rates calculated for Native American students, Female Native American students, and Male Native American students were 0.

Example 2.

Simla High School did not have any Black students- thus the dropout rates calculated for Black students, Female Black students, and Male Black students were 0.

To mitigate the problem, definition data queries were set throughout the data analysis process to eliminate high schools with minority populations equal to 0.

Table 1. Data Dictionary

Data Name	Data Type	Year	Data Source
Colorado Counties	Polygon shapefile	2010	El Paso County GIS Services http://www.elpasoco.com/gis/free_data_catalog.asp
Colorado Cities	Point Shapefile	2010	El Paso County GIS Services http://www.elpasoco.com/gis/free_data_catalog.asp
Pikes Peak Region (Derived from Colorado Counties)	Polygon Shapefile	2010	El Paso County GIS Services http://www.elpasoco.com/gis/free_data_catalog.asp
Military Installations (Derived from Land Ownership)	Polygon shapefile	2010	Bureau of Land Management Colorado http://www.blm.gov/co/st/en/BLM_Programs/geographical_sciences/gis/metadata.html
High Schools (Derived from Public Schools)	Point Shapefile	2010	GeoCommons http://www.cde.state.co.us/utility/k12schls.htm
Highways	Polyline Shapefile	2010	El Paso County GIS Services http://www.elpasoco.com/gis/free_data_catalog.asp
Military Installation Gates	GPS coordinates--Point Shapefile	2011	GPS point collection with Garmin GPS 60 unit; Accuracy within 10 feet
Graduation Rates by Total, Gender, and Race (School Level)	Excel Spreadsheet	2010	Colorado Department of Education http://www.cde.state.co.us/utility/k12schls.htm
Dropout Rates by Total, Gender, and Race (School Level)	Excel Spreadsheet	2010	Colorado Department of Education http://www.cde.state.co.us/utility/k12schls.htm

Methods

Multivariate analysis has been applied extensively to educational data in order to delineate possible relationships between graduation rates, dropout rates, and school related factors. For this study, Ordinary Least Squares (OLS) analysis was used with regression modeling. The spatial statistics extension of ArcGIS software contains an OLS tool. According to Esri the OLS tool, "Performs global Ordinary Least Squares (OLS) linear regression to generate predictions or to model a dependent variable in terms of its relationships to a set of explanatory variables" (Esri). The OLS tool generates a summary and diagnostics report of calculated statistics including an r-value and an r-squared value. In regression modeling the strength of a relationship is determined by the r-value (Burt et al 2009). An r-value below +/-0.4 is considered a weak or non-existent correlation, a value between +/-0.40 and +/-0.60 is considered a moderate correlation, a value between +/-0.60 and +/-0.80 is considered a strong correlation, and a value above +/-0.80 is considered at nearly perfect correlation (Fox, 2003). The r-value, otherwise known as the Pearson correlation coefficient, is calculated using the standard scores on each variable (Burt et al 2009). William Fox states, "A standard score—often called a Z-score—describes how many standard deviations from the mean [average value of the distribution] a score is located" (2003). Thus, the standard score is used to calculate the r-value using the following equation:

$$r = \frac{\sum Z_X Z_Y}{N}$$

where Z_X = standard score on the independent variable X.

Z_Y = standard score on the dependent variable Y.

N = the number of cases (sample size)

When the r-value is squared the value represents the percent of the distribution variance explained by the explanatory variable (Fox 2003). The OLS analysis was performed twice using graduation rates and then dropout rates as the dependent variable. The explanatory variable for each test was distance. A distance value for each school was derived from buffer zones created around the military installation gates. Schools that fell into each buffer zone were assigned the distance value associated with that buffer zone. Figure 2. is a map of the buffer zones.

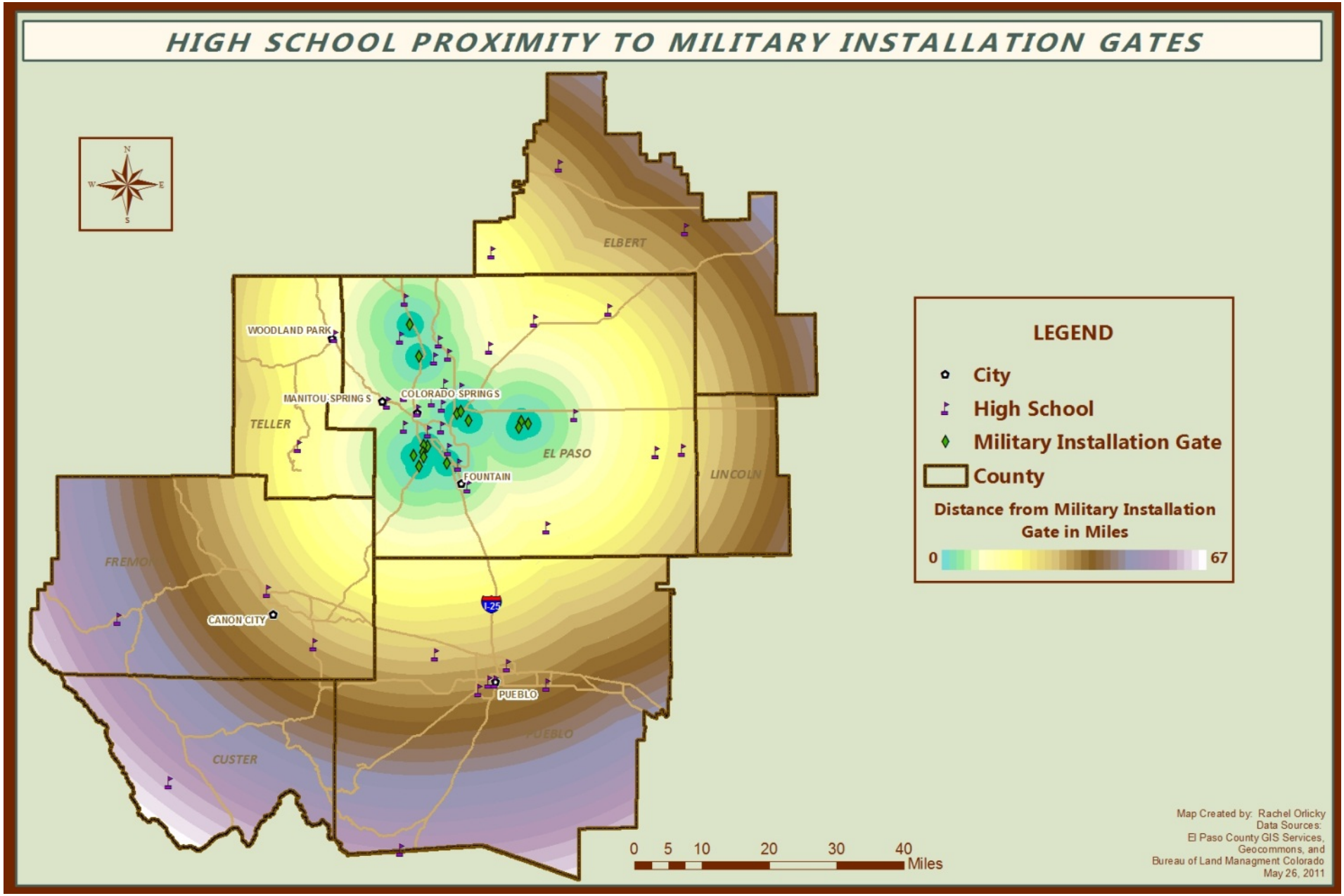

Figure 2. Map of Proximity Analysis Using Buffer Zones

I. STUDY IMPLEMENTATION

Results

The analysis produced point shapefiles of standard residual values and a report of OLS results for the dependent variables of graduation rates and dropout rates. The standard residuals represent the difference in the estimated graduation rate values derived from the regression model and the observed graduation rate values (Fox 2003). **A regression model of good fit produces a majority of standard residual values near 0 (-1 < and > 1).**

Variable 1. Graduation Rates

The results of the OLS regression analysis for graduation rates performed on all subgroups are represented in Table 2. The analysis yielded an *r* value of -0.0735 for all students. Since this value is near zero the relationship between the variable of graduation rates for all students and distance from military gates is very weak and insignificant. However, moderate and moderately strong correlations were discovered within four graduation rate subgroups. The subgroups with significant *r* values were as follows:

- Asian students (an *r* value of 0.4040)
- Asian male students (an *r* value of 0.5571)
- Native American students (an *r* value of -0.4792)

- Native American male students (an *r* value of -0.5598).

Table 2. Regression Analysis Results: Graduation Rates

Student Group	Graduation Rates		
	r	r^2	Strength of Correlation
All Students	-0.0735	0.0054	Weak
All Males	-0.0616	0.0038	Weak
All Females	-0.0424	0.0018	Weak
Asian Students	0.4040	**0.1632**	**Moderate**
Asian Males	0.5571	**0.3104**	**Moderate-Strong**
Asian Females	0.0800	0.0064	Weak
Black Students	0.1053	0.0111	Weak
Black Males	0.0995	0.0099	Weak
Black Females	0.0022	0.0000	Weak
Hispanic Students	-0.0458	0.0021	Weak
Hispanic Males	-0.1530	0.0234	Weak
Hispanic Females	0.0995	0.0099	Weak
Native American Students	-0.4792	**0.2296**	**Moderate**
Native American Males	-0.5598	**0.3134**	**Moderate-Strong**
Native American Females	-0.2142	0.0459	Weak
White Students	-0.0539	0.0029	Weak
White Males	-0.0316	0.0010	Weak
White Females	-0.0470	0.0022	Weak
Values in **RED** denote significant correlations.			

Results of All Students Graduation Rates

Figure 3. is a scatterplot of the data distribution and regression line (model of best fit) for all student graduation rates and distance from a military gate. The slope of the regression line was -0.0405. The y value (graduation rate) decreased by -0.0405 for every unit of x (distance). The

data points were scattered randomly and did not cluster near the regression line meaning that the model did not fit the distribution.

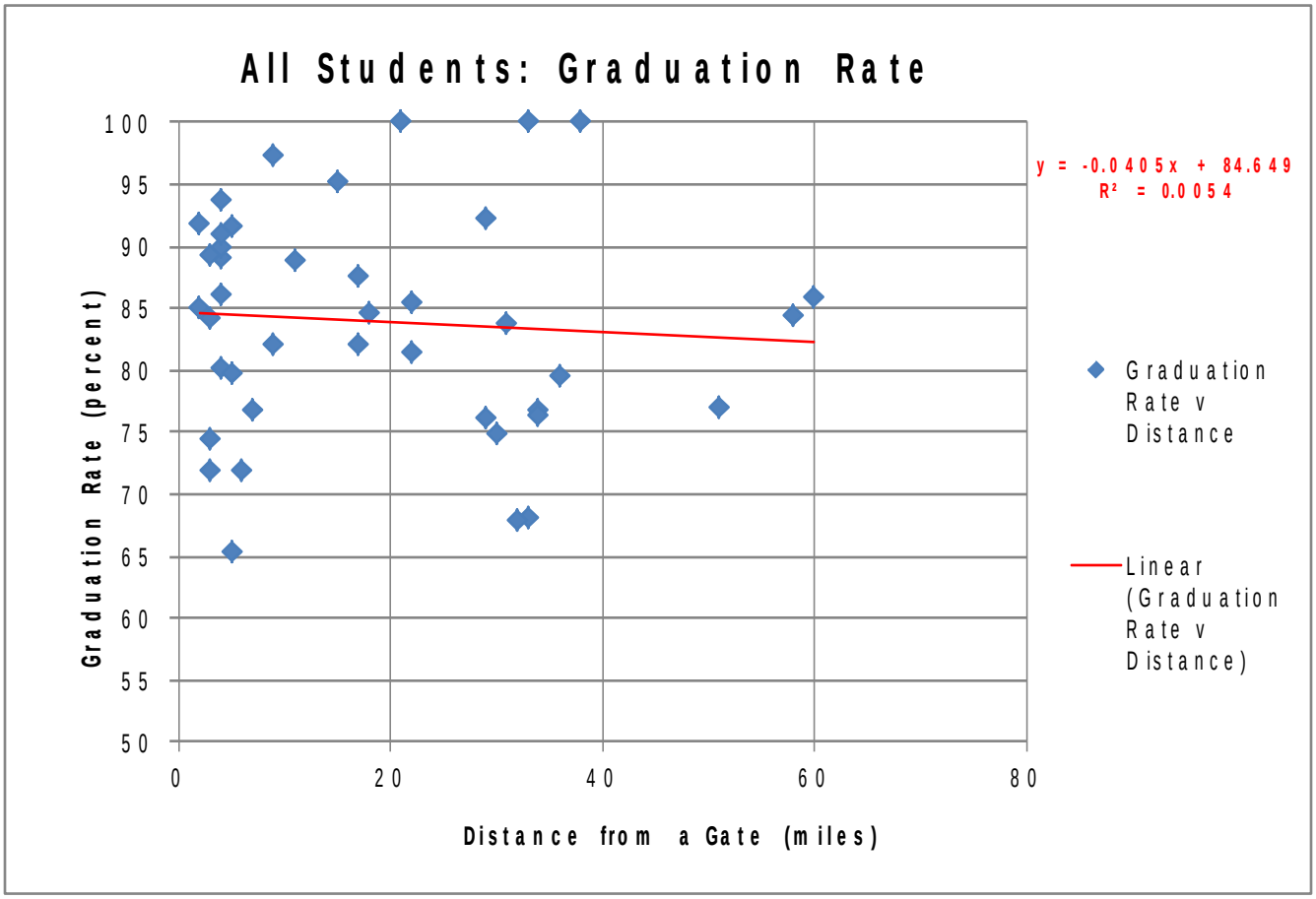

Figure 3. Regression Model of All Students Graduation Rates

Figure 4. is an illustration of the graduation rate standard residual values for Pikes Peak regional high schools. Two schools in Elbert County, two schools in Pueblo County, and eight schools in El Paso County had a residual value greater than positive one or less than negative one. The largest standard residual value for graduation rates was -2.12. The map illustrates that less than half of the standard residuals for this model (12 of 41 standard residuals) were greater than 1.00 and less than -1.00. The

model equation produced by the OLS analysis did not accurately predict graduation rates for all high school students based on distances from military installation gates even though the variables were weakly correlated.

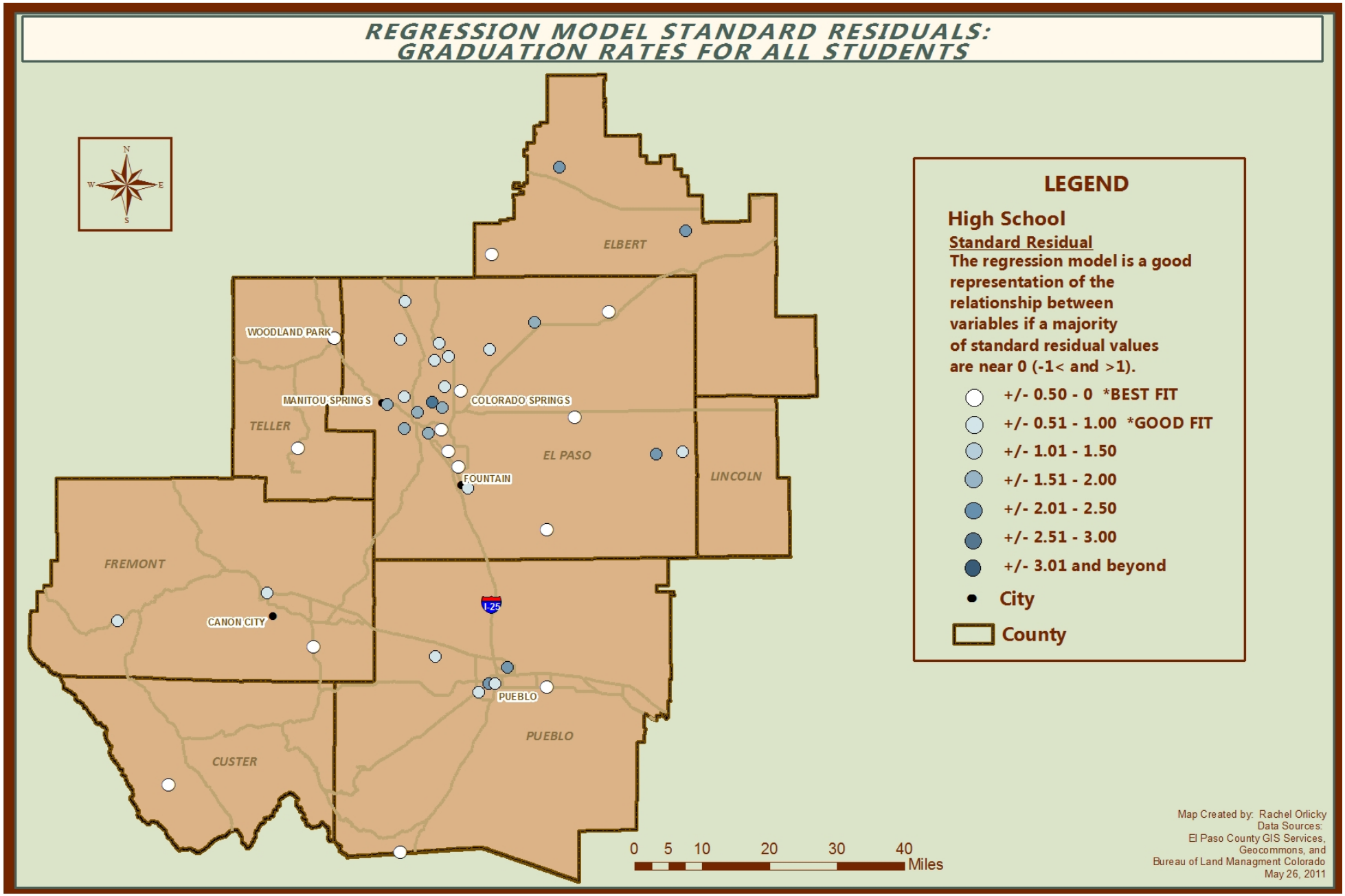

Figure 4. Regression Model Standard Residuals: Graduation Rates for All Students

Figure 5. is a map of the average high school graduation rates for all students in the Pikes Peak region relative to the locations of the area's five military installation gates. Different colors are used to pictorially describe the numerical values. The strength of correlation is weak and not statistically significant, although the correlation is in the expected negative direction. Graduation rates generally decrease as distance from a military installation gate increases.

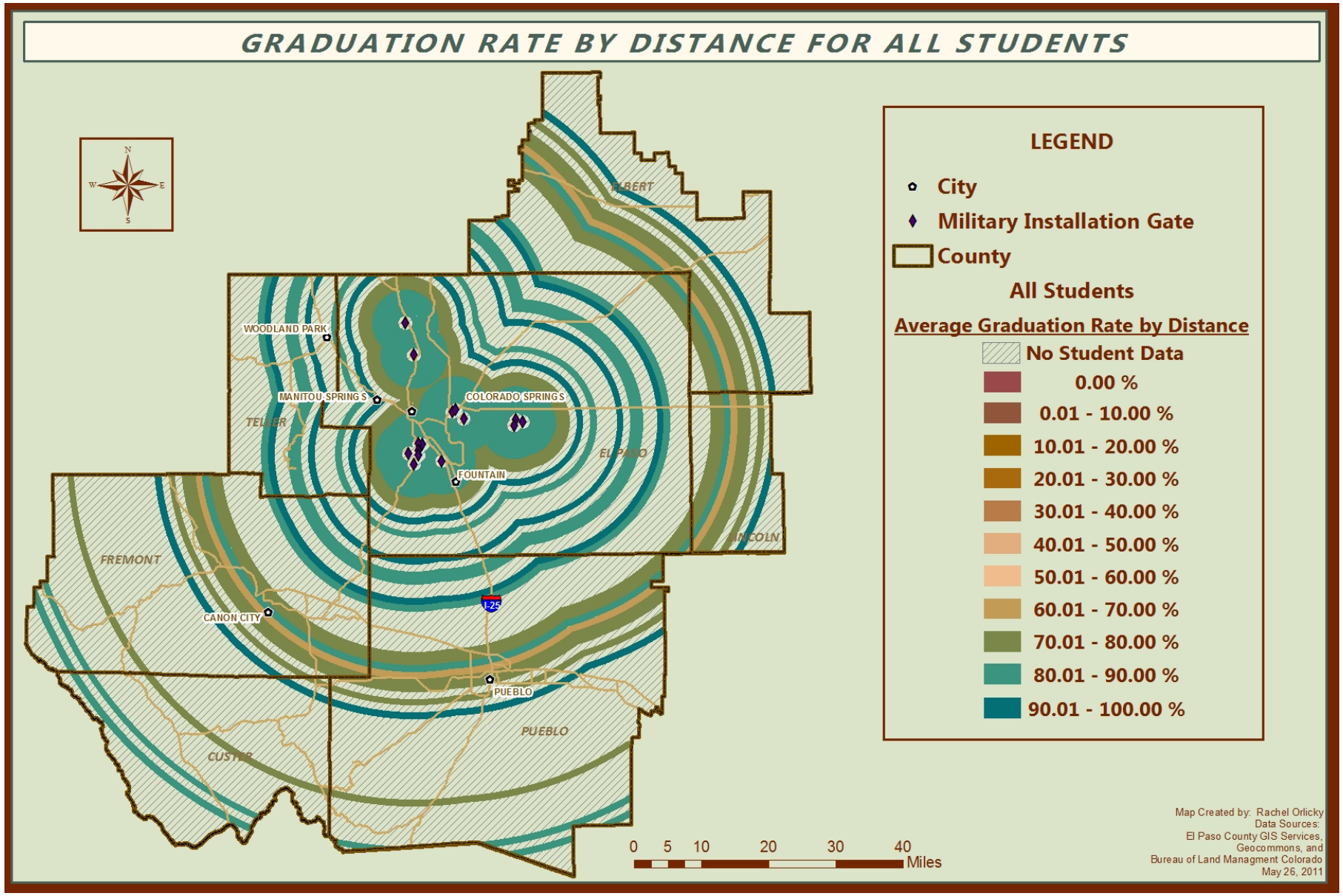

Figure 5. Average Graduation Rate by Distance for Asian Students

Results of Asian Students Graduation Rates

Figure 6. is a scatterplot of the data distribution and regression line (model of best fit) for Asian student graduation rates and distance from a military gate. The slope of the regression line was 0.5379. The y value (graduation rate) increased by 0.5379 for every unit of x (distance). The data points were distributed in a similar manner to the regression line meaning that the model was a good fit for the relationship between the two variables. The correlation of the variables is diametrically opposite of what was expected. Graduation rates for Asian students increased as distance from a military installation gate increased. The scatterplot also reveals data

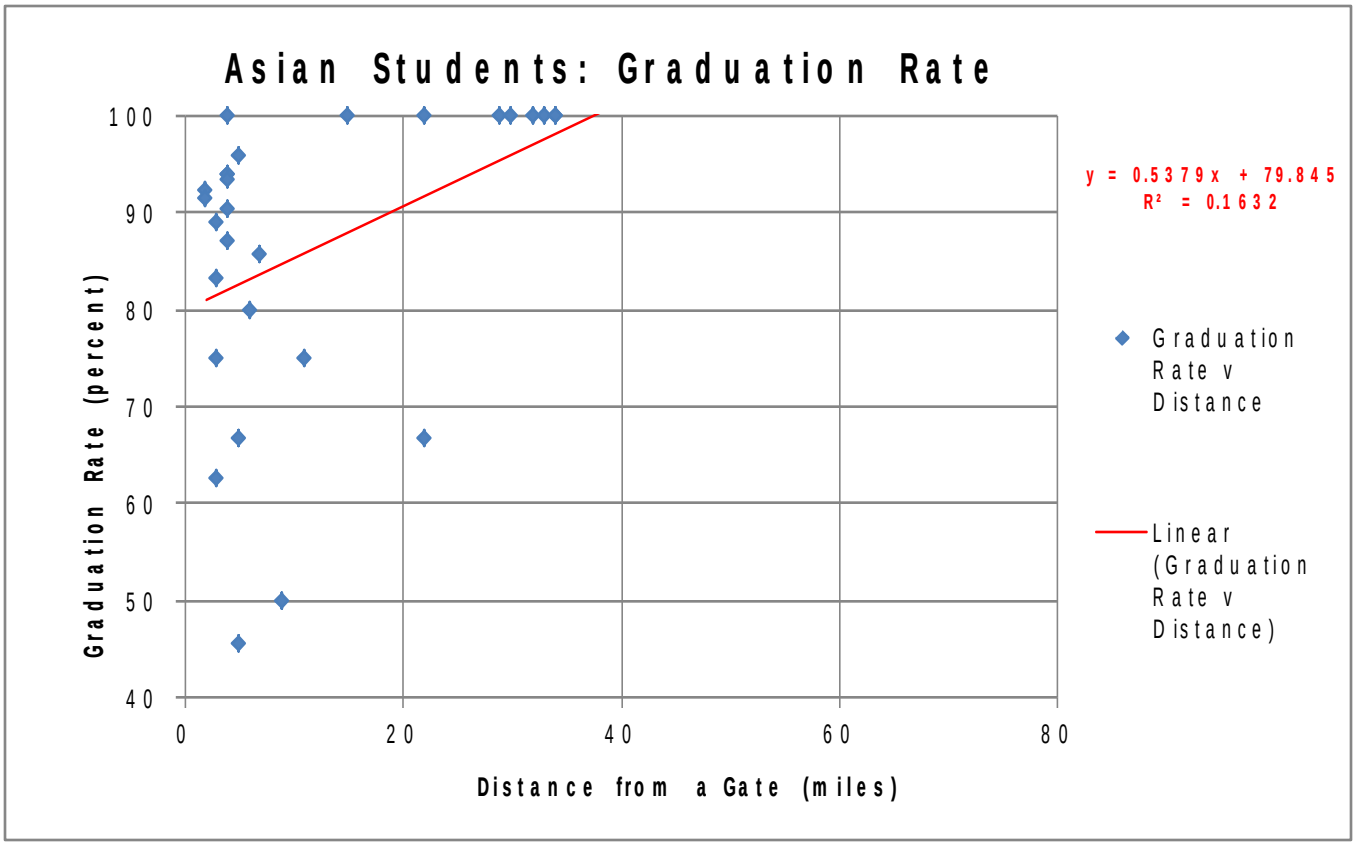

Figure 6. Regression Model of Asian Students Graduation Rates

outliers below the regression line.

Figure 7. is an illustration of the Asian student graduation rate standard residual values for Pikes Peak regional high schools. Five schools in El Paso County and one school in Teller County had a residual value beyond +/-1.00. The largest standard residual value for graduation rates was -2.57. The map illustrates that 22 of 28 standard residuals were within a range of +1.00 and -1.00. The model equation produced by the OLS analysis accurately predicted graduation rates for Asian high school students based on distances from military installation gates.

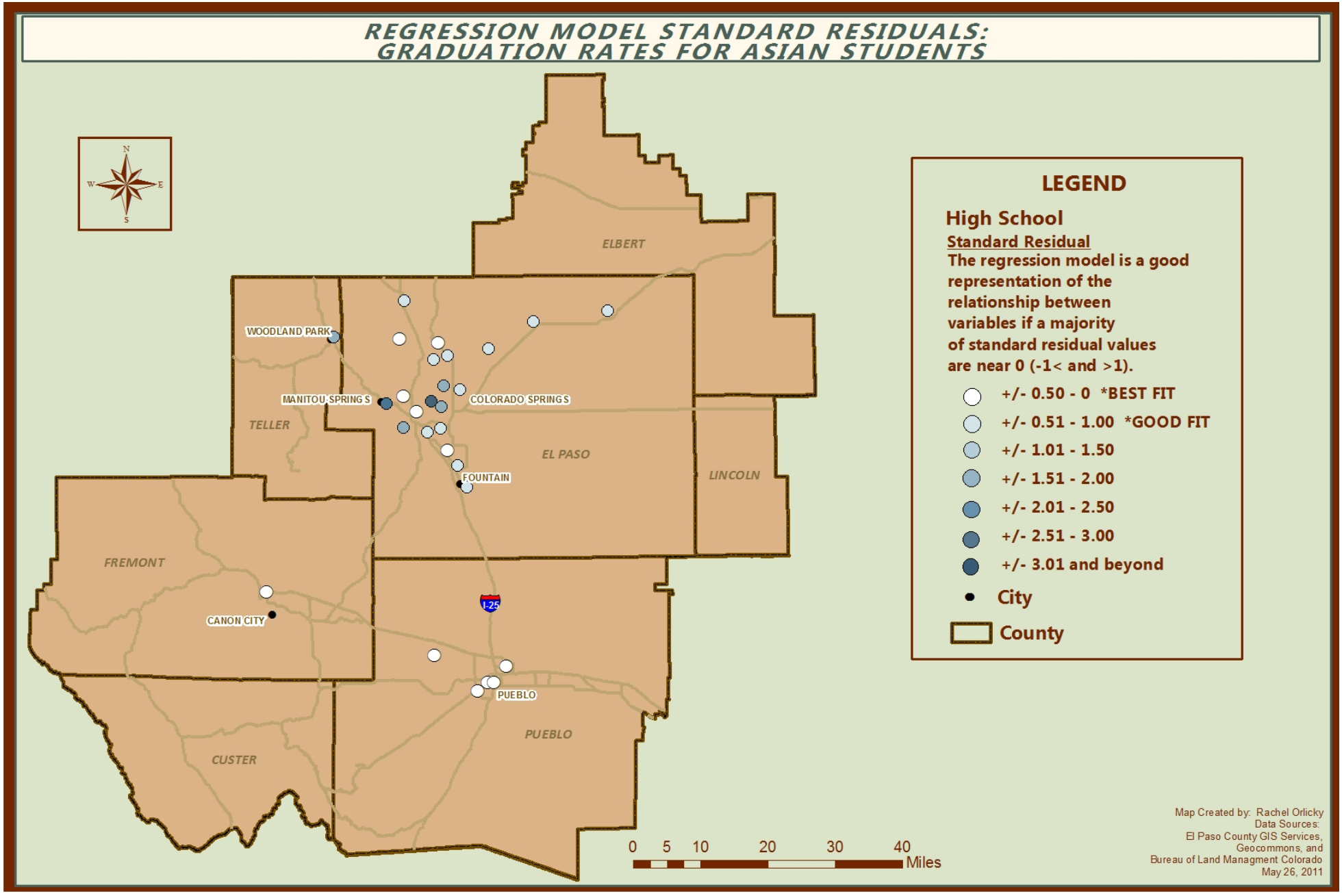

Figure 7. Regression Model Standard Residuals: Graduation Rates for Asian Students

Figure 8. is a map of the high school graduation rates for Asian students. Different colors are used to pictorially describe the numerical values. In general, graduation rates seem to be relatively similar across different distances from military installations. Asian students show high rates of graduation at most distances from military bases. There are a few exceptions, but small sample size may contribute to this. The original hypothesis that graduation rates are higher the nearer high schools are to military installations is not substantiated by the results of Asian graduates.

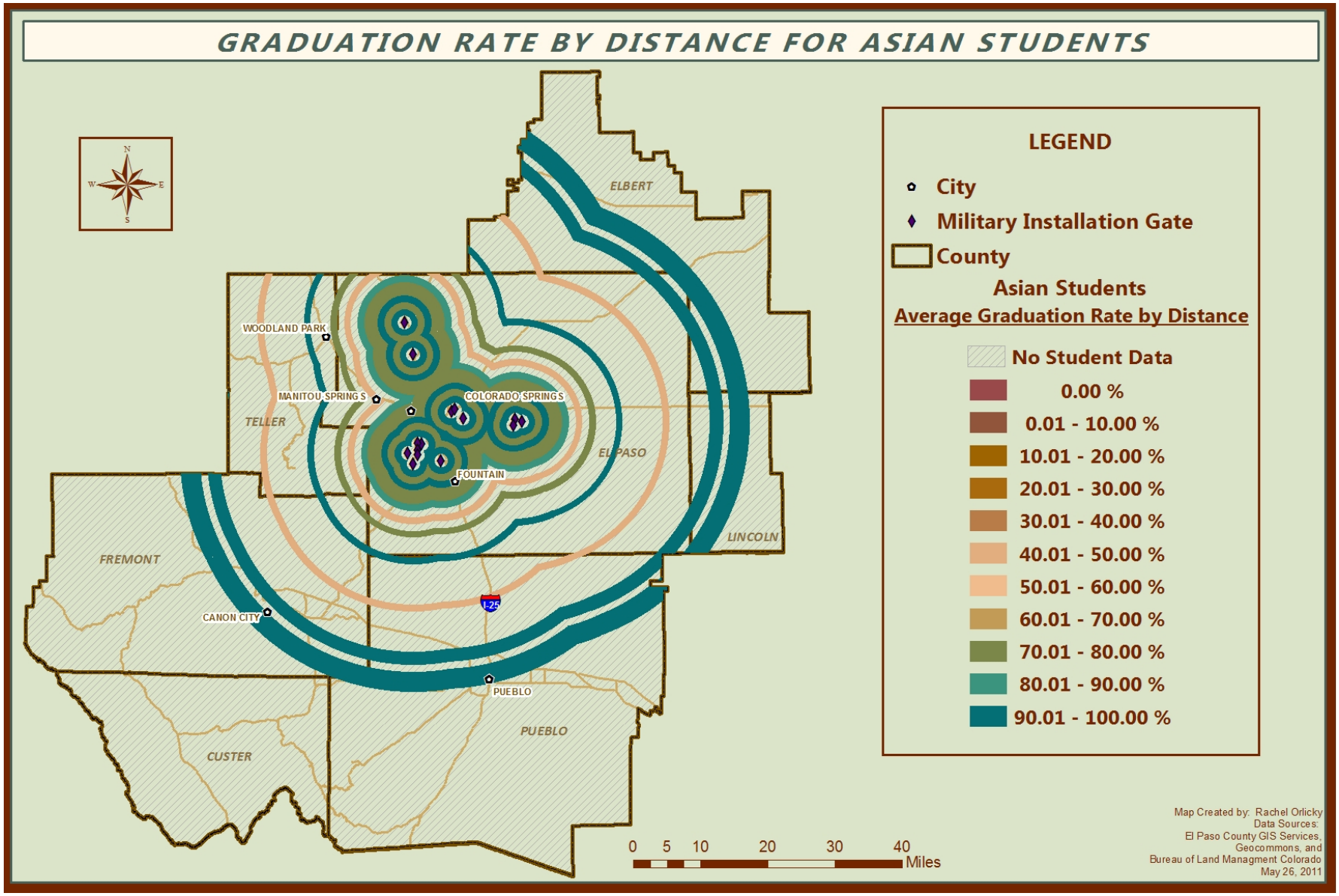

Figure 8. Average Graduation Rate by Distance for Asian Students

Results of Asian Male Students Graduation Rates

Figure 9. is a scatterplot of the data distribution and regression line (model of best fit) for Asian male student graduation rates and distance from a military gate. The slope of the regression line was 0.6648. The y value (graduation rate) increased by 0.6648 for every unit of x (distance). The data points were distributed in a similar manner to the regression line meaning that the model was a good fit for the relationship between the two variables. The correlation of the variables is diametrically opposite of what was expected. Graduation rates for Asian students increased as distance from a military installation gate increased.

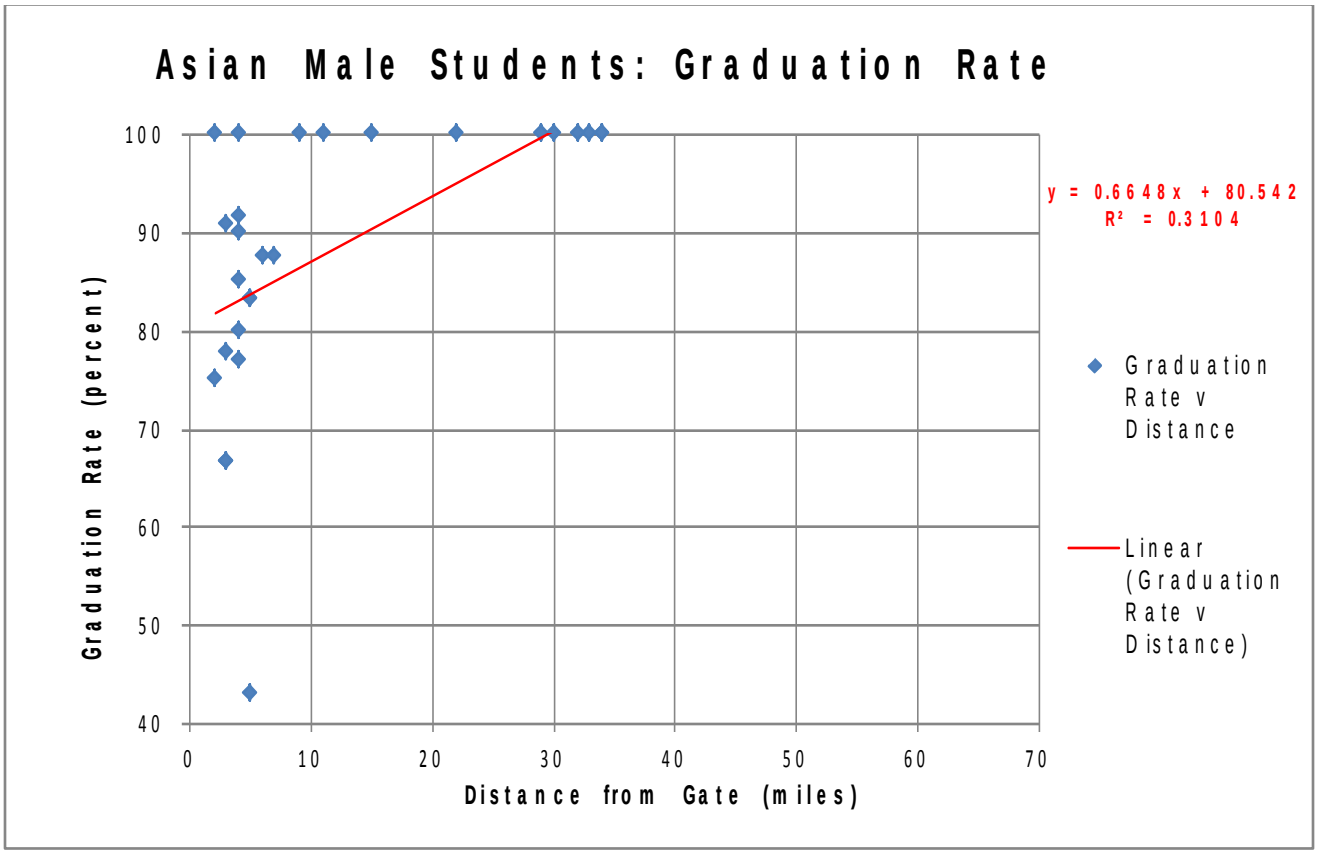

Figure 9. Regression Model of Asian Male Students Graduation Rates

Figure 10. is an illustration of the Asian male student graduation rate standard residual values for Pikes Peak regional high schools. Six schools in El Paso County had a residual value beyond +/-1.00. The largest standard residual value for graduation rates was -3.41. The map illustrates that 22 of 27 standard residuals were within a range of +1.00 and -1.00. The model equation produced by the OLS analysis accurately predicted graduation rates for Asian male high school students based on distances from military installation gates.

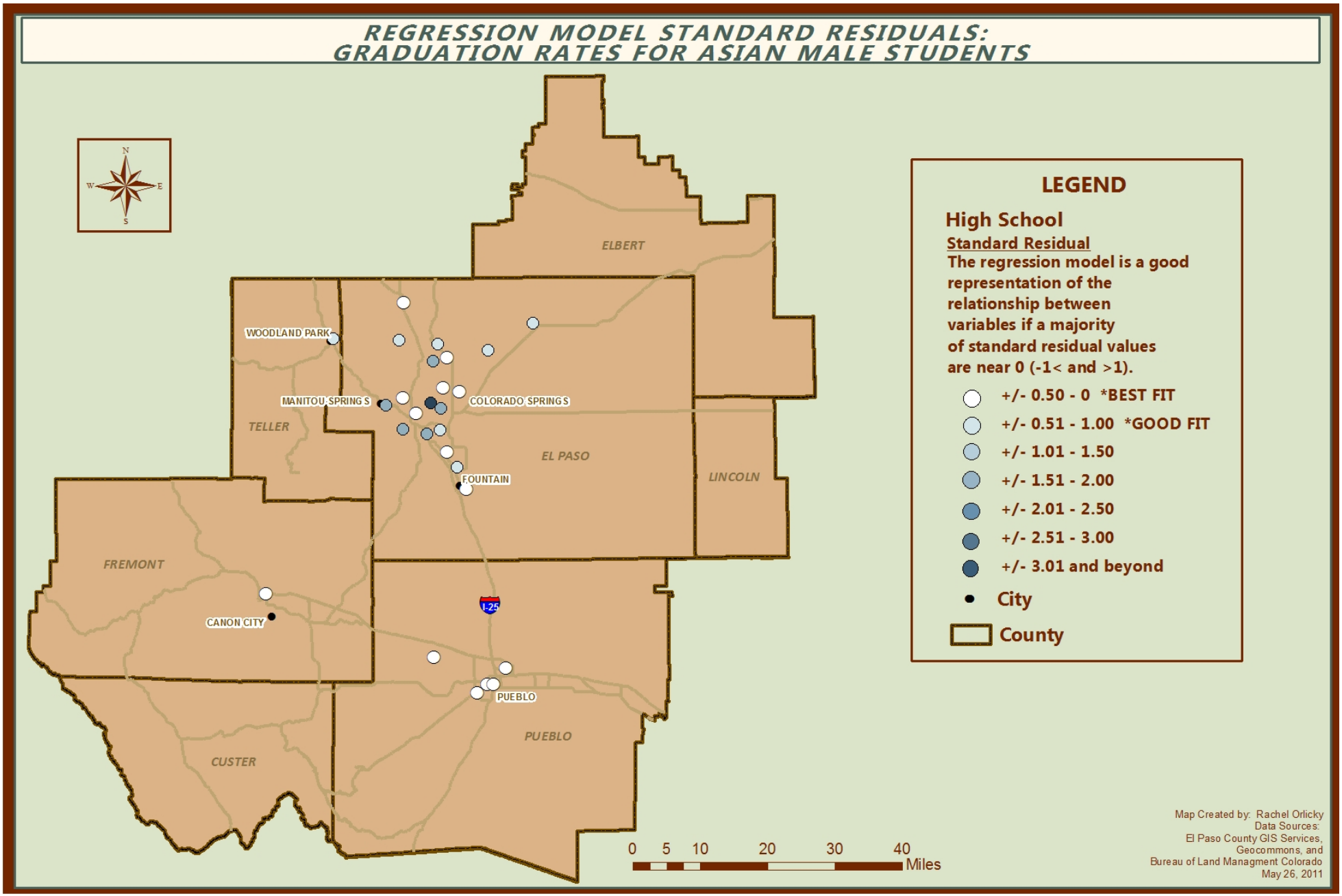

Figure 10. Regression Model Standard Residuals: Graduation Rates for Asian Male Students

Figure 11. is a map of the high school graduation rates for Asian male students. Different colors are used to pictorially describe the numerical values. Graduation rates for this group are similar to that for all Asian graduates, but with a stronger correlation observed. The direction of the correlation is opposite of the expected negative correlation. In general, the results show lower graduation rates at high schools geographically closer to military installations. This is contrary to the original hypothesis for graduation rates.

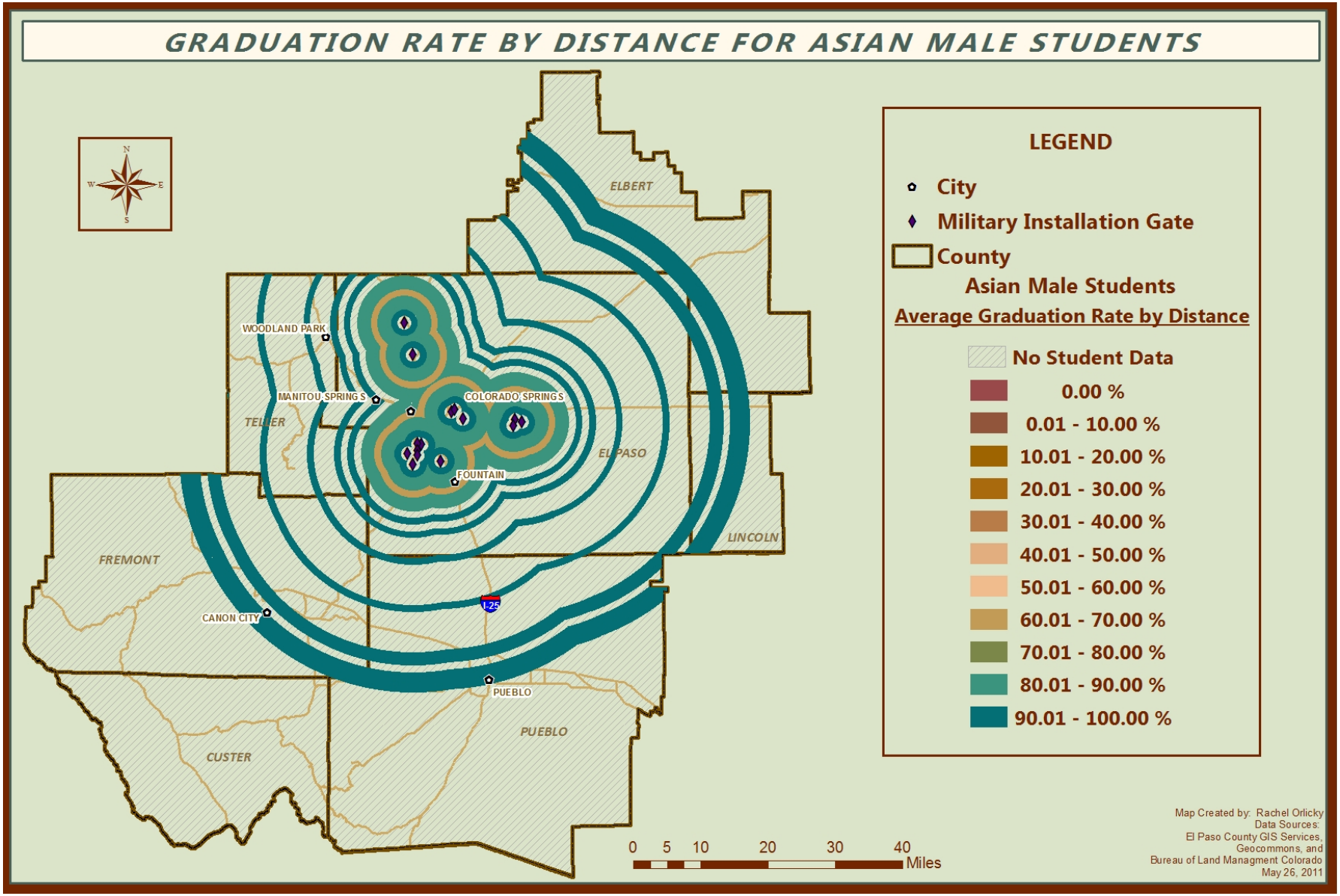

Figure 11. Average Graduation Rate by Distance for Asian Male Students

Results of Native American Students Graduation Rates

Figure 12. is a scatterplot of the data distribution and regression line (model of best fit) for Native American student graduation rates and distance from a military gate. The slope of the regression line was -1.0382. The y value (graduation rate) decreased by -1.0382 for every unit of x (distance). The data points were distributed in a similar manner to the regression line meaning that the model was a good fit for the relationship between the two variables. The results suggested significant data outliers above and below the regression line.

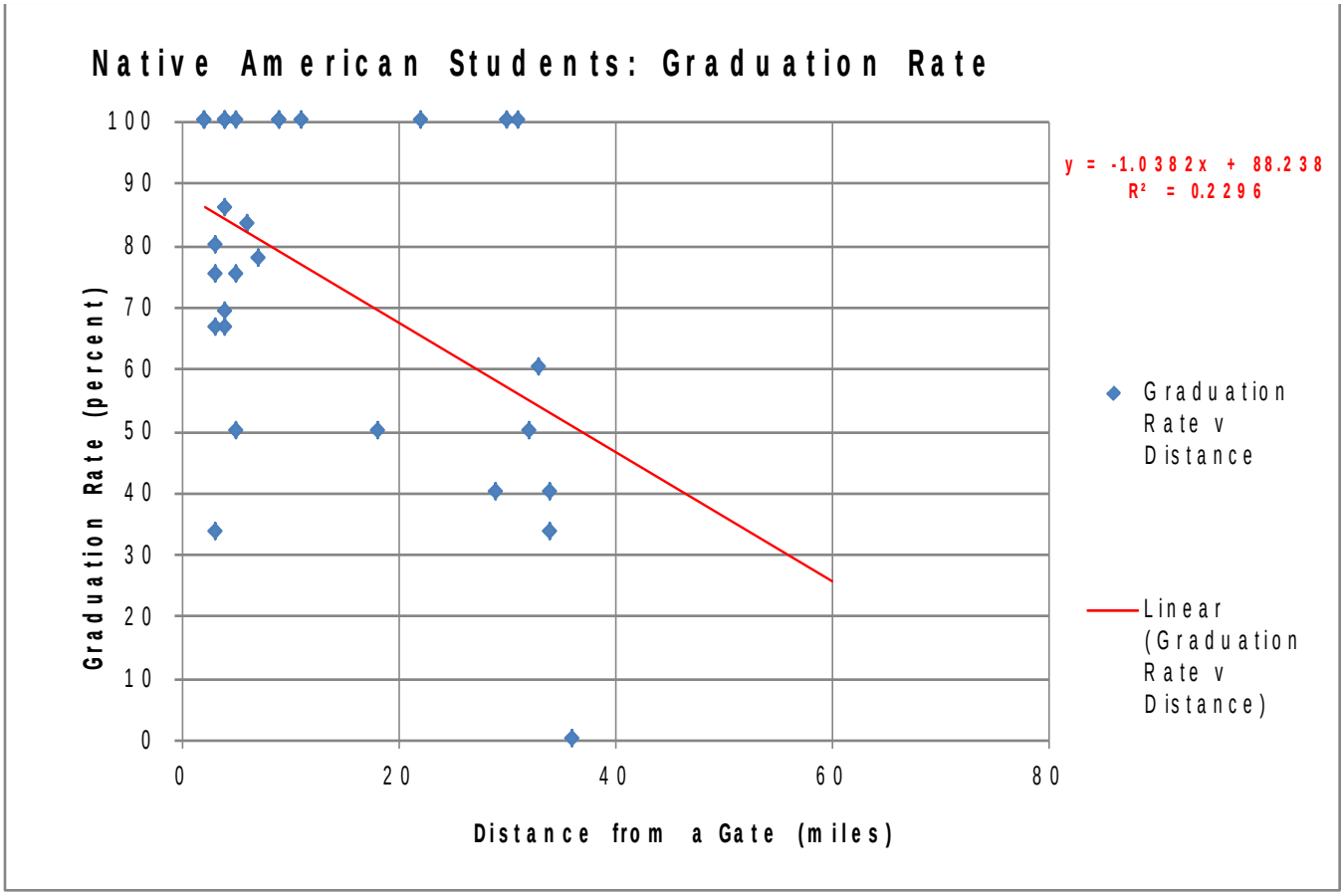

Figure 12. Regression Model of Native American Students Graduation Rates

Figure 13. is an illustration of the Native American student graduation rate standard residual values for Pikes Peak regional high schools. Two schools in El Paso County, two schools in Fremont County, one school in Pueblo County, and one school in Teller County had a residual value beyond +/-1.00. The largest standard residual value for graduation rates was -2.21. The map illustrates that 24 of 30 standard residuals were within a range of +1.00 and -1.00. The model equation produced by the OLS analysis accurately predicted graduation rates for Native American high school students based on distances from military installation gates.

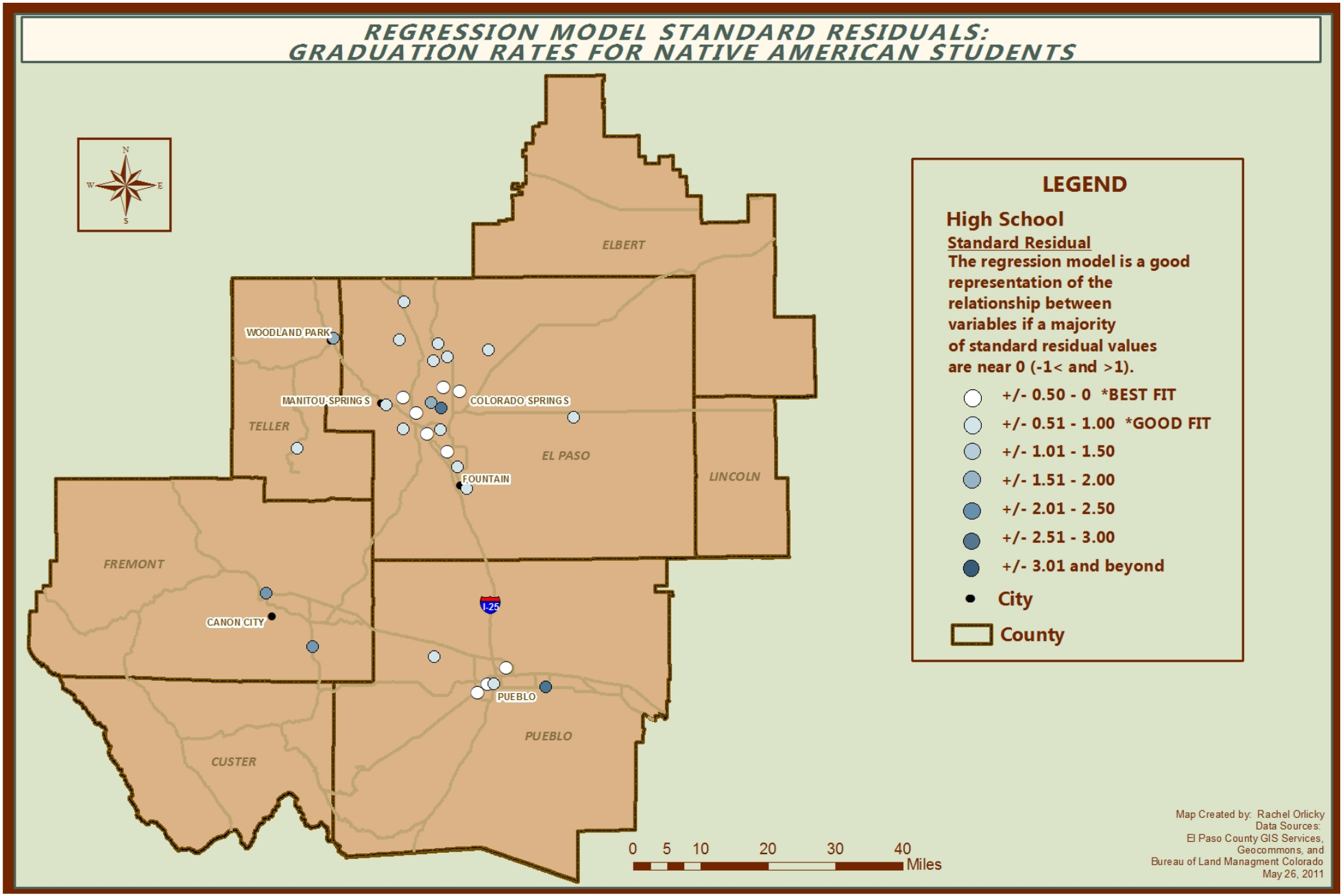

Figure 13. Regression Model Standard Residuals: Graduation Rates for Native American Students

Figure 14. depicts the average graduation rates against distance for Native American students. Different colors are used to pictorially describe the numerical values. The strength of the statistical correlation was moderate and in the expected negative direction. This means that Native American students had higher graduation rates the closer their high schools were to military installation gates. The geospatial and statistical results for this subgroup may not be valid as the sample sizes are small.

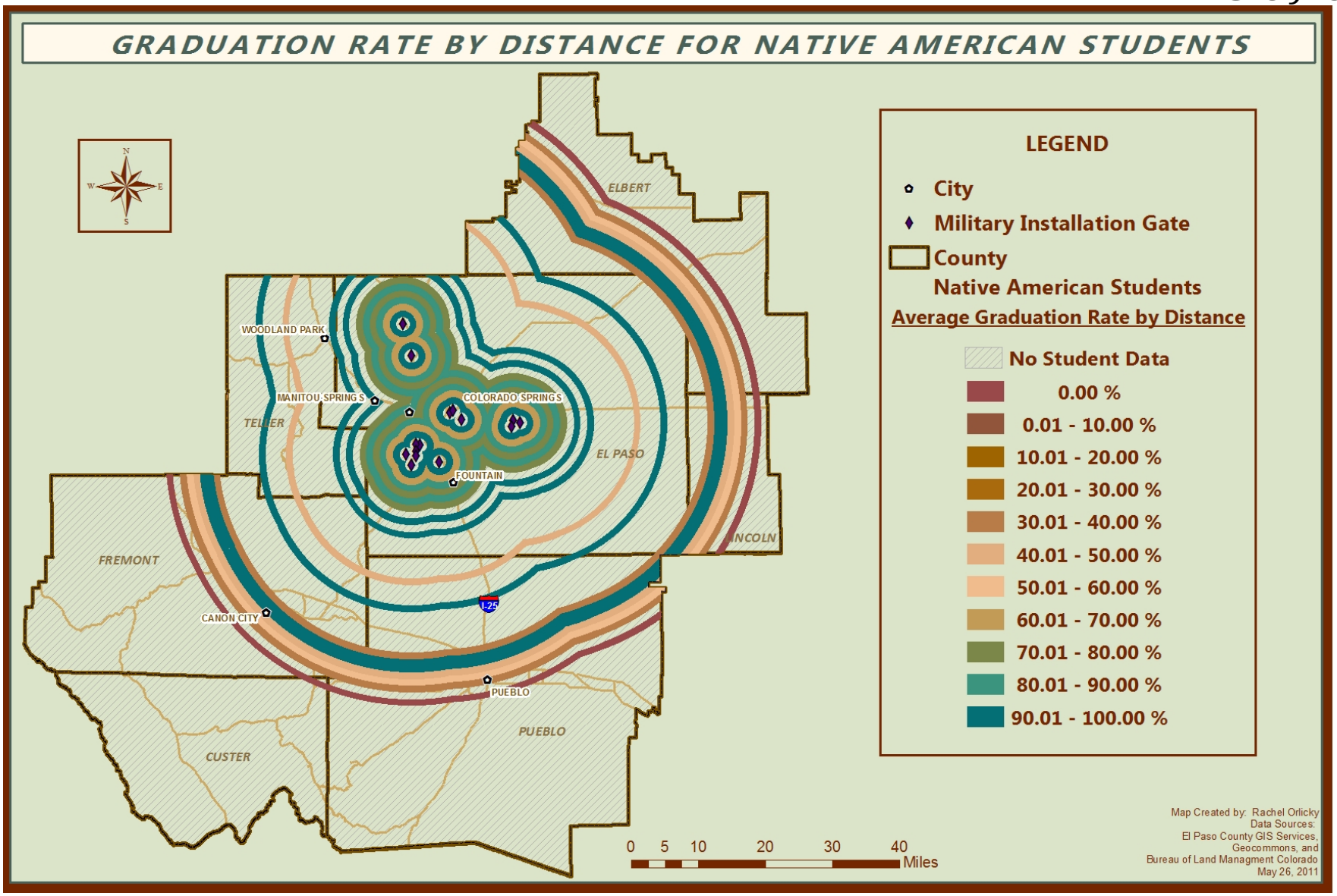

Figure 14. Average Graduation Rate by Distance for Native American Students

Results of Native American Male Students Graduation Rates

Figure 15. is a scatterplot of the data distribution and regression line (model of best fit) for Native American male student graduation rates and distance from a military gate. The slope of the regression line was -1.5671. The y value (graduation rate) decreased by -1.5671 for every unit of x (distance). The data points were distributed in a similar manner to the regression line meaning that the model was a good fit for the relationship between the two variables. The results suggested significant data outliers above and below the regression line.

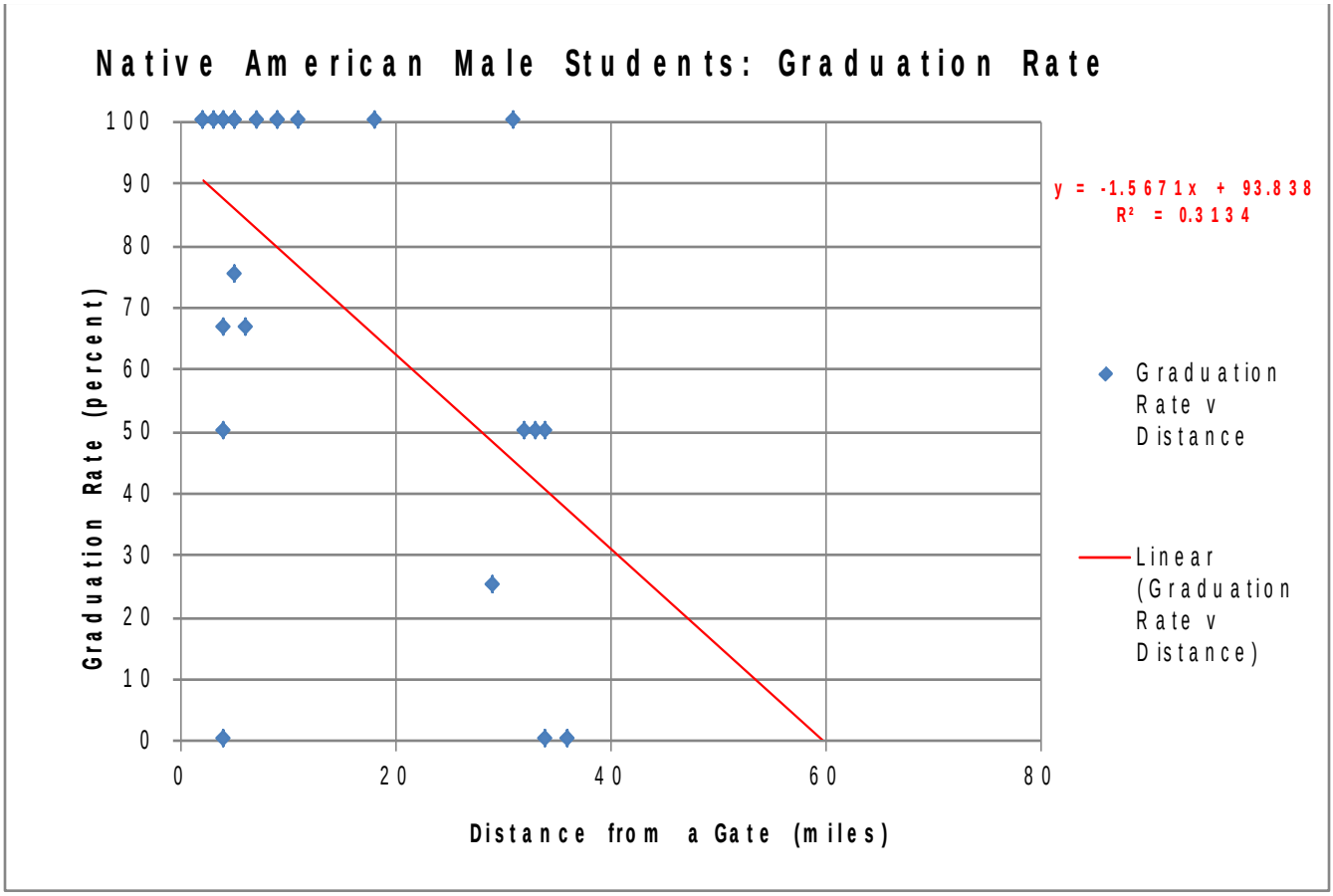

Figure 15. Regression Model of Native American Students Graduation Rates

Figure 16. is an illustration of the Native American male student graduation rate standard residual values for Pikes Peak regional high schools. Two schools in El Paso County, two schools in Fremont County, one school in Pueblo County, and one school in Teller County had a residual value beyond +/-1.00. The largest standard residual value for graduation rates was -2.85. The map illustrates that 18 of 24 standard residuals were within a range of +1.00 and -1.00. The model equation produced by the OLS analysis accurately predicted graduation rates for Native American male high school students based on distances from military installation gates.

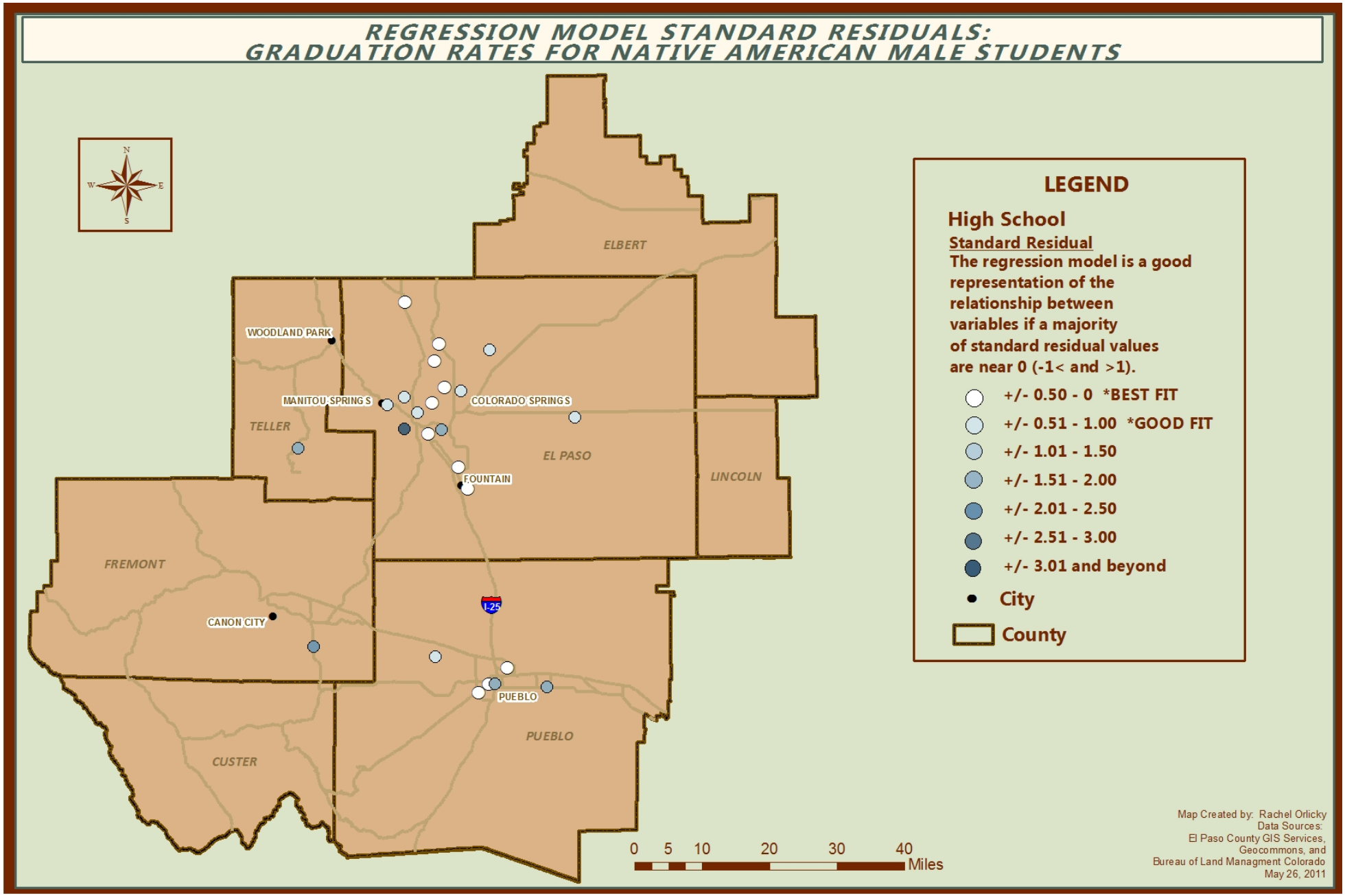

Figure 16. Regression Model Standard Residuals: Graduation Rates for Native American Students

Figure 17. depicts the average graduation rates against distance for Native American male students. Different colors are used to pictorially describe the numerical values. The strength of the statistical correlation was moderate to strong and in the expected negative direction. This means that Native American male students had higher graduation rates the closer their high schools were to military installation gates. The validity of geospatial and statistical results for this subgroup are perhaps suspect, as the sample sizes are the smallest of the subgroups analyzed.

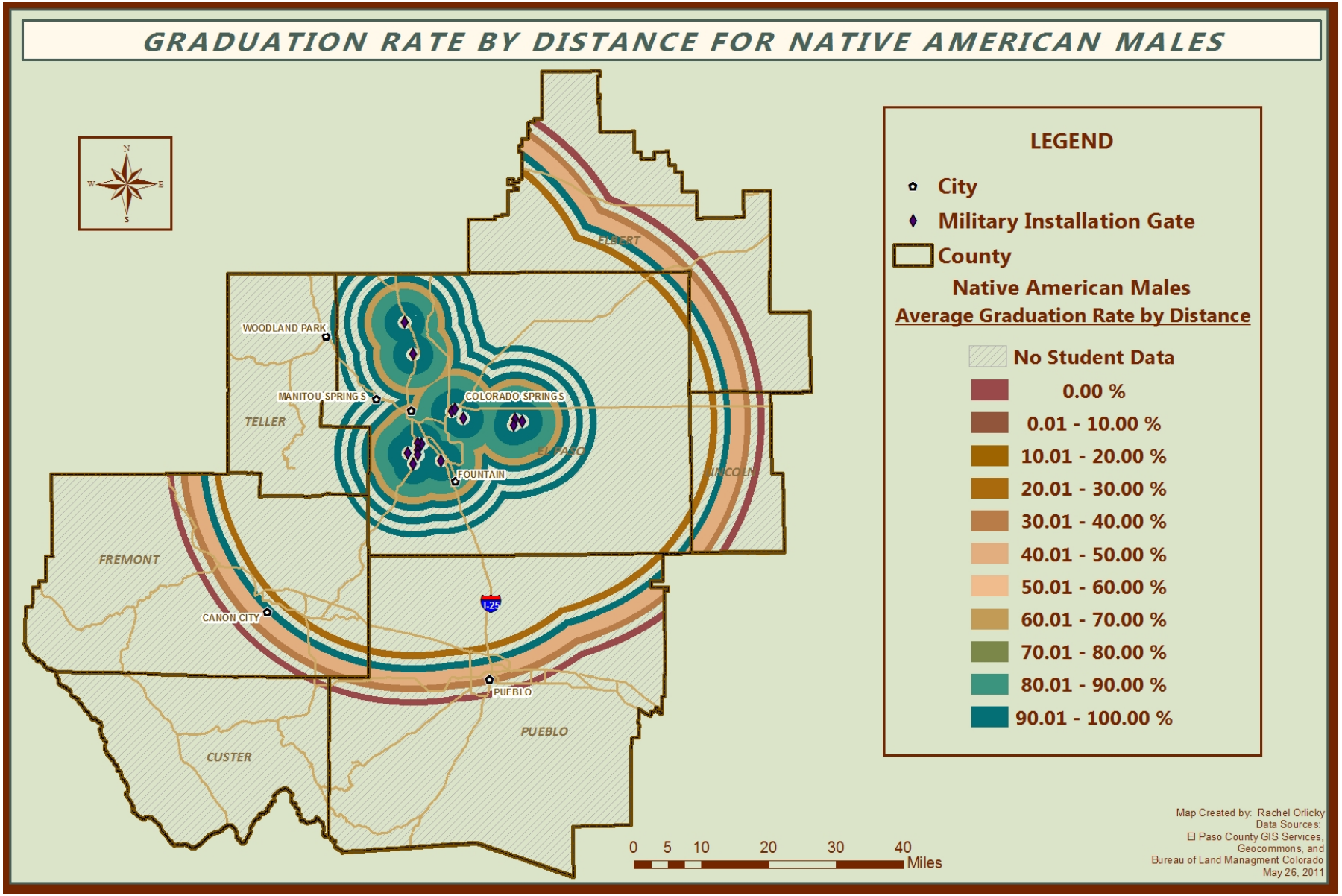

Figure 17. Average Graduation Rate by Distance for Native American Males

Variable 2. Dropout Rates

The results of the OLS regression analysis for graduation rates performed on all subgroups are represented in Table 2. The analysis yielded an *r* value of 0.1360 for all students. Since this value is near zero the relationship between the variable of dropout rates for all students and distance from military gates is very weak, though it is stronger than the relationship between graduation rates for all students and distance from military gates. However, a moderate correlation was discovered within one dropout rate subgroup. This subgroup was Hispanic female students (an *r* value of -0.4157).

Table 3. Regression Analysis Results: Dropout Rates

Student Group	Dropout Rates		
	r	r^2	Strength of Correlation
All Students	0.1360	0.0185	Weak
All Males	0.0458	0.0021	Weak
All Females	0.1926	0.0371	Weak
Asian Students	0.0014	0.0000	Weak
Asian Males	0.1265	0.0160	Weak
Asian Females	-0.1549	0.0240	Weak
Black Students	-0.1265	0.0160	Weak
Black Males	-0.1559	0.0243	Weak
Black Females	0.1010	0.0102	Weak
Hispanic Students	0.3709	0.1376	Weak
Hispanic Males	-0.0200	0.0004	Weak
Hispanic Females	0.4157	**0.1728**	**Moderate**
Native American Students	0.1330	0.0177	Weak
Native American Males	0.2179	0.0475	Weak
Native American Females	-0.2516	0.0633	Weak
White Students	0.0490	0.0024	Weak
White Males	0.0017	0.0000	Weak
White Females	0.0843	0.0071	Weak
Values in **RED** denote significant correlations.			

Results of All Students Dropout Rates

Figure 18. is a scatterplot of the data distribution and regression line (model of best fit) for all student dropout rates and distance from a military gate. The slope of the regression line was 0.0109. The y value (dropout rate) increased by 0.0109 for every unit of x (distance). The data points

were distributed in a similar manner to the regression line meaning that the model was a good fit for the distribution.

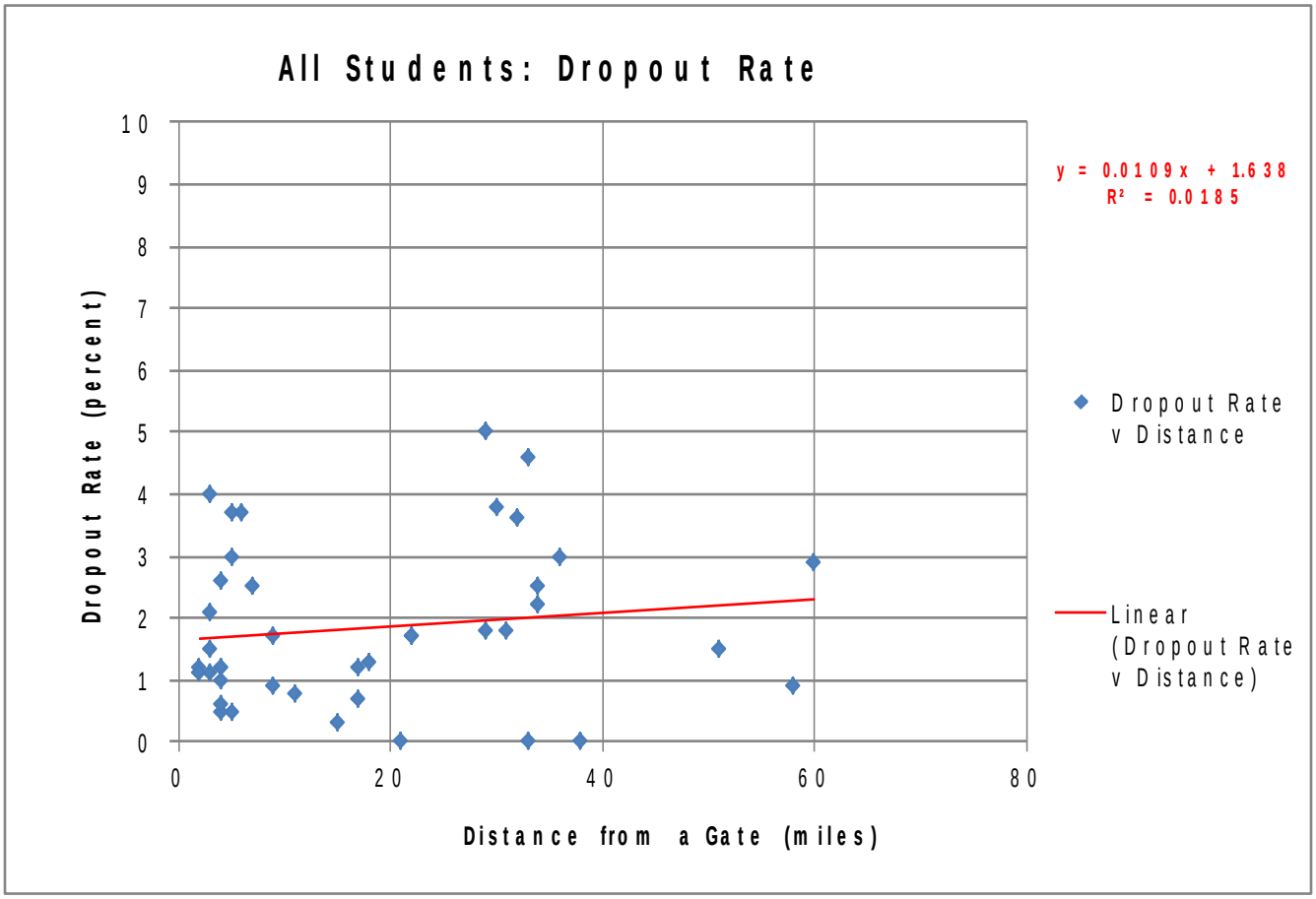

Figure 18. Regression Model of All Students Dropout Rates

Figure 19. is an illustration of the dropout rate standard residual values for Pikes Peak regional high schools. Six schools in El Paso County, three schools in Pueblo County, two schools in Elbert County, and one school in Fremont County had a standard residual value beyond +1.00 and -1.00. The largest standard residual value for dropout rates was 2.37. The map illustrates that more than half of the standard residuals for this model (29 of 41 standard residuals) are within a range of +1.00 and less than-1.00 and

meaning that the model equation produced by the ordinary least squares analysis accurately predicted dropout rates for high schools based on distances from military installation gates.

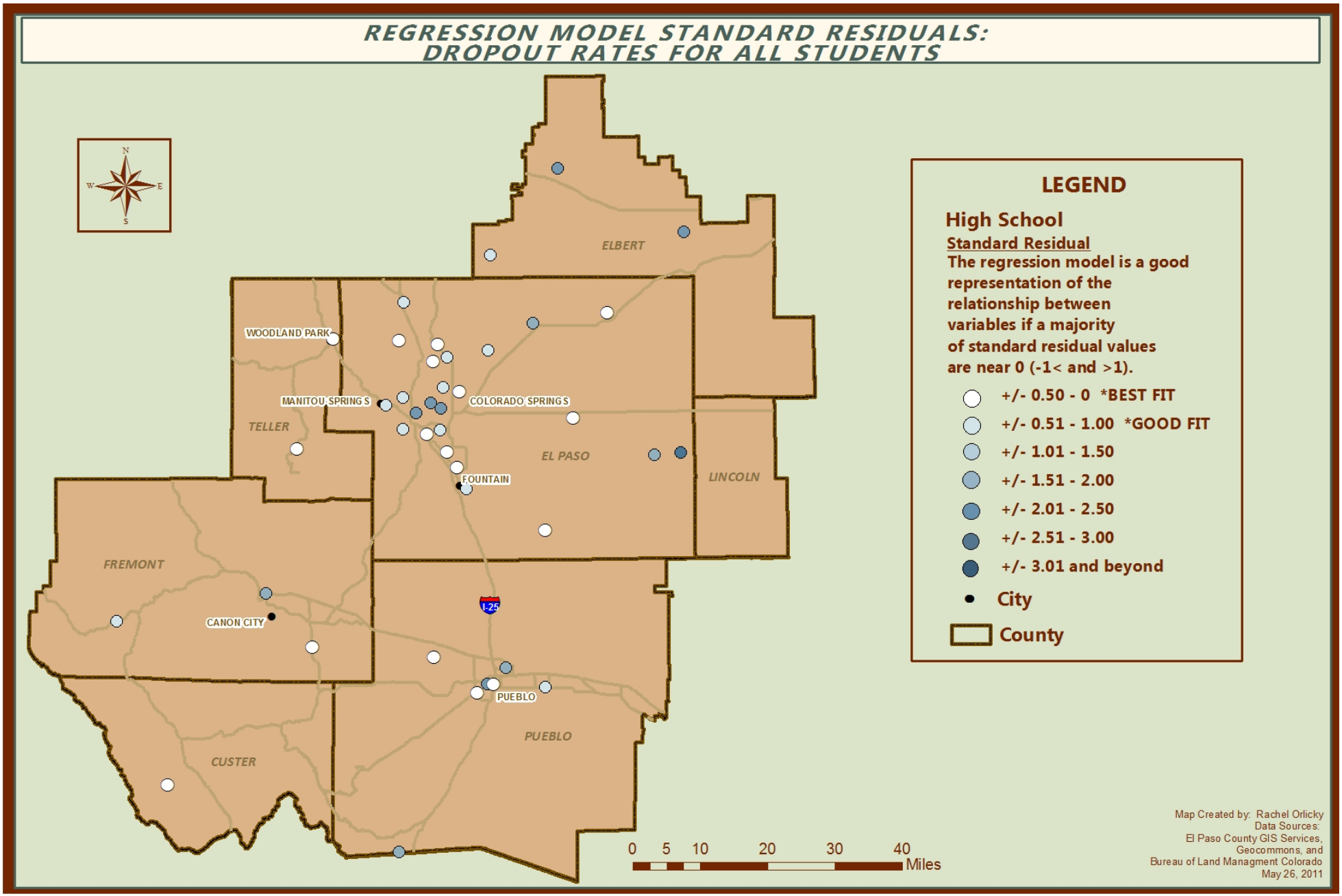

Figure 19. Regression Model Standard Residuals: Dropout Rates for All Students

Figure 20. is a map of the average high school dropout rates for all students in the Pikes Peak region relative to the locations of the area's five military installations. Different colors are used to pictorially describe the numerical values. The strength of correlation is weak and not statistically significant, although the correlation is in the expected positive direction.

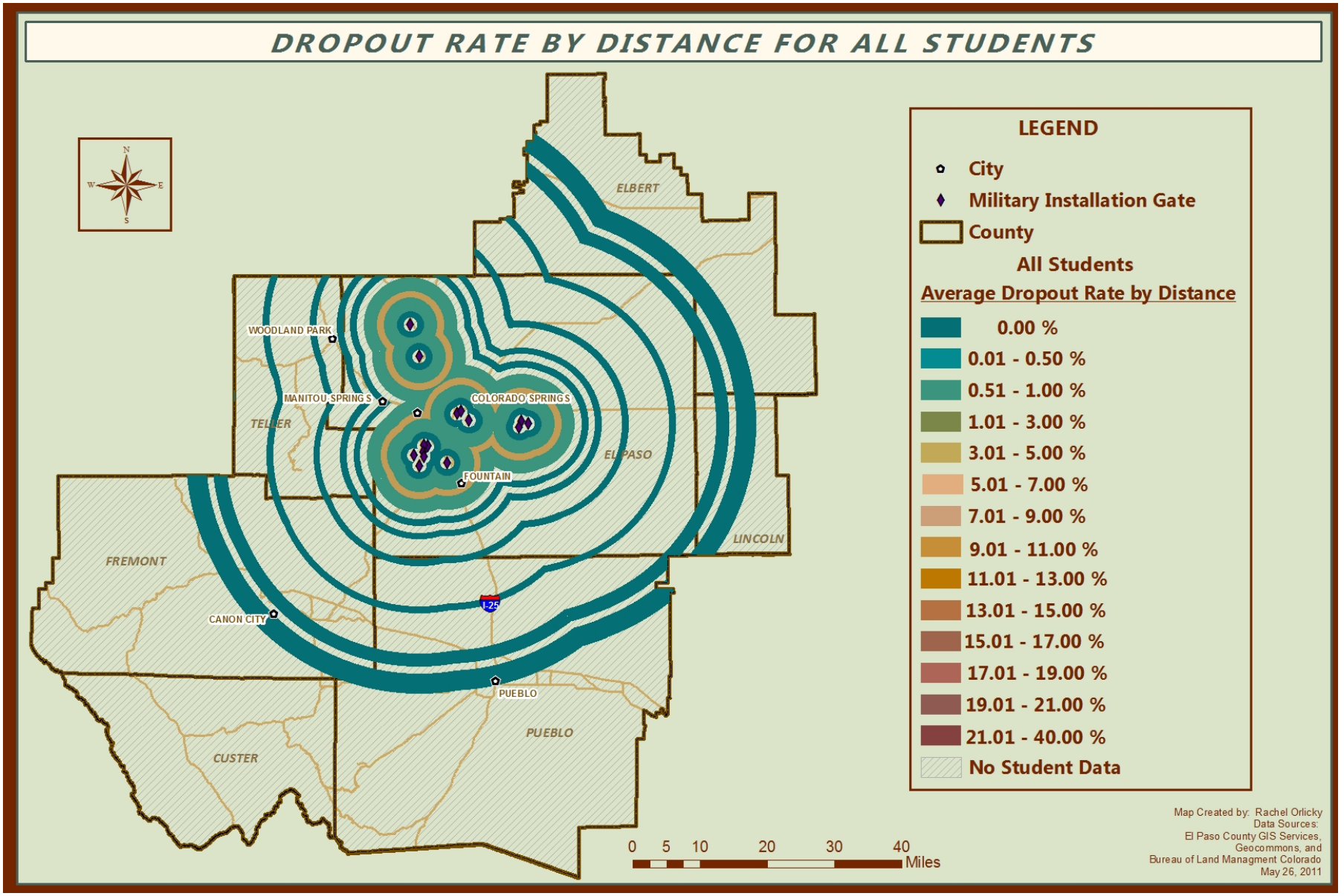

Figure 20. Average Dropout Rate by Distance for All Students

Results of Hispanic Female Student Dropout Rates

Figure 21. is a scatterplot of the data distribution and regression line (model of best fit) for Hispanic female student dropout rates and distance from a military gate. The slope of the regression line was 0.1688. The y value (dropout rate) increased by 0.1688 for every unit of x (distance). The data points were scattered randomly and did not cluster near the regression line meaning that the model did not fit the distribution. The data points were distributed in a similar manner to the regression line meaning that the model was a good fit for the relationship between the two variables.

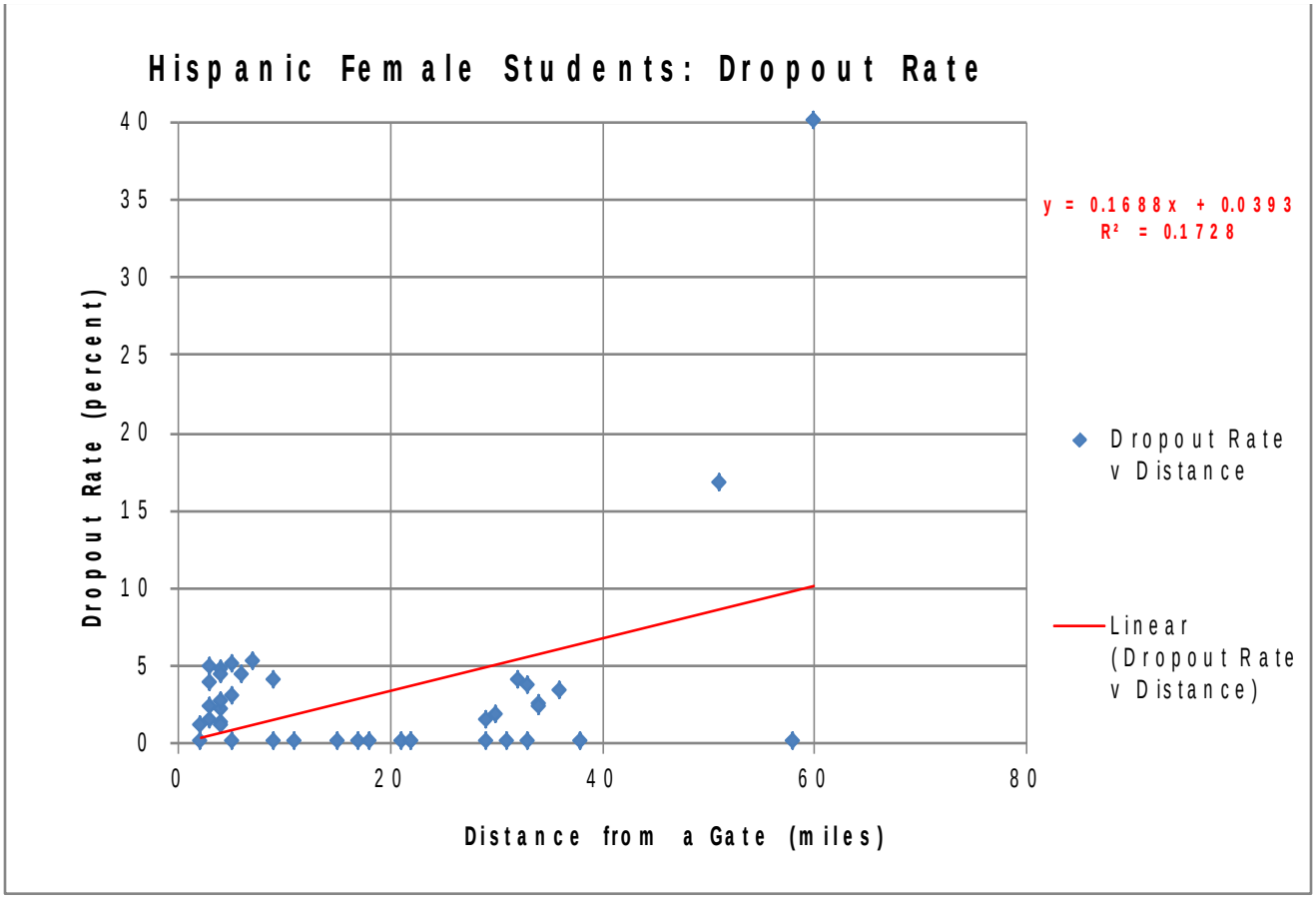

Figure 21. Regression Model of Hispanic Female Students Dropout Rates

Figure 22. is an illustration of the Hispanic female dropout rate standard residual values for Pikes Peak regional high schools. Three schools in Pueblo County and four schools in El Paso County had a standard residual beyond +/-1.00. The largest standard residual value for dropout rates was 2.91. The map illustrates that 33 of 40 were within a range of +1.00 and -0.50 meaning that the model equation produced by the ordinary least squares analysis accurately predicts Hispanic female dropout rates for high schools based on distances from military installation gates.

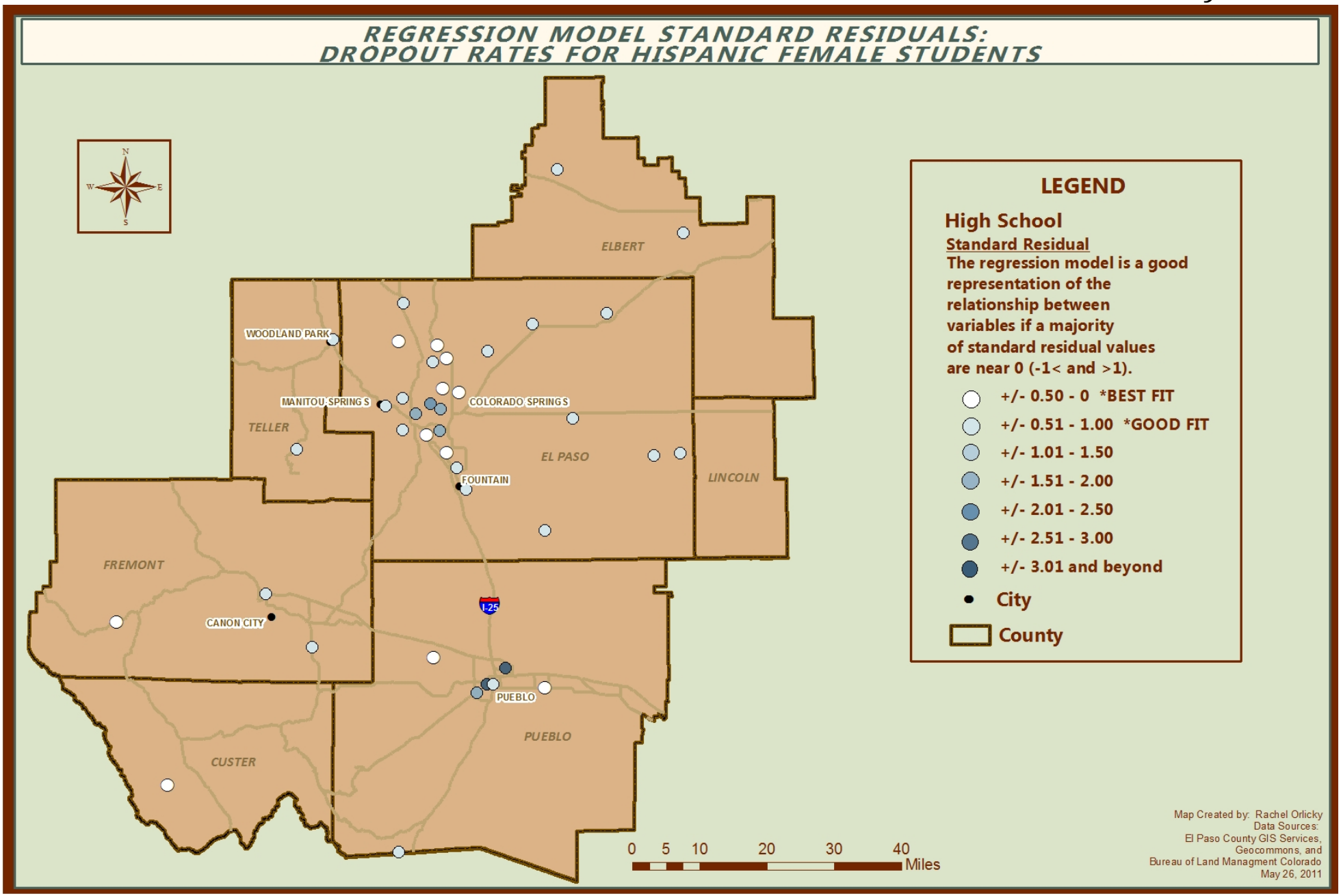

Figure 22. Regression Model Standard Residuals: Dropout Rates for Hispanic Female Students

Figure 22. shows a geospatial display of the average high school dropout rates for Hispanic female students within the study area. Again, different colors are used to pictorially describe the numerical values. According to our thesis statement #2, dropout rates are inversely correlated to distances from military installations. In other words, closer proximity (fewer miles away) of high schools to military bases should relate to lower dropout rates, and the more distant schools (greater miles away) should have higher dropout rates. This map reveals a moderately strong correlation in the direction expected. The most interesting aspects of this subgroups' results are the extremes. The closest schools had noticeably lower dropout rates for Hispanic female students, and the farthest away schools had obviously higher dropout rates. In light of recent educational campaigns seen on television and on-line about high Hispanic female dropout rates due to teen pregnancies, perhaps this analysis is actually capturing some portion of this social phenomenon. This could be a promising technique for future studies.

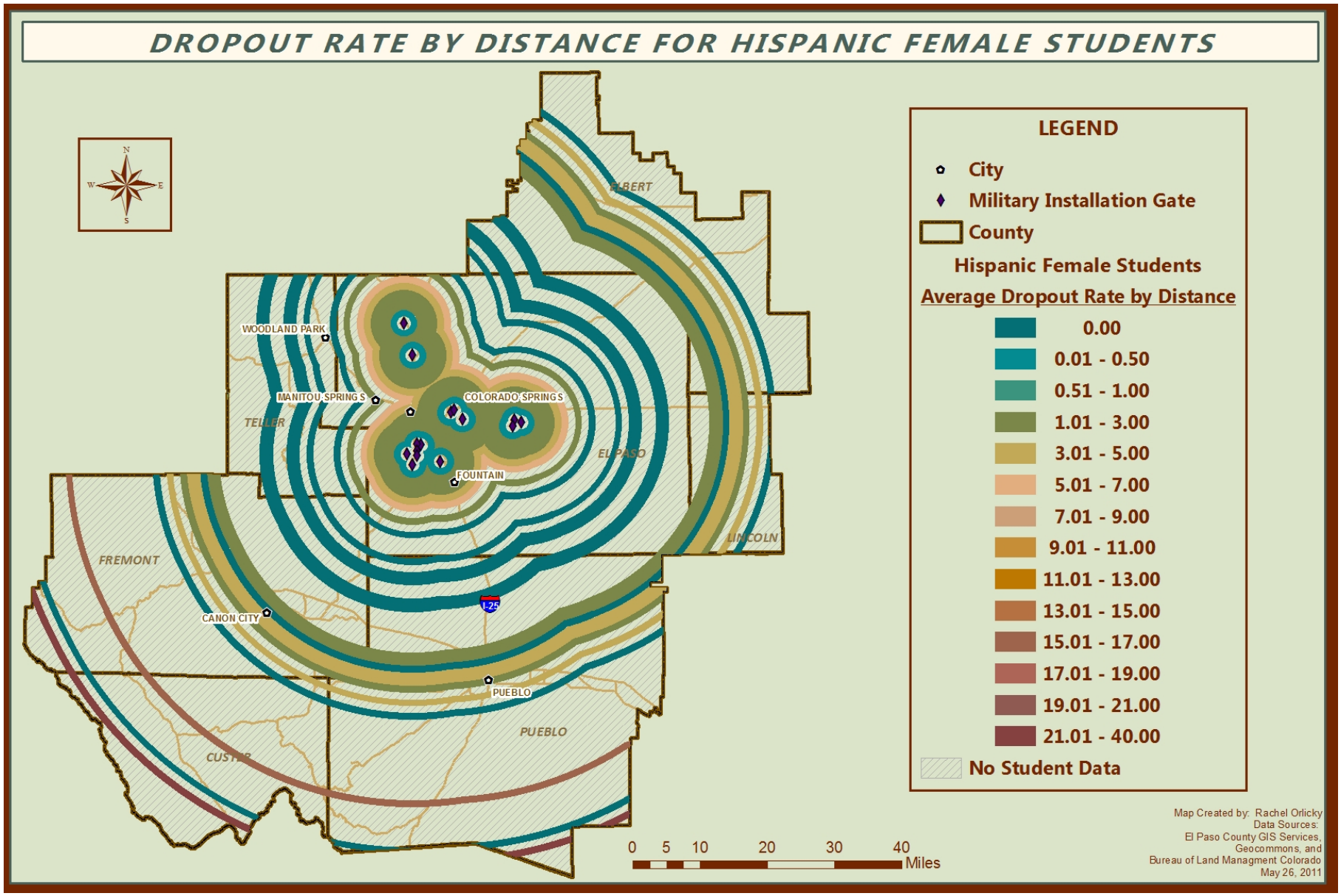

Figure 22. Average Dropout Rate by Distance for Hispanic Female Students

IV. CONCLUSION

Discussion of the Results

A significant correlation between all Pikes Peak high school student graduation rates/dropout rates and proximity to military installation gates was not discovered using Ordinary Least Squares analysis. Using the same methodology, significant correlations with proximity of high schools to military installations were found for 5 subcategories of students:

Asian students and graduation rates

Asian male students and graduation rates

Native American students and graduation rates

Native American male students and graduation rates

Hispanic females and dropout rates

The results revealed that there is something about the proximity of military installations to high schools that relates to some groups of minority students, and that there are gender variances within specific racial groups of students. Why there are significant differences in the calculated correlations is a topic for much follow-on research into possible socioeconomic and cultural characteristics, as well as gender differences that influence why some minority students have lower graduation rates and higher dropout rates, respectively.

The limited study area of this analysis was small and the especially when data was partitioned into 5 racial subcategories and 2 gender

subcategories. Small sample sizes could have produced unrepresentative results. Also, as all 5 military installations in El Paso county are within the Metropolitan Area of Colorado Springs (for commuting purposes), the correlations found could merely be due to proximity to the urban area itself. The availability or non-availability of jobs could contribute to lower high school graduation rates and/or higher dropout rates. Cultural differences in gender expectations, responsibilities, and family structure, such as for Hispanic females, may be greater influences than those that may come from attending high school near military installations.

For the majority of students in the Pikes Peak region, significant correlations between high school graduation rates/dropout rates and proximity to military installations was not observed in this study. However, for certain categories of students, such as minority subgroups, correlations were observed.

Significant positive correlations were found for graduation rates and distance from military gates for Asian students and Asian male students. Asian students are the only group, within the significant correlations, that has higher graduation rates as distance from a military installation gate increases. The sample population of Asian students was small which could contribute misleading results, but the moderately strong correlation with increased distance from military installations warrants further study.

A significant inverse/negative correlation was observed for graduation rates and Native American students and Native American male students. The Native American population of students was the smallest racial subgroup. Within this subgroup Native American male students accounted for only 25% of the entire Native American student population. Small numbers undoubtedly influenced the results and made it difficult to conclude whether the correlations were due to the small sample size or the relationship of distance from a military installation gate.

A significant positive correlation was discovered between dropout rates and Hispanic female students. This correlation differs from all other significant correlation findings in that the sample size was not small. Hispanics are the second largest racial group in the state of Colorado (Colorado Children's Campaign 2005). Dropout rates for Hispanic females in general were higher than dropout rates for other groups. The closest schools had noticeably lower dropout rates for Hispanic female students, and the farthest away schools had obviously higher dropout rates. Hispanic female dropout rates due to teen pregnancies have been a subject of particular interest in recent television commercials and online campaigns. The presence of military installations may be a positive factor for preventing Hispanic females from dropping out of school. This correlation warrants further investigation.

Areas for Further Research

Although this research did not uncover markedly high correlations between high school student graduation rates or dropout rates with proximity to military installations, it did identify significant correlations with racial and gender subsets of the students studied. The results of this study can be instrumental in guiding further research into the individual correlations that were found. The factor of military installation proximity can be combined with other factors such as educational attainment of parents, socioeconomic aspects, attendance statistics, and school funding availability in order to further explain why students graduate and why students dropout. Schools and school districts can use this research to pursue specified approaches for improving graduation and dropout rates for the identified subgroups.

This analysis can be applied to other aspects of military influence to see if results are consistent with this study's findings. Comparable analysis of other regions could provide validating evidence to substantiate this study's results. In particular, a comparison of graduation and dropout rate results between the Pikes Peak region and the Denver Metropolitan region could yield useful findings. Denver is the only other city in Colorado, besides Colorado Springs, that is home to a major military installation (Buckley Air Force Base).

To further validate the results of this study, the study area could be broadened to include regions across the nation with similar military influence. This broader approach could mitigate the problem of small sample size encountered within some subgroups. A larger study area would help control for undesirable factors that may influence results. The more accurate the correlations, the more useful the results will be to schools and school districts who are searching for ways to keep students in school until graduation.

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