Dissolved Lithium Concentrations, Gender, Race, and the Geography of Texas Suicide Mortality Rates 1980–1998: A Correlation Study

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Bio:

William Flanagan is a 2006 graduate of the University of North Texas with a Bachelor of Science in Geography. His undergraduate research and coursework allowed him to gain an insight into various disciplines such as Medical Geography, Geographic Information Science, Geology, Hydrology, Environmental Science, and Remote Sensing. He presented his research at University Scholar's Day at the University of North Texas. He was elected to the National Dean's List in 2005 and 2006. William is currently the Geographic Information Systems (GIS) Manager of Epact Services, an environmental consulting company in Fort Worth. He plans to begin graduate coursework at the University of North Texas in the fall, and is expecting to continue research within the field of Medical Geography.

Abstract:

This study examines the spatial distribution of suicide mortality rates in Texas counties, from 1980 to 1998. Using the conceptual framework of disease ecology, this study provides insight into selected risk factors associated with suicide mortality. In particular, the factor of dissolved lithium concentrations in the groundwater and the correlation to suicide mortality rates are tested. Spearman's rank correlations and the Wilcoxon test are used to examine race, gender, and dissolved lithium concentrations as risk predictors of suicide mortality. The results suggest that counties with lower dissolved lithium concentrations in their groundwater had significantly higher suicide mortality rates. Counties with higher populations of Whites had significantly higher suicide mortality rates, but counties with higher populations of Hispanics had significantly lower suicide mortality rates. Males had higher suicide mortality rates than females. Further research into the relationship between lithium concentrations and suicide is warranted.

Introduction

Every 18 minutes someone dies from suicide in the United States (Suicide and Crisis Center, 2005). According to the Association of Suicidology, suicide accounts for the deaths of nearly 32,000 people annually in the United States and ranks eleventh among the leading causes of death. Texas ranked 37th in the nation in total number of completed suicides in 2002 (Suicide and Crisis Center, 2005). With such alarming statistics, it is imperative that the factors influencing suicide patterns be examined and risk predictors associated with high-risk populations be ascertained.

This study will focus on examining the spatial distributions of suicide mortality rates in Texas counties from the years 1980 to 1998. The conceptual framework of disease ecology is used to model the effects of human behavior factors and environmental conditions on morbidity and mortality. The purpose of this study is to gain insight into selected risk factors associated with suicide mortality. In particular, the correlation of the factor of dissolved lithium concentrations in groundwater with suicide mortality rates will be examined. Race will also be tested as a risk factor for suicide. Gender will be controlled to see if a significant difference exists between male suicide mortality rates and female suicide mortality races.

Methodology and Data Sources

For this study, suicide will be defined by ICD-9 codes 950–959. Mortality data from the years 1980 to 1998 were extracted from the EPIGRAM online database provided by the Texas Department of Health's Vital Statistics Division. The mortality data have been age-adjusted to the United States' 2000 age standard. Dissolved lithium concentration data were extracted from the Texas Water Development Board Groundwater Database and are defined by Storet code 01130. Population and other data were obtained from the 2000 United States Census.

Risk Predictors of Suicide

Suicide is often a permanent solution to a temporary problem. The common stimulus for suicide is unendurable psychological pain. When faced with intolerable emotion and unacceptable anguish, people will sometimes opt for a cessation of consciousness (Suicide and Crisis Center, 2005). As Moscicki (1997) points out, "… suicide is a complex outcome of multiple, inter-related factors." Oftentimes, suicide behavior is influenced by many factors. These factors may include depression, chemical addiction, and negative life experiences such as a divorce, loss of a job, loss of a loved one, or financial difficulties. Behavioral and verbal clues are frequently expressed by someone who is contemplating suicide. This research will analyze selected risk predictors so that trends in suicide mortality can be identified.

Disparities have been shown to exist between male suicide mortality rates and female suicide mortality rates. Although females are three times more likely than males to attempt suicide, males complete suicide 4.1 times more than females (Suicide and Crisis Center, 2005). The reasons for this gender difference in suicide mortality rates have yet to be clearly determined; however, research has shown the gender gap may be explained by a variety of compounding factors. More aggressive behavior among men compared to women may be one of many factors influencing the gender difference apparent in suicide mortality rates. Dumais et al. (2005, para.1) determined that "…higher levels of impulsivity and aggression were associated with suicide." Compounding the aggressive behavior, there may be a larger proportion of men who are suffering from addictive disorders compared to females, as addictive behavior has been shown to affect suicide behavior (Suicide and Crisis Center, 2005). "Mental and addictive disorders, frequently in co-occurrence, are the most powerful risk factors for suicide in all age groups, accounting for over 90 percent of all completed suicides" (Moscicki, 1997, p. 499).

Depression is another factor that greatly influences suicide behavior and mortality, and gender trends of depression may also help explain the disparity evident between male and female suicide mortality rates. Further research is needed to determine if patterns of depression, addictive disorders, and aggressive behavior influence the gender pattern of suicide mortality. For the purposes of this study, a Wilcoxon test will be calculated to verify the significance of the differences between male and female age-adjusted suicide mortality rates.

Studies suggest that suicide mortality affects races differently. Minorities are not as affected by suicide mortality as their Caucasian counterparts. The Suicide and Crisis Center (2005, para.14) found that "… white males have the highest suicide mortality rate throughout all age groups, and minority females have the lowest." What causes this difference between race and corresponding suicide mortality rates is still unknown. It is possible that depression, which has been found to be a major risk factor of suicide behavior, may be more prevalent among Whites (Dumais et al., 2005).

Cultural and societal factors may also be playing a role behind the racial inequality of suicide mortality rates. The method of suicide may also differ across different races. Stack and Wasserman (2005) found that "African Americans are 2.24 times more likely than Caucasians to choose violent methods of suicide." A nonparametric test of correlation will be used to test for significant differences in suicide mortality rates in Texas.

In previous studies, lithium has been found to be a factor influencing suicide behavior and mortality rates. To better understand why lithium affects suicide behavior and mortality, a brief explanation of lithium is needed. Taking its name from the Greek word *lithos*, or stone, lithium (Li) is the lightest of the alkali metals and its prevalence in trace amounts is found in nearly all rocks (Schrauzer, 2002). The first legitimate medical application of lithium was

introduced in 1949, when lithium carbonate was found to be beneficial in manic-depressive illness, and today, lithium carbonate is one of the most widely prescribed psychiatric drugs (Schrauzer, 2002). Lithium has been associated with volcanism, a fact that may account for its common occurrence in the water of many aquifers, which are often composed of reworked and highly weathered igneous sediments (Schrauzer, 2002; Texas Water Development Board, 2005). Many counties and cities in Texas rely heavily, if not exclusively, on groundwater for their water needs. The effects of dissolved lithium concentrations in groundwater may provide a protective function on suicide behavior and mortality. Cipriani et al. (2005) found "…lithium is effective in the prevention of suicide…" (p. 1805). Schrauzer and Shrestha (1990) statistically observed highly significant inverse associations (p = 0.005 to 0.01) between water lithium levels and the rates of homicide, suicide, and forcible rape.

A nationwide study including all patients treated with lithium conducted by Kessing et al. (2005, p. 860) found that "continued lithium treatment was associated with reduced suicide risk regardless of sex and age." Groundwater may also have a direct influence in the natural nutritional uptake of lithium through many of the common foods and vegetables eaten daily because many of these foods contain trace amounts of lithium (Scharuzer, 2002). In this study, the sample data extracted from the TWDB groundwater database were averaged on a county-by-county basis for 248 counties (excluding Archer, Young, Shackleford, Stephens, Palo Pinto, and Rockwall counties), and are represented in micrograms per liter (µg/L). A non-parametric correlation will be attempted to test if suicide mortality rates in Texas are influenced by dissolved lithium concentrations in the groundwater.

Hypotheses

Four main hypotheses are examined in this research:

Hypothesis 1. Gender is a predictor of suicide mortality. Males will have significantly higher suicide mortality rates than females.

Hypothesis 2. Race is a predictor of suicide mortality. Counties with a higher population of Whites will have correspondingly higher rates of suicide mortality. Counties with higher population of African Americans and Hispanics will have correspondingly lower rates of mortality.

Hypothesis 3. County suicide mortality rates will be influenced by dissolved lithium concentrations in the groundwater. Counties with higher concentrations of dissolved lithium in the groundwater will have correspondingly lower rates of mortality.

Hypothesis 4. Suicide mortality rates are changing through time. The years 1980–1989 will have significantly lower average suicide mortality rates than the years 1990–1998.

Results

The Geography of Suicide Mortality Rates in Texas

Figure 1 shows the spatial distribution of age-adjusted suicide mortality rates in Texas counties. The southern and western regions of the state have some of the lowest rates of suicide mortality, particularly those counties bordering Mexico (with the exception of Brewster and Presidio counties), and those counties in the westernmost portion of the panhandle (Figure 1). It appears that the more south or west one moves across the state, the lower the suicide mortality rate. A cluster of relatively high suicide mortality rates appear in the south-central portion of the state.

Gender and Suicide

It was initially hypothesized that male suicide rates would be significantly higher than female suicide mortality rates. A Wilcoxon test examining the difference between male and female suicide mortality rates found a significant difference ($Z=-13.706$, $p=.000$). Male suicide mortality rates are significantly higher than female mortality rates (Figures 2 and 3). Note the differences in quintile distributions in age-adjusted death rate per 100,000 across gender. Out of

the 254 counties in Texas, males range from a minimum death rate of 0 to a maximum of 52.2. The female death rate ranges from a minimum of 0 to a maximum of 13.9.

Race and Suicide

Race was hypothesized to have an effect on suicide mortality rates. As hypothesized, counties with higher percentage of Whites would have correspondingly higher rates of suicide mortality. Counties with higher percentages of Blacks and Hispanics were hypothesized to have lower rates of suicide mortality. The Spearman rank correlation revealed a significant, positive correlation between percent White and suicide mortality (Table 1). Counties with higher percentage of Whites have significantly higher rates of suicide mortality ($r=.315$, $p=.000$). In contrast, counties with higher percentage of Hispanics had significantly lower rates of suicide mortality ($r= -.250$, $p=.000$). This correlation may explain the lower rates observed in southern counties (Figure 1) because a larger proportion of Hispanics reside in the southern counties of Texas. No significant correlation was found between African Americans and suicide mortality rates ($r= -.014$, $p=.827$).

Lithium Concentrations and Suicide

Dissolved lithium concentrations in the groundwater were hypothesized to correlate negatively with suicide mortality rates. Thus, counties with higher concentrations of dissolved lithium in the groundwater will have correspondingly lower rates of mortality. As shown in Table 1, a significant negative correlation between dissolved lithium concentrations in the groundwater and suicide mortality rates was found ($r = -.150$, $p < .025$). Figures 1 and 4 confirm this, particularly in the south-central region of the state where high suicide mortality rates correspond to low lithium concentrations.

Temporal Variations of Suicide

It was hypothesized that the suicide mortality rate would be lower for the years 1980–1989 than for the years 1990–1998. A Wilcoxon test found a significant difference by years ($Z = -2.351$, $p=.019$). The average suicide mortality rates from the years 1980–1989 were significantly lower than the average suicide mortality rates from the years 1990–1998. In short, the suicide rate is increasing. Figures 5 and 6 show the suicide rates of the two time periods, while Figure 7 highlights those counties that experienced the highest degrees of change between the years 1980–1989 compared to 1990–1998.

Conclusions

Suicide mortality rates in Texas counties appear to be influenced by gender, race, and the dissolved lithium concentrations in the groundwater. Male suicide mortality rates are significantly higher than female suicide mortality rates ($Z=-13.706$, $p=.000$). Suicide mortality rate is positively correlated with percent of population that is White ($r=0.315$, $p=.000$), but negatively related to percent of the population that is Hispanic ($r=-0.250$, $p=.000$). Counties in Texas that have lower rates of dissolved lithium concentrations in the groundwater appear to have higher suicide mortality rates ($r=.-0.150$, $p < .05$).

Further research is needed to clarify the relationship between lithium concentrations and suicide mortality rates, as the data used for dissolved lithium concentrations in this paper do not take into account intra-county variations. The underlying geology of the 30 major and minor aquifers in which most of the samples were drawn should also be further explored, perhaps identifying the spatial distribution of lithium concentrations across Texas. Although many counties in Texas rely heavily on groundwater for water needs, subsequent research may seek to broaden the focus and assess lithium concentrations in other water sources, such as surface and tap water, on a finer geographical scale. Due to the severity of suicide rates among Texans, it is

hoped that this study and others will provide insight into the trends and patterns associated with suicide behavior, so that necessary policies of education and prevention can be developed.

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Figure 1.

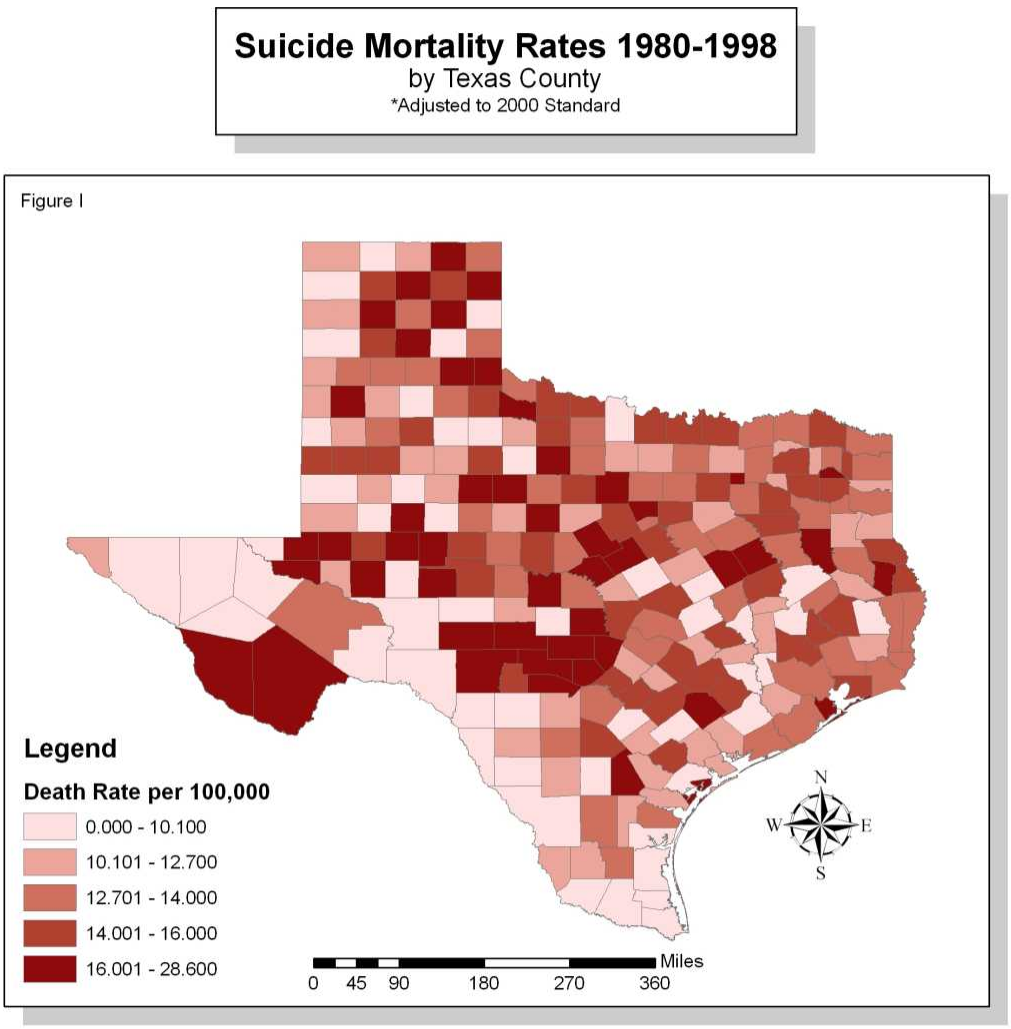

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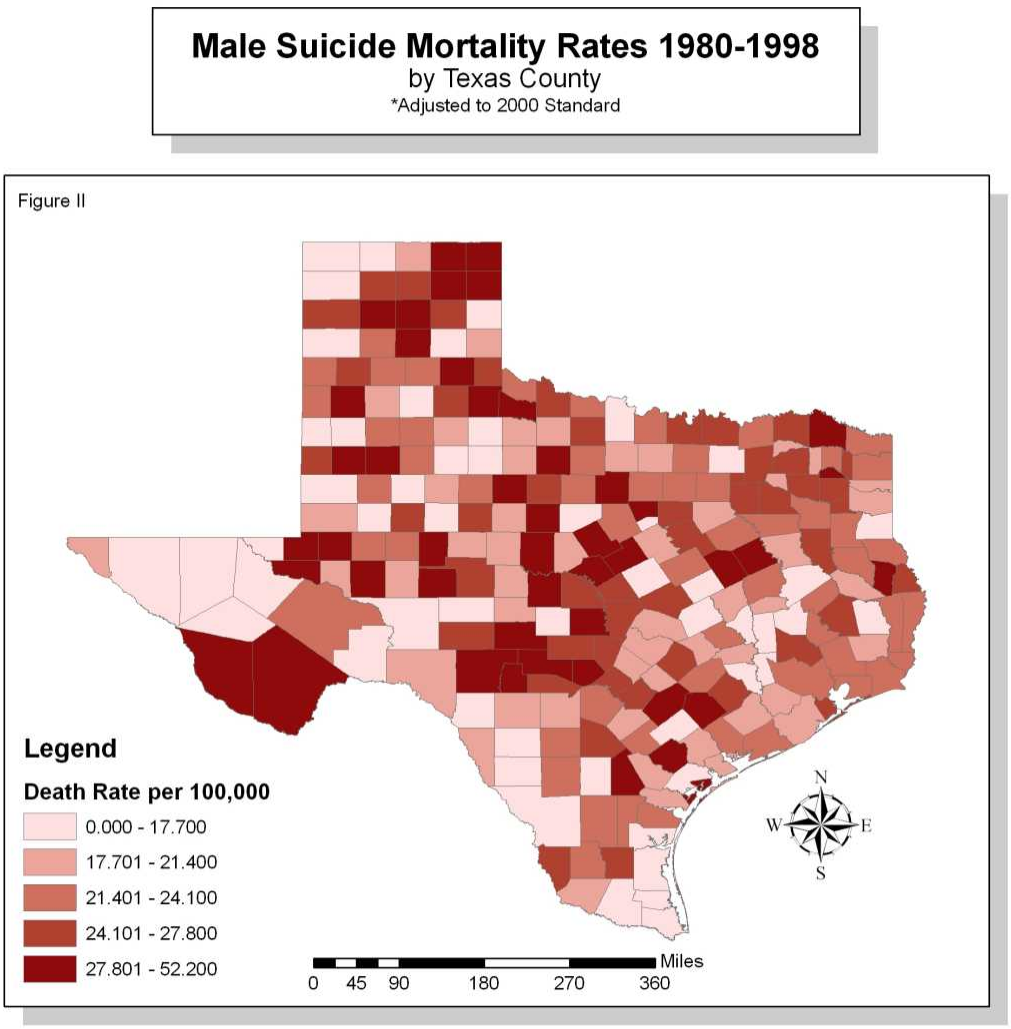
Figure 2.



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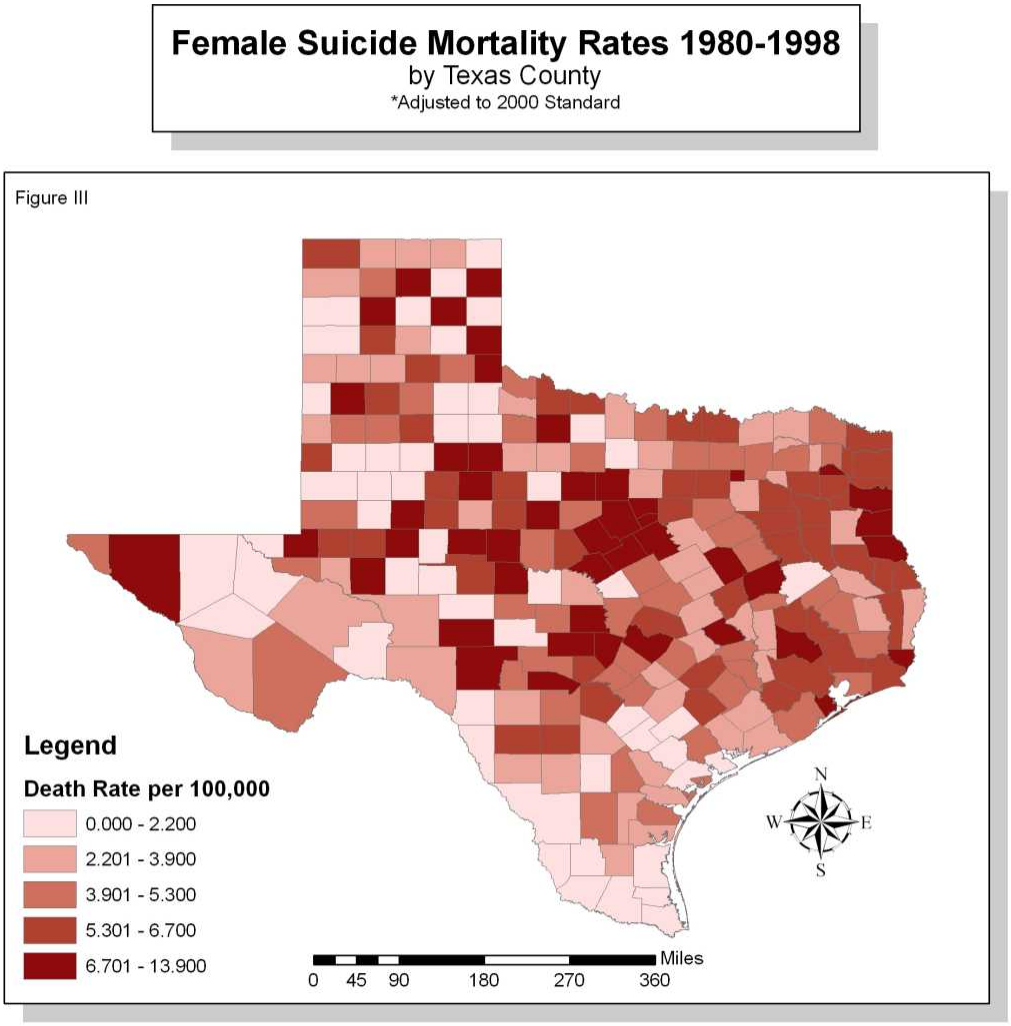

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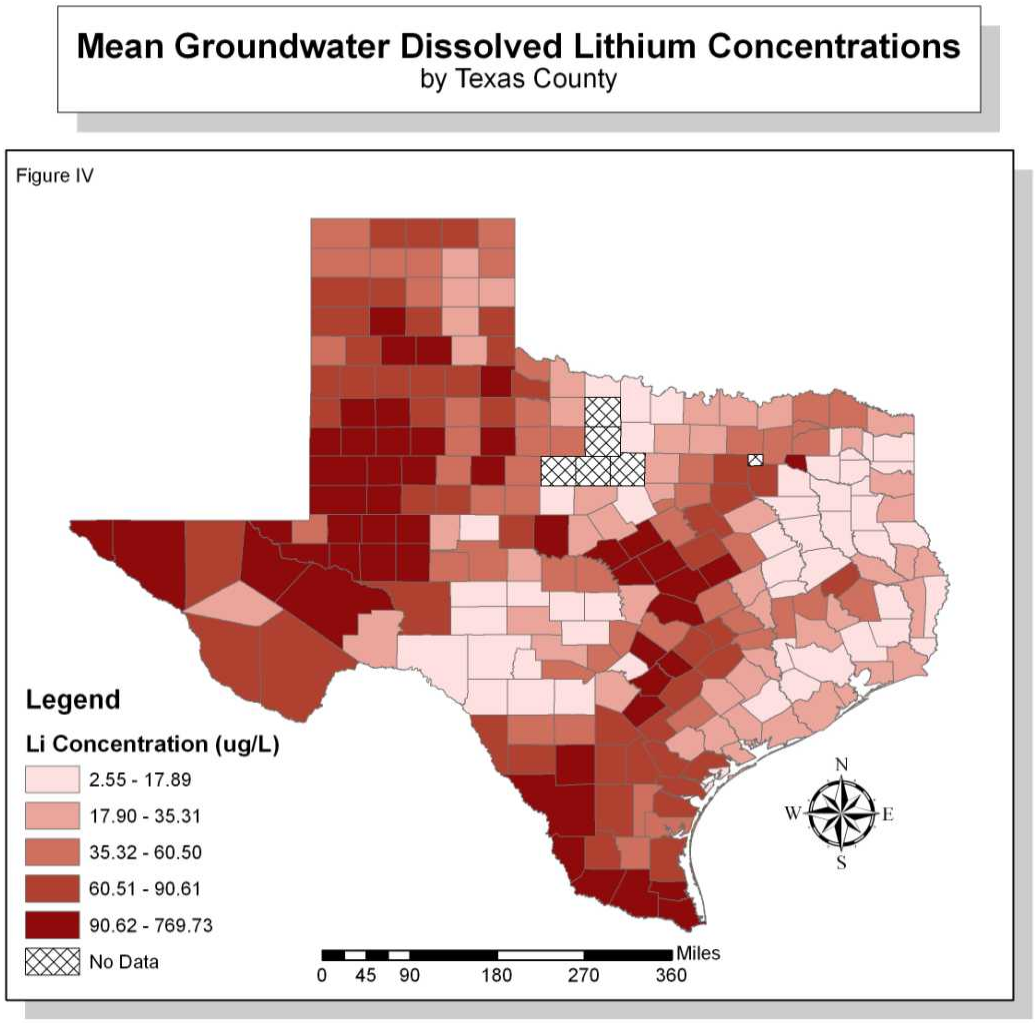

(Excerpt Texas Water Development Board Groundwater Database, retrieved October 21, 2005 from http://www.twdb.state.tx.us/DATA/waterwell/well_info.asp)

Table 1. Race, mean dissolved Li concentration, and age-adjusted suicide mortality.

	Mean Li	% Black	% White	% Hispanic
Suicide Mortality Rate	-0.150*	-0.014	0.315**	-0.250**

*Correlation is significant at the .05 level (Spearmans 2 tailed)
**Correlation is significant at the .01 level (Spearmans 2-tailed)

Figure 5.

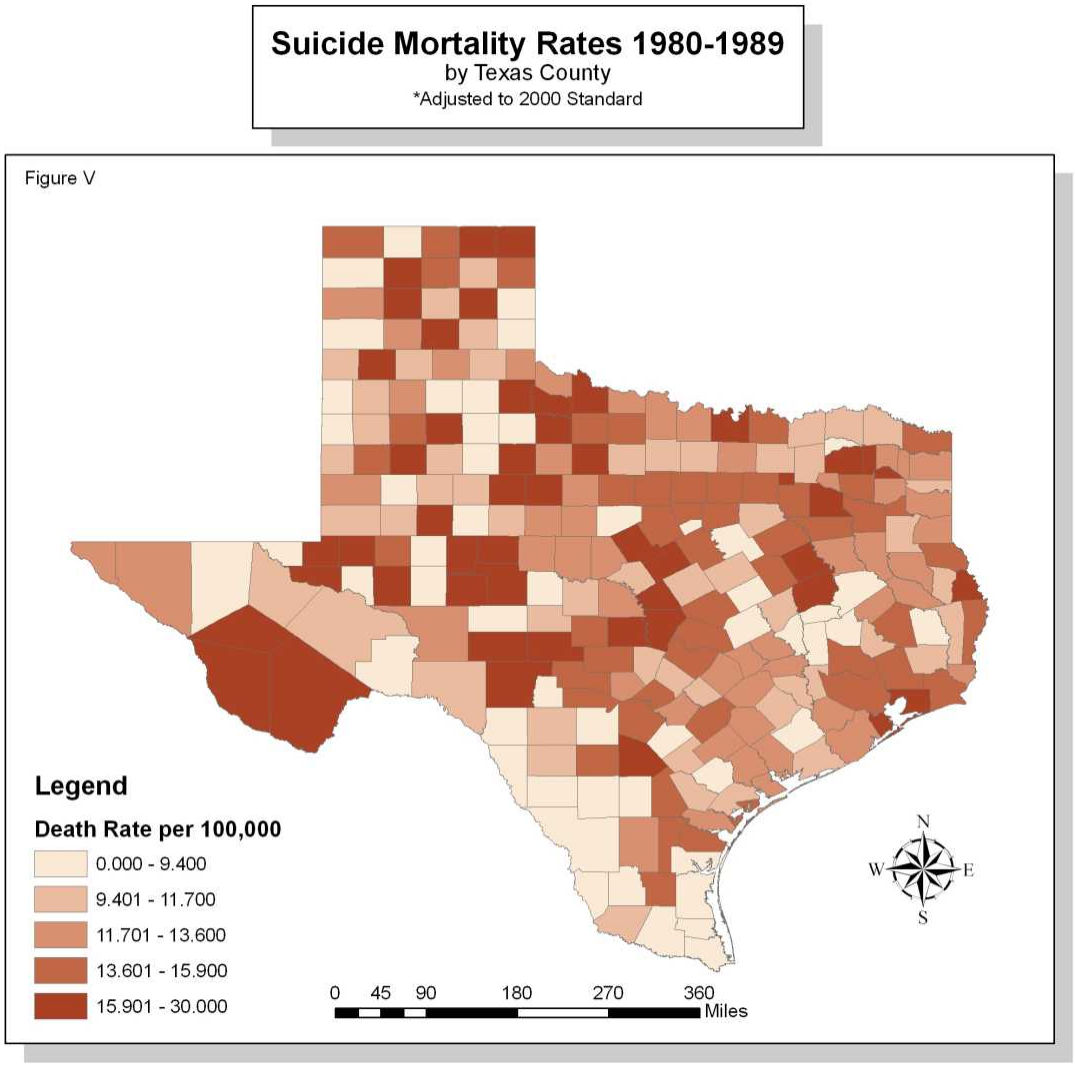

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Figure 6.

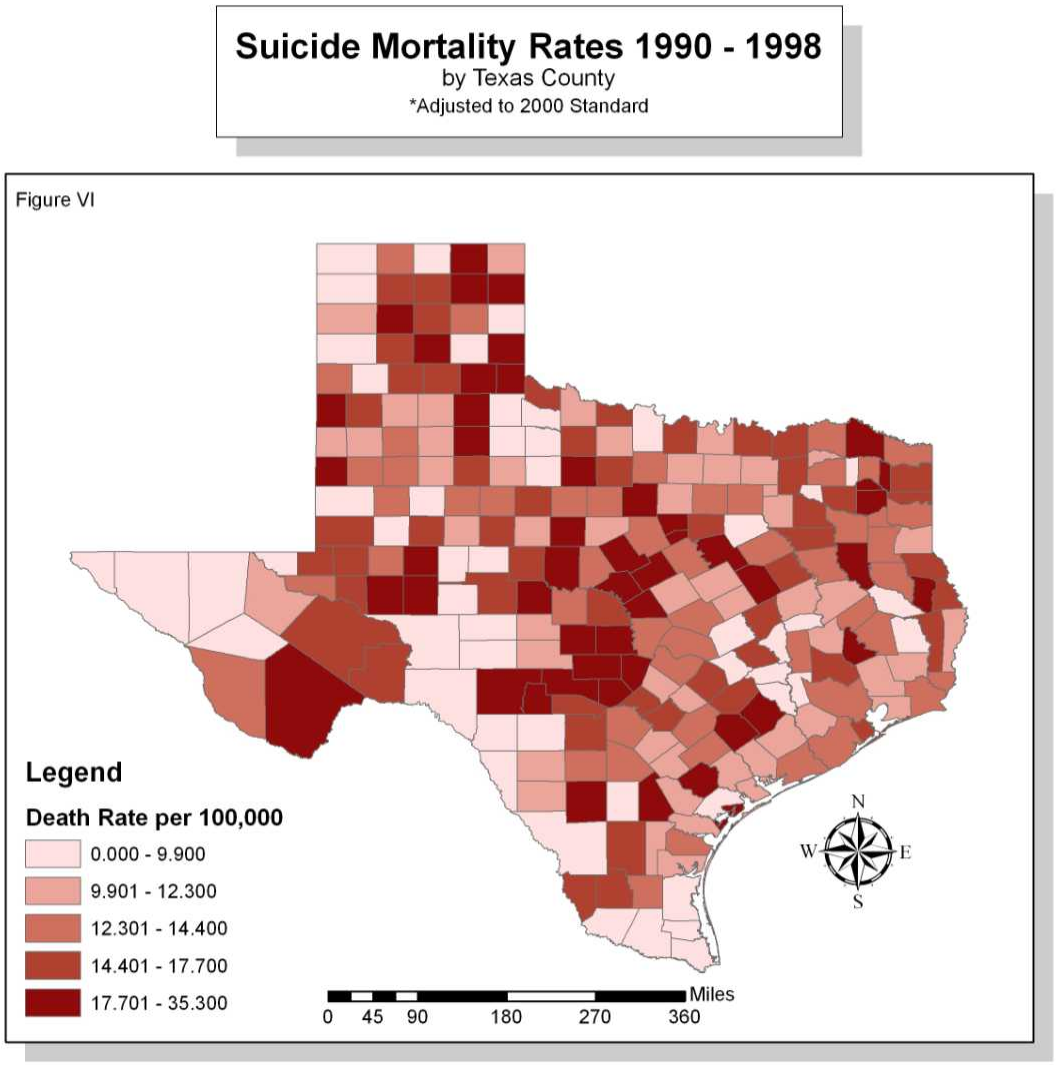

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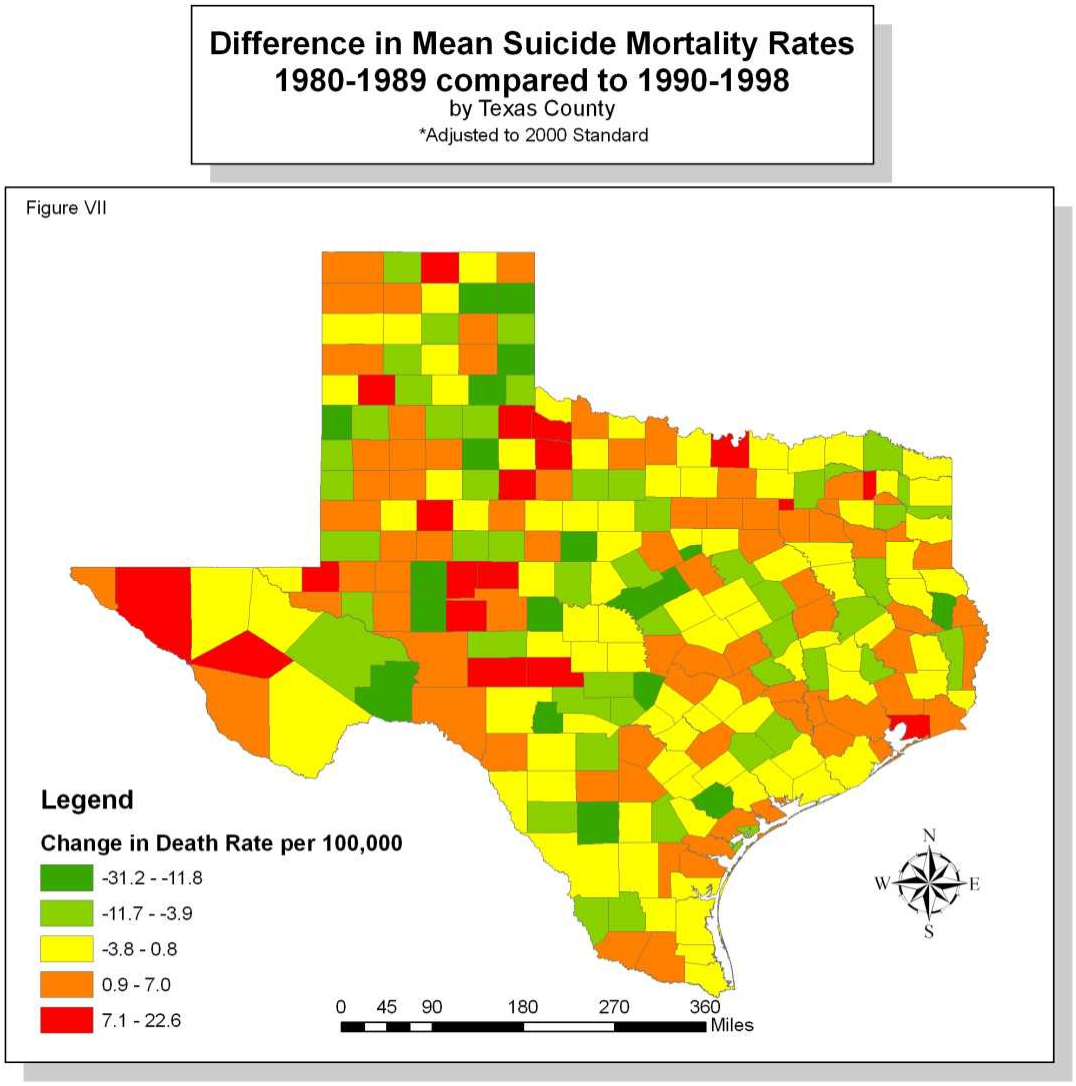
Figure 7.



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