Middle States Geographer, 2004, 37: 19-28

LIVING ALONG THE PIPELINE: POPULATIONS AT POTENTIAL RISK IN URBAN TEXAS

Susan M. Macey*
Department of Geography
Texas State University
San Marcos, TX, 78666-4616
and
Dona Schneider
Edward J. Bloustein School of Planning and Public Policy
Rutgers, The State University of New Jersey
New Brunswick, NJ, 08901-1958

ABSTRACT: *While pipeline accidents are rare, safety issues associated with residing near pipelines are of growing concern for local populations. Persons living near pipelines are at risk for property damage, injury and death associated with accidents and equipment failures. The perceived threat associated with residing near a pipeline put this issue at the forefront of the national agenda and resulted in the passage of the Pipeline Safety Improvement Act of 2002. Passage of the Act occurred without examining the non-occupational populations-at-risk for a pipeline-related incident. Therefore, we examined locational data for pipelines from the Texas Railroad Commission for five Texas city-county areas (Austin-Travis, Dallas-Dallas, Fort Worth-Tarrant, Houston-Harris and San Antonio-Bexar) along with U.S.2000 Census block group data. Using geographic information systems (GIS), Spearman correlations, and stepwise logistic regression, we evaluated the relationship between order of potential risk, as indicated by the absence or presence of a pipeline, and local population characteristics to identify populations at potential risk in urban Texas. While the overall explanatory power of the model is low, population density was found to have the most consistent explanatory power associated with the presence of a pipeline, while age, ethnicity/race and income showed mixed results.*

INTRODUCTION

Pipelines serve a vital economic role in transporting energy resources. The tradeoff is that accidents and pipeline equipment failures can cause leaks, explosions, and the contamination of local ecosystems. On rare occasions, pipeline-related incidents may cause injuries and even death to pipeline workers or other persons proximate to the equipment failure (Anonymous, 2002). Thus, while pipelines are generally the most energy efficient and safest means of transportation (Dey, 2002), they still have the potential to create a major hazard. For gas pipelines, "the probability of a failure with extended consequences has not decreased over the last years" (Papadakis, 1999, 103). In addition, it has long been recognized that media coverage increases the perceived threat (Slovic, 1986; Pilisuk et al., 1987). When a pipeline-related catastrophe happens, it grabs headlines, often producing extensive and protracted media coverage (Papadakis, 1999; Oko, 2000; Williams, 2002). Pressure from voters then pushes the health and safety issue to the forefront of the legislative agenda (Ichniowski, 2000; True, 2001). Constituents demand that pipeline safety be improved, not only to protect human health and safety, but to protect private property from environmental contamination and a loss of value.

Primarily in response to incidents such as the gas pipeline explosion in New Mexico in August 2000 that took 12 lives, the Pipeline Safety Improvement Act of 2002 (U.S. Congress, 2002) was signed into law in December of 2002, after two years in process (Fletcher, 2001; Winston and Ichniowski, 2002). The federal Office of Pipeline Safety within the U.S. Department of Transportation's Research and Special Programs Administration is responsible for regulating natural gas and hazardous liquid pipelines and enforcing regulations on pipeline design, construction, operations, maintenance, and emergency response to accidents (Office of the Federal Register, National Archives and Records Service, 2000). While the passage of legislation indicates that pipeline safety has or will be improved, the Office of Pipeline Safety which oversees public safety is widely known to be understaffed to perform its function (Felder, 1998; Pekow, 2002). The Office of Pipeline Safety's regional office in Houston is responsible for operations in Texas, Louisiana, Arizona, Oklahoma, and New Mexico, but has only 12 field inspectors assigned to it as of this writing.

Various federal and state programs ensure that particular subpopulations are not selectively disadvantaged with respect to potential technological hazard (Barlow, 1999; Committee on Environmental Justice Institute of Medicine, 1999; Gerrard, 2001). Disproportionate exposure to risk associated with policies and processes involved in locating undesirable and/or hazardous land uses for certain subgroups in the population has variously been termed environmental equity, environmental racism and environmental justice (U.S. Environmental Protection Agency, 1998). Environmental racism, first coined by Benjamin Chavis (United Church of Christ Commission for Racial Justice, 1987), is now a common theme in the technological hazard literature. Minority racial status and low income have consistently been shown to be associated with populations exposed to greater hazard risk (Mohai and Bryant, 1992; Downey, 1998; Bullard, 1999; Bullard and Johnson, 2000; Pine et al., 2002).

Few studies have examined the link between pipelines and population density, or proximity (Burke, 1993; Northridge et al., 2003). Jo and Ahn (2002) modeled various characteristics of pipelines and the potential size of the hazard area but did not extend their research to the population exposed to risk. While common in natural hazard research, age of the population exposed is rarely examined in technological hazard studies (Ngo, 2001). Intuitively, the factor would appear to be key to identifying vulnerability in the case of a pipeline accident. Population density is specifically noted in the Texas pipeline integrity assessment program (McDonald, 2000), while populated areas are specifically designated as “high consequence” areas in the federal rules and the 2002 Act (Office of the Federal Register, National Archives and Records Service, 2000; U.S. Congress, 2002).

Therefore, we followed the progress of the Act, wondering exactly which populations were at risk for a pipeline-related incident. To address our curiosity, we examined locational data for pipelines from the Texas Railroad Commission for the largest city-county units in Texas (Austin-Travis, Dallas-Dallas, Fort Worth-Tarrant, Houston-Harris and San Antonio-Bexar – see Figure 1), along with U.S. Census block group data for 2000. We asked whether there was evidence that specific sectors of the population, including young and elderly subgroups, ethnic or racial groups, or the poor are at increased risk for a potential pipeline-related incident.

While the literature on technological hazards is well established (Hohenemser et al., 1983), and vulnerability is a growing area of research in geography (Morrow, 1999; Cutter, Boruff, and Shirley, 2003), pipeline accidents have received little or no mention. Understanding who is at risk may help pipeline companies, as well as state and local emergency management agencies, address community concerns about potential explosions, leaks, and environmental contamination from pipeline failures. It may also inform public policies that create safety procedures for protecting the public, and influence guidelines for both companies and first responders who handle pipeline-related incidents.

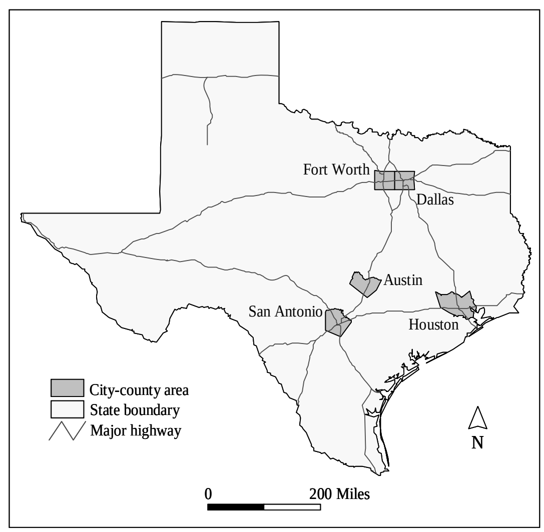

Figure 1.

DATA AND METHODS

The study sites encompass the five major urban areas in Texas and their associated counties: Austin-Travis, Dallas-Dallas, Fort Worth-Tarrant, Houston- discussion, the city name will be used in further Harris and San Antonio-Bexar (Figure 1). To simplify discussion, the city name will be used in further references to these city-county areas. These areas were chosen as providing the widest view of urban conditions in the region, and areas where potential risk would be greatest. Several studies have noted the importance of utilizing the finest scale available to more exactly represent subgroups in analyzing equity questions (Glickman, 1995; McMaster et al., 1997; Maantay, 2002). Census block groups generally contain between 250 and 550 housing units, with average block groups containing 400 households. This level of analysis was chosen to provide the finest resolution for characteristics possible, in keeping with the objective of examining risk based on proximity. Census data on demographic and housing unit characteristics for 2000 were obtained from the U.S. Census (U.S. Bureau of the Census, 2000a, 2000b).

Locational data for pipelines in the five study areas were obtained from the Texas Railroad Commission as an ArcView shapefile (Figure 2). This GIS vector file was overlain on the census block group shapefile to show those block groups where the potential for risk exists. The pipeline data table was joined with the census block group table in the GIS. The resultant data table was then sorted and block groups having any pipeline segment present were selected. To distinguish block groups where a potential hazard exists, a new variable was calculated where 0 = no pipeline present and hence zero risk; 1 = the presence of a pipeline and potential risk. While some sections of pipeline lie close to block group boundaries, we found that using a buffer around each pipeline decreased accuracy by enlarging the area designated as "at risk," particularly as many pipeline segments are found in the outskirts of the main urban areas where block groups tend to be larger in areal extent.

The data thus obtained were analyzed in two stages. First, we generated descriptive statistics to provide a background on each of the five areas, and to check that assumptions were met for further statistical procedures. As the majority of variables under study are not normally distributed, Spearman's rank order correlation was used to test the relationship between pipeline presence and census characteristics, including population size, population density, age, ethnic/racial composition, housing and income characteristics. Stepwise logistic regression was used in the predictive phase of analysis. Statistical confidence levels were set at 95%.

DISCUSSION OF RESULTS

Population attributes for the five Texas areas under study, Austin, Dallas, Fort Worth, Houston and San Antonio, are found in Table 1. All five areas grew rapidly in population size and density in the intercensal period. Austin's population grew the fastest between 1990 and 2000 (41%), although Houston remains the largest city (3.4 million persons), and Dallas the most densely populated of the five areas with 2,469 persons/square mile. Houston has the largest proportion of Black residents (18%), while San Antonio has the largest proportion of Hispanics (54%). All areas are close in age distribution, although San Antonio has a slightly larger proportion of persons aged 65 years and over (two to three percent larger than the other five cities). Median house value was lowest in San Antonio at $71,800. But along with Fort Worth, this area had the highest housing ownership (57%). Median house value was highest in Austin ($127,600), though this area had the lowest level of home ownership (49%). Austin and Fort Worth had the highest median household income in 1999, both being above $46,000. In all areas, both median household income and per capita income were lowest for Blacks and Hispanics. Poverty in all cities also was more prevalent in minority subgroups, especially among Blacks and Hispanics. In terms of the juxtaposition of pipelines and people, Houston is the most dissected with some segment of a pipeline present in over half of the block groups (see also Figure 2). Just under a third of the block groups in Fort Worth have pipelines running through them, while for Austin, Dallas and San Antonio pipelines are present in less than 20% of all block groups.

When we compared the demographic characteristics of census block groups in the five areas on the potential risk associated with the presence of a pipeline, we found multiple statistical relationships (Table 2). In all five areas, the pipeline presence was positively associated with population growth and inversely related to population density. This makes sense as all five areas grew in population, but pipelines are more likely to be found in the outer city or industrial areas rather than in more central or established residential ones.

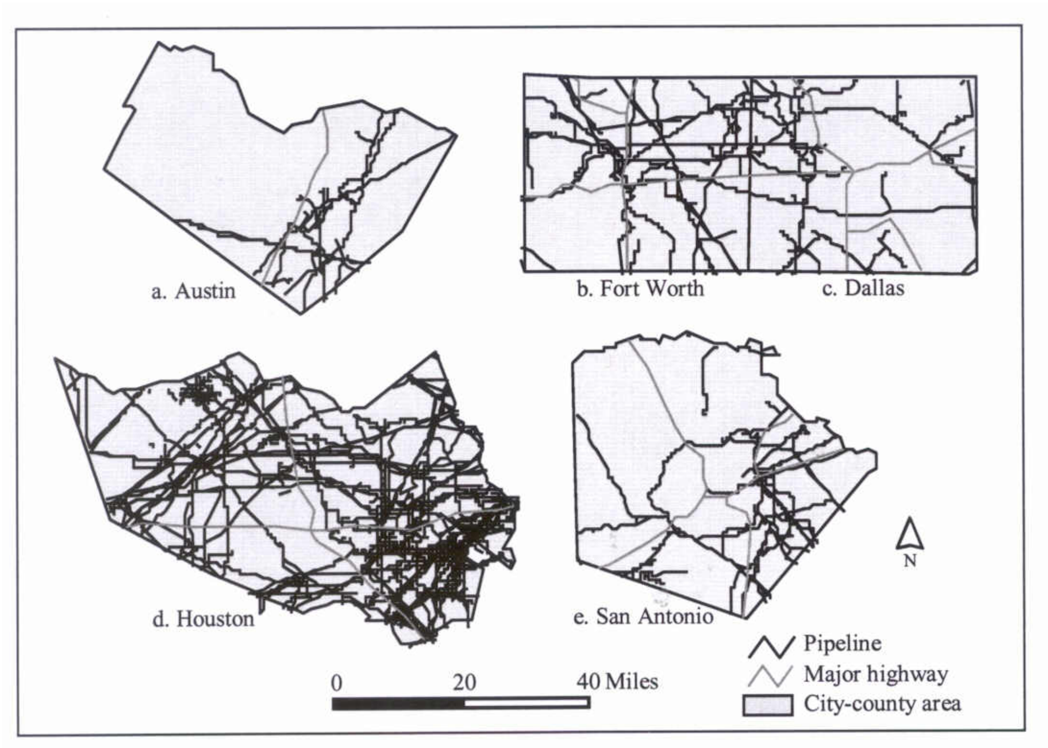

Figure 2.

Pipelines sometimes have structural space and right-of-way requirements. These requirements may limit the encroachment of new housing units proximate to some pipelines (Smith, 2002). In addition, the perceived risk of residing near pipelines or near industrial areas may lessen the demand for housing in these areas (Smith, 2002).

The historic location of pipelines also may go some way towards explaining these mixed results (Figure 2). In Austin, only 19 percent of block groups had a pipeline present, and pipelines are predominantly concentrated on the east side of the interstate highway (IH35), the major north-south artery which bisects the city. The east side is also predominantly lower income with higher percentages of ethnic/racial minority populations. In the other four areas, pipelines are much more dispersed. The greatest spread is found in Houston where 51% of block groups have pipelines running through them. However, in both Austin and Houston, a positive association was found with average household size and percent owner occupancy, while a negative relationship was found for median house value. In conjunction with the positive association with presence of children and lower population density, these relationships indicate that the development of newer residential areas which attract young families are encroaching on already established pipelines on the outskirts of Austin and Houston as suburbs spread outward. This perspective is reinforced by two other relationships: the negative association between pipeline presence and percent of the population aged 65 and older in all five areas, and the negative association between pipeline presence and percent of the total population below poverty level in three of the five areas (Dallas, Fort Worth, and Houston).

Most previous studies on pipelines have examined ethnicity/race and income separately, alluding only to their potential interaction. Except in Austin, pipeline presence is associated with higher median household income and a lower percent of the population below the poverty level. In order to give a clearer view of the specific factors at work, median

Table 1. Characteristics of the Five Texas Urban Areas

Characteristics[1]	Austin	Dallas	Fort Worth	Houston	San Antonio
Demographics					
Population 1990	576,407	1,852,810	1,170,103	2,818,199	1,185,394
Population 2000	812,280	2,218,899	1,446,219	3,400,578	1,392,931
Percent change 1990 to 2000	41	20	24	21	18
Persons/square mile 1990	548	2,061	1,301	1,618	945
Persons/square mile 2000	773	2,469	1,608	1,953	1,110
Percent urban 2000	93	99	98`	98	94
Age					
Percent under 5 years	7	8	8	8	8
Percent under 18 years	24	28	28	29	28
Percent 65 and older	7	8	8	7	10
Median age	30	31	32	31	32
Ethnic/Racial Composition					
Percent Hispanic	28	30	20	33	54
Percent Black	9	20	13	18	8
Percent Asian	4	4	4	5	2
Housing					
Average household size	2	3	3	3	3
Percent owner occupied	49	50	57	51	57
Median house value	127,600	90,800	88,600	84,200	71,800
Income					
Median household income 1999					
- Total population	46,761	43,324	46,179	42,598	38,328
- White population	52,582	53,455	51,708	56,680	49,196
- Black population	34,796	31,951	31,898	30,262	32,065
- Hispanic population	37,079	34,111	35,754	32,051	31,230
- Asian population	46,478	49,382	48,642	46,487	39,823
Per capita income 1999					
- Total population	25,883	22,603	22,548	21,435	18,363
- White population	33,801	34,154	27,764	32,679	27,987
- Black population	17,631	15,387	15,823	14,586	16,115
- Hispanic population	13,733	10,807	11,938	11,268	12,336
- Asian population	22,144	20,812	18,291	19,918	20,089
Percent below poverty level 1999					
- Total population	13	13	11	15	16
- White population	8	5	6	6	7
- Black population	18	20	20	23	19
- Hispanic population	19	21	19	23	22
- Asian population	18	11	12	13	10
Percent of block groups with pipeline present	19	14	28	51	18

[1] All data are for 2000 (U.S. Bureau of the Census 2000a, 2000b) unless otherwise noted.

household income and percent of the population below the poverty level were broken down by ethnicity/race categories. Overall, it would appear that income attributes are more consistently associated with the potential hazard risk than ethnicity/race (Table 2). With the exception of San Antonio, where Hispanics have the lowest median household income, Blacks are the lowest income group with White and Asian incomes generally above the total population average (Table 1).

We found positive relationships between pipeline presence and median household income broken down by ethnicity/race, except in Austin where higher income Whites and Asians are less likely to live in a pipeline area. The two central Texas cities, Austin and San Antonio, show no relationship between pipeline presence and Hispanic median household income. In both these areas, the percent Hispanic below the poverty level is the highest of any ethnic/racial group. Yet, Black percent below poverty level is positively associated with pipeline presence in Austin and San Antonio while the Hispanic percent below the poverty level is not. The greater concentration of the Black population in these two cities may provide a partial explanation. Black and Hispanic percent below poverty level is negatively related to pipelines in the two largest urban areas, Dallas and Houston, possibly because suburban development is responsible for increasing encroachment on pipeline areas. Overall however, the results indicate that Blacks with higher median household income are the group at more risk in every one of the areas. The greater segregation of this minority population even when household income is higher may explain this trend. Similarly, though their median household income may be higher, the Asian population remains spatially concentrated in cities like Dallas, Fort Worth and San Antonio.

To assist in interpreting these associations, stepwise logistic regression models were used for data from each of the five areas to determine the risk attributes with the most explanatory power. While the predictive power of these models is modest, they do show some consistent results. The models correctly predicted the presence of pipelines for over 70% of cases in all areas (Houston, 71% ; Fort Worth, 75% ; Austin and San Antonio, 85% ; and Dallas, 87% – see Table 3). Percent urban and population density characteristics consistently proved significant predictors of pipeline presence in all five areas. Here the relationships are negative, indicating pipelines are still more likely to be found in less urban and less densely populated areas of the city-county areas. Ethnicity/race are significant in the two central Texas areas, Austin (percent Hispanic and percent Black) and San Antonio (percent Black, and percent Asian), and in Dallas (percent Asian). Fort Worth and Houston showed no significant influence of ethnicity/race attributes in the overall model, possibly because minorities are more dispersed in these cities. Various income related characteristics – median house value (Austin, Fort Worth, and Houston), median household income (Dallas and San Antonio), and percent below the poverty level (Dallas and Houston) round out the model. The positive association between pipelines and higher median household income and housing values support the concept that suburban growth is leading to increased risk through the expansion of residential areas leading to increasing encroachment on pipeline locations. Age only contributed in two cases, Dallas (percent 65 and older), and Houston (percent under 18 years, and percent 65 and older), the two largest urban areas in the study. The direction of the relationship in these cases supports the view that young families moving into new housing may be creating risk where none was previously present.

CONCLUSION

For pipelines, a simple examination of population density may be the most effective and consistent determinant for establishing potential hazard risk areas. We found that in individual cities, while specific ethnic/racial minority groups, especially Blacks, may be more likely to live in areas at potential risk for pipeline hazards, areas with pipelines are more likely to have higher income, younger residents. In larger urban areas, like those under study here, housing expansion in outer areas may be creating the potential for hazard risk as families move into new residential subdivisions. Our results point to the importance of scrutinizing suburban expansion into previously sparsely populated areas as cities grow. A strong potential exists for increasing population risks to a technologic hazard as subdivisions sprout and encroach on pipeline areas. Further investigation is warranted to see if the patterns evident in this study of urban areas in Texas hold in other states.

Table 2. Relationship[1] between the Presence of a Pipeline and Population Characteristics

Characteristic	Austin	Dallas	Fort Worth	Houston	San Antonio
Demographics					
Population 1990	.10*	.08***	.14***	.15***	.09**
Population 2000	.15***	.12***	.17***	.21**	.12***
Percent change 1990 to 2000	.14***	.09***	.09**	.13**	.14***
Persons/square mile 1990	-.25***	-.28***	-.31***	-.37**	-.33***
Persons/square mile 2000	-.22***	-.27***	-.31***	-.33**	-.33***
Percent urban 2000	-.29***	-.23***	-.20***	-.22***	-.38***
Age					
Percent under 5 years	.25***	--	--	.11**	--
Percent under 18 years	.27***	--	--	.22**	--
Percent 65 and older	-.09*	-.10***	-.06*	-.19**	-.14***
Median age	-.17***	--	--	-.10**	--
Ethnic/Racial Composition					
Percent Hispanic	.32***	-.07**	-.10**	--	-.17***
Percent Black	.26***	--	--	--	.16***
Percent Asian	-.16***	.19***	--	--	.10***
Housing					
Average household size	.31***	--	--	.18**	--
Percent owner occupied	.12**	--	--	.18**	--
Median house value	-.34***	.07**	.10**	-.06**	--
Income					
Median household income 1999					
- Total population	-.12**	.10***	.12***	.10***	.07*
- White population	-.14**	.08***	.11***	--	--
- Black population	.13**	.18***	.08**	.15***	.14***
- Hispanic population	--	.09***	.07*	.13***	--
- Asian population	-.14***	.15***	.07*	--	.11***
Percent below poverty level 1999					
- Total population	.10*	-.12***	-.12***	-.13***	--
- White population	--	--	--	--	.10***
- Black population	.17***	-.08***	--	-.07**	.07*
- Hispanic population	--	-.07**	-.06*	-.10***	--
- Asian population	--	.13***	--	--	--

[1] Spearman's rho coefficient: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 3. Results of Stepwise Logistic Regressions

Characteristic **City (County)**	B	S.E.	Wald	Sig.	Exp(B)	Percent correctly explained
Austin (Travis)						85.1
Percent Hispanic	.0266	.007	13.087	.000	1.027	
Percent urban	-.0145	.006	6.063	.014	.986	
Persons/square mile	-.0003	.000	19.089	.000	1.000	
Median house value	.0000	.000	15.358	.000	1.000	
Population	.0004	.000	12.988	.000	1.000	
Percent owner occupied	.0129	.006	4.503	.034	1.013	
Percent Black	.0171	.009	3.917	.048	1.017	
Constant	.0271	.806	.001	.973		
Dallas (Dallas)						87.4
Percent urban	-.0331	.007	2.438	.000	.967	
Median Black household income 1999	.0000	.000	7.222	.007	1.000	
Percent Asian	.0519	.012	19.526	.000	1.053	
Persons/square mile	-.0002	.000	59.994	.000	1.000	
Population	.0004	.000	16.914	.000	1.000	
Percent Asian below poverty level 1999	.0131	.004	12.701	.000	1.013	
Percent 65 and older	-.0484	.015	1.006	.002	.953	
Percent below poverty level 1999	-.0370	.010	14.665	.000	.964	
Median household income 1999	.0000	.000	4.545	.033	1.000	
Constant	2.6746	.790	11.474	.001		
Fort Worth (Tarrant)						75.0
Persons/square mile	-.0003	.000	72.684	.000	1.000	
Population	.0007	.000	57.110	.000	1.001	
Percent urban	-.0216	.008	6.524	.011	.979	
Median house value	.0000	.000	7.510	.006	1.000	
Constant	1.6555	.829	3.984	.046		
Houston (Harris)						70.7
Persons/square mile	-.0002	.000	121.098	.000	1.000	
Population	.0005	.000	68.260	.000	1.001	
Percent under 18 years	.0610	.009	43.371	.000	1.063	
Percent below poverty level 1999	-.0293	.005	35.964	.000	.971	
Median house value	.0000	.000	26.161	.000	1.000	
Percent urban	-.0975	.040	5.822	.016	.907	
Percent 65 and older	-.0239	.011	4.841	.028	.976	
Constant	9.0820	4.047	5.035	.025		
San Antonio (Bexar)						85.0
Percent urban	-.0240	.005	26.927	.000	.976	
Persons/square mile	-.0003	.000	4.448	.000	1.000	
Population	.0003	.000	17.314	.000	1.000	
Percent Black	.0159	.006	6.803	.009	1.016	
Median household income 1999	.0000	.000	1.076	.002	1.000	
Percent Asian	.0983	.035	7.760	.005	1.103	
Constant	1.7352	.485	12.809	.000		

REFERENCES

Anonymous 2002. Pipeline Explosion Suit Settled for $75 Million. *ENR* 248, no. 16: 19.

Barlow, C.D. 1999. State Environmental Justice Programs and Related Authorities. In *The Law of Environmental Justice: Theories and Procedures to Address Disproportionate Risk*, M. B. Gerrard ed. 140–56. Chicago, IL: American Bar Association.

Bullard, R.D. 1999. Dismantling Environmental Racism in the USA. *Local Environment* 4(1): 5–19.

Bullard, R.D. and Johnson, G.S. 2000. Environmental Justice: Grassroots Activism and its Impact on Public Policy Decision Making. *Journal of Social Issues* 56(3): 555–78.

Burke, L.M. 1993. Race and Environmental Equity: A Geographic Analysis in Los Angeles. *Geo Info Systems* 3(9): 44–5.

Committee on Environmental Justice, Institute of Medicine 1999. *Toward Environmental Justice: Research, Education, and Health Policy Needs*. Washington, D.C.: National Academy Press.

Cutter, S.L., Boruff, B.J. and Shirley, W.L. 2003. Social Vulnerability to Environmental Hazards. *Social Science Quarterly* 84(2): 242–61.

Dey, P.K. 2002. An Integrated Assessment Model for Cross-country Pipelines. *Environmental Impact Assessment Review* 22(6): 703–21.

Downey, L. 1998. Environmental Injustice: Is Race or Income a Better Predictor? *Social Science Quarterly* 79(4): 766–78.

Felder, R.B. 1998. Building Experience With Risk Management. *Pipeline & Gas Journal* 225, no. 9: 44–7.

Fletcher, S. 2001. U.S. Senate Ready to Act on Pipeline Safety as Public Attention Sharpens. *Oil & Gas Journal* 99 (6): 58.

Gerrard, M.B. 2001. Reflections on Environmental Justice. *Albany Law Review* 65(2): 357–65.

Glickman, T.S. 1995. *Evaluating Environmental Equity in Allegheny County. Discussion Paper 95–13*. Washington D.C.: Resources for the Future.

Hohenemser, C., Kates, R.W., and Slovic, P. 1983. The Nature of Technological Hazard**.** *Science* 220(4595): 378–84.

Ichniowski, T. 2000. Pipeline Safety Legislation Spurred on by Accident. *ENR* 244(18): 11.

Jo, Y.D., and Ahn, B.J. 2002. Analysis of Hazard Areas Associated with High-Pressure Natural-Gas Pipelines. *Journal of Loss Prevention in the Process Industries* 15(3): 179–88.

Maantay, J. 2002. Mapping Environmental Injustices: Pitfalls and Potential of Geographic Information Systems in Assessing Environmental Health and Equity. *Environmental Health Perspectives Supplements* 1101(2): 161–71.

McDonald, M.R. 2000. Pipeline safety regulations Subchapter B. Requirements for Natural Gas and Hazardous Liquids Pipelines. *Texas Register* 25: 11620-11622.

McMaster, R.B., Leitner, H. and Sheppard, E. 1997. GIS-Based Environmental Equity and Risk Assessment: Methodological Problems and Prospects. *Cartography and Geographic Information Systems* 24(3): 172–89.

Mohai, P. and Bryant, B. 1992. Environmental Racism: Reviewing the Evidence. In *Race and the Incidence of Environmental Hazards: A Time for Discourse*, eds. B. Bryant and P. Mohai, 163–76. Boulder, CO: Westview Press.

Morrow, B.H. 1999. Identifying and Mapping Community vulnerability. *Disasters* 23(1): 1–18.

Ngo, E.B. 2001. When Disasters and Age Collide: Reviewing Vulnerability of the Elderly. *Natural Hazards Review* 2(2): 80–9.

Northridge, M.E., Stover, G.N., Rosenthal, J.E., and Sherard, D. 2003. Environmental Equity and Health: Understanding Complexity and moving Forward. *American Journal of Public Health* 93(2): 209–14.

Office of the Federal Register, National Archives and Records Service 2000. Federal Register: Part III Department of Transportation Research and Special Programs Administration 49 CFR Part 195 Pipeline Safety: Pipeline integrity management in high consequence areas (Hazardous liquid operators with 500 or more miles of pipeline); Final Rule., 65, no. 232:75378–75411. Washington, D.C.: Superintendent of Documents U.S. Government Printing Office.

Oko, D. 2000. Blazing Controversy: Naked City. *Austin Chronicle*, October 27, 2000.

Papadakis, G.A. 1999. Major Hazard Pipelines: A Comparative Study of Onshore Transmission Accidents. *Journal of Loss Prevention in the Process Industries* 12(1): 91–107.

Pekow, C. 2002. Lines of Fire: The Only Thing Standing Between You and a Deadly Oil Pipeline Accident is Washington's Most Hapless Regulatory Agency. *Washington Monthly*, 33–8.

Pilisuk, M., Parks, S.H., and Hawkes, G. 1987. Public Perception of Technological Risk. *The Social Science Journal* 24(4): 403–13.

Pine, J.C., Marx, B.D., and Lakshmanan, A. 2002. An Examination of Accidental-Release Scenarios from Chemical-Processing Sites: The Relation of Race to Distance. *Social Science Quarterly* 83(1): 317–31.

Slovic, P. 1986. Informing and Educating the Public About Risk. *Risk Analysis* 6(4): 403–15.

Smith, A. 2002. Living By the Line. *Home* 21(24).

True, W.R. 2001. Regulatory Actions Loom for U.S. Pipelines in 2001. *Oil & Gas Journal* 99(1): 7.

United Church of Christ Commission for Racial Justice 1987. *Toxic Wastes and Race in the United States: A National Report on the Racial and Socioeconomic Characteristics of Communities with Hazardous Waste Sites.* New York: United Church of Christ.

U.S. Bureau of the Census 2000a. Census of Population and Housing, Summary Tape File 3A. Department of Commerce, Washington D.C.

U.S. Bureau of the Census 2000b. Census of Population and Housing, Summary Tape File 4A. Department of Commerce, Washington D.C.

U.S. Congress 2002. Public Law 107–355 Pipeline Safety Improvement Act of 2002. *U.S. Statutes at Large* 116: 2985–3012.

U.S. Environmental Protection Agency, Office of Federal Activities 1998. *Final Guidance for Incorporating Environmental Justice Concerns into EPA's NEPA Compliance Analyses*. Washington, D.C.: U.S. Government Printing Office.

Williams, B. 2002. Buried Threats. *Oil and Gas Journal* 100(18): 21.

Winston, S., and Ichniowski, T. 2002. House Panel Approves Safety Bill. *ENR* 248(21): 9.