MIDDLE STATES GEOGRAPHER - VOL. 28, 1995

DISASTER: THE UNNATURAL FACTOR

Kerrie Fanton
Undergraduate Major, Geological Sciences
c/o Department of Geography
S.U.N.Y. Geneseo
Geneseo, NY 14454

ABSTRACT: Different types of natural disasters occur every day around the world. This paper explores just how natural these disasters are by observing how the level of destruction may be related to human-induced factors. These factors include population density, health care quality, and economic status. Forty-nine selected countries were studied. For each country the average number of deaths per reported disaster was calculated and set as the dependent variable. The explanatory power of human environmental factors proved to be generally weak. Analysis of residuals revealed noteworthy global-regional clusters.

The struggle between man and nature has been a continuing conflict since the beginning of time, with always the unanswered question of which one will overcome the other. One irony of the struggle is that humanity routinely worsens the impact of nature's hazards by ill-advised settlement and human activity. Research has shown that over the past two decades calamitous disasters have become more frequent, and that with each individual disaster the death toll has tended to worsen (Wijkman, Timberlake, 1984, p. 11). But at the same time it has also been observed "that there is no evidence that the climatological mechanisms associated with droughts, floods, and cyclones are changing... or that the earth movements associated with earthquakes, volcanoes and tsunamis are becoming more violent" (Wijkman, Timberlake, 1984, p. 11). If so this would seem to indicate the presence of human controlled factors that allow the disasters of similar magnitude to kill more people than they used to. When human controlled factors such as population density, economic status, and life expectancy were all plotted against the number of deaths per disaster in forty nine selected countries a relationship between the three factors and the average death toll from disasters was apparent.

The data used for comparison were obtained from several different sources. The average death toll per disaster was taken from a chart in Natural Disasters, Acts of God or Man? by Anders Wijkman and Lloyd Timberlake. The chart is a list of countries with the number of disasters occurring from 1980 to 1981 for each country and the number of overall people who died in each country because of the total disasters. Although the authors discuss the problem of defining what exactly qualifies as a disaster, they never resolve the problem with an all-embracing technical definition. Nonetheless, for the purposes of this analysis we will accept the authors' somewhat subjective identification of disasters in the forty nine countries reported. The rest of the data obtained, which included population density, GNP per capita, persons per physician, crude death rate, and life expectancy were taken from the 1981 United Nations Statistical Yearbook, and the 1981 World Almanac.

Six factors were correlated with the average death toll for the forty nine countries, with few significant coefficients obtained. Then after creating natural log values for each of the six factors, the average death toll was regressed against a combination of logged and unlogged values, for up to three dependent variables. The combination that produced the best results was a regression of mortality on three variables -- population density, log GNP per capita, and life expectancy.

Population density within the plot was shown to have a weak but significant linear relationship with deaths per disaster. As population density increased, so in general did the number of deaths. This idea logically makes sense, a country with a closely packed population that experiences a major disaster is going to have more people affected by the catastrophe.

A prime example of where population density has a large role in the death toll is Bangladesh, where the average density is 2028 people per square mile. When the monsoons come each year the storms kill many people, not just by the monsoon's severity, but because people are so closely packed together on the flood-prone land. Just such a calamity occurred in November of 1970 when the combination of a cyclone and 50 foot high tidal wave ripped through Bangladesh, killing at least 300,000 inhabitants. Then again in July and August of 1974 over 2,000 people died, and up to a million were reported injured by a monsoon induced flood that covered Bangladesh for the duration of the two summer months. On a smaller scale population density plays a role in the deaths due to flooding along such major rivers as the Nile in Egypt, or the Yellow River in China. People live crowded along these river banks because of the life giving water, and rich soil, but at the same time they play a deadly game of survival against the floods that come each year.

The second factor, economic status, represented by GNP per capita, had an inverse relationship to deaths per disaster, as GNP per capita increased, death toll decreased. The correlation coefficient between disaster mortality and per capita GNP was -.175, not a significant association at the 95% confidence level. As the second independent variable in the multiple regression model, however, per capita GNP was highly significant ($p = .002$) once the variance attributable to population density had been removed. Therefore when considering two countries of comparable population density, the death toll tends to be appreciably lower in the wealthier settings. There are many reasons to believe this generalization. GNP per capita is simply a reflection of several factors which influence disaster mortality.

One such factor is technology. A wealthier country is usually more technologically advanced, and therefore it usually has more sophisticated ways of dealing with disaster. An example is earthquake resistant technology; consider Los Angeles and Tangshan, China. The city of Tangshan, before the earthquake in 1976, was constructed mostly of cheap, easily erected prefabricated cement buildings which collapsed like a house of cards when the earthquake struck. The death toll was upwards of 300,000 people. On the other hand in Los Angeles many buildings are constructed especially to withstand the force of the quakes, by building shock absorbers into the foundation or using the most resistant and well put together material available. The same idea applies to the ability of a country to build levees for floods, irrigation systems for drought and other preventative measures for disaster.

Another aspect of economics is that poorer countries tend to participate in activities that will increase the destructiveness of a disaster when it occurs. The major example of this is deforestation, whether it's to clear land for farming or to sell the wood for profit. Poorer countries tend to put short term economic gains ahead of the potential for disaster they are creating. One scenario of this is in the Sichuan province of China where deforestation began early in the last century in order to build imperial castles. Then in the late nineteen-fifties deforestation began again as people cut down trees to fuel their backyard smelting furnaces, as they participated in Mao's steel making promotion.

Trees were again cut down later in the sixties for farmland under the "grain first" campaign.

Now the lack of vegetation allows the silty soil around the Yellow river to be eroded easily as there is nothing to stop the heavy flow of runoff as it heads for the river. When all the silt enters the river it displaces water and causes water levels to rise, at the same time as the heavier particles are settling and building up the bottom, thus increasing the ability of the river to flood. Also when there is no vegetation to stop the flow of heavy rains the water never soaks into the soil and can bring on drought-like conditions, especially in tropical climates where the majority of rainfall comes in short hard bursts.

The third factor compared to the number of deaths per disaster was life expectancy; as life expectancy increased the number of deaths per disaster decreased. As with GNP per capita, the simple linear correlation coefficient between life expectancy and disaster mortality was insignificant at a value of -.056. But if life expectancy is examined as the third independent variable in the multiple regression model it has a moderately significant result (p= .031) once the variance due to the other two factors had been removed. If two countries with similar population densities, and per capita GNP are compared, then the death toll is lower in those countries with high life expectancies.

This makes sense, since in a country like India, where people are only expected to live to the age of forty six to begin with, then how are they expected to be able to live through a major disaster? Life expectancy can be seen as a representative of a country's overall level of public health care, and social welfare. This concept is illustrated by comparing China and India, where both countries have fairly similar population densities and GNP per capita. However when a comparison is made between life expectancy, China shows an average 66 years, while India's life expectancy is 60. This is a direct result of the two countries' public health plans. China has been able to implement broad basic care throughout the country. This can be observed by comparing statistics such as number of persons per physician, where China has 643 persons per physician, India has 2471. The same trend occurs with the crude death rate. India's crude death rate is 43 percent higher than that of China. China has used its resources to devise and implement a better health care plan than India, and in a disaster situation China will probably be better able to take care of casualties and other health related situations.

The final model shows that a highly populated, economically depressed country, with poor living conditions is more likely to have people die in a disaster. The multiple regression model incorporating population density, logged per capita GNP and life expectancy yielded intercept and slope coefficients significant at the 95 percent level or better, and a multiple r-squared of 29.4 percent and 24.7 percent adjusted for the degrees of freedom in the regression design. Of the variance in y 'explained' by the three independent variables, the contribution of each variable was as follows:

Population Density:	36.0%
Log GNP per capita:	37.6%
Life Expectancy:	26.3%

However, it is true that the model fails to 'explain' three quarters of the variance in the disaster mortality, and the standardized pattern of residuals from the best-fit model warrants scrutiny.

Some countries don't fit the model well. They have exceptionally high disaster related death rates, like China, Peru, and Bangladesh. These death rates turn out to be much higher than would be predicted given the country's economic status, and population density. However in each case this seems to reflect the role of one major catastrophe that killed a majority of the people that make up the high reported death toll over the two decades. One example would be the Chinese earthquake in Tangshan, which accounts for approximately ninety eight percent of the deaths reported for China.

The same is true for Peru where an earthquake in Yungay accounted for seventy-seven percent of the reported deaths in that country. In Bangladesh it was one exceptionally bad flood in 1970 which accounted for forty seven percent of the deaths. One other problem with the model is the large amount of influence Bangladesh has on the parameters of the regression. Bangladesh anchors the slope of the population density graph/mortality scatterplot.

The idea is simple and logical that the death toll in a disaster is dependent on three variables: population density, per capita GNP and life expectancy -- all unrelated to disaster severity per se. Instead they are directly linked to situations created by humanity -- living in unsafe areas, having insufficient technological development, or having unsanitary and poorly developed health care conditions. Sadly they are conditions which are very difficult to correct. Therefore for the time being these are factors that will continue to influence the disaster -- related death rate in countries that are over-populated, underdeveloped, and have poorly organized social welfare systems.

WORKS CITED

"China." Colliers Encyclopedia. 1992 ed.

Davis, Lee. Natural Disasters. New York: Facts On File, 1992.

Ebert, Charles. Disasters. Dubuque: Kendall/Hunt Publishing Company, 1988.

"India." Colliers Encyclopedia. 1992 ed.

1981 United Nations Statistical Yearbook. United Nations, 1981.

Wijkman, Anders and Lloyd Timberlake. Natural Disasters: Acts of God or Acts of Man? Washington: International Institute for Environment and Development, 1984.

TABLE 1. DISASTER MORTALITY AND POTENTIAL ASSOCIATED CHARACTERISTICS: A 49-COUNTRY PROFILE

Country	Average Mortality, Persons per Disaster 1960-1981	Population Density p.p.s.m., 1980	GNP Per Capita 1980 U.S.dollars	Life Expectancy years, 1980
China	12350*	409	360	66
Bangladesh	10047	2028	180	45.8
Ethiopia	6438	112	130	37.5
Nicaragua	6235	73	470	53.5
Peru	2935	45	898	52.59
Somalia	1727	27	170	40.9
Iran	1263	92	1400	57.63
Morocco	722	151	990	53.8
Honduras	646	114	960	55.4
India	625	683	350	46.4
Chile	471	45	2130	61.30
Vietnam	400	530	2309	51.1
Haiti	376	594	440	49.1
Turkey	364	194	3100	53.7
Pakistan	352	378	380	53.72
Dominican Republic	330	394	998	57.15
Indonesia	288	262	490	47.5
Italy	254	496	14600	69.69
Philippines	224	567	700	59.1
Algeria	190	28	2170	54.4
Chad	164	11	190	29.0
Spain	158	202	11100	70.41
Nepal	153	349	160	44.0
Thailand	130	286	1170	53.6
S. Korea	107	1134	5600	62.70
Yugoslavia	107	265	5040	65.42
Sri Lanka	106	687	380	64.8
Brazil	105	45	2540	57.61
Mozambique	84	49	110	44.4
South Africa	75	85	2600	58.9
Mexico	70	118	2680	62.76
Colombia	69	76	1300	60.0
Japan	63	850	17100	73.46
Burma	58	160	408	51.0
Afghanistan	45	65	220	40.0
Mali	42	17	250	40.6
Argentina	38	30	2134	65.16
Laos	36	44	503	42.1
Madagascar	32	53	200	37.5
Malaysia	31	141	2460	67.12

Ecuador	30	98	1040	59.51
Sudan	28	28	330	45.5
Bolivia	25	26	690	46.5
Gambia	18	211	230	39.4
Greece	13	196	7650	70.13
Panama	9	84	1980	64.26
Costa Rica	4	158	1810	66.26
Senegal	4	104	615	40.6
Mauritius	2	1366	1950	60.68

Sources: United Nations Statistical Yearbook; Natural Disasters: Acts of God or acts of man?; 1980 World Almanac.

NOTE: *Average mortality per disaster reported for China must be higher than the figure reported by Wijkman and Timberlake (Tangshan alone would yield a higher value for the two decades covered). I was, however, unable to discover an accurate alternative estimate for the People's Republic of China.

MULTIPLE REGRESSION MODEL, N = 49 COUNTRIES

$y = 3901 + 1.93x1-1445x2+118x3$

y = DEATH TOLL PER DISASTER, PREDICTED

x1 = POPULATION DENSITY, PERSONS PER SQUARE MILE

x2 = log GNP PER CAPITA, DOLLARS

x3 = LIFE EXPECTANCY, YEARS

R-squared = 24.7 percent (adjusted for degrees of freedom)

$t_a = 2.21, p = .032$

$t_{x1} = 2.33, p = .025$

$t_{x2} = 3.34, p = .002$

$t_{x3} = 2.22, p = .031$
