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Social vulnerability and the natural and built environment

A model of flood casualties in Texas

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Socially vulnerable populations suffer disproportionately in terms of property damage, injury, and death. Social vulnerability (SV) is the possession of social attributes that increase susceptibility to disasters.

Texas consistently outranks all states in deaths, injuries, and property loss resulting from floods, with its death rate by storms and floods more than double the national rate. Researchers including Texas A&M-based Walter Gillis Peacock, Samuel D. Brody, and Arnold Vedlitz (of the Bush School of Government and Public Service) hypothesized that higher levels of social vulnerability result in higher flood casualties in Texas counties. The researchers evaluated natural environment variables like day-of and day-before precipitation; built environment variables including dams and impervious surfaces; and socioeconomic variables such as population density, local preparedness, and presence of socially vulnerable populations. Local preparedness was measured by FEMA Community Rating System (CRS), which assigns scores to communities based on enacted mitigation strategies and provides corresponding insurance premium discounts.

FINDINGS

Researchers found that heavier rainfall the day before a flood event lowered the odds of death and injury; perhaps perceived seriousness increased safety efforts including evacuation.

Additionally, for every unit increase in FEMA insurance discount (which reflects local mitigation), the odds of death and injury decreased by 8.6 percent.

An increase in the number of dams actually reduced the probability of a casualty-free flood, possibly because dams are likely to appear in areas with higher flood counts and

In Hurricane Audrey (June 1957), blacks experienced significantly higher death rates (322 deaths per 1000) compared to whites (38 per 1000). This tragedy illustrated how disasters can disproportionately affect different populations when types of households are limited to hazardous locations or inadequate homes and are less equipped to anticipate, resist, and recover from disaster. According to Mark Pelling, United Nations Development Program:

"Natural disasters are in fact social disasters waiting to happen that may be triggered by a particular natural force."

TOP 3 TEXAS COUNTIES IN TERMS OF FLOOD CASUALTIES

Since property damage corresponds to flood force, level of property damage and flood casualties are linked. The top 3 Texas counties in terms of flood casualties are listed below, with property loss in 2007-adjusted USD:

1. COMAL 1060 casualties (1058 injuries, 2 deaths)
Property loss: 127.4 million
2. BEXAR 891 casualties (880 injuries, 11 deaths)
Property loss: 36.6 million
3. GUADALUPE 859 casualties (854 injuries, 5 deaths)
Property loss: 89.1 million

In Texas, flash floods are responsible for the majority of flood-related injuries and deaths due to intense periods of rainfall coupled with poor soil composition. Central Texas is the most flash flood-prone area in North America, termed “Flash Flood Alley” by the Flood Safety Education Project.



therefore higher odds of injury or death by a flood. However, short of structural failure, dams seemed to help mitigate flood casualties.

Moreover, a single unit increase in the level of socially vulnerable or disadvantaged populations in a county increased odds of death or injury by 42.4%. Therefore, as predicted, localities with a higher composition of poor and minority residents are more likely to experience injury and death from flooding.

In urban areas, impervious surfaces caused rainwater to reach streams and produce floods more quickly because the hydrological system could not effectively store water. However, impervious cover was insignificant compared to the social vulnerability factor.

STRATEGIES AND IMPLICATIONS

First, amount of precipitation is not as important as its timing: “It is vital that decision-makers and the public understand that sunny skies followed by heavy precipitation can result in dangerous flooding immediately, rather than several days later.” Further, rainfall before a flood weakens the absorption capacity of hydrologic systems, increasing the probability of property damage on the day of the flood.

Second, structural solutions to flood mitigation significantly reduce flood casualties. However, dams are extremely costly alternatives that require substantial public investment. They can also intensify development in flood-prone areas, increasing the presence of vulnerable populations by giving residents a false sense of security. Decision-makers should also consider that dams and related structures can present a hazard in the event of structural failure.

Third, non-structural mitigation solutions (policies and community preparedness) significantly lower risks. Communities engaging in public information, mapping and regulations, and damage reduction in exchange for reduced flood insurance premiums experience fewer flood-related casualties. The success of these strategies may explain why a decreasing percentage of floods in the U.S. involve death and injury, while the country's number of floods, population size, and property damage from floods have increased.

Fourth, communities with socially vulnerable populations tend to experience more casualties in a flood event. Flood impacts are unequally distributed in communities by their racial and income composition. This finding lends support to broader policy reform combatting poverty, inequality, and socioeconomic segregation, since the probability of a casualty-free flood event increases with a decrease in the percentage of socially vulnerable persons in an area.

The researchers analyzed 832 flood events in Texas counties from 1997–2001 using data from the Spatial Hazard Events and Losses Database for the United States (SHELDUS), which in turn derives its data from public sources such as National Climatic Data Center publications. In terms of socially vulnerable populations, it is likely that resource constraints contribute to the failure of low-income and minority households to evacuate in the event of a flood. These may include:

- lack of privately owned vehicles
- ineffective public transit
- few refuge alternatives outside evacuation zones

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