Geographic Information Systems helped to forecast how ground motions generated by scenario earthquakes would be distributed to different buildings within a region.

Mapping the Data

With a study of this size, we needed a system that could analyze large amounts of data. Our solution was Geographic Information Systems (GIS) technology. GIS is a computer system capable of capturing, storing, analyzing, and displaying large amounts of geographically referenced information. (See http://erg.usgs.gov/isb/pubs/gis_poster/).

To begin, we used GIS to develop geographically based databases and map them in relation to one another. We were able to highlight areas of interest and view, understand, question, interpret, and visualize the data in ways that weren't possible until mapped and related. With this system, we were able to identify and model a variety of hypothetical earthquake scenarios and their probable consequences.

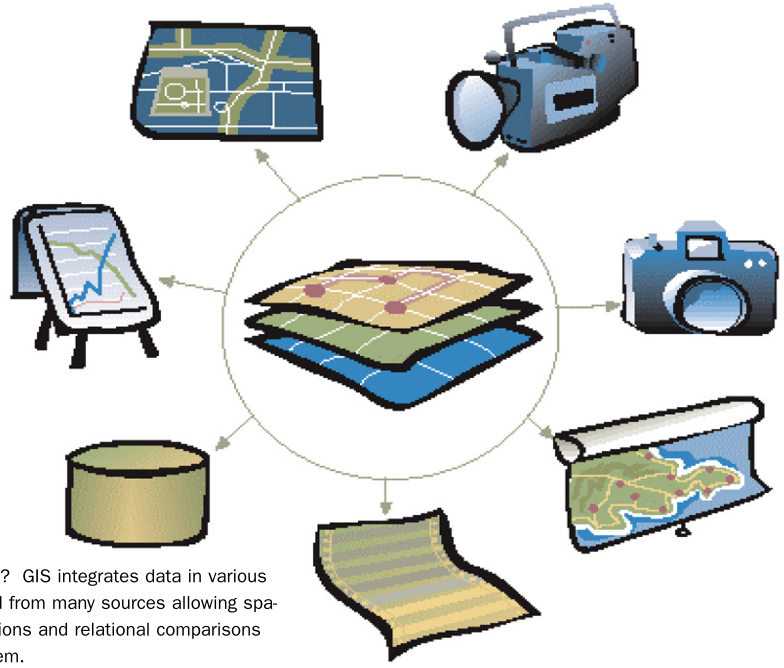
Forecasting Locations

With GIS technology, we were able to relate different information in a spatial context and reach a conclusion about these relationships. For example, using data about soil and the age, size, and value of buildings, we were able to relate the intensity of ground motions to every building in the region and estimate *what losses* might result. Moreover, we were able to forecast how earthquake ground motions generated by likely scenario events would be distributed to different buildings within a region.

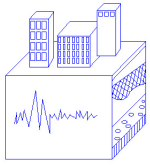
Additional information was linked to population information, distance to the nearest hospital, police station, fire station, and more. All in all, GIS tools and methods enhanced the efficiency and analytical power of traditional cartography.

Using Risk Assessment Software

In partnership with the National Institute for Building Sciences, FEMA's Mitigation Division has developed a risk assessment software program, *Hazards US* (*HAZUS*), for analyzing potential losses from earthquakes, floods, and hurricane winds. The software uses the latest scientific and engineering knowledge, plus GIS technology, to produce estimates of hazard-related damage before or after a disaster occurs, including social impacts, physical damage, and economic loss (See http://www.fema.gov/hazus/). Using *HAZUS* risk assessment software, we were able to estimate the scale and extent of damage and disruption that may result from potential earthquakes in the NY-NJ-CT region.



What is GIS? GIS integrates data in various formats and from many sources allowing spatial calculations and relational comparisons between them.



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Calculating Potential Losses

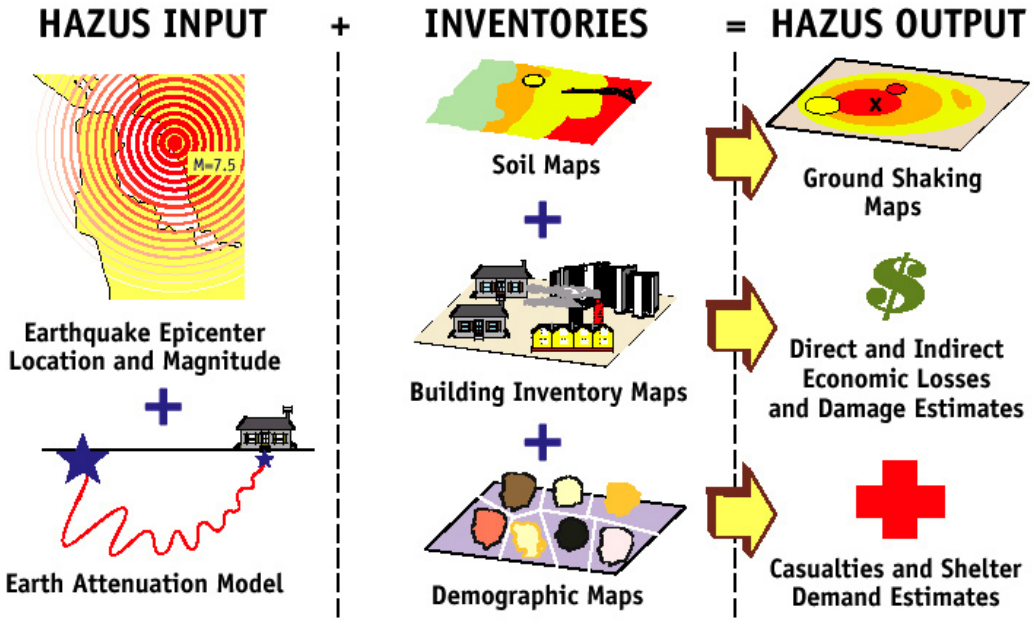
The figure on this page illustrates how *HAZUS* software calculates potential losses. Once the size and location (epicenter) of a hypothetical earthquake is selected, the software uses a series of mathematical formulas to calculate the intensity of ground shaking, the amount of damage, the disruption and economic losses caused by the earthquake, the number of casualties, and the number of people displaced by damaged structures. Moreover, by changing the size and location of hypothetical earthquakes, we were able to see the range of damage that may occur in the community.

To generate more accurate estimates, we incorporated region-specific "inventories," including soil maps, building inventory maps, and demographic maps. The "outputs" from these inventories are illustrated in the figure on this page:

- Information on soil conditions helped determine the estimated shaking intensity that a structure would experience; regions with softer soil tend to have a greater likelihood of damage.
- Building inventory maps (e.g., how buildings were constructed, how old, how tall, their value, etc.) were essential for calculating economic losses and estimating damages.
- Demographic information enabled *HAZUS* to determine casualties and shelter requirements for various earthquake scenarios.

Why Do We Need to Estimate Earthquake Losses?

If we can predict which parts of the community would experience the most violent shaking, which buildings would sustain the greatest damage, and which areas would likely sustain the most casualties, then we can develop appropriate emergency response plans and engineer buildings and infrastructures to withstand earthquakes. Loss estimates can also help state and federal governments plan for assistance to jurisdictions and disaster victims.



Using Geographic Information Systems (GIS) technology, the *HAZUS* methodology computes estimates of damage and loss that could result from an earthquake.