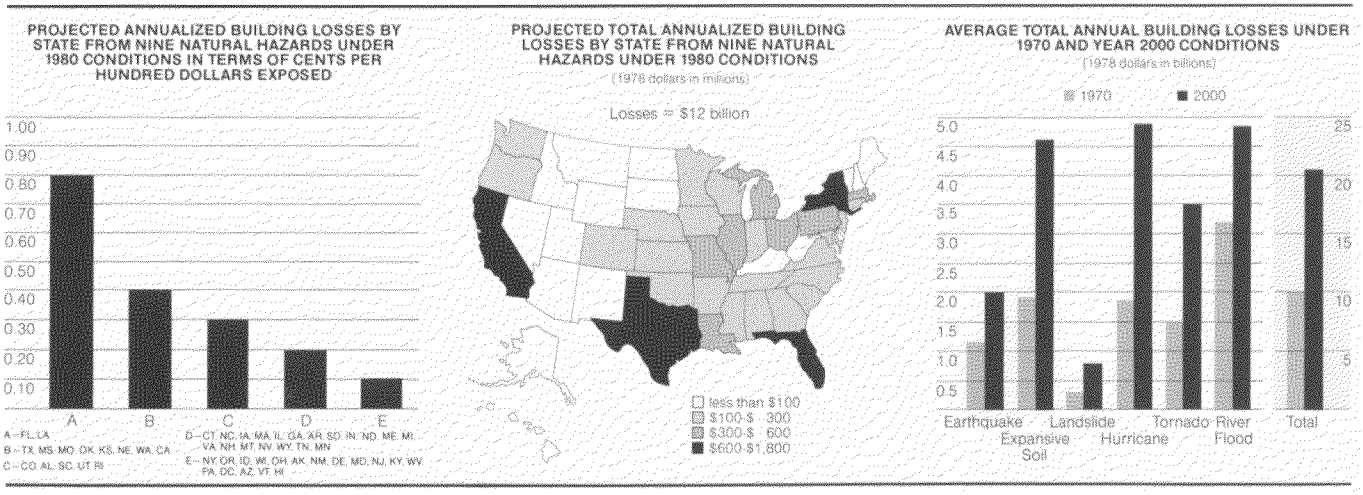


Unless significant new steps are taken, the cost of replacing or repairing buildings destroyed and damaged by the nine natural hazards studied, during a typical year, are likely to increase more than 85 percent in the 30-year period between 1970 and 2000.

The Wiggins studies estimate that, under average 1970 conditions, building losses from earthquake, expansive soil, landslide, riverine flood, hurricane wind/storm surge, tornado, local flood, local wind and tsunami would approximate 10.5 billion 1978 dollars. Compare this with the 4.5 billion 1978 dollars in building losses caused annually by fire Unless appropriate mitigations are applied, these monetary figures are almost certain to reach approximately 19 5 billion in constant dollars annually beginning in 2000.

On the other hand, if the most effective mitigations against each hazard modeled in the studies were to be applied, beginning in 1980, total annual dollar losses could be reduced nearly 25 percent or approximately $5 billion, by 2000 In fact, this reduction represents over half the projected rise in dollar losses.

Figures Probably Low

Many of these figures are probably low because of the historically poor damage estimates on which portions of the models are based. Nevertheless, they are the most comprehensive assessments available to date. It should be noted, however, that these building loss estimates only represent the tip of the iceberg. Damage to infrastructure, such as roads and bridges, which is not covered by these studies, is believed to often equal that suffered by buildings. In addition, secondary losses, estimated in the next phase of these studies—in terms of building contents, income, transportation effect due to dislocation of suppliers, homelessness and unemployment—compound the figure even more.

During an average year, building damage from these hazards, per dollar exposed, is greatest in Florida and Louisiana. Also hard hit, in relation to their numbers of buildings, are Mississippi, Missouri, Kansas, Texas, Nebraska, Oklahoma, Washington and California Using the same criteria, the states with the lowest damage rate from the hazards studied are the District of Columbia, Hawaii, Arizona, Vermont and Pennsylvania

When viewed solely in terms of *total* damage to buildings from the hazards, California heads the list. Next come Florida, Texas, New York and Illinois States sustaining the least dollar damage to their building stock are Vermont, Alaska and Wyoming.

Flood Damage Greatest

Although riverine flood causes the most damage to buildings today—an estimated $3 billion annually—hurricane wind/storm surge and expansive soil are likely to pass it up, becoming our No. 1 and 2 hazards by the year 2000, unless appropriate mitigations are applied

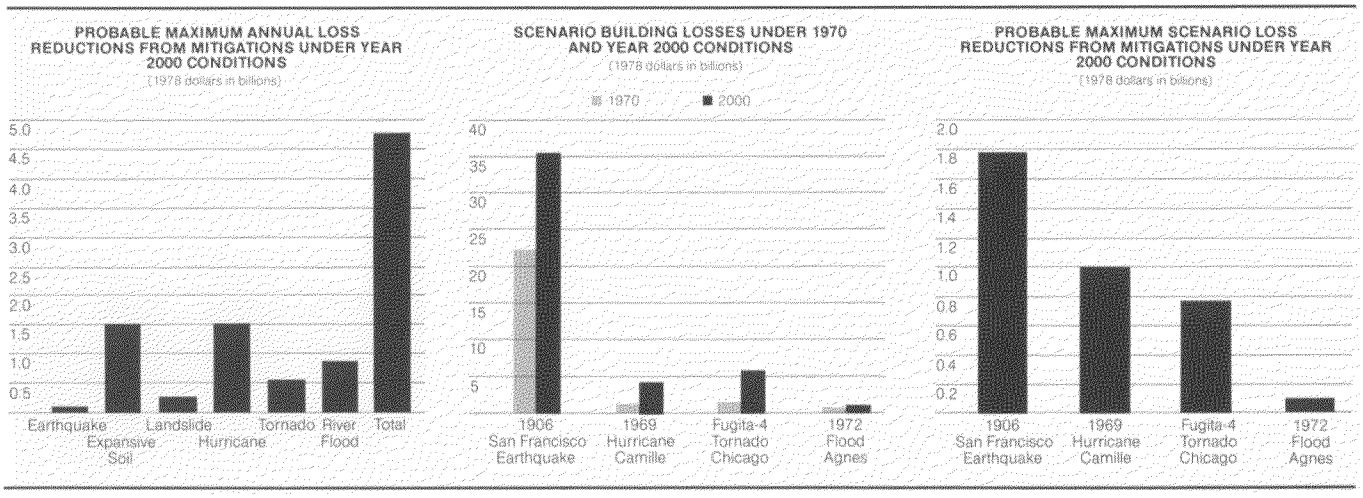
While flood damage might even decline over the next few years, because of current emphasis on dam building and other flood control projects, destruction of buildings by hurricanes is expected to grow from today's almost $2 billion to about 5 billion constant dollars annually by 2000. This is largely due to population growth and movement, coastal development and higher construction values

If nothing significant is done to prevent it, all damage from expansive soil could be almost equally devastating by the year 2000. The forecasts reveal that today's annual losses of $2 billion will mount to 4 5 billion 1978 dollars within the 30-year period studied unless something more is done. Ironically, the studies also reveal that expansive soil damage to new construction could be reduced as much as 85 percent by the year 2000, if stringent siting and building controls were mandated nationally beginning in 1980

35% Reduction Possible

Mitigations studied could reduce annual damage to all buildings by 2000 as much as 35 percent in the case of expansive soil and varying amounts, depending upon the hazard, down to a still meaningful 11 percent in the case of earthquake Even more substantial reductions could be realized, of course, should further research develop new, but presently unknown, mitigations

The impact of infrequent, but devastating sudden losses upon our building stock and economy must also be taken into consideration. Granted that unless current efforts to develop a reliable early detection and warning system are successful, the state of current technology only makes it possible to reduce earthquake damage to buildings 11 percent But this represents a sizeable saving in the event of a catastrophic occurence If the 1906 San Francisco Earthquake reoccurred in the year 2000, it would cause damage to buildings in excess of 36 billion 1978 dollars, as well as about 5,000 deaths and 200,000 injuries, without even taking into account possible fire damage But, if mitigations triggering an 11 percent reduction were begun in 1980, nearly $4 billion, 600 deaths and 24,000 injuries could be shaved from this amount.



Similarly, if Hurricane Camille repeated its 1969 devastation in the year 2000, building damage would top 4 billion 1978 dollars and cause 200 to 400 deaths and 20,000 to 40,000 injuries. But if the most effective mitigations studied were to be applied beginning in 1980, damage could be reduced over $1 billion, 50 to 100 lives saved and 5 000 to 10 000 injuries avoided

Another unfortunate consequence of the tendency to act only when a persistent, albeit less severe, hazard exists, is that homeowners who are literally wiped out by local flood or landslide seldom receive the degree of relief available to those hit by area-wide disasters, such as riverine flood or hurricane. The National Flood Insurance Program actually precludes recovery from localized flooding, despite the fact that thousands of families are hard hit by such occurrences each year. Further, it's a rare occasion when a home destroyed by landslide is either insured or covered by Federal or state disaster relief programs

Some Pictures Difficult

It was not possible to develop as complete a picture of losses and mitigations pertaining to local flood, local wind and tsunami as it was in the case of the other six hazards:

(1) In practice, a 15-city sample proved too unrepresentative to inspire confidence in the findings of the local flood study, particularly in view of traditionally spotty reporting practices. Many experts felt the estimate of $350 million in building damage from local flooding during a typical year could well represent less than half the actual total. The accuracy of the subsequent projections and mitigations is, therefore, highly suspect.

(2) The wind panel utilized in Wiggins' hurricane, tornado and local wind studies found it exceedingly difficult to estimate typical damage which might be anticipated from varying degrees of less-than-hurricane velocity winds. Nevertheless, the model *does* reveal that local wind damage to buildings is most severe in Wyoming, Rhode Island, North and South Dakota and Colorado; that the damage amounts to at least 19 million 1978 dollars each year; and that, unless appropriate mitigations are applied, this is likely to increase about 120 percent by the year 2000 Population growth and higher building values are cited as the primary reasons for the size of this increase. If all new construction were required to be 50 percent more wind resistant, beginning in 1980, an annual reduction of nearly 15 percent could be realized by the year 2000, according to the model.

(3) Eighty-five tsunamis have attacked U.S. shores in the past 160 years. Nearly 60 percent of them hit Hawaii and over 35 percent California. Washington, Oregon and Alaska also have been hit by the giant seismic waves, generated by submarine earthquakes, volcanic eruptions or landslides around the Pacific Rim. There are many who believe the Eastern Seaboard and Gulf States may ultimately experience a similar phenomenon. The two most powerful tsunamis in recent years devastated Crescent City, California, and Hilo, Hawaii. Originating in the Eastern Aleutian Islands, the latter wave caused approximately 320 million 1978 dollars damage to buildings throughout Hawaii in April, 1946. Unfortunately, it was impossible to model future tsunami trends or attempt to develop potential mitigations.

Deeper Study Needed

It is clear that a deeper study of these hazards should be undertaken to obtain more complete forecasts. In fact, it is evident from all the results of these pioneer studies that far more data is required about *all* natural hazards There is a pressing need to accelerate the identification of hazardous locations, as well as to develop and promote viable mitigations. In all cases, potential savings must then be measured against construction and land use considerations, on an ongoing basis, in all parts of the nation.

There are growing indications that more stringent building codes and land use requirements either may not be sufficient or fail to offer the ideal solution It is doubtful if the technical capabilities of 55,000 separate jurisdictions are adequate to administer such comprehensive programs, regardless of their beneficial impact. At the very least, more trained people are required to develop and test the mitigations, draft the codes and participate in their enforcement. Perhaps provision of incentives for individual and local action might offer a more effective answer than enactment of more regulations.

The challenge is enormous, but the stakes are high. Billions of dollars and thousands of lives can be saved over the next decades by mitigating the losses caused by any one or a combination of these natural hazards