Chapter 2 – An Introduction to Catastrophe Models and Insurance

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This chapter provides an overview of the history of catastrophe models and their role in risk assessment and management of natural disasters. It examines the insurability of catastrophe risk and illustrates how the output from catastrophe models aids insurers in meeting their goals for risk management. Throughout the chapter, there is an emphasis on understanding catastrophe modeling for earthquake and hurricane hazards and how it is used to manage natural hazard risk. In the final section, a framework for integrating risk assessment with risk management via catastrophe modeling is presented.

2.1 History of Catastrophe Models

Catastrophe modeling is not rooted in one field or discipline. The science of assessing and managing catastrophe risk originates in the fields of property insurance and the science of natural hazards. Insurers may well argue that catastrophe modeling’s history lies in the earliest days of property insurance coverage for fire and lightning. In the 1800’s, residential insurers managed their risk by mapping the structures that they covered. Not having access to Geographic Information Systems (GIS) software, they used tacks on a wall-hung map to indicate their concentration of exposure. This crude technique served insurers well and limited their risk. Widespread usage of mapping ended in the 1960’s when it became too cumbersome and time-consuming to execute (Kozlowski and Mathewson, 1995).

On the other hand, a seismologist or meteorologist may well argue that the origin of catastrophe modeling lies in the modern science of understanding the nature and impact of natural hazards. In particular, the common practice of measuring an earthquake’s magnitude and a hurricane’s intensity is one of the key ingredients in catastrophe modeling. A standard set
of metrics for a given hazard must be established so that risks can be assessed and managed. This measurement began in the 1800’s, when the first modern seismograph (measuring earthquake ground motion) was invented and modern versions of the anemometer (measuring wind speed) gained widespread usage.

In the first part of the twentieth century, scientific measures of natural hazards advanced rapidly. By the 1970’s, studies theorizing on the source and frequency of events were published. Significant analyses include the U.S. Water Resources Council publication on flood hazard (USWRC, 1967), the Algermissen study on earthquake risk (Algermissen, 1969) and National Oceanic and Atmospheric Administration (NOAA) hurricane forecasts (Neumann, 1972). These developments led U.S. researchers to compile hazard and loss studies, estimating the impact of earthquakes, hurricanes, floods, and other natural disasters. Notable compilations include Brinkmann’s summary of hurricane hazards in the United States (1975) and Steinbrugge’s anthology of losses from earthquakes, volcanoes, and tsunamis (1982).

These two separate developments – mapping risk and measuring hazard – came together in a definitive way in the late 1980’s and early 1990’s, through catastrophe modeling as shown in Figure 2.1. Computer-based models for measuring catastrophe loss potential were developed by linking scientific studies of natural hazards’ measures and historical occurrences with advances in information technology and geographic information systems (GIS). The models provided estimates of catastrophe losses by overlaying the properties at risk with the potential natural hazard(s) sources in the geographic area. With the ability to store and manage vast amounts of spatially referenced information, GIS became an ideal environment for conducting easier and more cost-effective hazard and loss studies.

Around the same time, several new modeling firms developed computer software for analyzing the implications of natural hazard risk. Three major firms emerged: AIR Worldwide was founded in 1987 in Boston; Risk Management Solutions (RMS) was formed in 1988 at Stanford University; and EQECAT began in San Francisco in 1994 as a subsidiary of EQE International. In 2001, EQE International became a part of ABS Consulting.

When introduced, the use of catastrophe models was not widespread. In 1989, two large-scale disasters occurred that instigated a flurry of activity in the advancement and use of these models. On September 21, 1989, Hurricane Hugo hit the coast of South Carolina, devastating the towns of Charleston and Myrtle Beach. Insured loss estimates totaled $4 billion before the storm moved through North Carolina the next day (Insurance Information Institute, 2000). Less than a month later, on October 17, 1989, the Loma Prieta Earthquake occurred at the southern end of the San Francisco peninsula. Property damage to the surrounding Bay Area was estimated at $6 billion (Stover and Coffman, 1993).