Increasing Concentrations of Property Values and Catastrophe Risk in the US

April 2015
Introduction

Residential, commercial, and industrial property values in the US continue to increase faster than GDP growth and the general rate of inflation. According to KCC estimates, insured property values increased by nine percent from 2012 to 2014.

In aggregate, building values now exceed $40 trillion, and when contents and time element exposures are added in, estimated insured property values swell to over $90 trillion. Along with increasing values, there are highly concentrated pockets of exposure, particularly in regions vulnerable to natural catastrophes.

For example, tier one counties along the Gulf and Atlantic coasts account for over 17 percent of total exposure at $16 trillion. Six counties have over $1 trillion of exposure each and on a combined basis, account for more than 12 percent of the US total. One county—Los Angeles—accounts for over three percent of exposed property values.

One implication of increasing concentrations of property value is the higher probability of mega-catastrophe losses. A major storm or earthquake has not occurred in a densely populated metropolitan area such as Galveston-Houston, Miami, or Los Angeles for decades.

This study shows that when a large magnitude event occurs in specific concentrated areas, the losses will be multiples of the PMLs (Probable Maximum Losses) the insurance industry has been using to manage risk and rating agencies and regulators have been using to monitor solvency. Insurers typically manage their potential catastrophe losses to the 100 year PMLs, but because of increasingly concentrated property values in several major metropolitan areas, the losses insurers will suffer from the 100 year event will greatly exceed their estimated 100 year PMLs.

This paper explains why the PMLs can give a false sense of security and suggests new risk metrics—Characteristic Events (CEs)—for monitoring exposure concentrations. The CEs help companies better understand their catastrophe loss potential so they can avoid surprise solvency-impairing events. Because it’s likely that catastrophe loss potential will continue to grow in already concentrated areas, insurers require multiple perspectives on increasing catastrophe risk.
Overview of US Property Values

A detailed database of US property values by construction, occupancy, and five digit ZIP code is part of the RiskInsight® suite of models and tools. KCC researchers have recently updated this database (KPD) to reflect values as of the end of 2014.

The cost to replace residential and commercial properties destroyed by natural disasters has continued to rise faster than the general economy, primarily due to increasing construction costs per square foot. Overall, US property values have increased more than nine percent since 2012.

In the residential sector, costs per square foot went up eight percent but there are wide disparities across the US with average square foot costs ranging from a low of $45 in some areas of the country to a high of over $250 in cities such as New York and San Francisco. Construction costs for commercial and industrial properties have also increased and differ by geographical region and occupancy type. Certain types of occupancies, such as health care facilities, can cost over $350 a square foot to rebuild. Low value structures, such as parking garages, average closer to $50 per square foot.

The pie chart below shows the 2014 breakdown of total estimated property values by occupancy class.

![Estimated Property Value by Occupancy](chart.png)
The state with the most property value is California, followed by New York and Texas. The top ten states account for over 50 percent of the US total.

Five of the top ten counties are in areas highly vulnerable to major natural catastrophes. Six counties, including Los Angeles, New York, and Harris, have over $1 trillion of property value each.
The US vulnerability to hurricanes and other coastal hazards continues to rise because of increasing concentrations of property values along the coast. Of the $90 trillion in total US property exposure, over $16 trillion is in the first tier of Gulf and Atlantic coastal counties, an increase from $14.5 trillion in 2012.

### Exposed Property Values ($ billion)

<table>
<thead>
<tr>
<th>State</th>
<th>Total Value</th>
<th>Coastal Counties</th>
<th>Peak Coastal County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>1,100</td>
<td>144</td>
<td>98</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1,261</td>
<td>786</td>
<td>359</td>
</tr>
<tr>
<td>Delaware</td>
<td>268</td>
<td>89</td>
<td>54</td>
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<tr>
<td>Florida</td>
<td>4,673</td>
<td>3,657</td>
<td>688</td>
</tr>
<tr>
<td>Georgia</td>
<td>2,472</td>
<td>109</td>
<td>65</td>
</tr>
<tr>
<td>Louisiana</td>
<td>1,103</td>
<td>397</td>
<td>126</td>
</tr>
<tr>
<td>Maine</td>
<td>398</td>
<td>239</td>
<td>105</td>
</tr>
<tr>
<td>Maryland</td>
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<tr>
<td>Massachusetts</td>
<td>2,365</td>
<td>1,278</td>
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<tr>
<td>Mississippi</td>
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<td>76</td>
<td>43</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>406</td>
<td>109</td>
<td>109</td>
</tr>
<tr>
<td>New Jersey</td>
<td>3,100</td>
<td>1,216</td>
<td>319</td>
</tr>
<tr>
<td>New York</td>
<td>7,838</td>
<td>5,610</td>
<td>2,484</td>
</tr>
<tr>
<td>North Carolina</td>
<td>2,092</td>
<td>180</td>
<td>57</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>352</td>
<td>156</td>
<td>60</td>
</tr>
<tr>
<td>South Carolina</td>
<td>998</td>
<td>276</td>
<td>103</td>
</tr>
<tr>
<td>Texas</td>
<td>5,963</td>
<td>1,588</td>
<td>1,187</td>
</tr>
<tr>
<td>Virginia</td>
<td>2,019</td>
<td>312</td>
<td>104</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>38,529</strong></td>
<td><strong>16,242</strong></td>
<td><strong>6,302</strong></td>
</tr>
</tbody>
</table>

The Increasing Probability of Mega-Catastrophes

As property values continue to rise and become more concentrated in areas prone to natural disasters, the probability of a mega-catastrophe loss increases. No major hurricane or earthquake has occurred in a densely populated urban center for decades. When a 100 year type event does occur in one of these areas, the property damage and economic loss will dwarf the losses from Hurricane Katrina and Superstorm Sandy.

What does the 100 year event look like for hurricanes and earthquakes in the US and what are the losses that would result? This paper addresses those questions because the return period events are generally not analyzed by the insurance industry—most insurers rely on the 100 year PML (Probable Maximum Loss) derived from the catastrophe model Exceedence Probability (EP) curves. The EP curves are typically generated by simulating many random events—not specific return period events.

Hurricanes

For US hurricane, the 100 year events for different landfall points along the coast can be developed utilizing meteorological expertise and analyses of the historical data. Since 1900, the most intense hurricanes at landfall were the Labor Day Hurricane (1935), Camille (1969), and Andrew (1992)—all Category 5 storms with estimated peak wind speeds of 165 mph or greater.

The most likely regions for such an event are Texas, the Gulf, and South Florida, where hurricanes are most frequent and the waters are warmest. Given the data and climatological information, a credible 100 year event for these regions is a hurricane with peak winds at landfall of 165 mph. Other characteristics, such as forward speed and storm track, are selected specifically for the region and the particular landfall point.

The map to the left indicates how the severity of the 100 year hurricane changes along the coastline. For example, the 100 year hurricane in the Northeast region is a Category 3 storm. The most intense hurricane to make landfall in this region was the Great New England Hurricane of 1938—this storm is estimated to have had peak sustained winds of 120 mph at landfall. While much weaker, the hurricanes in this region tend to be much larger and faster moving, and this is reflected in the characteristics of the 100 year event.

By superimposing these 100 year events on the 2014 property values in the KPD, three regions emerge as the most likely for mega-catastrophes. In all of these regions, the largest losses from the 100 year event are much larger than the 100 year PMLs.
Texas

The chart below shows the industry losses that would result from the 100 year hurricanes making landfall at different points along the Texas coastline. The 100 year hurricane making landfall near Galveston would cause industry losses far higher than the estimated industry PML for the state of Texas. While the model-estimated 100 year PMLs are in the range of $40-50 billion, the largest losses from the 100 year hurricane are in excess of $100 billion. This is not surprising given that Harris county with over $1 trillion is the fifth largest US county in terms of property values.

The map illustrates the wind footprint that would create the largest loss of $180 billion. The storm track puts the peak winds over Houston, and as property values continue to increase in this metropolitan area, so do the potential losses.

Florida

The 100 year hurricane making a direct hit on downtown Miami will cause over $250 billion in insured losses today, two times the estimated 100 year PML. Catastrophe models generally agree that if the Great Miami Hurricane of 1926 occurred this year, the insured losses would be around $125 billion—in line with the estimated 100 year PML. That hurricane was a Category 4 storm—a Category 5 hurricane would likely cause twice the losses.

Another way to benchmark the 100 year hurricane loss is to estimate the losses from Hurricane Andrew making a direct hit on downtown Miami. In 1992, Andrew made landfall well to the south of Miami near Homestead, Florida. It caused over $15 billion in insured losses, which would have been $60 billion at the time if the track had been 50 miles north. Since Andrew, coastal property values in Florida have risen from $870 billion to over $3.7 trillion—more than a fourfold increase.
Increasing Concentrations of Property Values and Catastrophe Risk in the US

The chart below shows that the 100 year hurricane making landfall along the 100 mile strip of coastline between Homestead and Lake Worth, Florida, will likely cause losses above the 100 year PML. While many of the 100 year hurricanes have a second landfall in Louisiana, most of the estimated losses are in Florida.

Northeast

The 100 year hurricane event in the Northeast shares similarities with the 1938 Great New England Hurricane that made landfall near Westhampton, NY, on Long Island. Experts agree that this storm today would cause insured losses of about $40 billion. This same storm with the track moved to the west so that landfall is over Western Long Island, would cause over $100 billion in insured losses.
Earthquakes

Earthquake risk is not as extensively covered by the private insurance market. Take-up rates vary by region and by county within a region. For example, in California, an estimated 10% of residents have earthquake coverage statewide, but that number ranges from a low of around six percent for counties such as Napa, to a high of over 20% in counties around San Francisco.

Insurers may be reluctant to offer earthquake coverage due to uncertainty about the risk, low premiums outside the most hazardous regions, and potential concentration of risk (only property owners in the most hazardous areas buy the coverage). Again the PMLs from the EP curves do not give much visibility into loss potential. Analyzing the losses from 100 year, and other, return period events provides more insight into earthquake risk.

The US Geological Survey (USGS) and other scientific organizations provide this information. For the mapped faults and other known seismically active areas, the USGS studies and reports provide the estimated return period-magnitude relationships.

In recognition of the fact that not all faults are known, the USGS has also implemented the concept of background seismicity, which accounts for the possibility of a significant earthquake anywhere. Scientists have estimated the return periods of different magnitude background events. For example, the graphic below shows the estimated magnitude-frequency distribution for California for fault-based and gridded background seismicity.

In California, the 100 year background event is a magnitude 7 earthquake. Based on KPD which includes all property values, and the RiskInsight® Earthquake Reference Model, the 100 year PML for total losses (insured and uninsured) is just under $200 billion. The map above shows the locations of a magnitude 7 event in California that would likely cause total losses greater than $200 billion.
Managing Exposure Concentrations and Potential Solvency Impairing Losses with Characteristic Events (CEs)

Today insurers and reinsurers manage their catastrophe risk according to the Exceedence Probability (EP) curves generated by the catastrophe models. Two numbers derived from this curve—the 1 in 100 and 1 in 250 year PMLs—are used for solvency and capital requirement formulas, reinsurance purchases, and corporate risk tolerance statements.

The catastrophe model EP curves are created by generating many random events and estimating the resulting losses. The losses are then sorted from most severe to least severe and the 1 in 100 year loss is calculated by simply moving down the list of losses until the one percent probability value is found. In the PML approach the events themselves are not that important—they are primarily used to generate the EP curve and the probabilities of exceeding various loss amounts.

The PMLs can give a false sense of security and can mask exposure concentrations leading to solvency-impairing events. Because the model-generated EP curves are developed through simulations of random event characteristics, exposure concentrations can be missed entirely—that is, there may be no, or insufficient, events in geographical areas where a company has significant exposure concentrations. (Alternatively, other areas can be over sampled.)

The 100 year PML is also frequently referred to as the 100 year event. The previous sections of this paper illustrated that the losses from the 100 year events are quite different from the 100 year PMLs. It’s also easy to forget that the 100 year PML is the loss amount for which there is a one percent chance of exceeding. It doesn’t indicate where or how much that loss amount is likely to be exceeded.

The new methodology of defining the probabilities based on the hazard rather than the loss is called the Characteristic Event (CE) approach. Instead of simulating many thousands of random events, in the CE approach events are meticulously and judiciously created using all of the scientific knowledge about the events in specific regions. The same scientific information and data used by the vendor models, are used to develop events with characteristics reflecting various return periods of interest, such as the 100 and 250 year. Once the events are created, they are “floated” to estimate losses at specific locations.
For example, the 100 year hurricane CE loss chart is shown below for a hypothetical company. The landfall points are shown along the x-axis, and the red bars show the losses from the 100 year events at each point. The black horizontal line shows the company’s model-generated 100 year PML in a position that’s typical for most insurers.

The CE chart illustrates more complete information than a single PML number alone. It shows clearly where the company can have a loss well above the 100 year PML from the 100 year hurricane CE. Because the CEs are stable from year to year, companies can use them to measure and monitor loss potential over time and to develop more optimal portfolios of business while reducing the “spikes.”

Another way to view exposure concentration is to estimate the market share of industry losses, shown by the red dots in the graphic below. The losses (green bars) show the company’s absolute concentrations while the market shares (red line) show the company’s relative concentrations.

Insurers can monitor other metrics such as the CE to PML ratio—that is, how big is the tallest spike relative to the PML—and the CE width which measures losses for which CE > PML. A CE loss distribution can also be created. Rating agencies and regulators may be interested in how insurers compare to each other and to the industry with respect to these metrics.
Summary and Conclusions

The detailed KCC property database (KPD) has been updated to reflect 2014 property values which now total to over $90 trillion, including building, contents, and time element exposures. Property values have continued to become more concentrated in areas prone to natural catastrophes, and this has increased the opportunity for mega-catastrophe losses. The main points of the report are:

- Property values along the coast and in earthquake-prone areas continue to grow faster than the general rate of growth across the country and industry exposures are becoming more concentrated over time.

- The PML risk metrics insurers have been using to manage catastrophe risk do not give a complete picture of catastrophe loss potential and do not reveal potential solvency-impairing exposure concentrations.

- The PMLs can give a false sense of security and are frequently misinterpreted as the 100 year events.

- In many regions of the US, the losses from the 100 year event (CE) will be far greater than the estimated 100 year PMLs.

- To protect against solvency-impairing events, insurers should monitor their exposure concentrations with additional metrics, such as the CEs and the CE to PML ratio.