Innovation in Flood Insurance: Models, Data and New Views of Risk

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Learning Objectives

At the end of this presentation, you will be able to:

• Understand the current state of the NFIP
• Appreciate the issues of the private flood market
• Understand shortcomings in the current FIRM maps
• Recognize advances in flood modeling for insurance
• Identify trends in future market development
• Appreciate scientific research impacting future flood potential
NFIP Loss Experience: Catalyst for Flood Insurance Reform

[Bar chart showing NFIP Loss Dollars Paid from 1978 to 2017, with significant spikes for Katrina, Sandy, and Harvey events.]

Not Adjusted for Inflation or Growth

https://www.fema.gov/loss-dollars-paid-calendar-year

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NFIP Premium vs. Claims

Figure 1: Difference Between Earned Premium and Claims Paid by NFIP By Year
(1978–2015 in $Millions)

Sources: FEMA

NAIC Center for Insurance Policy and Research Study:
Flood Risk and Insurance (2017)
Current State of NFIP

- Debt limit of $30.425B reached following Harvey
- Congress cancelled $16B debt to pay HIM claims
- Current Debt: $20.5B
Steps Towards Private Flood

• A goal of NFIP reform was to transfer risk to private sector and have government focus on mitigation; has evolved to more of a cost sharing and shared effort to increase take-up

• Biggert-Waters Flood Insurance Reform Act (2012) and Homeowner Flood Insurance Affordability Act (2014) encouraged greater involvement of private market

• Specifically granted Administrator authority to secure private reinsurance

• Additional reforms and long term authorizations stalled in 115th Congress
NFIP Reinsurance Placements

<table>
<thead>
<tr>
<th>Date</th>
<th>Type</th>
<th>Coverage amount</th>
<th>Coverage Levels</th>
<th>Premiums Paid by FEMA</th>
<th>To Date Claims Paid to FEMA</th>
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<td>$4-8</td>
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<td>$5-10</td>
<td>$0.062 (first year)</td>
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<td>$6-10</td>
<td>$0.032 (first year)</td>
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</table>

Private Insurers and Flood

- Until recently most insurers focused on commercial flood
- Residential coverage offered through WYO carriers
- Some non-admitted carriers offered excess flood (above NFIP maximums), often to high valued homes
- Private Flood Premiums (NAIC)
  - 2018: $644M
  - 2017: $589M
  - 2016: $376M
  - NFIP: $3.5B
Potential Barriers to Private Flood

- Mandatory Purchase Requirement
- Continuous Coverage Rules
- Non-Compete Clause for WYOs
- NFIP Subsidized Rates
  - Risk Rating 2.0 may re-orient the landscape
- Regulatory Uncertainty at State level
- Lack of Access to NFIP policy and claims data
- Adequate participation to create a large pool
  - Mandatory purchase has not driven sufficient take-up
- More consumer choice but reduced NFIP revenue
Why Is Privatization a Big Deal for Insurers?

Flood Insurance Gap Is a USD 40 Billion Opportunity

Issues with Traditional Approaches for Quantifying and Managing Flood Risk
FIRM Maps Are Often Outdated and Not Representative of the Current Risk

- It can take several years to update a FIRM map
- The data underlying a FIRM map is typically several years older than the effective date
- Some regions have not received an update for over a decade

Source: FEMA
Traditional Flood Estimation is Largely Based on Statistical Techniques

Peak flood estimates such as the 100 year flood are generated from flood gauge data and statistical techniques.

Table 18.14: U.S. Geological Survey gage 07099500 (and others) Arkansas River annual peak-flow record consisting of 86 peaks from 1914 to 1994. This table contains the water year of the annual peak and the corresponding annual peak in cubic feet per second (cfs).

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<th>Annual peak streamflow (cfs)</th>
<th>Water year</th>
<th>Annual peak streamflow (cfs)</th>
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<td>1951</td>
<td>--</td>
<td>1980</td>
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</table>

USGS gage data annual peak-flow records for the Arkansas River at Pueblo, CO

Source: USGS
Statistical Techniques Reliant on Historical Data Are Ill-Suited to Capture Underlying Trends

Source: USGS
Traditional Approaches Will Underestimate Impacts in Areas Undergoing More Rapid Change

1 Percent AEP (100 Year Flood)
Significant Flood Risk Outside SFHA

- Estimates for Hurricane Harvey: nearly 75% claims outside SFHA
- Nearly 25% of all federal flood claims occur outside SFHA

Sources: Harris County Flood Control District, City of Houston
Modern Catastrophe Modeling Approaches and Decision Tools are Available

- Underwriting
- Pricing
- Portfolio Management
Flood Models Enabled by Technological Gains

- Coupled climate and weather models
- Advanced modeling of tropical cyclone precipitation
Flood Catastrophe Models Cover Continental and Local Scale

- AIR Model includes continental scale hydrology and hydraulics
- Event based to explicitly capture correlations
- On/Off Plain Flooding
Risk Scoring Tools Enable Underwriting

WaterLine Scoring Methodology

- Signifies the expectation of flood hazard severity at any location
- Reflects the whole spectrum of frequency and severity of hazard
- Leverages AIR U.S. inland and storm surge models
- Validated using data from ISO®, USGS, and Claims from Development Partners

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Physically-Based Catastrophe Models More Accurately Capture the Current Environment and Risk – Hurricane Harvey

KCC models each sub-peril including inland flood explicitly

Tropical storms are the primary source of the largest “inland flood” events!
Modern Technology Can Estimate Losses and Claims Volumes in Real Time

1 - Reads in Projected Track
2 - Calculates Intensity Footprints
3 - Estimates Damage
4 - Calculates Losses and Claims

Mean Damage Function

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<tr>
<th>Intensity (mph)</th>
<th>TIV</th>
<th>LOSS Gross</th>
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<tbody>
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<td>1: 40-50</td>
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<td>109,828,000</td>
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<td>2: 50-60</td>
<td>1,688,091,414,000</td>
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<td>1,251,951,961,000</td>
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<td>4: 70-80</td>
<td>796,202,751,000</td>
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<td>6: 90-100</td>
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<td>7: 100-110</td>
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<td>8: 110-120</td>
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<td>9: 120-130</td>
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<td>10: 130-140</td>
<td>4,096,865,000</td>
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Catastrophe Model Accuracy is Verified in Real Time – KCC model and PCS Estimates

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<th>Hazard</th>
<th>Residential</th>
<th>Commercial and Industrial</th>
<th>Auto</th>
<th>Total</th>
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<td>Wind</td>
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<tr>
<td>Storm Surge</td>
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<td>0.3</td>
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<td>0.5</td>
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<tr>
<td>Inland Flooding*</td>
<td>1.1</td>
<td>8.1</td>
<td>3.2</td>
<td>12.4</td>
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<tr>
<td>Total</td>
<td>2.7</td>
<td>9.3</td>
<td>3.4</td>
<td>15.4</td>
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<table>
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<th>All Hazard</th>
<th>Residential</th>
<th>Commercial and Industrial</th>
<th>Auto</th>
<th>Total</th>
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<td><strong>3.2</strong></td>
<td><strong>11</strong></td>
<td><strong>3.3</strong></td>
<td><strong>17.5</strong></td>
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*Estimates do not include NFIP losses

KCC loss estimates from 9/1/2017
Catastrophe Models Use the Same Physical Simulation Techniques to Create Large Catalogs of Likely Future Events

Event Catalog

- Create a large sample of hypothetical events
  - Where? How big? How frequent?
- For each event estimate intensity at each location
- Based on intensity and exposure at each location estimate damage
- Apply policy conditions to estimate insured losses

Intensity

Vulnerability

Financial

Event 1
Event 2
Event 3

Probabilty \( p(L) \) that losses will exceed \( L \)

Loss Exceedance Probability (EP) Curve

1 in 100
1 in 250
1%
.4%
Loss, \( L \)

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How Can Tropical Cyclones Result in Such Extreme Flooding?
Harvey’s Track and Forward Speed Positioned the Storm Near A Limitless Supply of Super-Humid Air
This Combination of Factors Led to Unprecedented Precipitation Totals

- Harvey was the most significant tropical cyclone rainfall event in United States history
- Eighteen locations exceeded the previous continental US record for peak precipitation
It is Not Unusual For Tropical Cyclones to Remain Close to the Coast
How Can We Proactively Prepare for Future Floods?

Source: NOAA
Climate Research Indicates Tropical Cyclones are Slowing Down

- Trends in tropical cyclone translation speed show storms are slowing in every basin except the Northern Indian Ocean
- Estimated decrease in translation speed:
  - Region near Australia ~ 14%
  - Global ~ 10%
  - North Atlantic ~ 6%

Higher SST is Estimated to Increase Average Tropical Cyclone Precipitation by 7% per Degree C

Atlantic basin composite storms:

Sources: Knutson et al., 2008, Nature Geoscience
Global Sea Levels are Anticipated to Rise

- Global sea level has risen by about 7–8” inches since 1900, and about 3” since 1993 (very high confidence).

- Human-caused climate change has made a substantial contribution to global sea level rise since 1900 (high confidence).

- Global sea level (relative to year 2000) is very likely to rise by 0.3–0.6 feet by 2030, 0.5–1.2 feet by 2050, and 1.0–4.3 feet (30–130 cm) by 2100 (very high confidence in lower bounds; medium confidence in upper bounds for 2030 and 2050; low confidence in upper bounds for 2100).

Source: Climate Science Special Report, 2017.
Catastrophe Model Technology Can Quantify Impacts of Different Tropical Cyclone and Flood Scenarios

- Sea Level Rise
- Slower Moving Storms
- More Intense Hurricanes
Summary

• The NFIP has repeatedly fallen into debt as collected premiums are dramatically below loss experience.
• Growing need for private flood market is underscored by an estimated $40B insurance gap.
• Recent events confirm that FIRM maps do not accurately reflect current conditions or appropriately identify properties at risk.
• Tropical cyclones have been the driver for the largest flood losses.
  – Tropical cyclones can produce extreme precipitation and associated flooding.
  – Scientific research suggests the factors that intensify tropical cyclone flooding are likely to increase in the future.
• Catastrophe models have advantages over traditional FIRM maps and underwriting approaches including:
  – Physical models that reflect current conditions.
  – Ability to quantify risk at an industry, region, or individual property resolution.
  – Can provide loss estimates in real time.
  – Can estimate losses for future scenarios and conditions.