Flood Insurance—Past, Present and Future

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About Our Presenters

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Outline of Presentation

• Current landscape of flood insurance
  – National Flood Insurance Program (NFIP)
  – Private flood insurance market
• Flood catastrophe models
In the past 5 years how many states have had an economic loss from flood? (Federal Emergency Management Association – FEMA)

A  8
B  15
C  25
D  38
E  50

Polling Question #1
Did You Know?

• 99% of US counties have had a flooding event from 1996-2019
• Nine out of 10 presidentially declared disasters involve flooding
• One inch of water can cause $25,000 of damage
• Average flood claim in 2017: $91,735
  – Average flood claim in 2016: $62,247
• 25% of flood losses in designated “low to moderate risk” areas
• Over the last 15 years, more than $10 billion in losses in areas considered low to moderate risk
• All 50 states have had economic loss from flooding in past five years
Flood: Timeline

- **Early 1900s:** Major flood events
- **1929:** No private insurance
- **1930s:** Federal government loans/aid
- **1950:** Disaster Relief Act
- **1968:** NFIP Act
- **1973:** Amendments
- **1980s:** Rate increases
- **1983:** Write Your Own program (WYO)
- **1968:** NFIP Act
Flood: Timeline

2005: Hurricane Katrina
2008: Hurricane Ike
2012: Biggert-Waters
2012: Superstorm Sandy
2017: Hurricane Harvey
National Flood Insurance Program (NFIP)

Program formed to:

1. address lack of coverage offered in private insurance market
2. reflect limited tools to assess risk
3. address problem of adverse selection
NFIP: Policies in Force by Calendar Year

Source: fema.gov
## Top 10 NFIP Events in Past 40 Years

<table>
<thead>
<tr>
<th>Storm Name</th>
<th>Amount (Billions)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hurricane Katrina</td>
<td>$16.3</td>
<td>2005</td>
</tr>
<tr>
<td>2. Hurricane Harvey</td>
<td>$8.9</td>
<td>2017</td>
</tr>
<tr>
<td>3. Superstorm Sandy</td>
<td>$8.8</td>
<td>2012</td>
</tr>
<tr>
<td>4. Hurricane Ike</td>
<td>$2.7</td>
<td>2008</td>
</tr>
<tr>
<td>5. Louisiana 2016 storms</td>
<td>$2.5</td>
<td>2016</td>
</tr>
<tr>
<td>6. Hurricane Ivan</td>
<td>$1.6</td>
<td>2004</td>
</tr>
<tr>
<td>7. Hurricane Irene</td>
<td>$1.4</td>
<td>2011</td>
</tr>
<tr>
<td>8. Topical Storm Allison</td>
<td>$1.1</td>
<td>2001</td>
</tr>
<tr>
<td>9. Hurricane Irma</td>
<td>$1.1</td>
<td>2017</td>
</tr>
<tr>
<td>10. Hurricane Matthew</td>
<td>$0.7</td>
<td>2016</td>
</tr>
</tbody>
</table>
NFIP Evolution

- Major CATs
- Major Deficits
- Significant Borrowing
- NFIP Reform
NFIP: Risk Rating 2.0

• FEMA announced in March 2019
  – Modernize how risks assessed and insurance rates set
  – Provide a more accurate picture of perils facing individual properties
  – Easier to understand rating characteristics
• Likely lead to higher flood insurance rates for some homeowners and lower rates for others
• Planned to be implemented on October 1, 2021
Private Insurance Drivers

- Increased reinsurance capacity
- Likely increase willingness of private insurers to underwrite coverage
Flood Facts—Private Insurance Market Share

Based on 2019 WP—Top US Private Flood Insurers (Comm. + Res.)

- Assurant Inc.: 16.9%
- Zurich Insurance Group: 15.7%
- Swiss Re Ltd.: 13.2%
- AIG: 10.2%
- AXA: 7.0%
- Arch Capital Group Ltd.: 6.8%
- Liberty Mutual: 4.5%
- Berkshire Hathaway Inc.: 4.4%
- Alleghany Corp.: 3.9%
- Allianz: 3.9%
- Other: 13.3%
Flood Insurance Facts

According to Insurance Information Institute (III):

• 15% of American homeowners had a flood insurance policy in 2018

• Possible reasons for low take-up rate:
  – Too expensive
  – Homeowners not aware they don’t have coverage
  – Underestimation of risk of flooding

• Opportunity for growth in the US!
Considerations/Benefits/Uncertainties

- Data
- Models
- Rates
- Coverage
- Capital

- Choice
- Innovation
- Increased Revenue
- Profit Potential

- Price Restrictions?
- Underwriting Restrictions?
- Adverse Selection
- Catastrophic Loss
Quantification of Flood Risk Using Catastrophe Models
Even though flood occurrences may be frequent and losses significant, there is still a lack of detailed and comprehensive historical loss data that can be used to project future losses.

- Catastrophe occurrences are rare and/or data is limited
- Population growth and infrastructure development (building code requirements) alter the risk landscape
- Catastrophe occurrences cause large loss over a wide area; models are a tool to manage accumulation of risk
- Catastrophe models provide a means to understand plausible scenarios that have not occurred in recent history
Catastrophe models provide a holistic view of portfolio cat risk at various risk tolerance thresholds, while accounting for thousands of plausible scenarios that haven’t been observed in the historical record.

### Average Annual Loss
Measure of overall catastrophe risk, function of both severity and frequency of losses
On average, you can expect to incur $48M of catastrophe loss in a given year

### Probable Maximum Loss (PML) or Return Period Loss
An estimate of the likelihood that a catastrophic loss will be met or exceeded
The 100 yr return period is $548M – There is a 1% probability of having a loss of $548M or greater

### Occurrence Exceedance Probability (OEP)
Probability that the single largest event loss in a year will exceed a loss threshold

### Aggregate Exceedance Probability (AEP)
Probability that the aggregate event losses in a year will exceed a loss threshold

### Volatility
Mean losses will fluctuate from year to year
Volatility measures the amount of fluctuation

**Measurement:** $CV = \frac{\text{Standard Deviation}}{\text{Average Annual Loss}}$
Sources of Flood

**Fluvial (Riverine) Flooding**
- Heavy rainfall or snow melt that causes water levels in rivers or creeks to overtop the banks

**Storm Surge**
- Rising coastal flood water due to a hurricane

**Pluvial (Flash) Flooding**
- Heavy downpour of rain that saturates the urban drainage system and excess water cannot be absorbed

**Hurricane-Induced Precipitation Flooding**
- Flooding from rainfall associated with a tropical storm or hurricane
How Do We Know If a Flood Model is Good?

All components of a catastrophe model from hazard and vulnerability to losses can be evaluated to identify model strengths and concerns, with the ultimate goal of helping clients choose a best-fit solution based on their portfolio and risk management goals.

Hazard
- Are event frequency/severity relationships reasonable?
- Are current scientific methods used to create event footprints?

Vulnerability
- Are relationships between risk characteristics and vulnerability regions reasonable?
- How are relationships between hazard and damage derived? Are they defendable?

Losses
- Is loss distributed appropriately across geographic regions?
- How do different types of events contribute to loss along the EP curve?
- Where are key historical event losses positioned on the EP curve?
Hazard: Methodology

Hurricane Tracks
- Stochastic events from the hurricane models

Hazard Model
- Changes in hazard parameters along the length of the track
- Bathymetry

Hydrology
- Precipitation data is used to create stochastic events
- Rainfall runoff is determined considering factors such as soil, elevation, and land use

Hydraulics
- Rainfall runoff is routed through drainage basins and into the river network; Converted to a flood depth

Flood Depth
- Surge / Flood depth stored in hazard grid
- Compared with ground elevation grid
- Building elevation also considered

Damage
- Differentiation in vulnerability varies by model
- Key characteristics include story height, year built, construction and foundation type
Evaluating Storm Surge Hazard Approaches

Evaluation of storm surge hazard involves a two-fold approach of evaluating the driving hurricane wind model in addition to evaluating the storm surge model itself.

Evaluating a Hurricane Model

- **How Often?** Regional landfall rates by category compared to historical
- **How Strong?** Central pressure and one-minute sustained wind speed (Vmax)
- **How Wide?** Radius of maximum winds (Rmax)
- **How Fast?** Forward speed

Different Storm Surge Model Types

- **Parametric Model**
  - Height of water on land is modeled analytically given a few key inputs such as distance to coast, elevation, land cover, height of water at the coast, etc.

- **Simplified Numerical Model: SLOSH**
  - SLOSH is developed by the National Weather Service (NWS) and utilizes regional meshes to force coastal flooding on land
  - Simplified versions of shallow water equations used

- **Fully Hydrodynamic Models: MIKE 21 & ADCIRC**
  - 2D hydrodynamic models that use unstructured triangular regional meshes
    - Uses shallow water equations to simulate hydrodynamics
    - Uses high-resolution topography, bathymetry, and land use data
Evaluating Inland Flood Hazard Approaches

Hydrologic Cycle

Event generation (both on-plain and off-plain)?
- GCM vs. Gauge Data
- Event definition
- Consideration of snowmelt

Data sources and vintage; Resolution

Surface runoff – How are discharges determined along the river network? How are off-plain flood footprints determined?

Flood Routing & Hydraulic Modeling

Flood routing approach employed

Distances between cross sections for determining discharge along river network

Resolution of DTM used in hydraulic model for estimating flood depths
Flood Depth & Damage

Source and Approach:
- Component-based vs. Observation
- Army Corps of Engineers
- Institute of Water Resources
- Claims Data

Resolution of hazard grid and resolution of ground elevation
Validation of depths for historical events

Primary risk characteristics supported
- Availability of key construction and occupancy classes

Supported secondary modifiers
Key Vulnerability Inputs for Flood

- Do the loss cost relativities make sense?
- What are the assumptions for unknown?
- Is there the ability to input user-defined first floor height?

- What options are available?
- What is the impact of going from unknown to known?

- Is this input supported in the flood model?
- Are the impact by coverage as expected?

- Are the required construction classes available?
- Do the loss cost relativities make sense?

- How implemented in the model?
- Is the impact as expected?

- Are the required occupancy classes available?
- Do the loss cost relativities make sense?
Investigation of Losses

**EP Loss Comparisons**
- OEP vs AEP
- EP losses by Flood Zone
- Where do key historical events sit on the curve?
- Comparison to claims data where available

**Geographic Distribution of Losses**
- AAL By County
  - Geographic distribution of loss
- AAL by Location
  - Elevation
  - Flood Zone
  - Proximity to Water
- Loss Cost By County
  - Does distribution make sense?
  - Flash flooding vs. Riverine
- Excess AAL
  - Where are the most severe events occurring?
  - Historical events? Claims Data?
Investigation of Losses

**EP Loss Comparisons**

- Model A
- Model B
- Model C

**Geographic Distribution of Losses**

- AAL By County
- Loss Cost By County

**Frequency vs. Severity Relationships**

- Model A
- California Flood X Zone
- Model B
- California Flood X Zone

**EP Loss Comparisons Table**

<table>
<thead>
<tr>
<th>Return Period</th>
<th>Model A</th>
<th>Return Period</th>
<th>Model B</th>
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</thead>
<tbody>
<tr>
<td>500-yr</td>
<td>1,865M</td>
<td>500-yr</td>
<td>11,181M</td>
</tr>
<tr>
<td>100-yr</td>
<td>1,269M</td>
<td>100-yr</td>
<td>3,151M</td>
</tr>
<tr>
<td>10-yr</td>
<td>419M</td>
<td>10-yr</td>
<td>255M</td>
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</tbody>
</table>

- AAL is **less than 2%** different between the two models
- 100-year return period is **148% higher** in Model B than in Model A
What else should we be thinking about?
Additional Model Considerations

**Geocoding Approach**
- Street segment vs. Parcel Based vs. Rooftop Geocoding

**Treatment of Flood Prevention Structures**
- Source and vintage of levees implemented
- How are levee failures considered?
- How are dams as a flood reduction measure considered in event generation / footprint development?

**Non-Modeled Risk**
- Regions / Perils with No Available Model
- Classes and LOBs not covered by models
- Secondary Perils and Effects Not Covered
- Coverages not considered by models

http://cmisheetpiling.com/
Availability of Additional Flood Capabilities

Return Period Floodplain Scenarios
- Return periods available
- Flood depths associated with different return periods

Historical Event Scenarios
- How many and what events are available?
- Geographic spread

Real-Time Event Modeling
- Availability of aggregation footprints during / quickly after event
- Resolution of footprints

Underwriting Tools
- Flood Zone
- Ground Elevation / BFE
- Distance to Flood Plain
- AAL Grids
- Flood Score

Louisiana Flood Shape (August 2016) shown in IoD
Important Hurricane Trends

**Precipitation**
Rainfall rates expected to increase in the future with a warmer atmosphere, which is able to hold more moisture.

**Forward Speed**
Hurricanes may be moving slower, resulting in a longer duration of strong winds and precipitation at a particular location and increased probability of storm surge overlapping with a high tide.

**Sea Level Rise**
Rising sea levels dramatically increase the potential for damaging floods from storm surge; Sea level rise along the coastal Northeast expected to exceed the global average rise.
Flood is a key growth opportunity (often no. 1 for many reinsurers) and technology and analytics are the key to education, expansion, and profitability!

- **Flood Models**
  - More and better flood models entering the market
  - Multi-model vendor insights

- **Spatial Analytics**
  - Manage aggregations
  - Compare risks to FEMA’s digital flood maps or floodplains available from other vendors
  - Event footprints

- **Flood Strategy**
  - A and V zone vs. X zone
    - Improve coverage over NFIP or at a reduced price?
  - Personal vs. commercial lines
  - Sub-limits
  - Set premium (no touch) or strategic underwriting

- **Implementation**
  - How to educate policyholders, agents, etc.?
  - Reinsurer support
  - Platform stability
Questions?
Join Us for the Next Pinnacle APEX Webinar

Thursday, September 24
2:00 p.m. ET
Registration is Open

Group Captives 101

with Pinnacle’s Joe Herbers and Marsh Management’s Dave Huber
Final Notes

• We’d like your feedback and suggestions
  • Please complete our survey

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Thank You

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