AIR Inland Flood Model & NFIP Claims Analysis
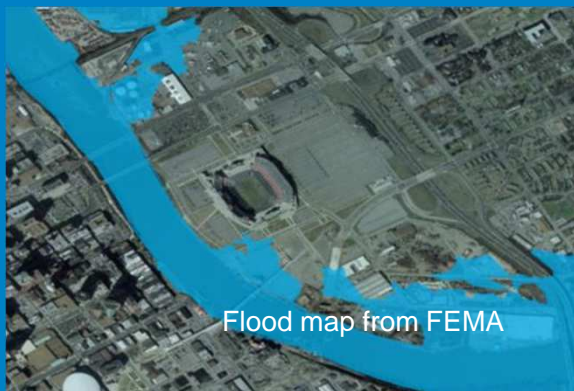
Raulina Wojtkiewicz

AIR WORLDWIDE®

The State of Flood Insurance in the United States
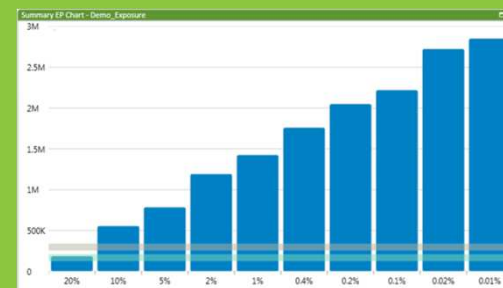
Common Tools Used in the Industry

- **FEMA Flood Maps**

- **Historical Footprints**

- **Actuarial models based on trended losses**
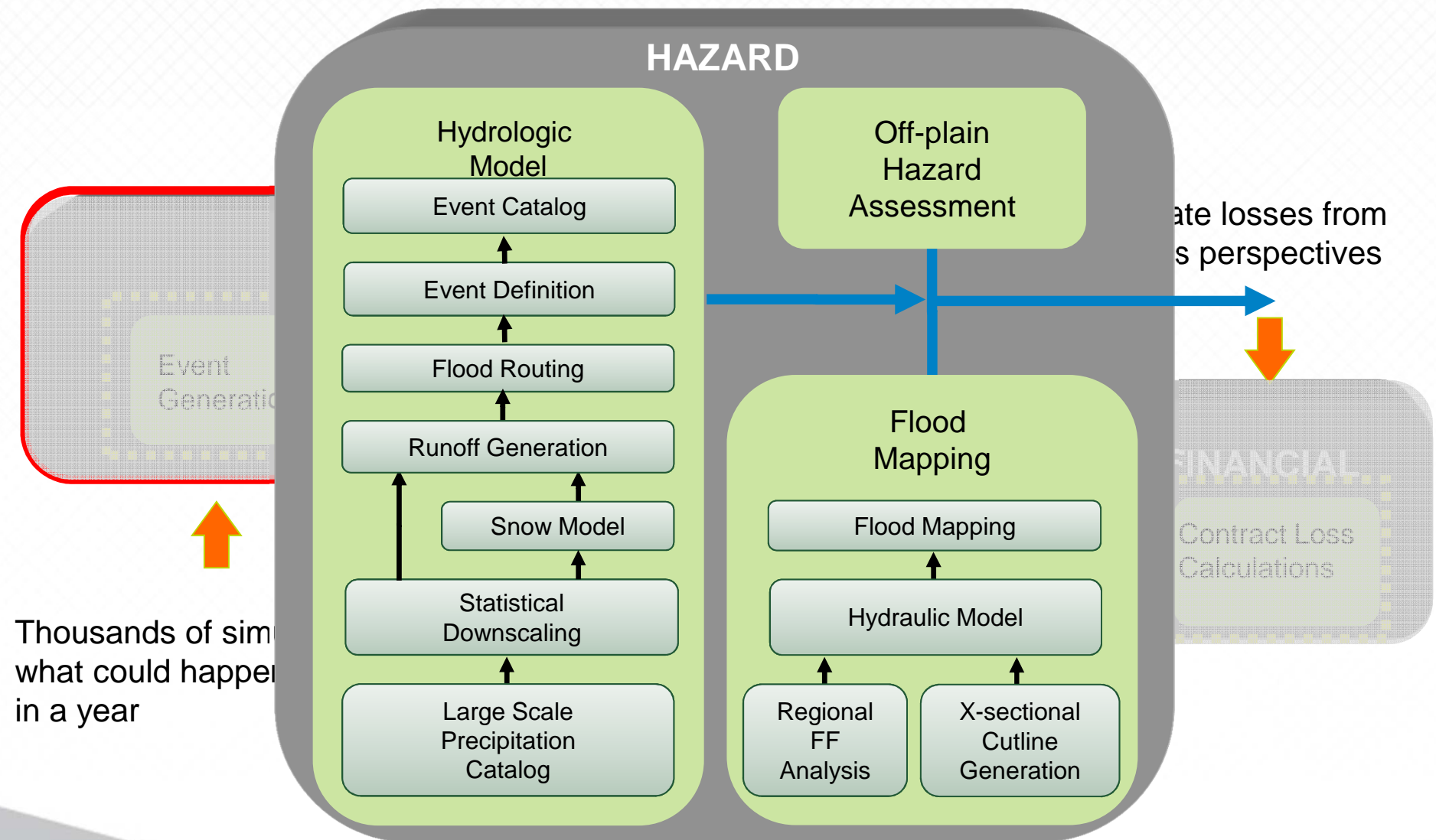

Flood map from FEMA

Catastrophe Models

- **Event based simulation provides portfolio view risk at different exceedance probabilities levels**

- **Current portfolio of exposure is considered in the modeling**

- **Consistent and complete flood hazard maps**

AIR Uses a Similar Model Framework Across Many Different Perils

HAZARD

Hydrologic Model
- Event Catalog
- Event Definition
- Flood Routing
- Runoff Generation
- Snow Model
- Statistical Downscaling
- Large Scale Precipitation Catalog

Off-plain Hazard Assessment

Flood Mapping
- Flood Mapping
- Hydraulic Model
- Regional FF Analysis
- X-sectional Cutline Generation

Event Generation

Thousands of sim... what could happen... in a year

ate losses from ...s perspectives

FINANCIAL

Contract Loss Calculations

A Flood Hazard Model Contains Three Main Components
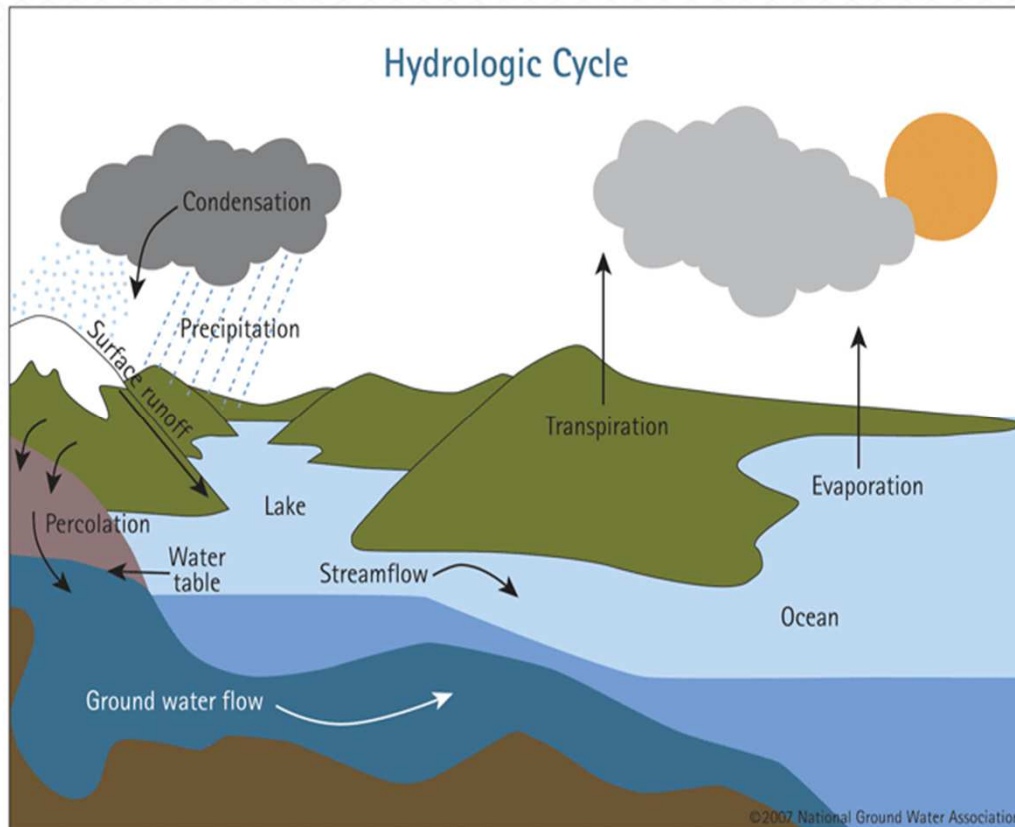
Illustration source: http://www.ngwa.org/Fundamentals/use/PublishingImages/hydrologic_cycle.gif

Precipitation

Runoff & Flow

Flood Extent Mapping
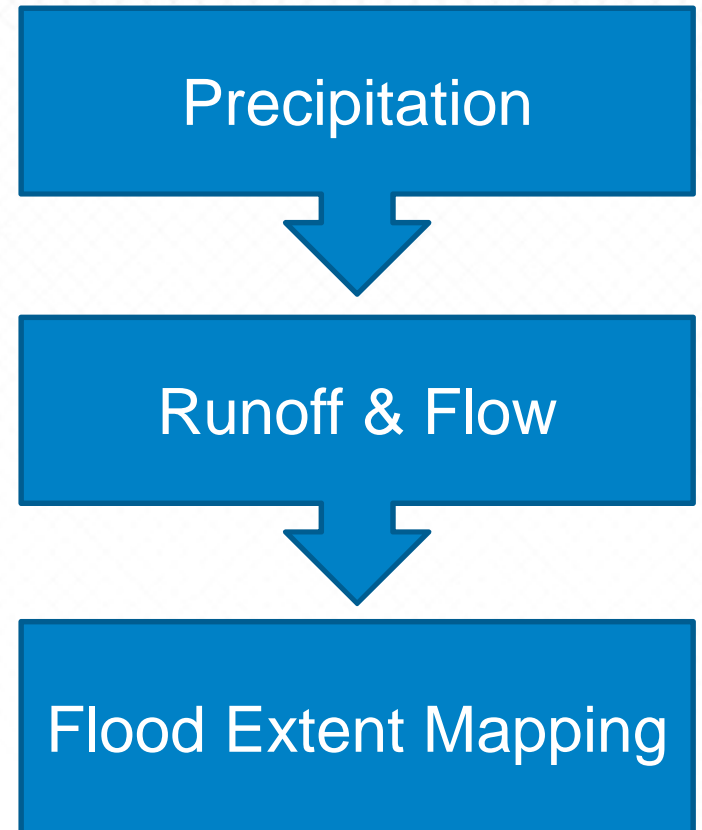
Coupling GCM and NWP Models Helps Creating Realistic Simulated Events

- Couple a Global Circulation Model (GCM) with a mesoscale Numerical Weather Prediction (NWP) model to provide coherent large-scale patterns

- Employ statistical downscaling techniques to realistically simulate small-scale features

GCM   NWP   Downscaled
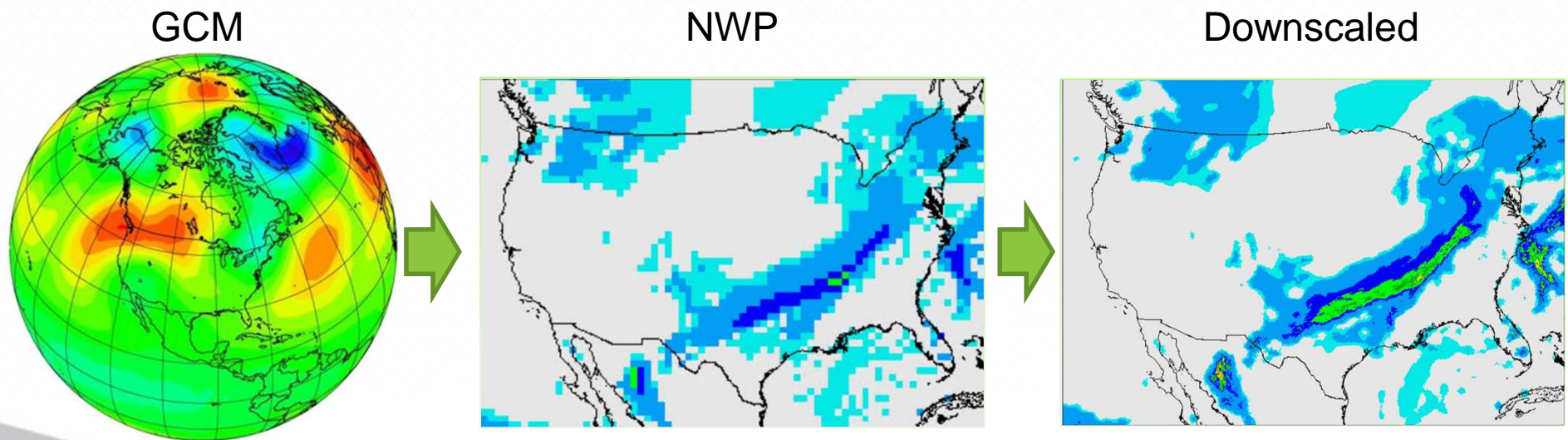
Well Established Approaches Are Used to Transform Precipitation to Flow

Precipitation
i = 1…10,000 years
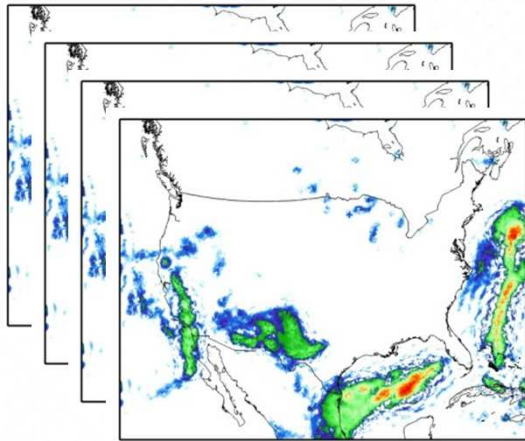
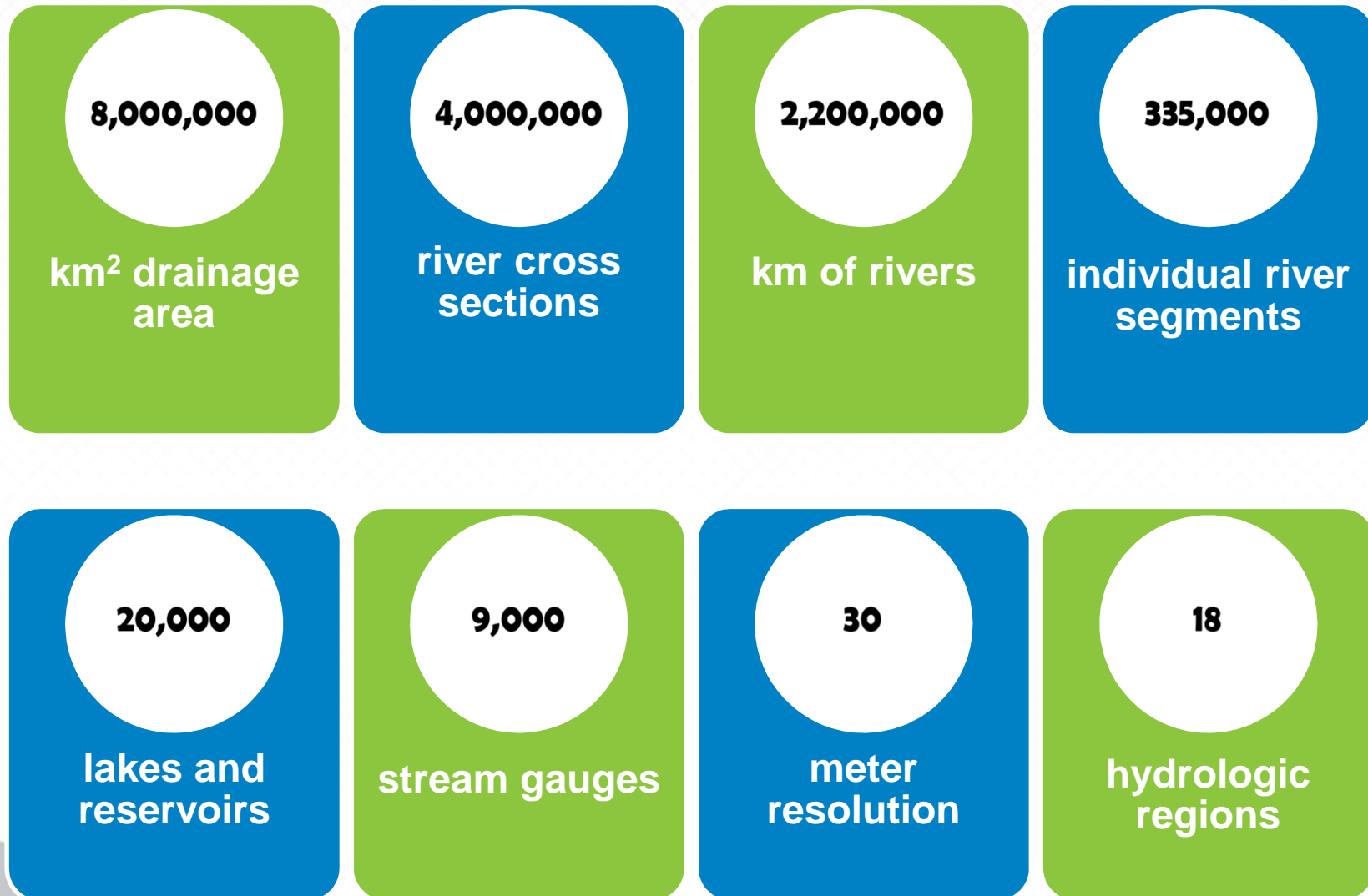Runoff & Flow Generation Model

Flow

Excess Runoff

On-plain damage



Off-plain damage

Inadequate Drainage Conditions

AIR US Flood Model by the Numbers

|			
8,000,000 km² drainage area	**4,000,000** river cross sections	**2,200,000** km of rivers	**335,000** individual river segments
20,000 lakes and reservoirs	**9,000** stream gauges	**30** meter resolution	**18** hydrologic regions

Primary and Secondary Risk Features Allow for Improved Loss Estimates

- Primary risk characteristics
  - Location and design recommendations, Occupancy, Construction, Height
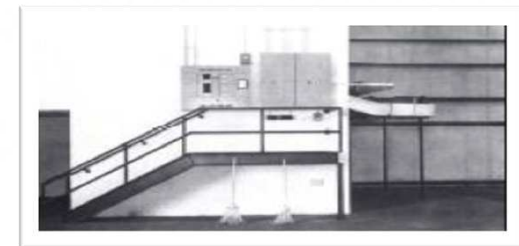- Customized Mitigation Effects

Foundation Type
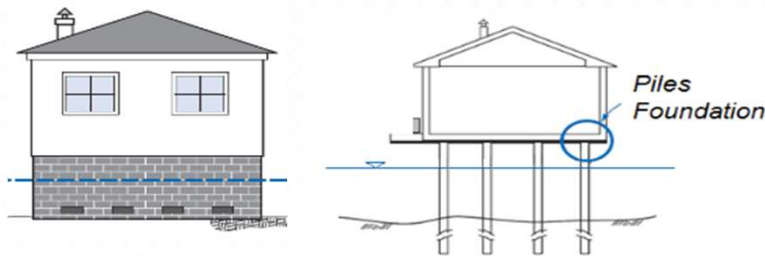
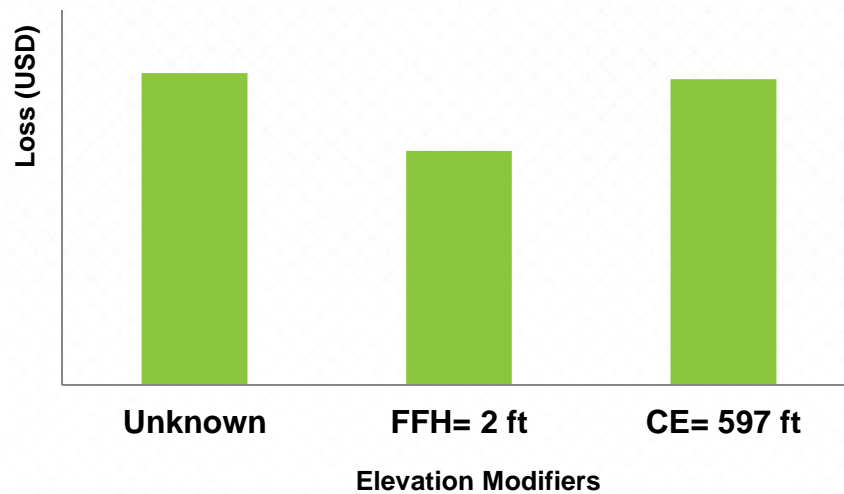**Custom Flood Protection**
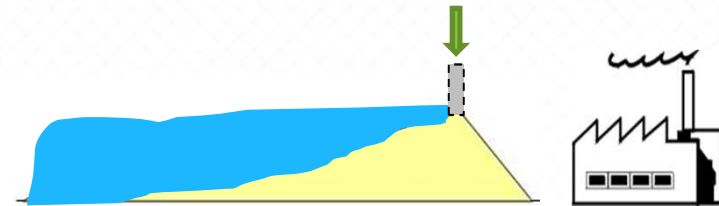
First Floor Height and Elevation
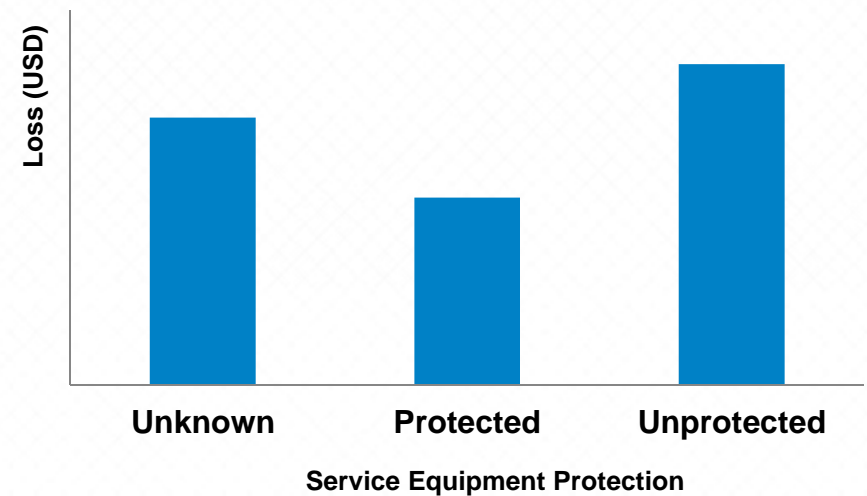

Service Equipment Location

Vulnerability Module Accounts for Exposure Characteristics in Assessing Flood Losses
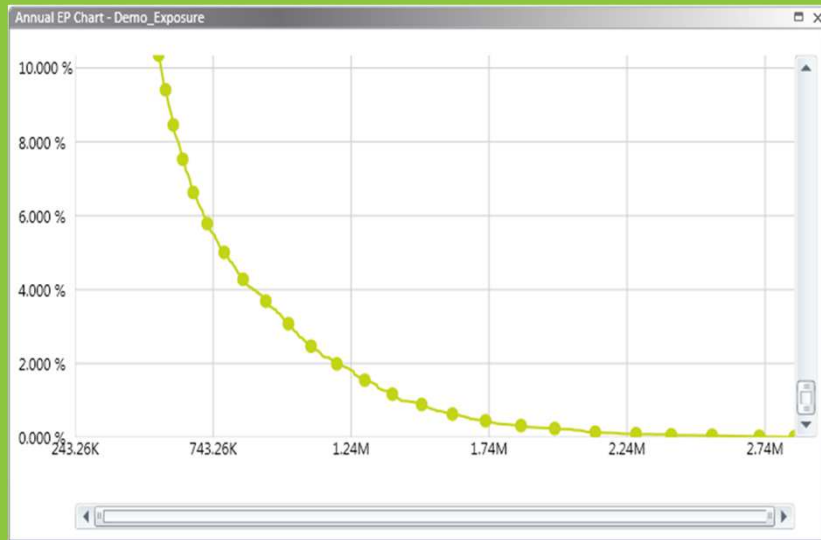
Average Annual Loss Changes

Elevation Modifiers: Unknown, FFH= 2 ft, CE= 597 ft

Average Annual Loss Changes
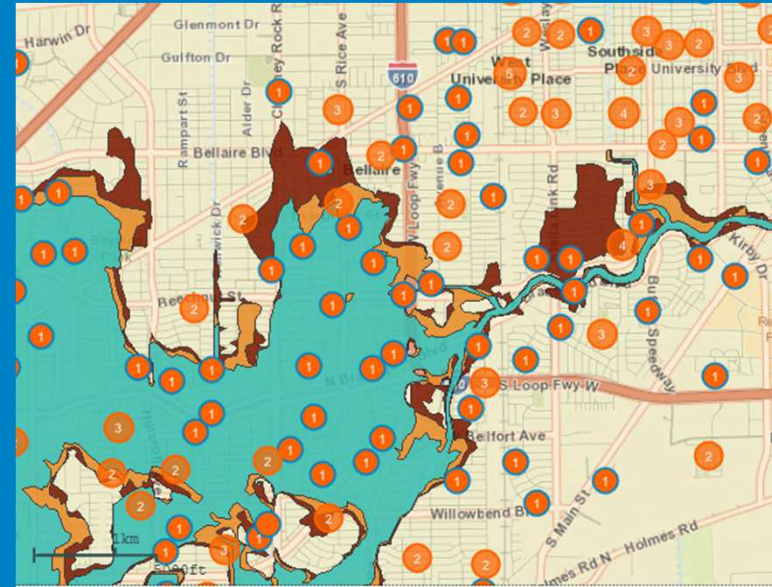

Service Equipment Protection: Unknown, Protected, Unprotected

AIR US Flood Model in Touchstone Offer a Consistent and Complete View of the Flood Risk

Fully Probabilistic Results

Geospatial Analysis

AIR's Inland Flood Model Also Provide Historical Events for Loss Evaluation
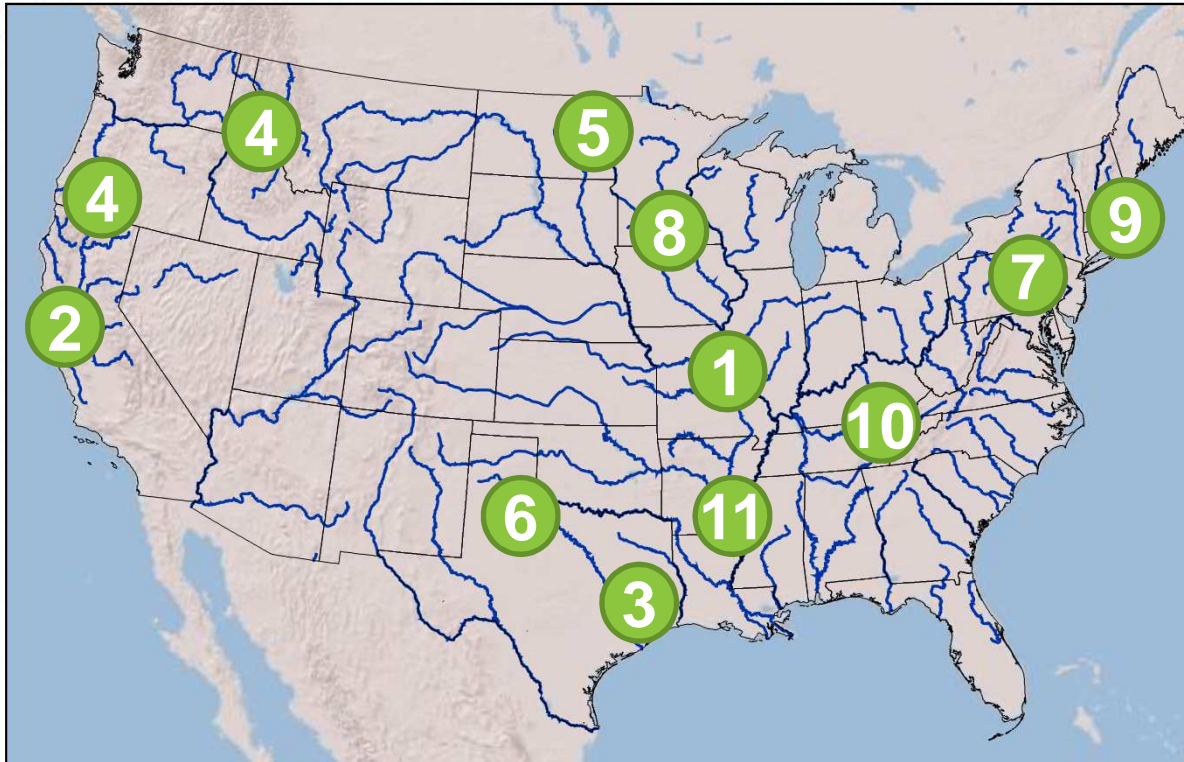
1. The Great Flood, 1993
2. California Flood, 1995
3. Gulf Coast Flooding, 1995
4. Pacific Northwest, 1996-97
5. Red River Flood, 1997
6. Texas Flood, 1998
7. Northeast Flood, 2006
8. Midwest Flooding, 2008
9. Rhode Island Flooding, 2010
10. Tennessee Flooding, 2010
11. Lower Mississippi River, 2011

NFIP Detailed Exposure and Claims Data Enables AIR Inland Flood Model Evaluation

- Flood Insurance Risk Study (FIRS) was mandated by the Biggert-Waters Act
  - AIR was engaged as a subcontractor to model Inland Flood and Storm Surge for NFIP Portfolio ($2T in RV, 5.4M risks) for use in reinsurance studies and econometric models. AIR conducted extensive data cleansing, validation and augmentation exercise

- AIR Conducted Claims Study
  - Location level claims data from 1978-2012 (2M records, $50B paid loss)
  - Bucketed historical claims into peril (i.e. inland flood, surge, etc.)
  - Verified model reasonability against the largest writer in this space – validated historical vs. modeled losses by event, LOB, coverage, state

FEMA Provided Location Level Exposure Data

- AIR inland flood loss study was done using the 2012 exposure at the location level
- Exposure Indexing Methodology Accounts for Changes in NFIP Portfolio
    - Necessary to account for these changes when modelling historical events using 2012 exposure
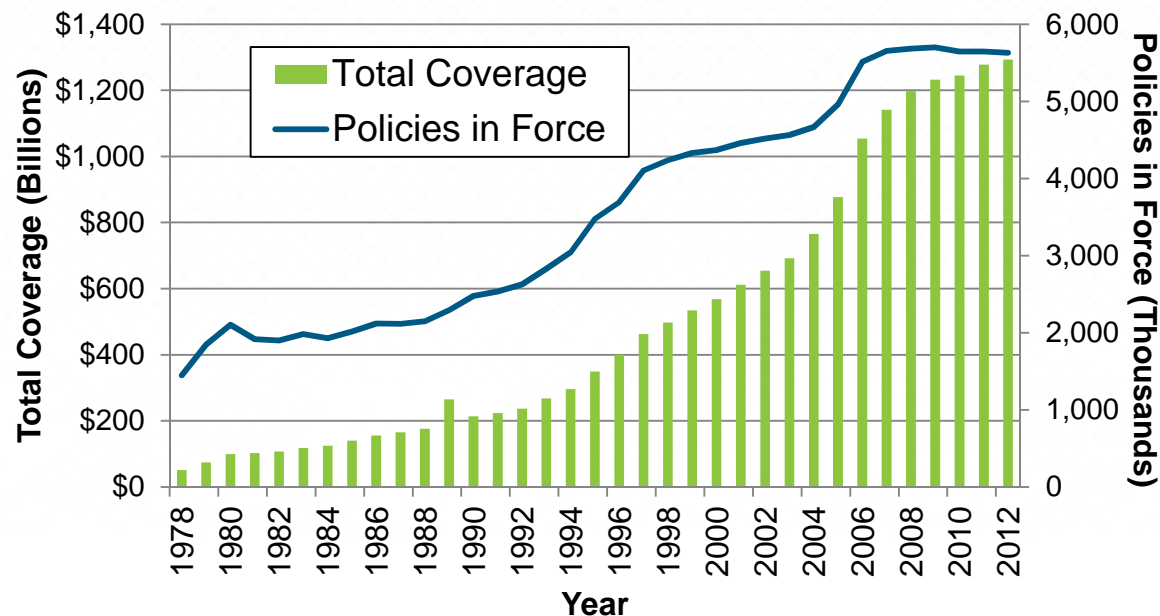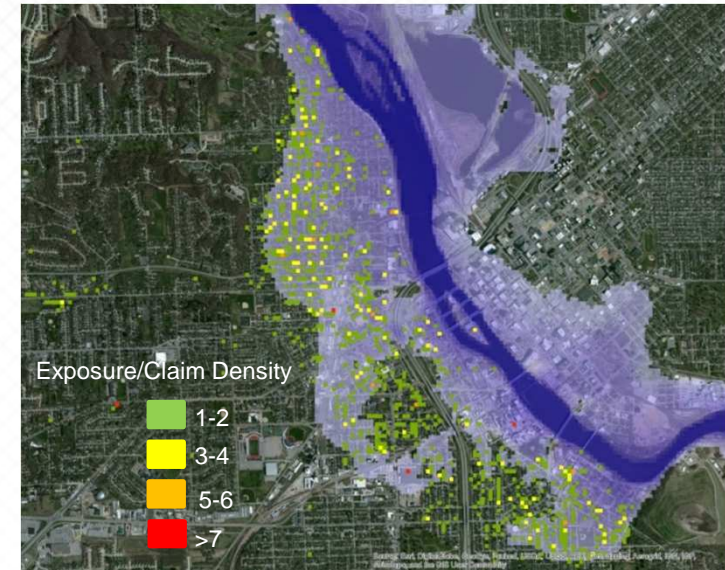
Exposures Indexing Accounts for Change in Exposure Distribution In Addition to Exposure Growth and Inflation
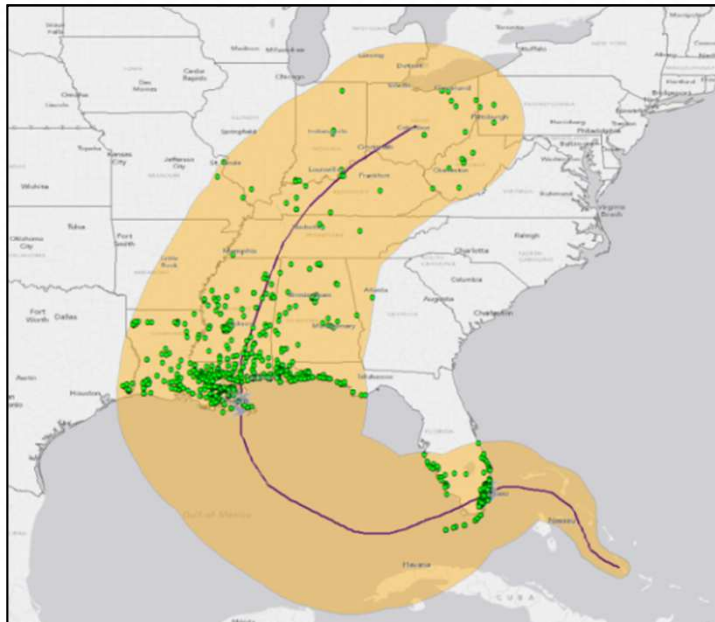

Cedar Rapid, Iowa (2008)

Exposure/Claim Density
- 1-2
- 3-4
- 5-6
- >7

Cedar Rapid, Iowa (2012)

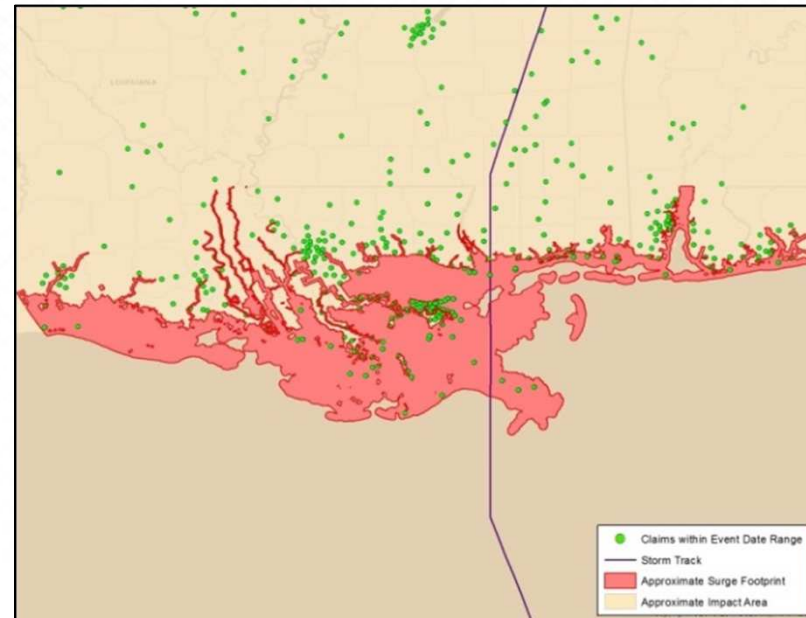Exposure/Claim Density
- 1-2
- 3-4
- 5-6
- >7
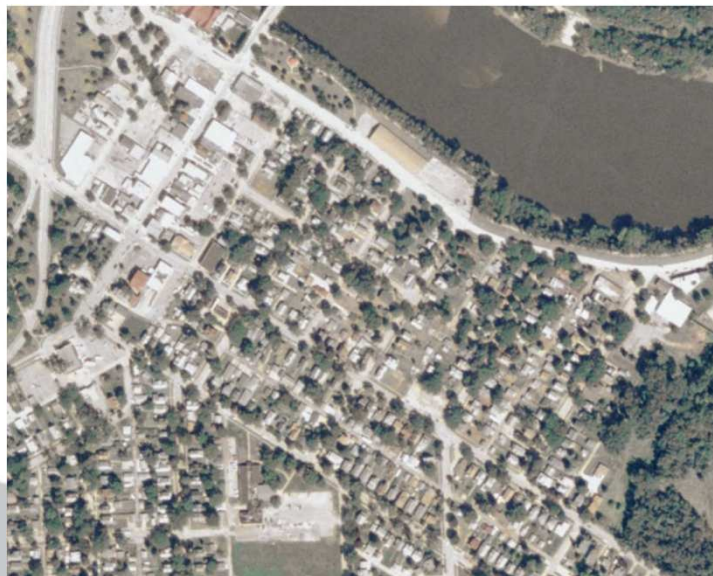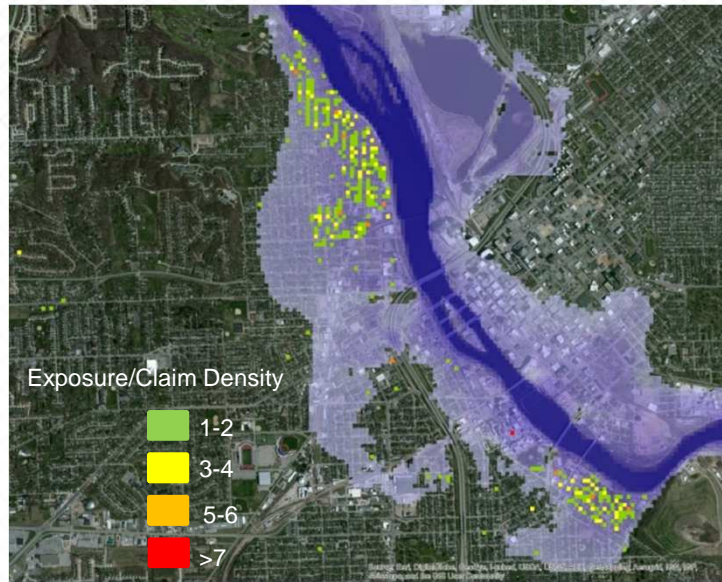
Event Identifiers Assigned to Claims Must be Supplemented to Define Events Consistent with AIR Models

- AIR Identified flood losses by sub-perils
- Floods / torrential rains, nor'easters and tropical storms
  - FEMA's Significant Event Report
    - Reports total losses for all events with more than 1,500 paid claims
- Hurricanes
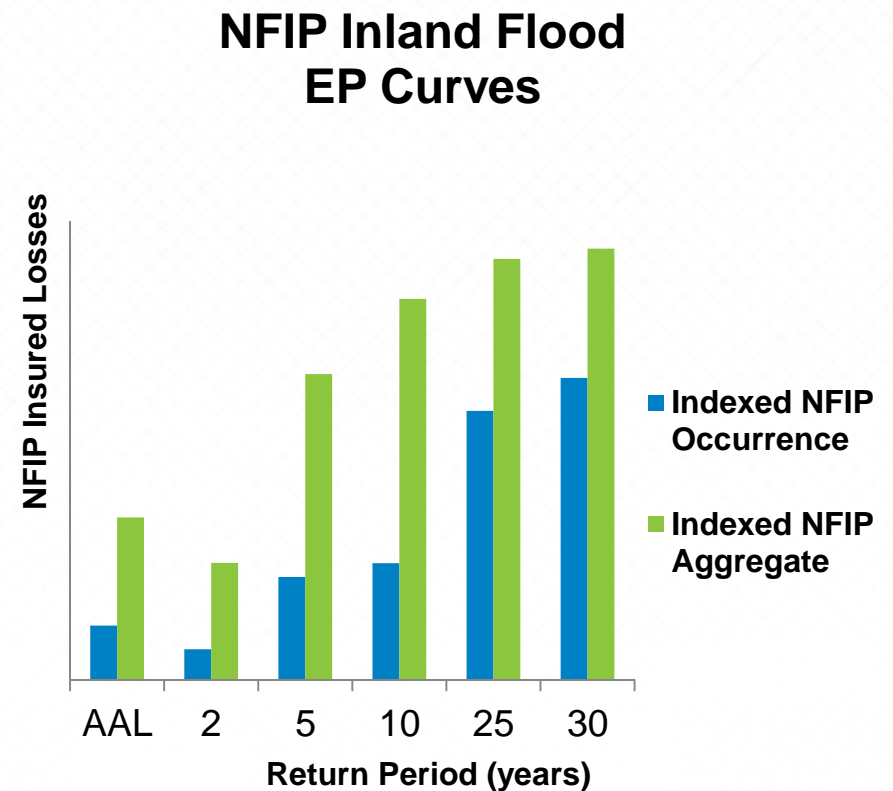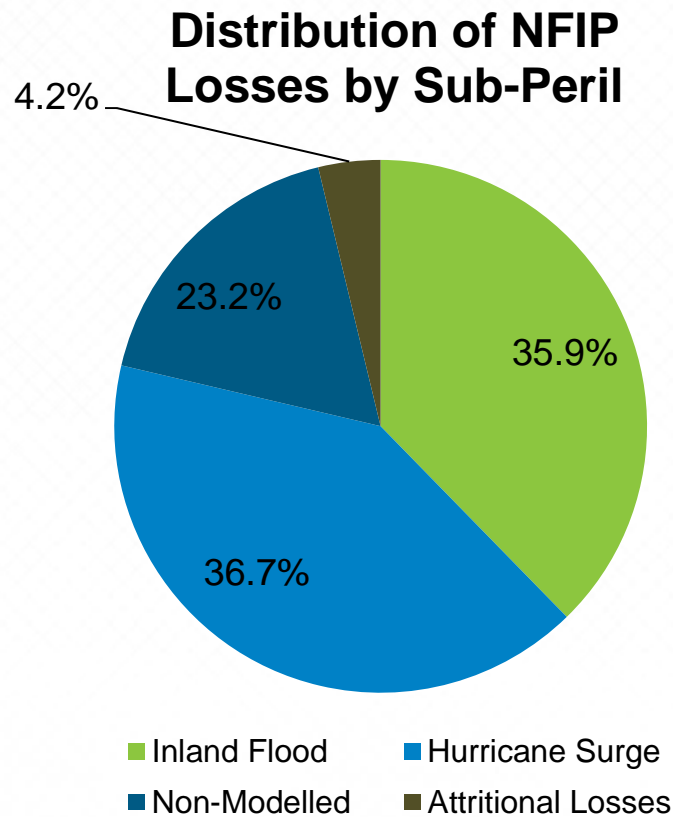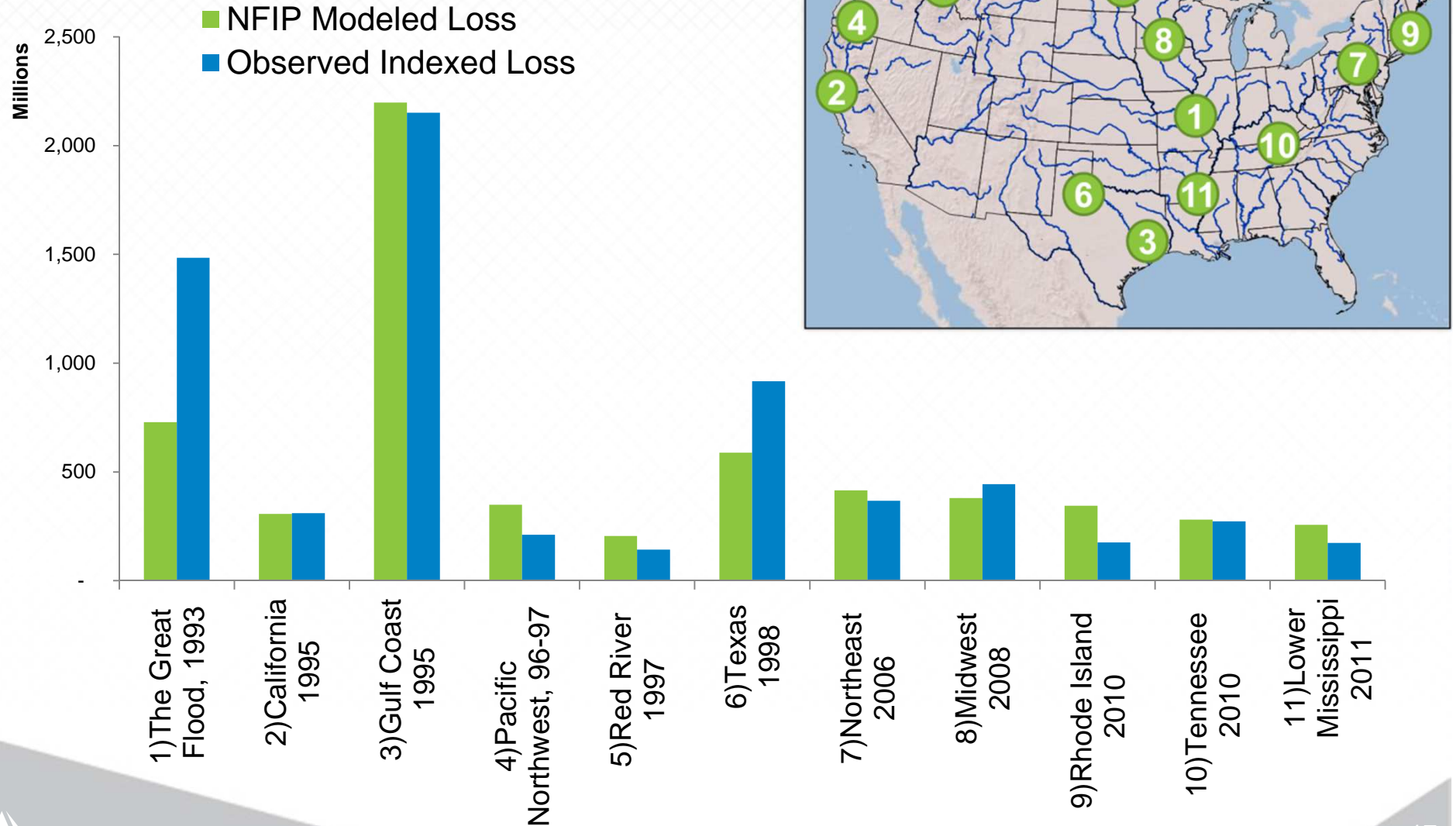 - NOAA HURDAT data was used to generate a track for each hurricane

Katrina, 2005

Gustav, 2008

Legend:
- Claims within Event Date Range
- Storm Track
- Approximate Surge Footprint
- Approximate Impact Area

FEMA Claims Data Showed that Losses from Inland Floods are Almost as Large as Losses from Storm Surge

Distribution of NFIP Losses by Sub-Peril

4.2%
23.2%
35.9%
36.7%

- Inland Flood
- Hurricane Surge
- Non-Modelled
- Attritional Losses

NFIP Inland Flood EP Curves

NFIP Insured Losses

AAL   2   5   10   25   30

Return Period (years)
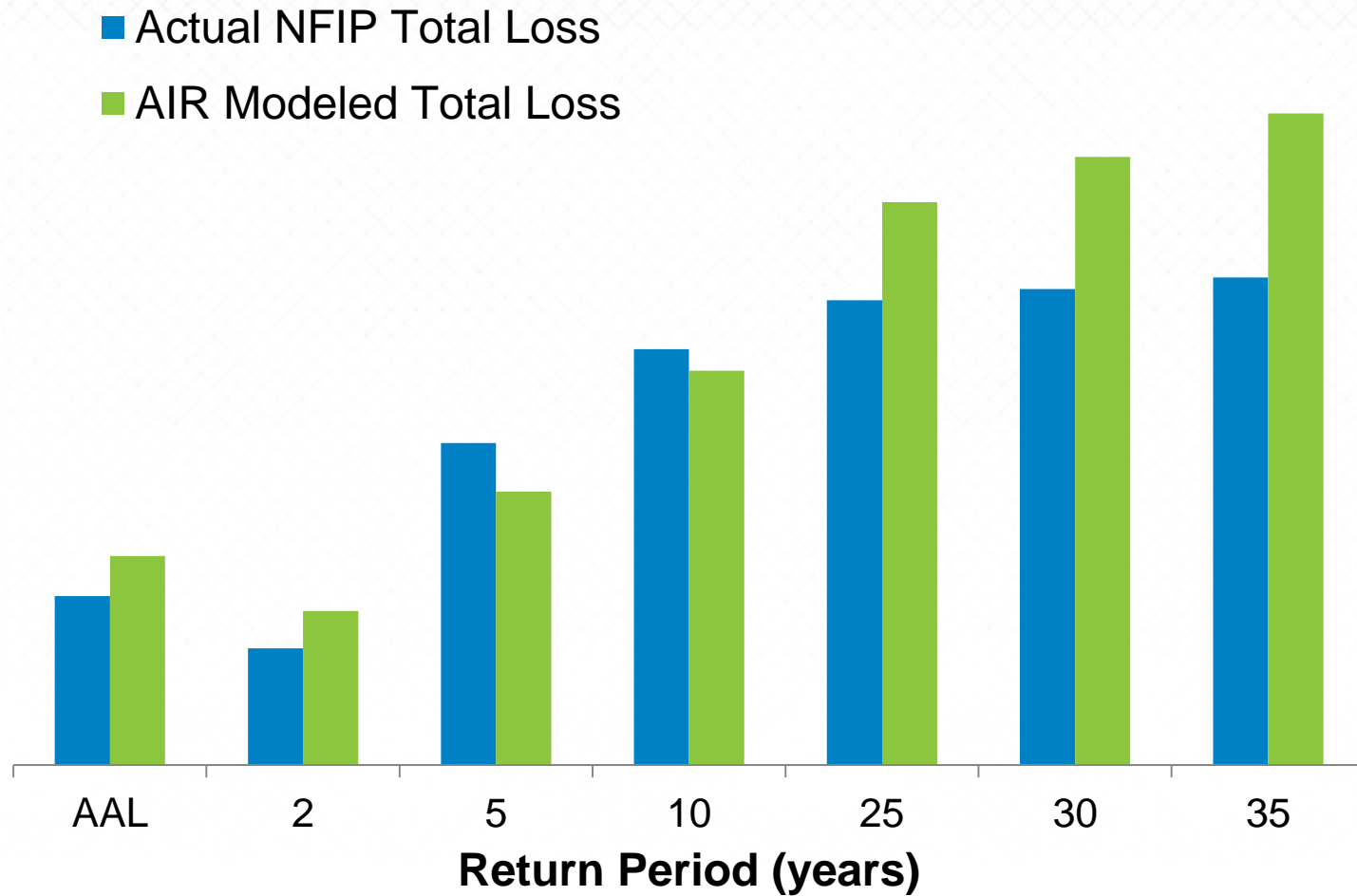
- Indexed NFIP Occurrence
- Indexed NFIP Aggregate

AIR

Comparison of Model and Indexed NFIP Losses for All Marquee Events

# Aggregate EP Curve Loss Evaluation Using 35 years of Actual NFIP Losses

Legend:
- ■ Actual NFIP Total Loss
- ■ AIR Modeled Total Loss

X-axis: Return Period (years): AAL, 2, 5, 10, 25, 30, 35

Countrywide Aggregate Stochastic Catalog Loss Evaluation

Actual NFIP Loss Experience

AIR Modeled Loss
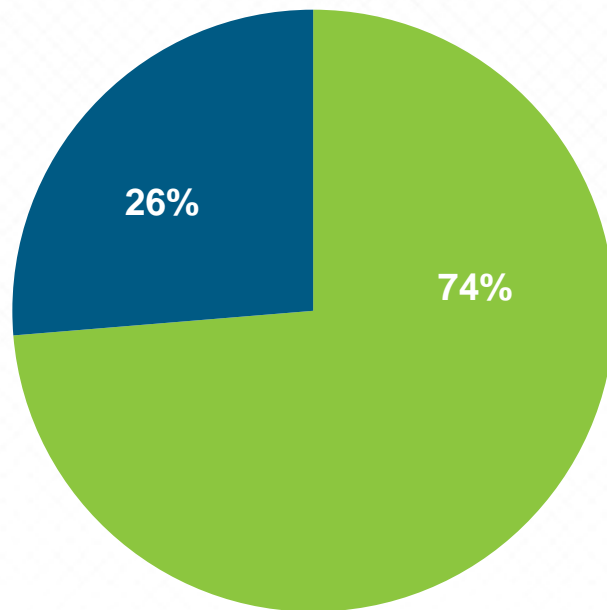
Actual NFIP Loss Experience pie chart: 74% green, 26% blue
- 🟩 Actual NFIP AAL Total Building Contribution
- 🟦 Actual NFIP AAL Total Content Contribution
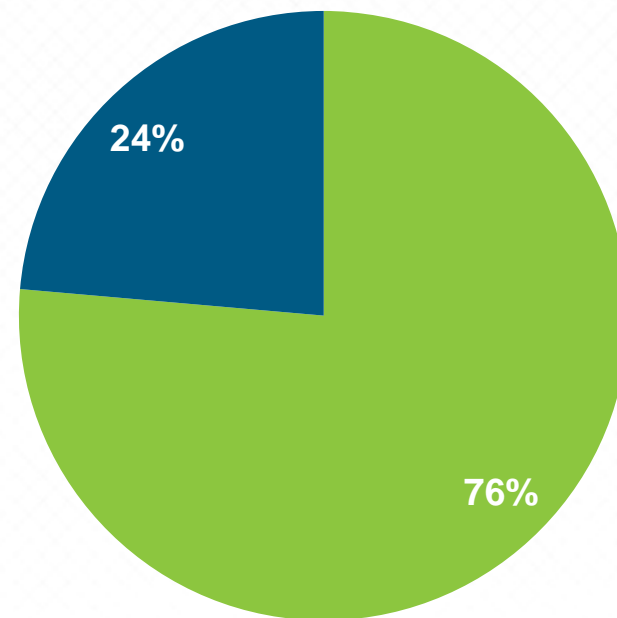
AIR Modeled Loss pie chart: 76% green, 24% blue
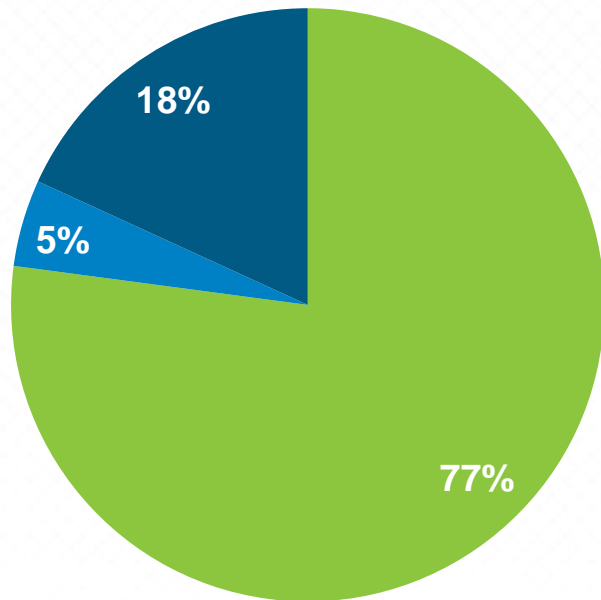- 🟩 AIR Modeled AAL Total Building Contribution
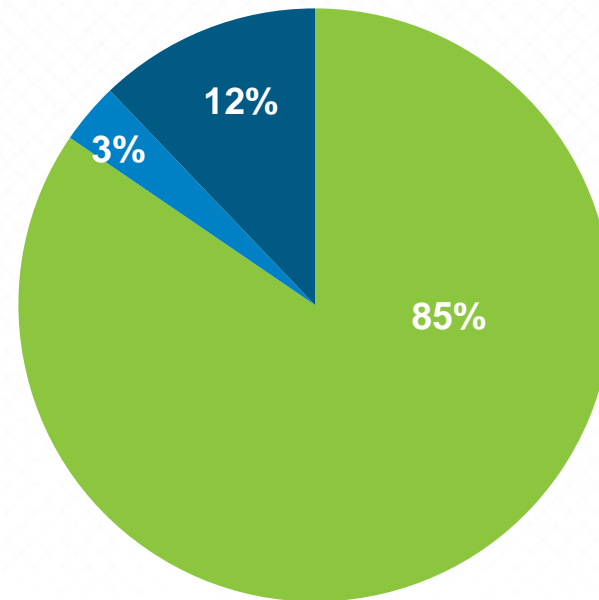- 🟦 AIR Modeled AAL Total Content Contribution

Countrywide Aggregate Stochastic Catalog Loss Evaluation

Actual NFIP Loss Experience

- Actual NFIP AAL Residential
- Actual NFIP AAL Apartment
- Actual NFIP AAL Commercial

AIR Modeled Loss

- AIR Modeled AAL Residential
- AIR Modeled AAL Apartment
- AIR Modeled AAL Commercial

AIR Comprehensive Inland Flood Risk Map of the United States