Hurricanes, Flood and Mortgages: Links between Natural and Default Hazards

June 27, 2018

CoreLogic
at a Glance

Enabling Smarter Decisions

CoreLogic Connects
To create a secure and safe customer experience

- Homeowners
- Appraisers
- Agents
- Insurance Carriers
- Insurance Adjuster
- Brokers
- Inspectors
- Public Sector
- Sellers
- Home Improvement
- Buyers
- Internet of Things OEM
- Contractors
- Investors
- Lenders

Complete, Current & Connected Information
Powered by Data, Analytics & Data-Enabled Services

OCCUPANTS

- Occupant and Contents Risks
- Property Maintenance
- Home Business Activities

ENVIRONMENT

- Catastrophe Models
- Weather Forensics
- Construction Cost Trends
- Environmental Hazard Data

FINANCIAL

- Economic Housing Market Data
- Mortgage Financing & HELOCs
- Liens & Encumbrances
- Auto Loans
- Valuation and Due Diligence

LOCATION

- Parcel Boundary
- Locational Accuracy
- Location Intelligence
- Fire Protection

BUILDING

- Building Characteristics
- Reconstruction Costs
- Imagery and 3-D Wireframe
- Structural Risks
- Condition Information

Hurricanes, Flood and Mortgages: Links between Natural and Default Hazards

June 27, 2018
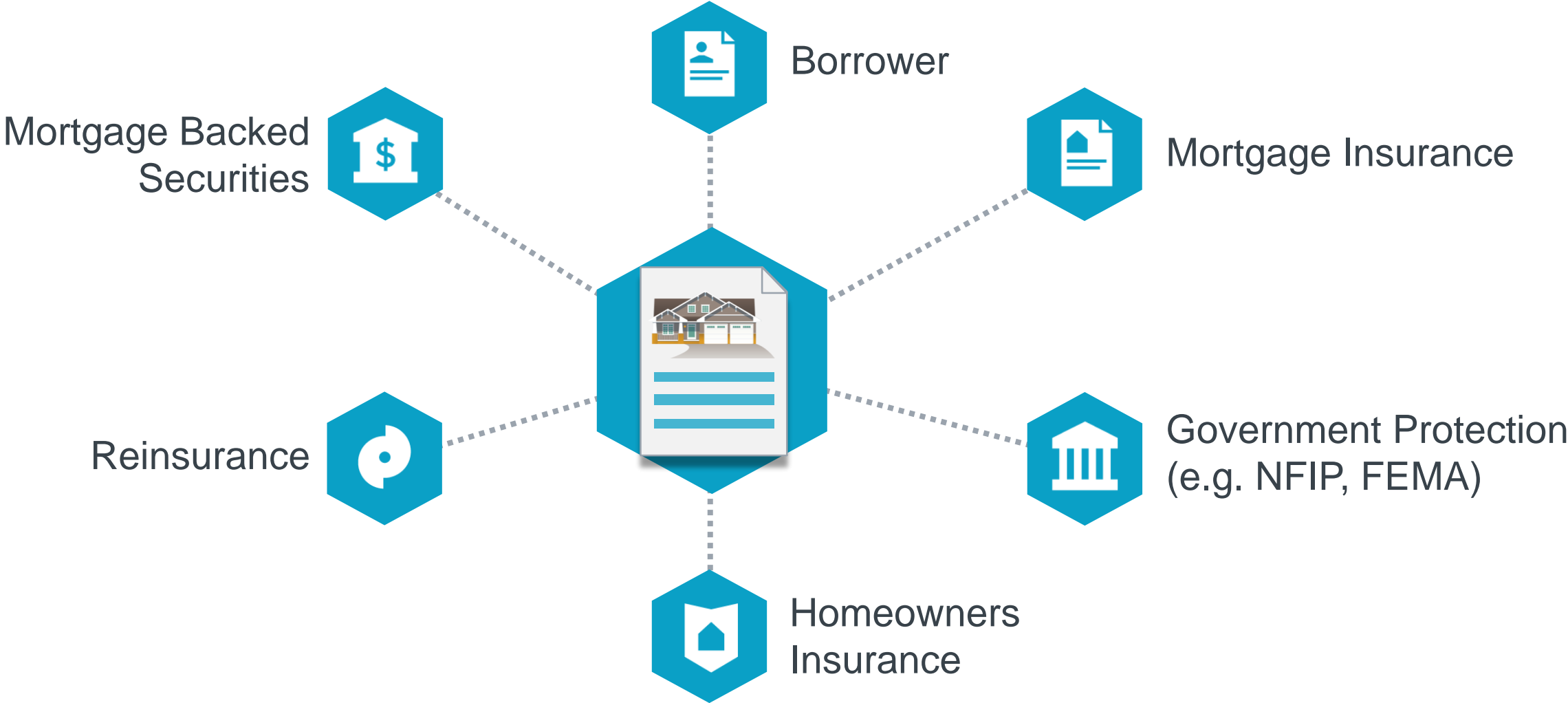
Discussion Topics

- Complete View of Property Risk

- Hurricane Harvey Review

- Quantifying the Impact of Hurricane Harvey
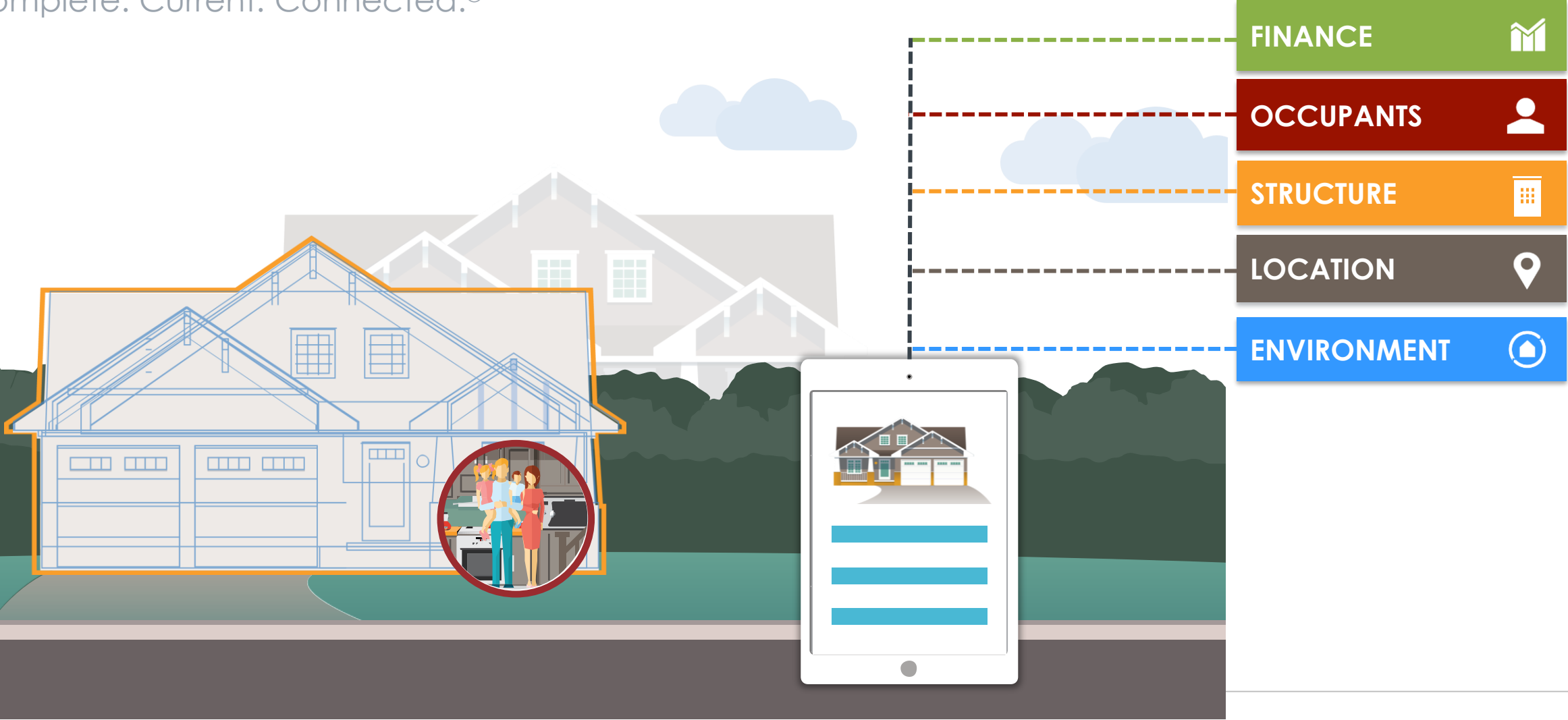
- Q&A

Complete View of Property Risk

Components to Consider
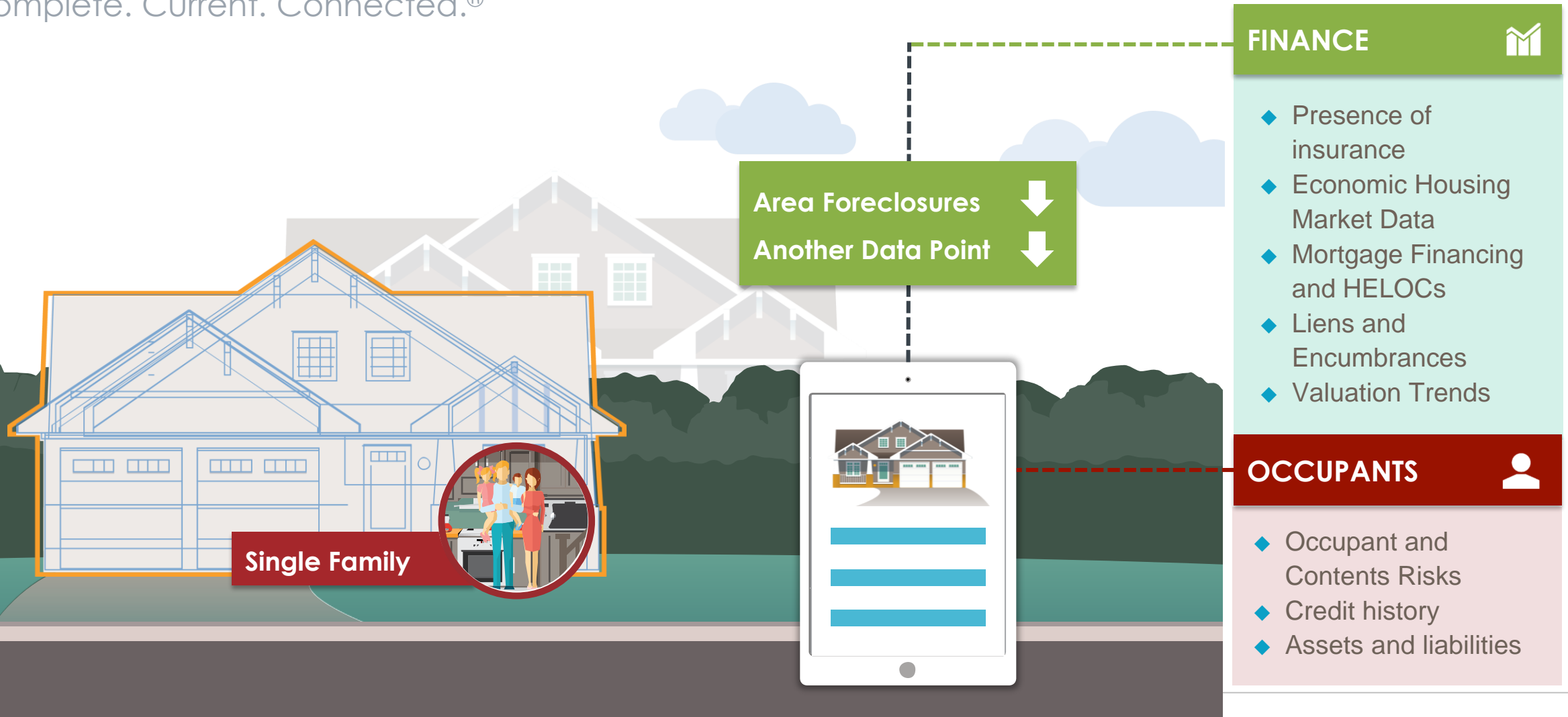
The Financial Ecosystem of a Mortgage

Borrower

Mortgage Insurance

Government Protection (e.g. NFIP, FEMA)

Homeowners Insurance

Reinsurance

Mortgage Backed Securities

Quantifying Risk

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FINANCE

OCCUPANTS

STRUCTURE

LOCATION

ENVIRONMENT

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Quantifying Risk

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Area Foreclosures ⬇

Another Data Point ⬇

Single Family

FINANCE

- Presence of insurance
- Economic Housing Market Data
- Mortgage Financing and HELOCs
- Liens and Encumbrances
- Valuation Trends

OCCUPANTS

- Occupant and Contents Risks
- Credit history
- Assets and liabilities

Important Alternative Data Considerations to Quantify Risk

- **Alternative Data for Mortgage Default** is Natural Catastrophe Events and Other Property Financials
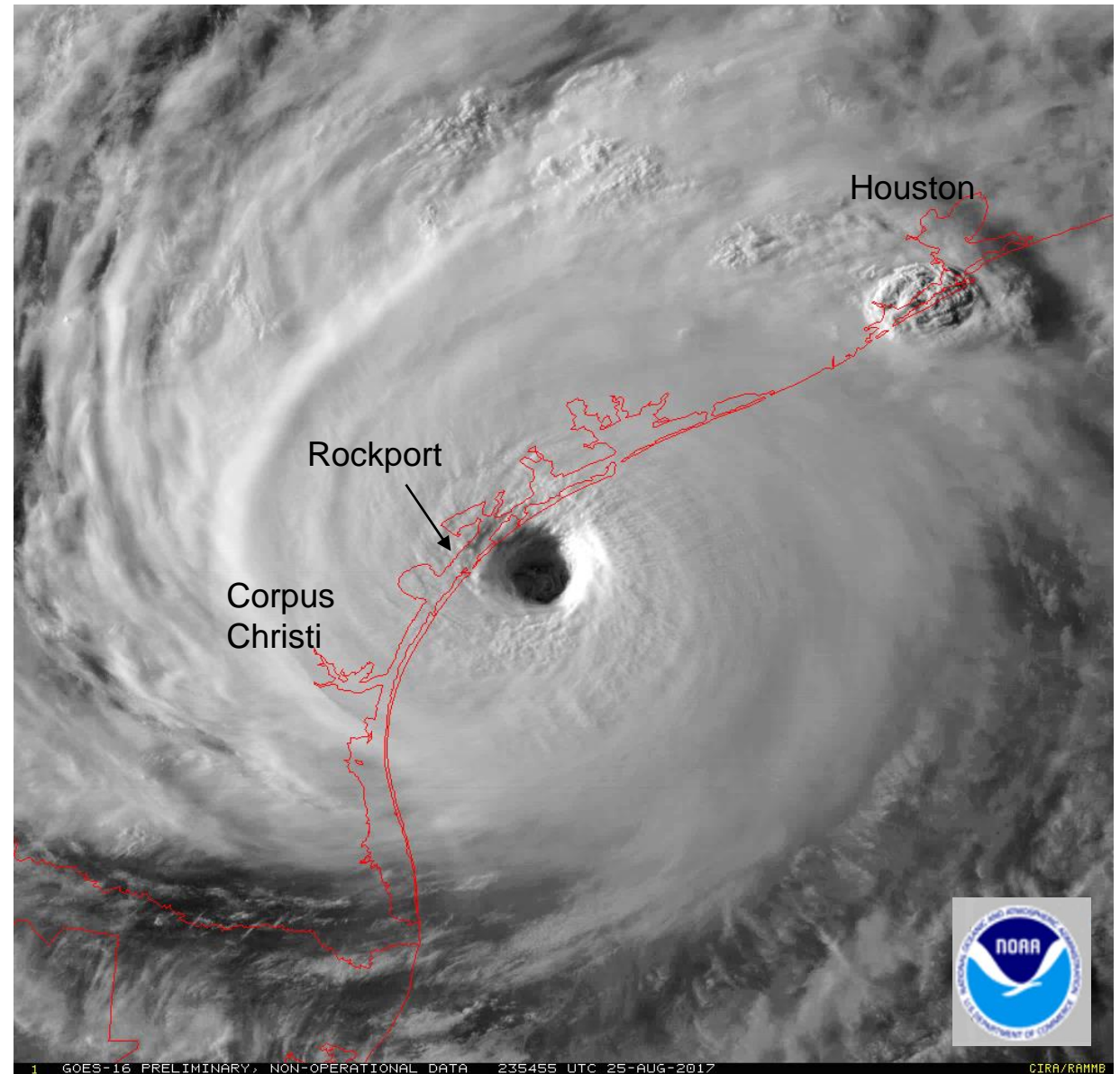- **Alternative Data for Insurance Risk** is Mortgage Default

Property Characteristics

Reconstruction Cost

FINANCE

OCCUPANTS

STRUCTURE

LOCATION

ENVIRONMENT

- ◆ Natural Hazard and Catastrophe Events
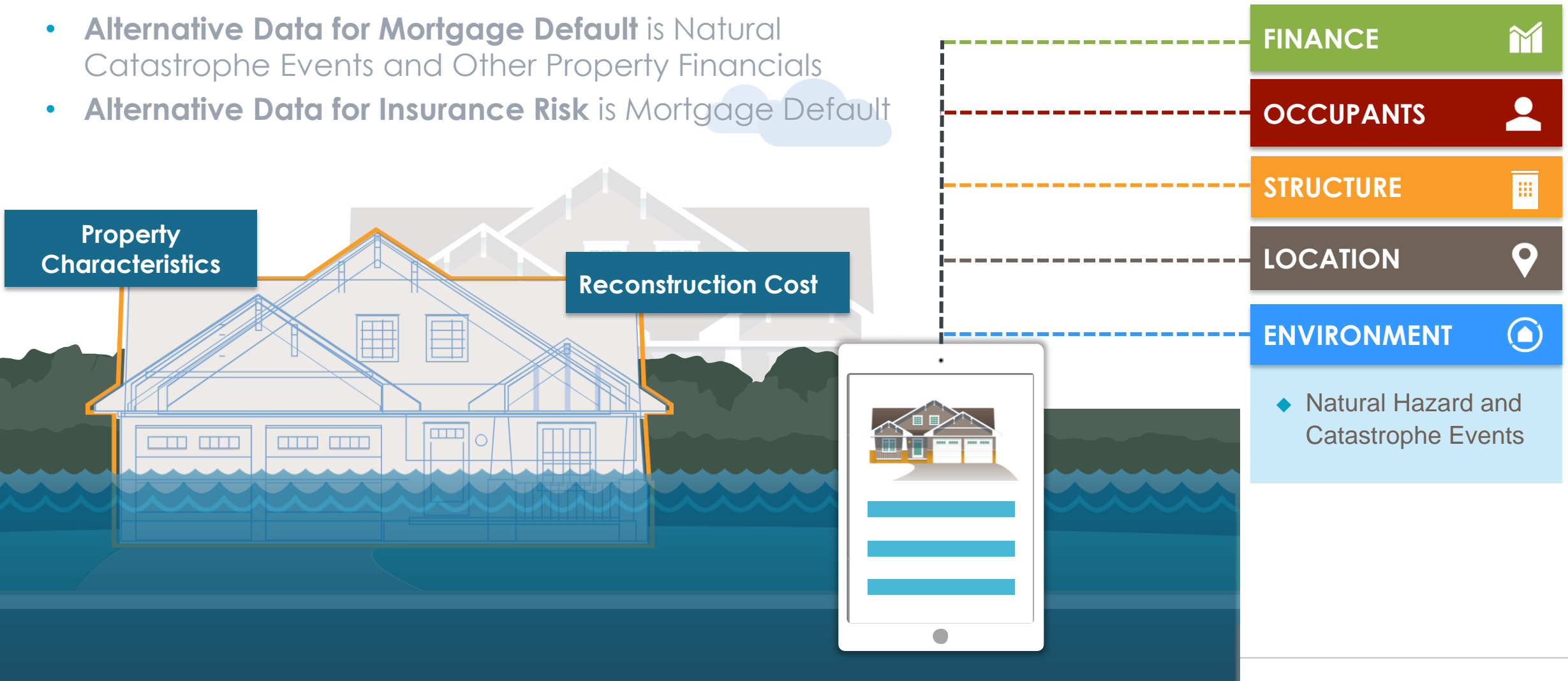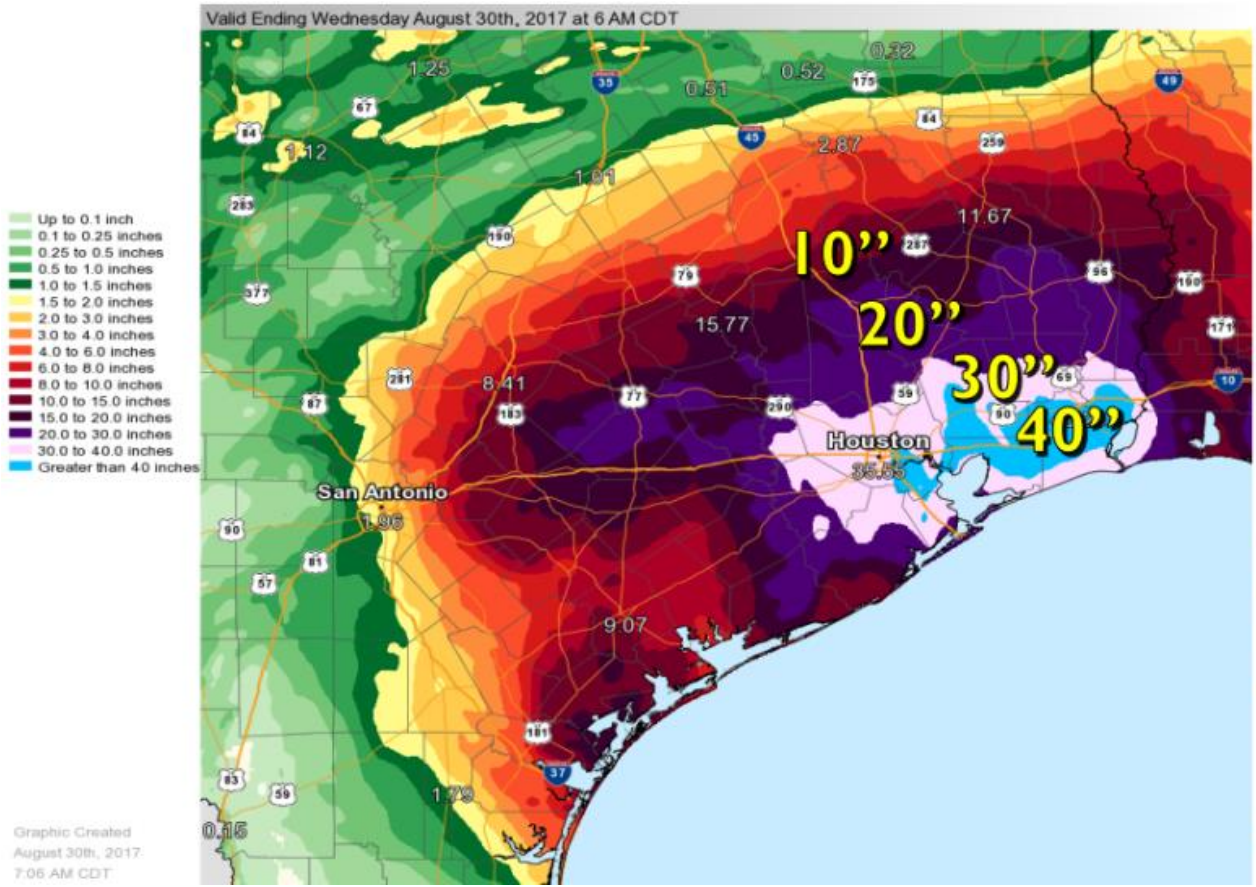
Hurricane Harvey

Hurricane Harvey: Landfall

- Made landfall in Rockport, TX as a Category 4 storm
- Strongest storm at landfall since Charley in 2004

- Highest recorded gust: ~132 mph in Port Aransas, ~20 miles NE of Corpus Christi
- Hurricane force winds extended out to 40 miles
- Spawned at least 29 tornadoes

Houston

Rockport

Corpus Christi

1 GOES-16 PRELIMINARY, NON-OPERATIONAL DATA   235455 UTC 25-AUG-2017   CIRA/RAMMB

Harvey Rainfall (National Weather Service)

Valid Ending Wednesday August 30th, 2017 at 6 AM CDT

Graphic Created
August 30th, 2017
7:06 AM CDT

Legend:
- Up to 0.1 inch
- 0.1 to 0.25 inches
- 0.25 to 0.5 inches
- 0.5 to 1.0 inches
- 1.0 to 1.5 inches
- 1.5 to 2.0 inches
- 2.0 to 3.0 inches
- 3.0 to 4.0 inches
- 4.0 to 6.0 inches
- 6.0 to 8.0 inches
- 8.0 to 10.0 inches
- 10.0 to 15.0 inches
- 15.0 to 20.0 inches
- 20.0 to 30.0 inches
- 30.0 to 40.0 inches
- Greater than 40 inches

5 Day Point Rainfall Amounts in Inches

- Harvey continued to produce record breaking **rainfall totals** of **45 to over 50 inches**… with continued rainfall
- **Cedar Bayou**   **- 51.88**
- **Berry Bayou**   **- 44.88**
- **League City**   **- 49.84**
- **Mary's Creek**   **- 49.80**
- **Goose Creek**   **- 44.08**
- **Greens Bayou**   **- 41.36**
- **Buffalo Bayou**   **- 35.60**
- **Addicks Dam**   **- 33.44**

Point rainfall data courtesy

Agency View
An interactive map of the
Harris County Flood Control District

Coastal Storm Surge Risk

Category	Properties Affected	Residential Structure Value
Extreme	74,654	$27,192,190,159
Very High	147,129	$59,542,751,090
High	122,044	46,345,353,434
Moderate	114,903	43,938,734,695
Low	N/A	N/A
Total	458,730	$177,019,029,378
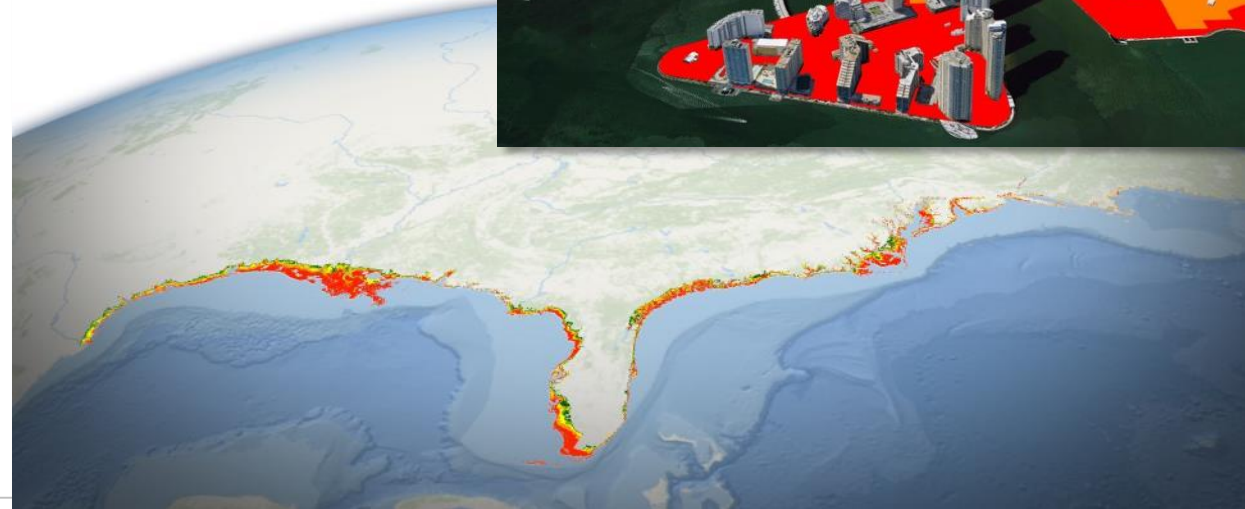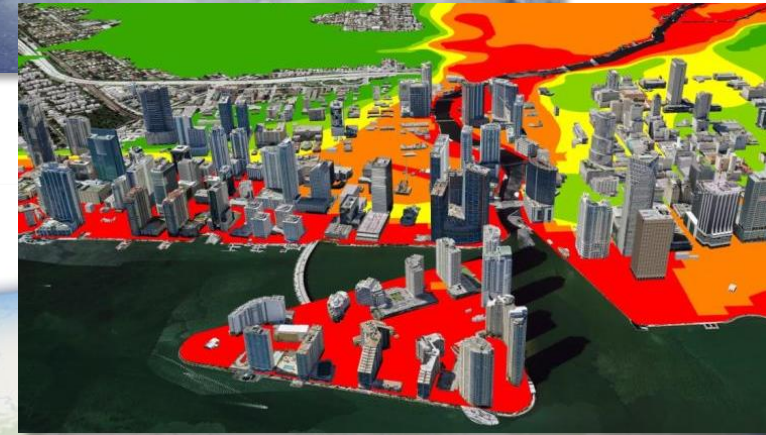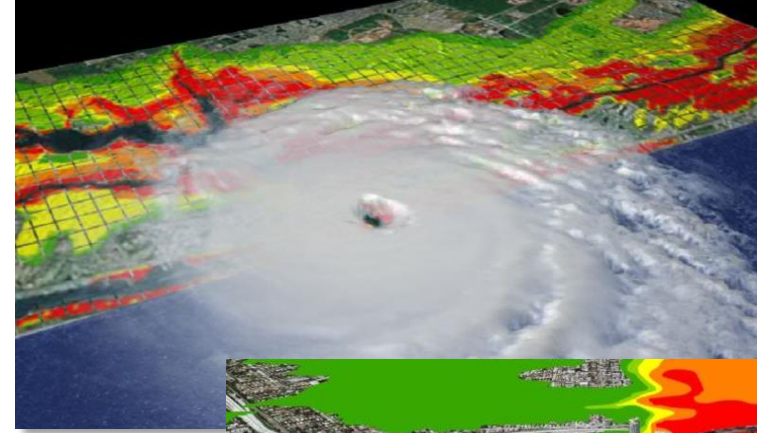
- **Extreme:** Category 1 - 5 storm
- **Very High:** Category 2 – 5 storm
- **High:** Category 3 – 5 storm
- **Moderate:** Category 4 – 5 storm
- **Low:** Category 5 storm only
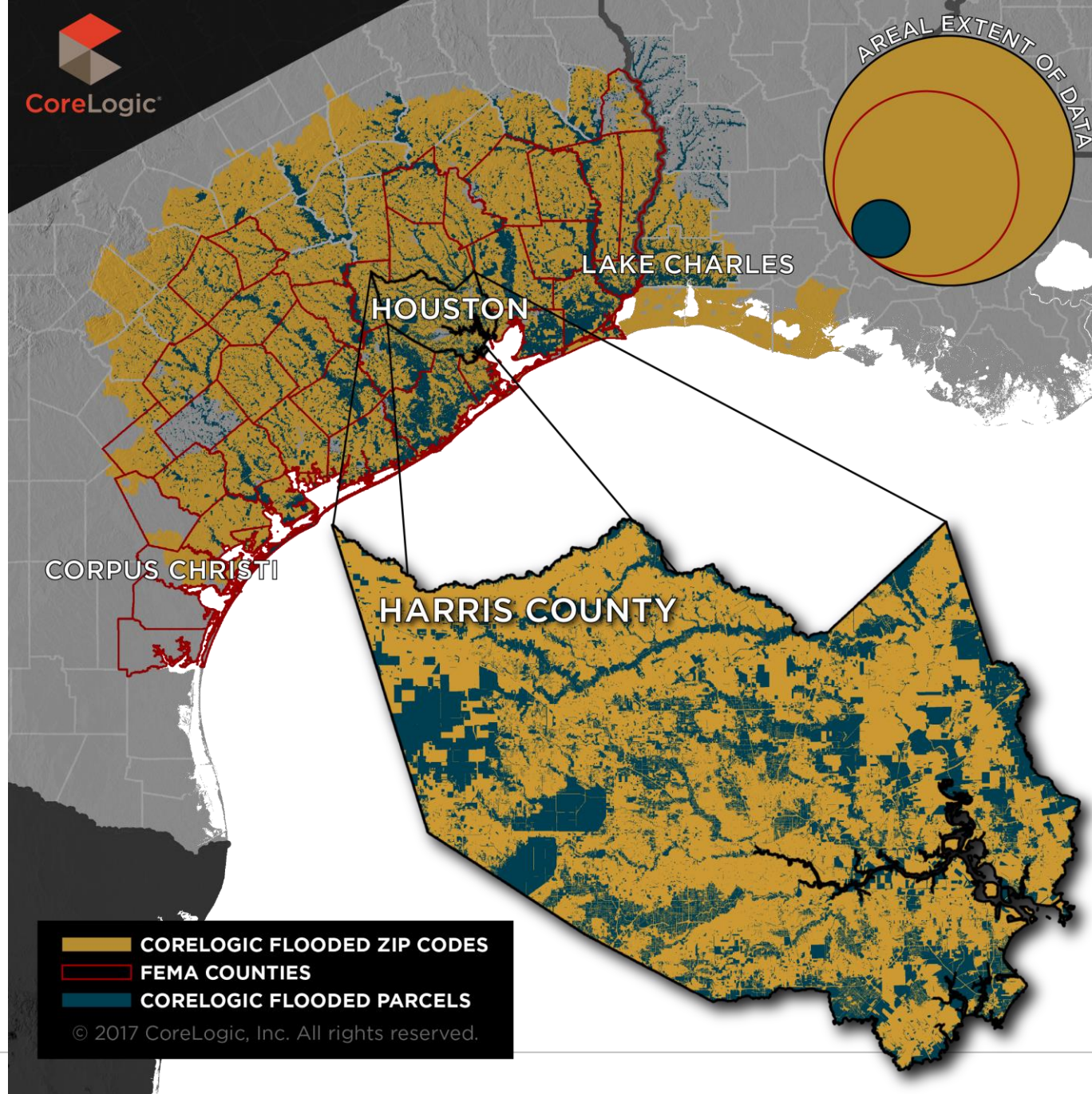
Harvey Loss Estimates

- CoreLogic estimates total insured and uninsured flood loss for Hurricane Harvey to be between $36 billion and $56 billion
  - NFIP: $6 – $9 Billion
  - Private: $14 – $20 Billion
  - Uninsured: $18 – $27 Billion

- Modeled loss return periods
  - In Texas: ~250 years
  - In the Gulf: ~300 years

- More than 50% of flood damage is uninsured

- More than 50% of properties in Houston at high and moderate risk of flood are not in designated flood zones
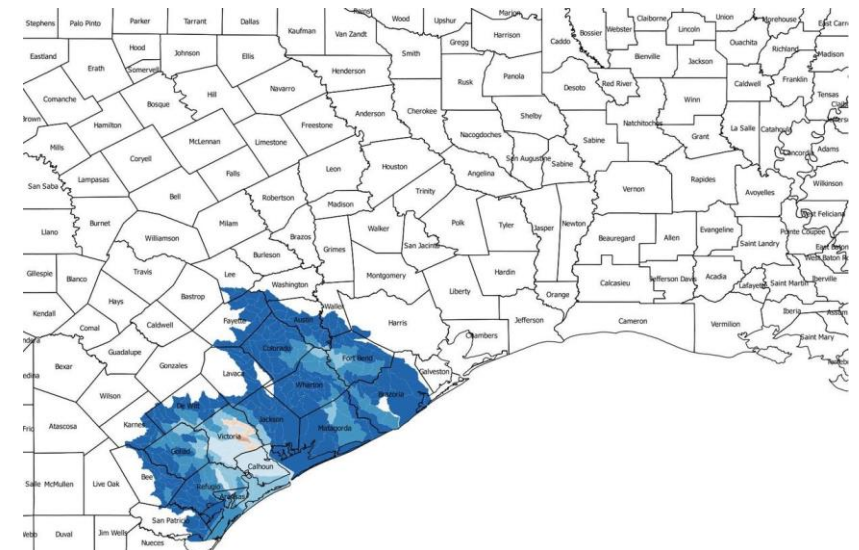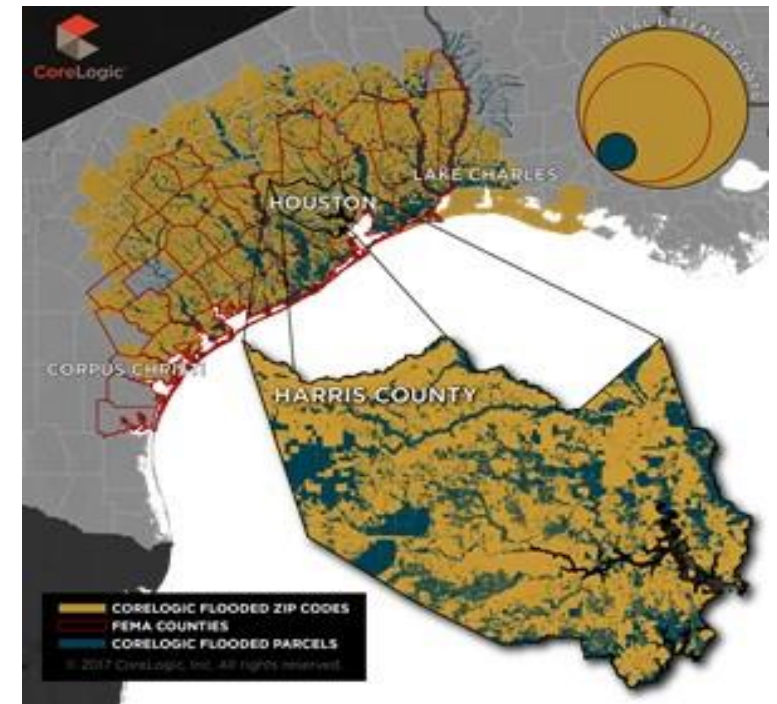
Harvey Modeled Damage Distribution by ZIP Mortgage Property Data

- % Damage Properties in ZIP, by threshold range

- 75% means at least 75% of properties have nonzero modeled damage
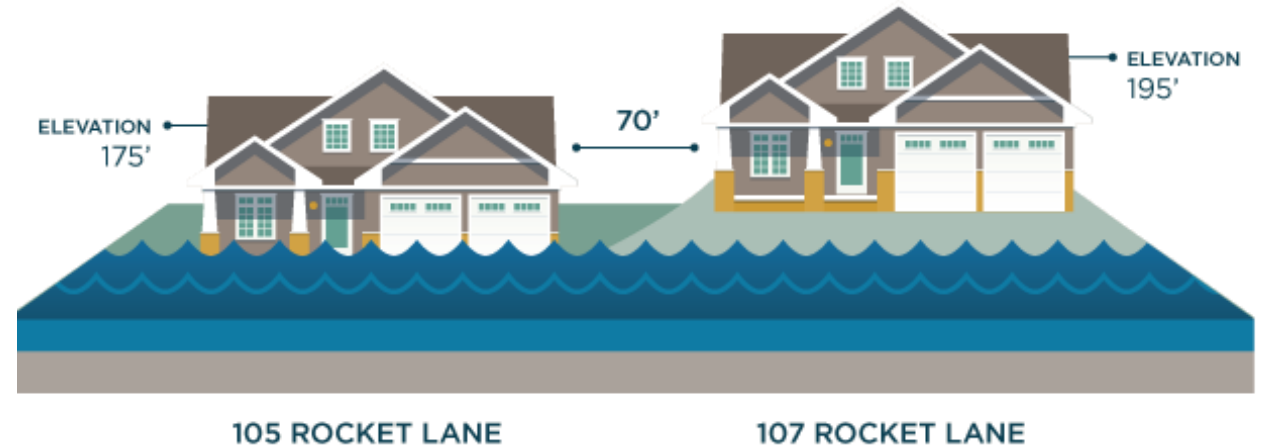
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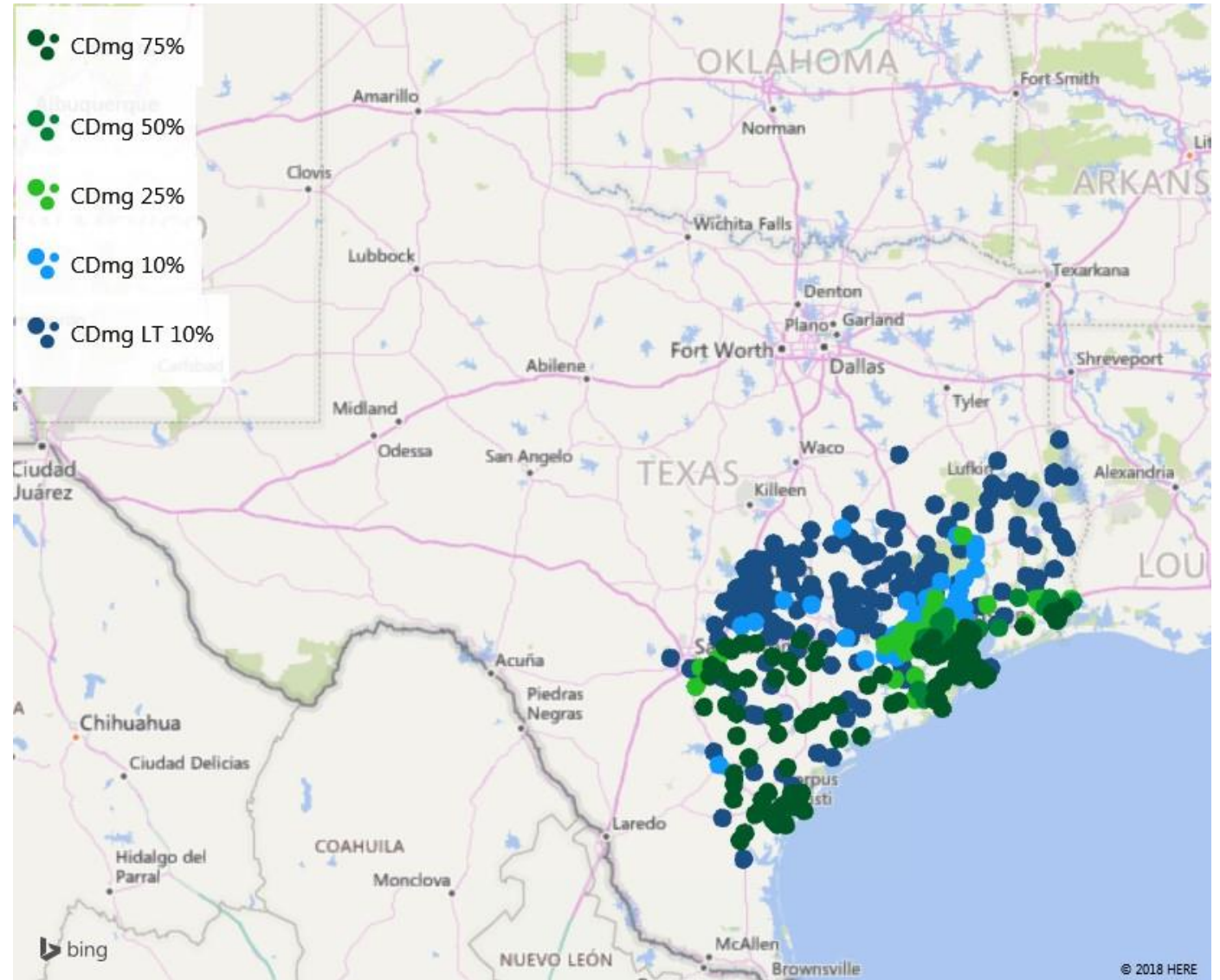
Hurricanes Harvey and Irma Event Response

- Drivers of damage to consider:
  - Flood Zones
  - Distance to FZ & Elevation variance
  - Forensic Wind Speed
  - Modeled Water Depths
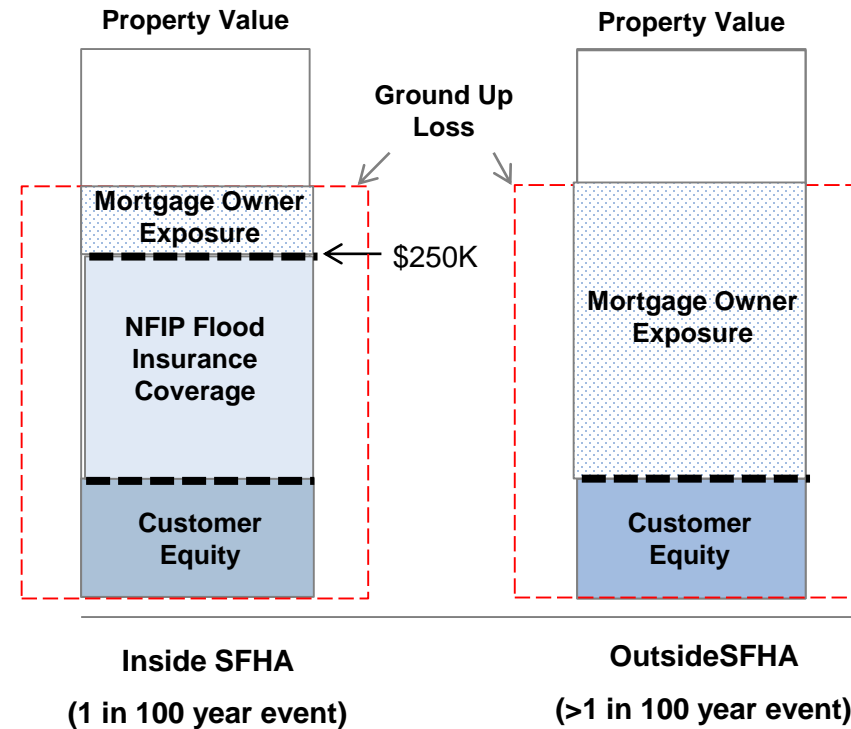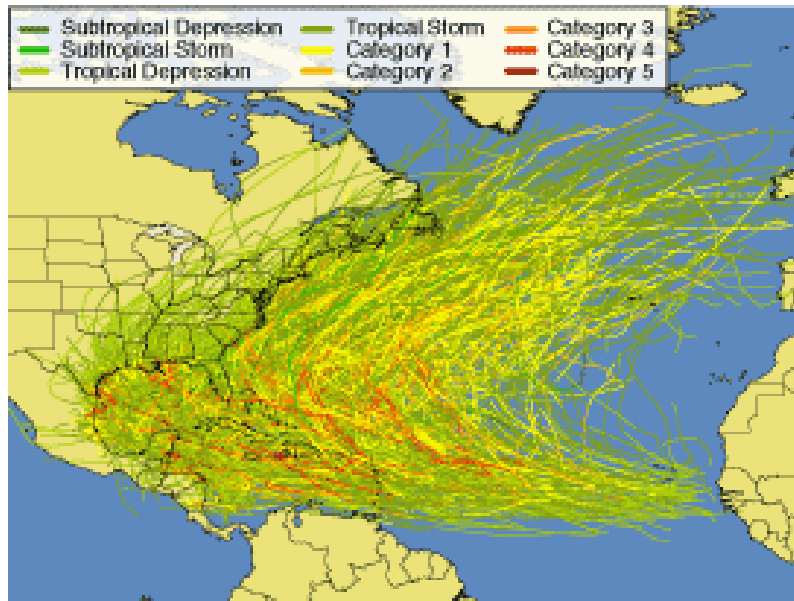 - Reconstruction Cost
  - Modeled % and $ financial impact

- Granularity:
  - Portfolio Level
  - Property Level

ELEVATION 175'

70'

ELEVATION 195'

105 ROCKET LANE

107 ROCKET LANE

Damage Estimate as a % of Reconstruction Cost Value

Damage (%)	Count	%	Damage ($)	Avg Damage ($)	Reconstruction Cost $ (Resi 1-4 unit only)	Avg Reconstruction Cost $ (Resi 1-4 unit only)	Damage (%)	Damage ($)[in
0-0.05	92,978	90.1%	62,360,346	671	22,055,960,509	237,260	0.3%	0-50000
0.05-0.1	4,145	4.3%	73,282,220	17,680	1,087,072,960	262,261	6.8%	50000-100000
0.1-0.15	1,378	1.4%	40,158,480	29,122	324,151,488	235,063	12.3%	100000-1500
0.15-0.2	1,044	1.1%	42,875,210	41,088	251,281,748	240,691	17.1%	150000-2000
0.2-0.25	878	0.9%	49,563,274	56,679	221,104,089	252,402	22.4%	200000-2500
0.25-0.3	770	0.8%	53,268,484	69,180	194,841,909	253,041	27.3%	250000-3000
0.3-0.35	672	0.7%	52,726,935	78,463	162,102,588	241,259	32.2%	300000-3500
0.35-0.4	325	0.3%	35,285,962	108,480	90,729,072	280,397	37.6%	350000-4000
0.4-0.45	200	0.2%	24,686,677	121,659	58,933,089	280,805	41.9%	400000-5000
0.45-0.5	118	0.1%	17,575,229	146,010	38,571,100	307,320	47.2%	Grand Total
0.5-0.55	32	0.0%	3,628,378	113,324	6,946,611	217,088	52.4%	
0.55-0.6	8	0.0%	735,819	122,636	1,288,948	215,656	56.6%	
0.6-0.65	2	0.0%	542,315	271,157	901,813	450,907	60.1%	
Grand Total	102,551	100.0%	458,468,381	4,451	24,690,041,735	238,808	1.7%	

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Hurricane & Flood Exposure Coverage Gaps

- ➢ Properties in high-risk areas with mortgages are required to have flood insurance.

- ➢ FEMA designated Special Flood Hazard Area (SFHA) have a 1in 4 chance of flooding during a 30-year mortgage.

- ➢ Moderate to Low-risk area properties are not required to have mortgages, however, 20% of all National Flood Insurance claims are submitted by people outside SFHAs.

- ➢ The most common flood insurance program National Flood Insurance program (NFIP) has a coverage limit of $250K.

When a catastrophe happens and there is damage… What does the borrower do?

Financial strain: insufficient funds for

       home repairs + loan payments

- *Inadequate insurance for hazard events*
- *Delays in claim payment or government aid*
- *Business interruption could affect employment and income*

Hurricane Impacts – Damage, Recovery, Infrastructure

Quantifying Property Risk

Impact of Harvey

Pricing and Underwriting: Quantifying Mortgage Risk

Traditional: Borrower, Loan, Collateral

- **LTV** : **(combined) LTV at origination**
    Loan Amount Total / Appraised Value at Origination

- **FICO** : credit score at origination

- Underwriting ratio 1 Front End Ratio DTI
    Housing Payments/Gross Income
- Underwriting ratio 2 Back End Ratio DTI
    (Housing pmts + all other monthly debt)/Gross Income
- Loan Amount (Jumbo, Conforming)
- Loan Purpose (Purchase, Cash-Out Refi, etc)
- Product Type (Fixed, ARM, etc) and Loan Term
- Property Type (SFR, Condo, etc)
- Occupancy Type (Owner, 2nd, etc)
- Documentation Level (Full, Low, etc)

LTV and FICO rate card in Mortgage Insurance

Alternative: Collateral
Reconstruction Cost
Total Living Area
Year Built
NumberOfStories
NumberOfFamilies

Collateral
HPI or HPA
Home Price Index
Home Price Appreciation

Alternative: Natural Hazards
Flood Risk Score
FEMA Defined Flood Zone*
All Hazards Damage Risk Score
All Hazards Frequency Risk Score
Flash Flood Risk Score
Hurricane Risk Score
Estimated Damage Post Event

Mandatory NFIP: 1% or greater chance of flooding (A) and an additional hazard associated with storm waves (V*). These areas have a 26% chance of flooding over the life of a 30-year mortgage. aka SFHA Special Flood Hazard Areas

Roadmap of Analysis

1. 30-Day Delinquency by LTV
2. 90-Day Delinquency
   a. Traditional data by impact group: LTV, FICO
      1. Est Damage >0
      2. PDMDA - FEMA No Damage
      3. All other TX - No FEMA No Damage
   b. Gross Damage to Current Home Value

3. Random Forests and Logistics
   a. Variable Classes
      1. Alternative – Collateral and Natural Hazards
      2. Retrospective – Known only post event
      3. Prospective – Known at origination

Traditional: Borrower, Loan, Collateral

- **LTV** : (combined) LTV at origination
  Loan Amount Total / Appraised Value at Origination

- **FICO** : origination credit score

Collateral
HPI or HPA
Home Price Index
Home Price Appreciation

Alternative: Collateral
Reconstruction Cost and Elements

Alternative: Natural Hazards
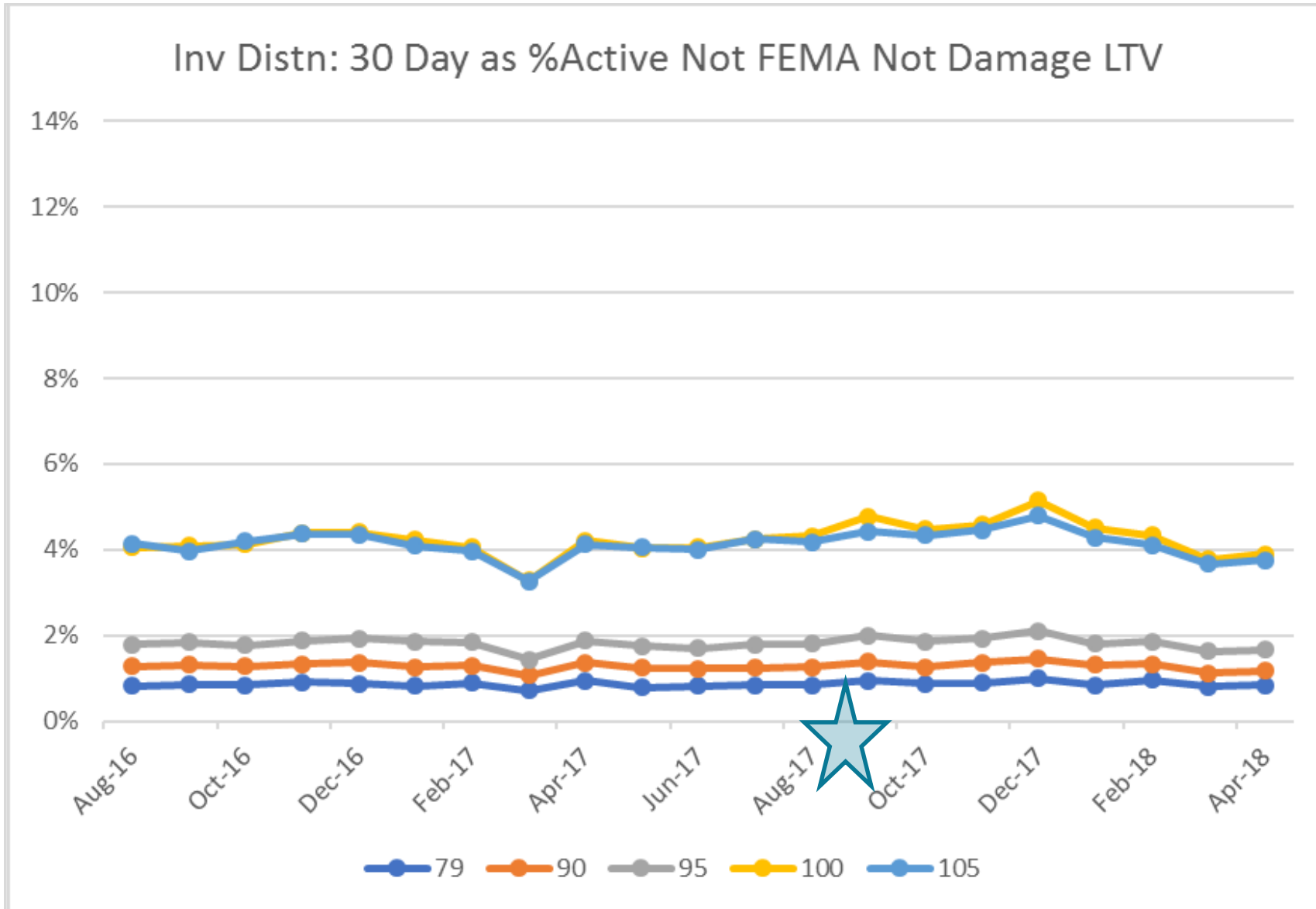FEMA Defined Flood Zone*
All Hazards Damage Risk Score
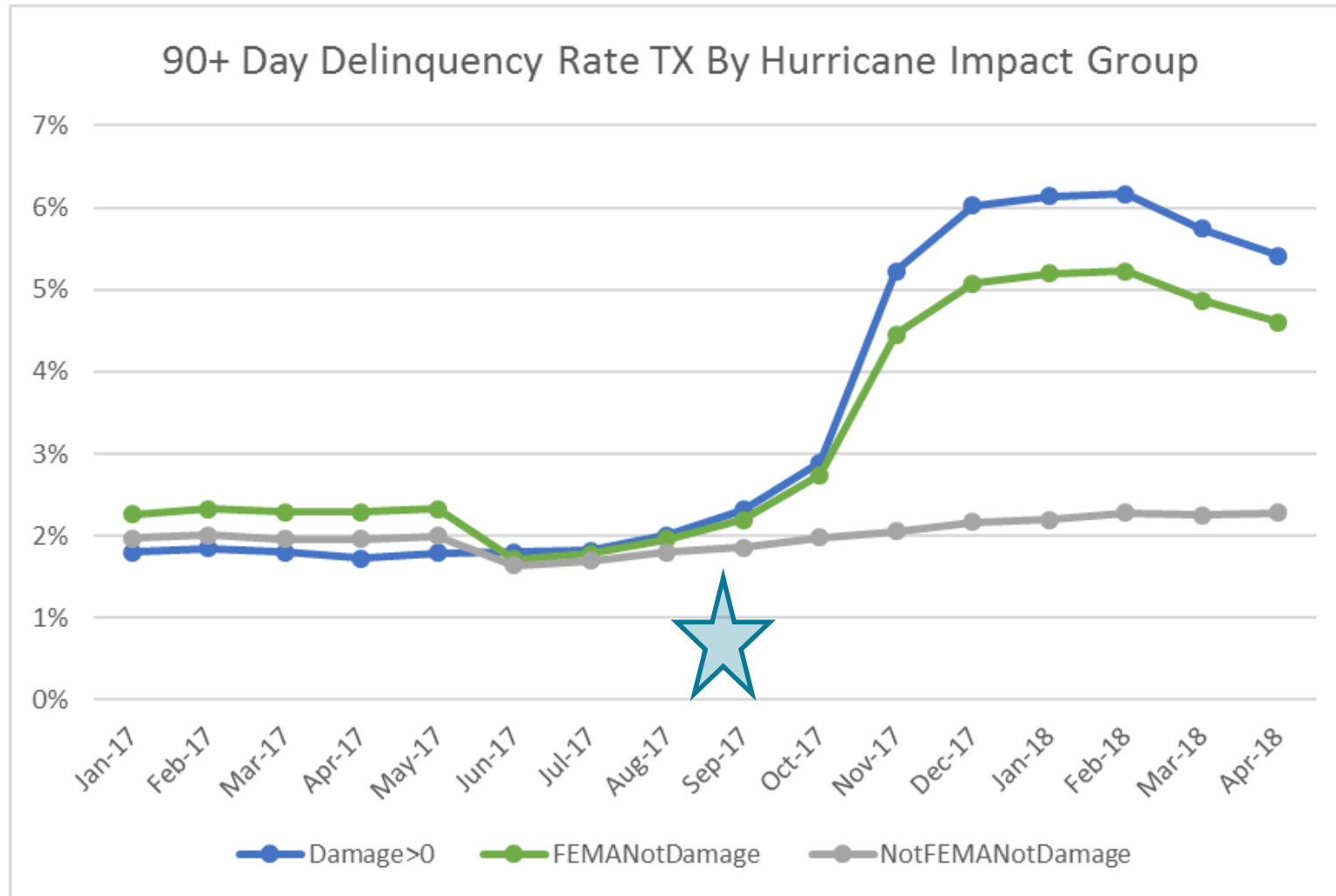All Hazards Frequency Risk Score
Flood Risk Score
Flash Flood Risk Score
Estimated Damage Post Event

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Loan-To-Value (LTV): 30 Day Delinquencies

Inv Distn: 30 Day as %Active Not FEMA Not Damage LTV

Legend: 79, 90, 95, 100, 105

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Empirical Top Line Harvey TX 90+ Day Delinquencies

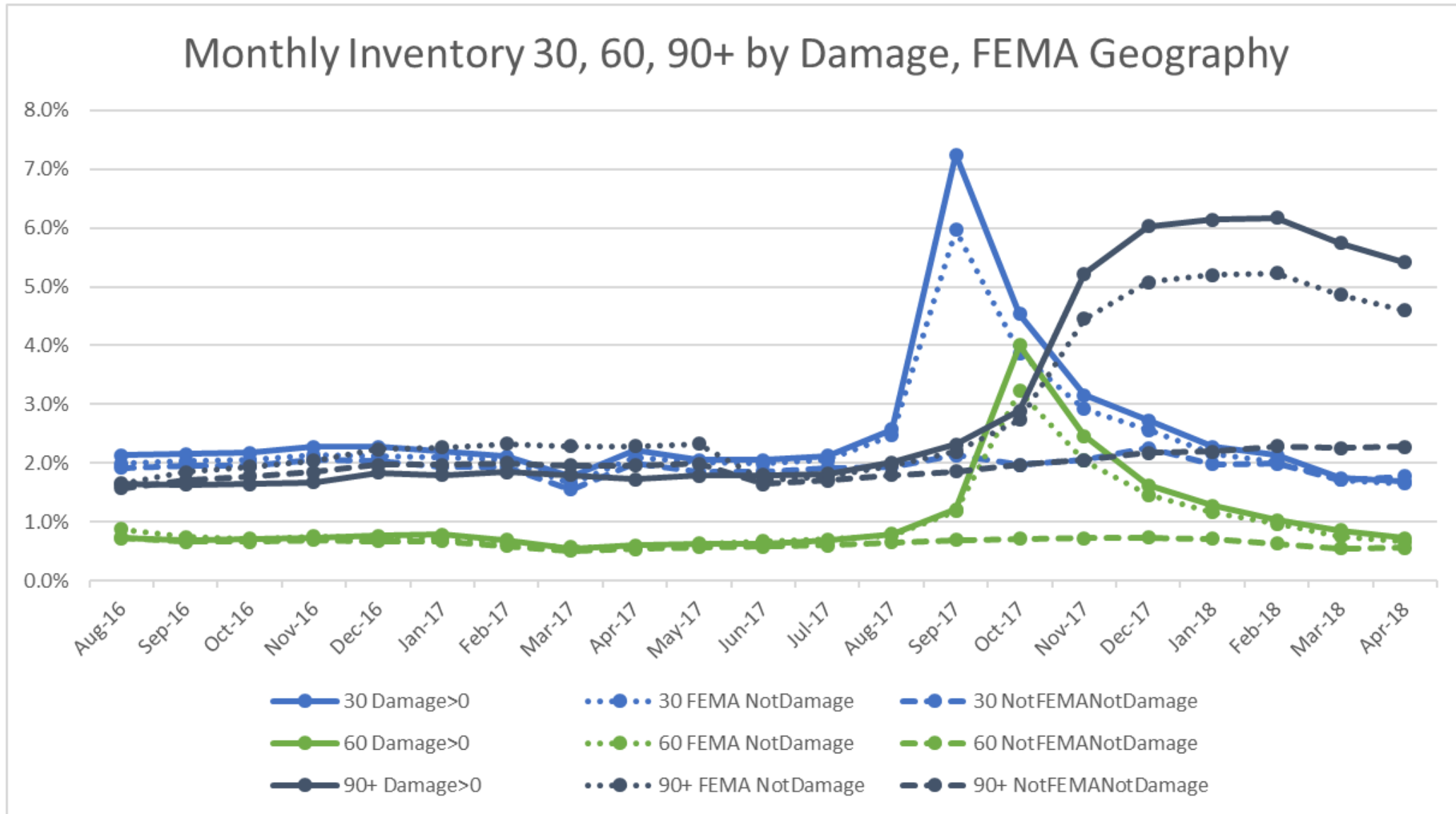90+ Day Delinquency Rate TX By Hurricane Impact Group

Loans on properties with estimated damage have highest default rate and rate increase
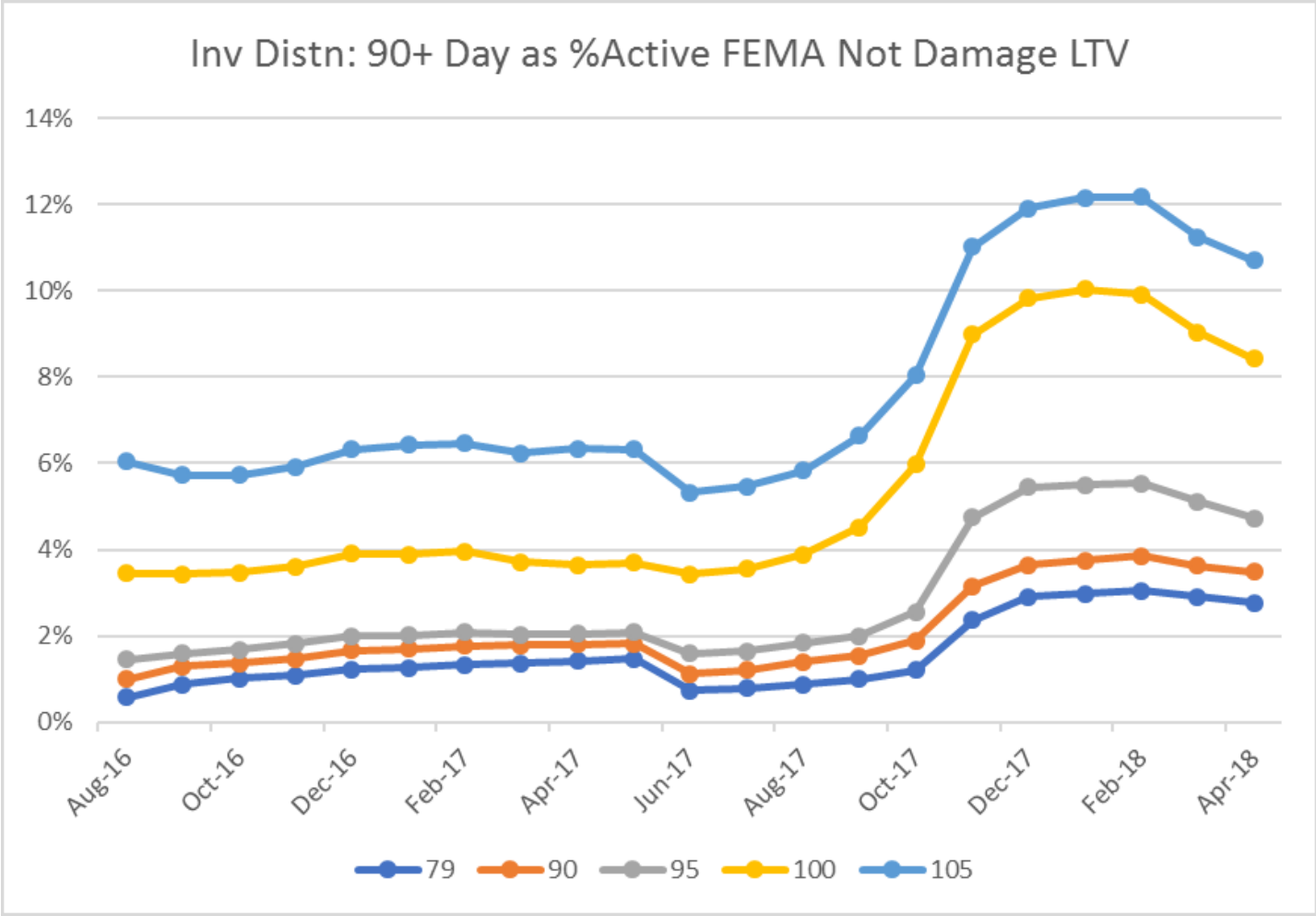
30-Day Delinquencies progressed

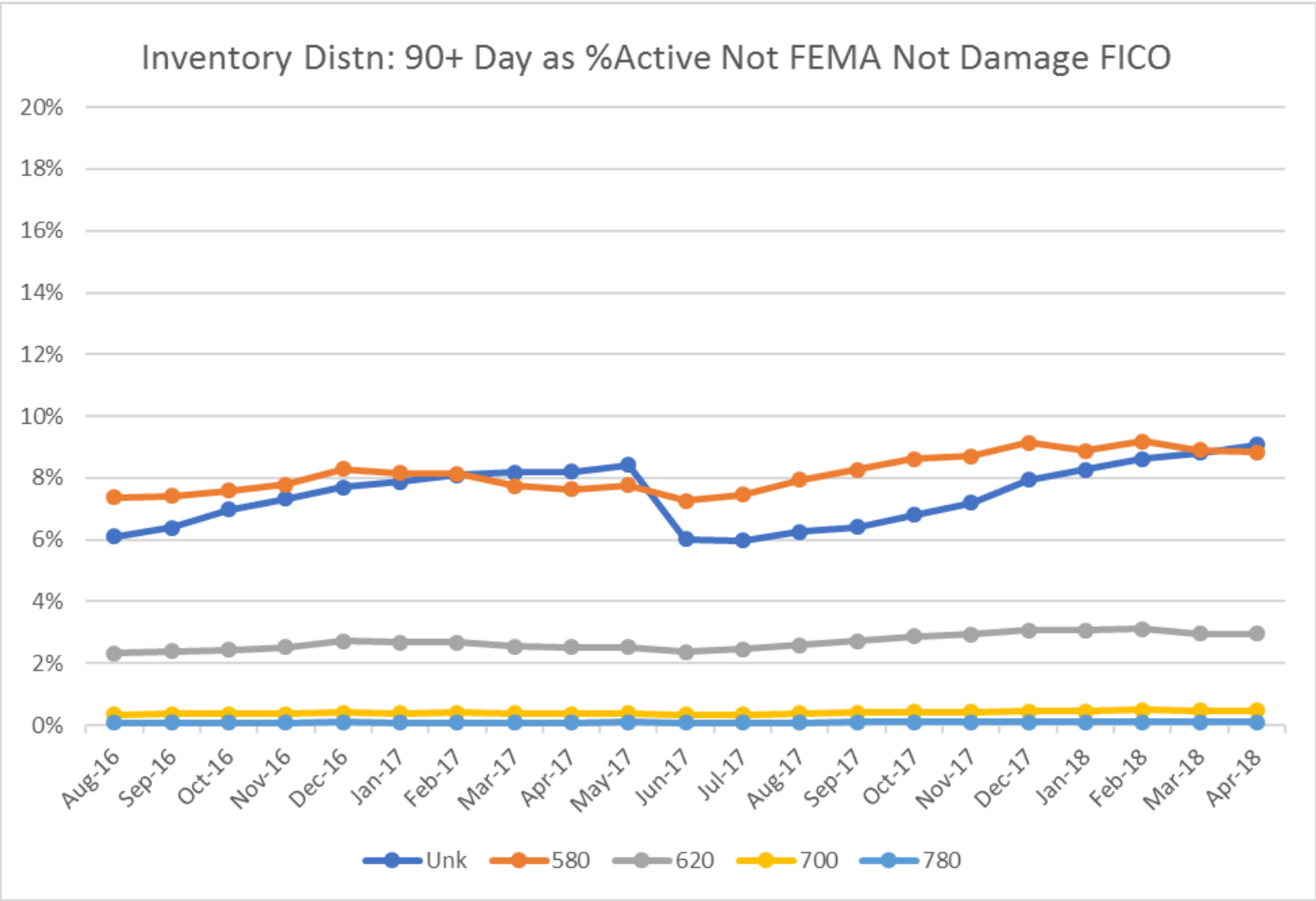Loans in PDMDAs but no estimated damage also show increase

Rest of TX flat

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Top Line Inventory – Lag of Statuses - Early warning

Monthly Inventory 30, 60, 90+ by Damage, FEMA Geography

Legend:
- 30 Damage>0
- 30 FEMA NotDamage
- 30 NotFEMANotDamage
- 60 Damage>0
- 60 FEMA NotDamage
- 60 NotFEMANotDamage
- 90+ Damage>0
- 90+ FEMA NotDamage
- 90+ NotFEMANotDamage

Loan-To-Value (LTV): 90+ Day Delinquencies

Inv Distn: 90+ Day as %Active FEMA Not Damage LTV

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Credit Score (FICO): 90+ Day All TX and Subset Estimated Damage>0

Inventory Distn: 90+ Day as %Active Not FEMA Not Damage FICO
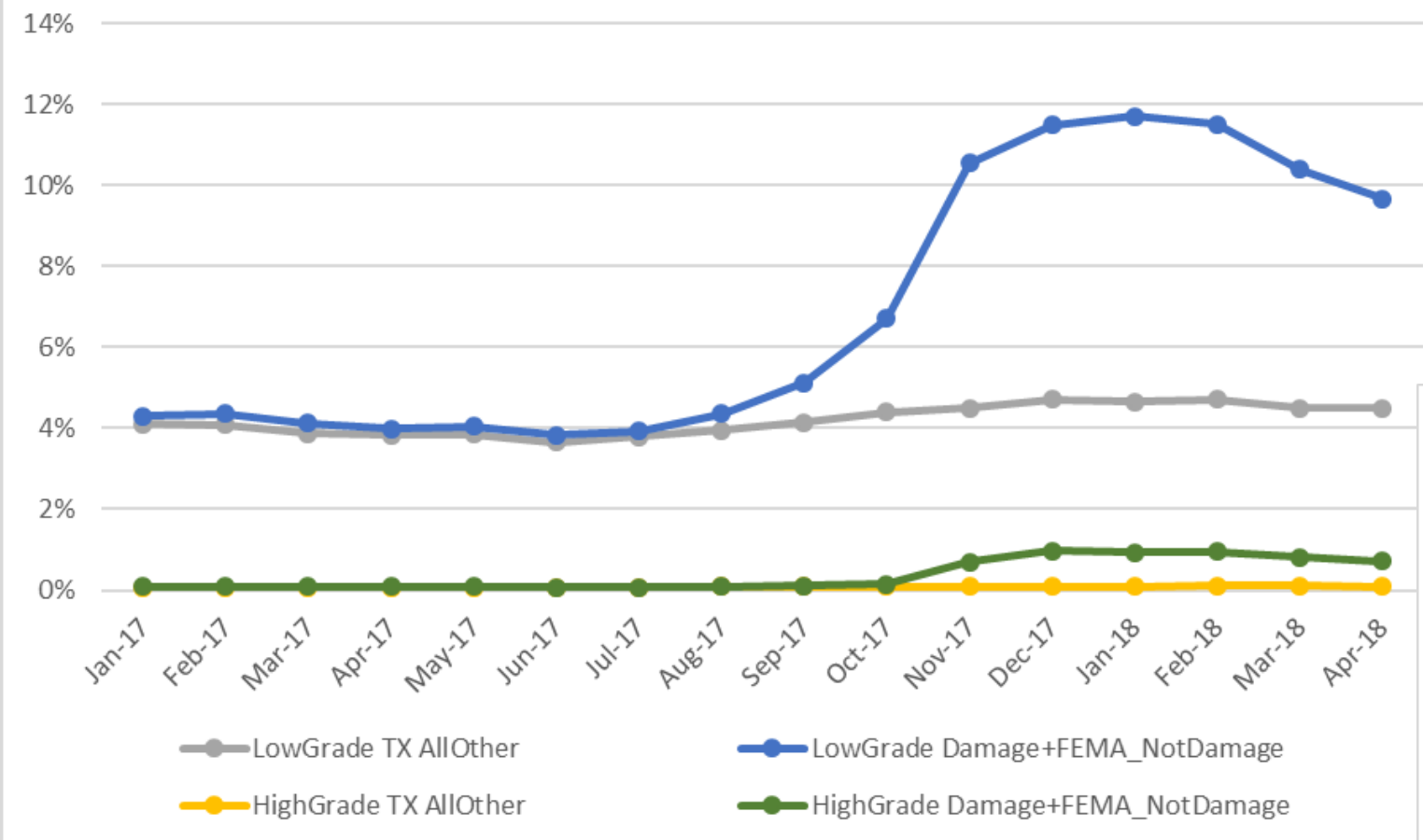
Legend: Unk, 580, 620, 700, 780

90+ Day Delqs Equity, Credit, and Hurricane Impact Group


90+ Day Delinquency Rate TX Equity/FICO Grade by Hurricane Impact Group

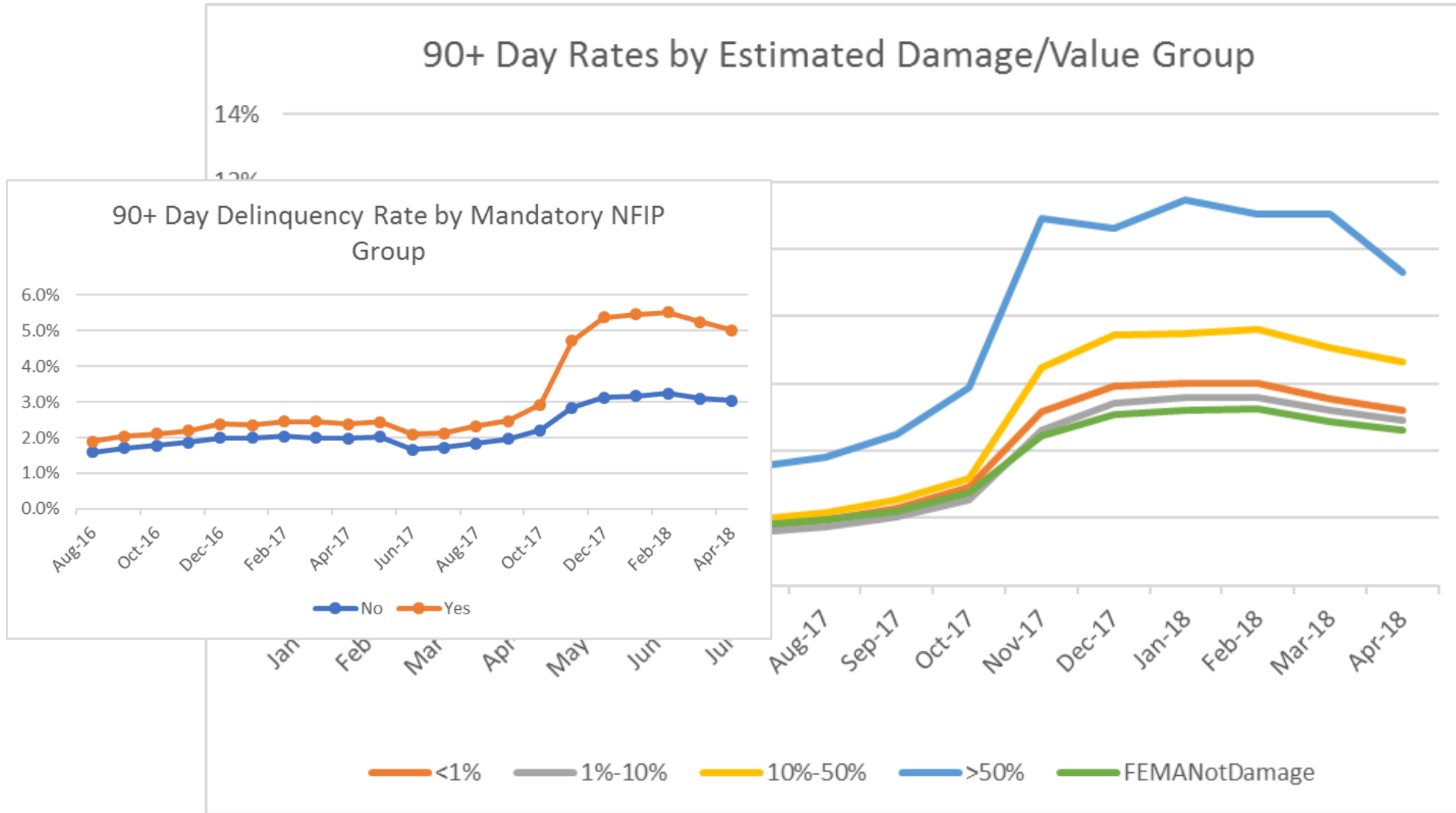LowGrade: LTV>=100 FICO <720
HighGrade: LTV<80 FICO>=720

Damage+FEMA_NotDamage:
    In FEMA Indiv or EstDamage>0
270% increase Aug-17 to Jan-18 LowGrade
1000% increase Aug-17 to Jan-18 HighGrade

90+ Day Delinquency Rate TX High Equity High FICO by Hurricane Impact Group
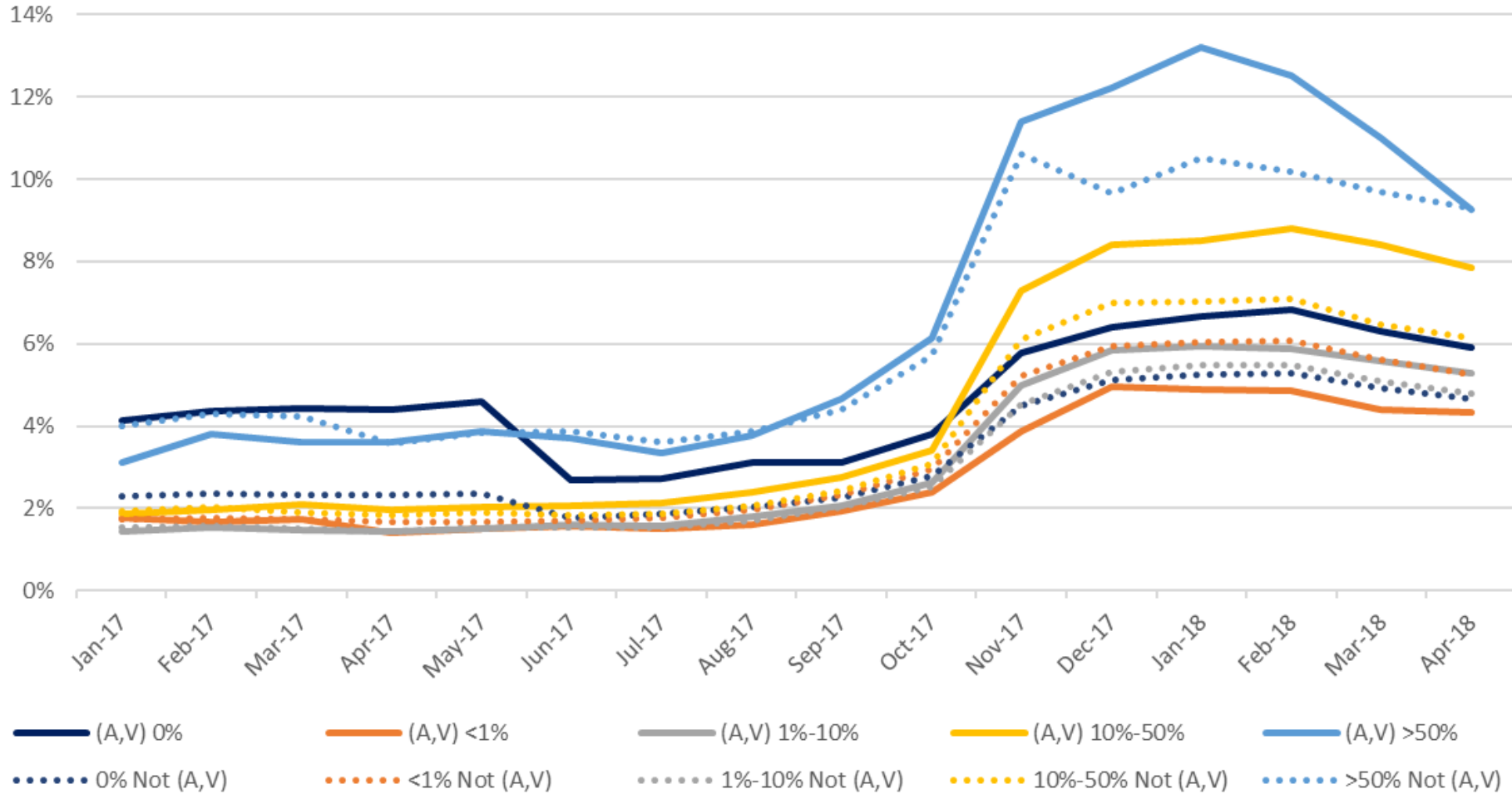
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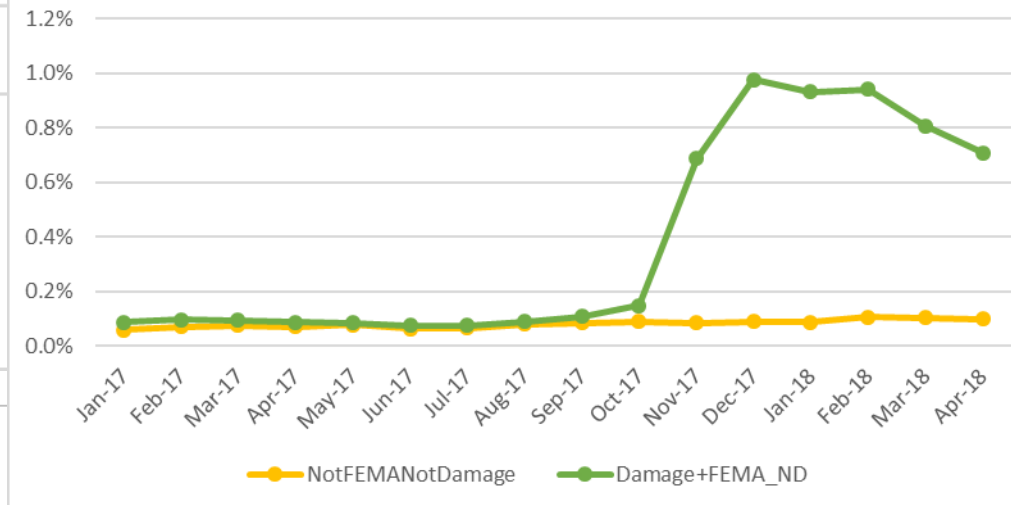
Gross Damage Relative to Current Home Value

90+ Day Rates by Estimated Damage/Value Group

90+ Day Delinquency Rate by Mandatory NFIP Group

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Gross Damage / Current Home Value by Mandatory NFIP (A*,V*)

90+ Day Rates (A,V) and NOT (A,V) Zones by Gross Est Damage/Value Group

Legend:
- (A,V) 0%
- (A,V) <1%
- (A,V) 1%-10%
- (A,V) 10%-50%
- (A,V) >50%
- 0% Not (A,V)
- <1% Not (A,V)
- 1%-10% Not (A,V)
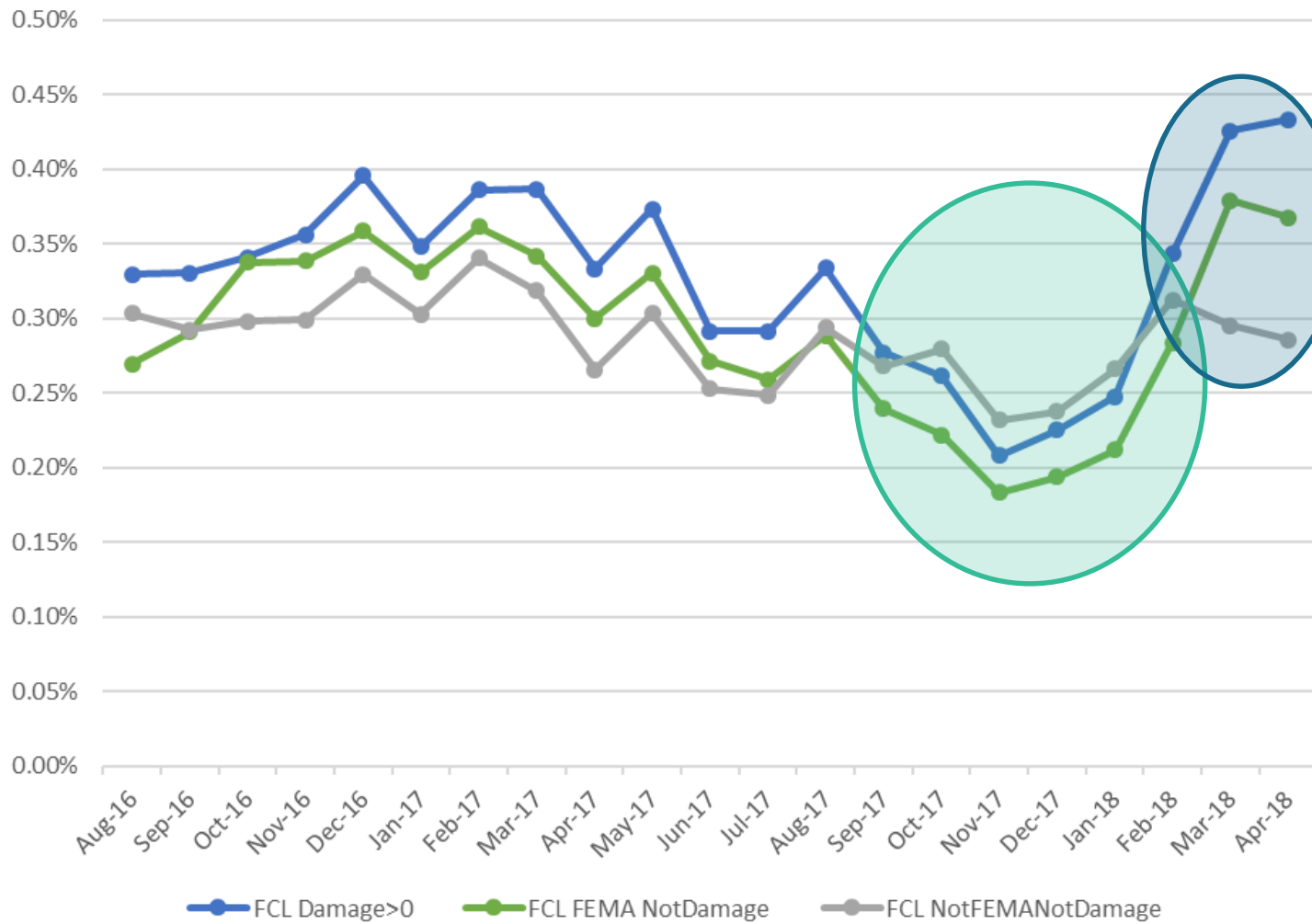- 10%-50% Not (A,V)
- >50% Not (A,V)

? Counterintuitive

Uncaptured demographics
-Lower median income ZIPS
-Employment?
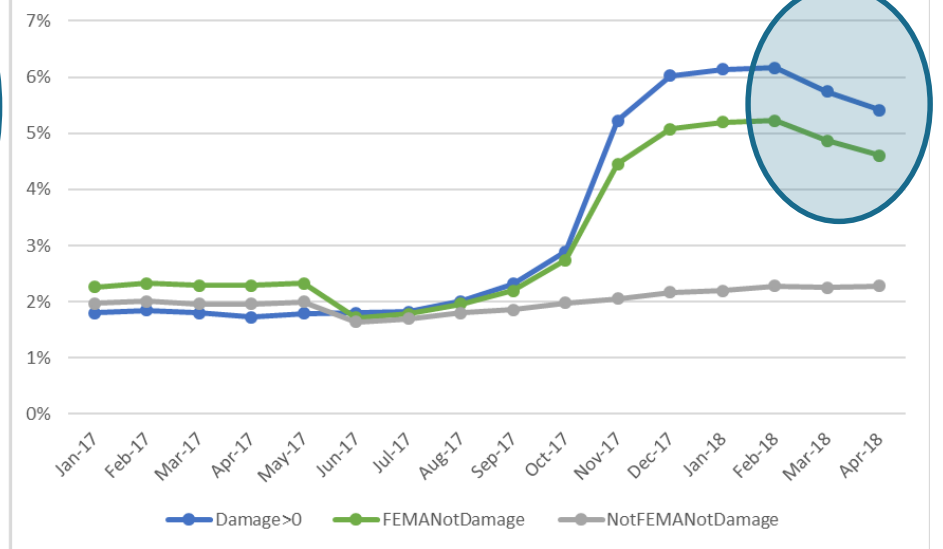-Borrower Resiliency

Lags in claims compensation?
demand surge

Top Line FCL Rate – Forbearance and Moratorium in PDMDAs (FEMA)

Monthly FCL Inventory by Damage, FEMA Geography

Legend: FCL Damage>0 · FCL FEMA NotDamage · FCL NotFEMANotDamage

90+ Day Delinquency Rate TX By Hurricane Impact Group

Legend: Damage>0 · FEMANotDamage · NotFEMANotDamage

Getting messy with variables

Are you convinced there is a potential impact of natural hazards worth modeling?

Model Variables for Target: 90+ Days Delinquent Nov17-Apr18 and Current at Harvey

Traditional: Borrower, Loan, Collateral

- LTV : combined LTV at origination
- FICO : credit score at origination
- Origination Year of Loan
- Interest Only Flag
- Rate spread at origination
- Negative Amortization Flag
- Rate reset
- Margin
- ARM Index
- UW ratio 1
- UW ratio 2
- Loan Purpose (Purchase, Cash-Out Refi, etc)
- Property Type (SFR, Condo, etc)
- Product Type (Fixed, ARM, etc)
- Occupancy Type (Owner, 2nd, etc)
- Documentation Level (Full, Low, etc)
- Loan Amount
- Loan Term
- Appraised Value at Origination
- *Ever Delinquent Prior to Event (Retro)*

Collateral

HPA in ZIP *(Retro)*

- Home Price Appreciation from Origination to Event
- Current Home Value

Alternative: Collateral Reconstruction Cost

- Total Living Area
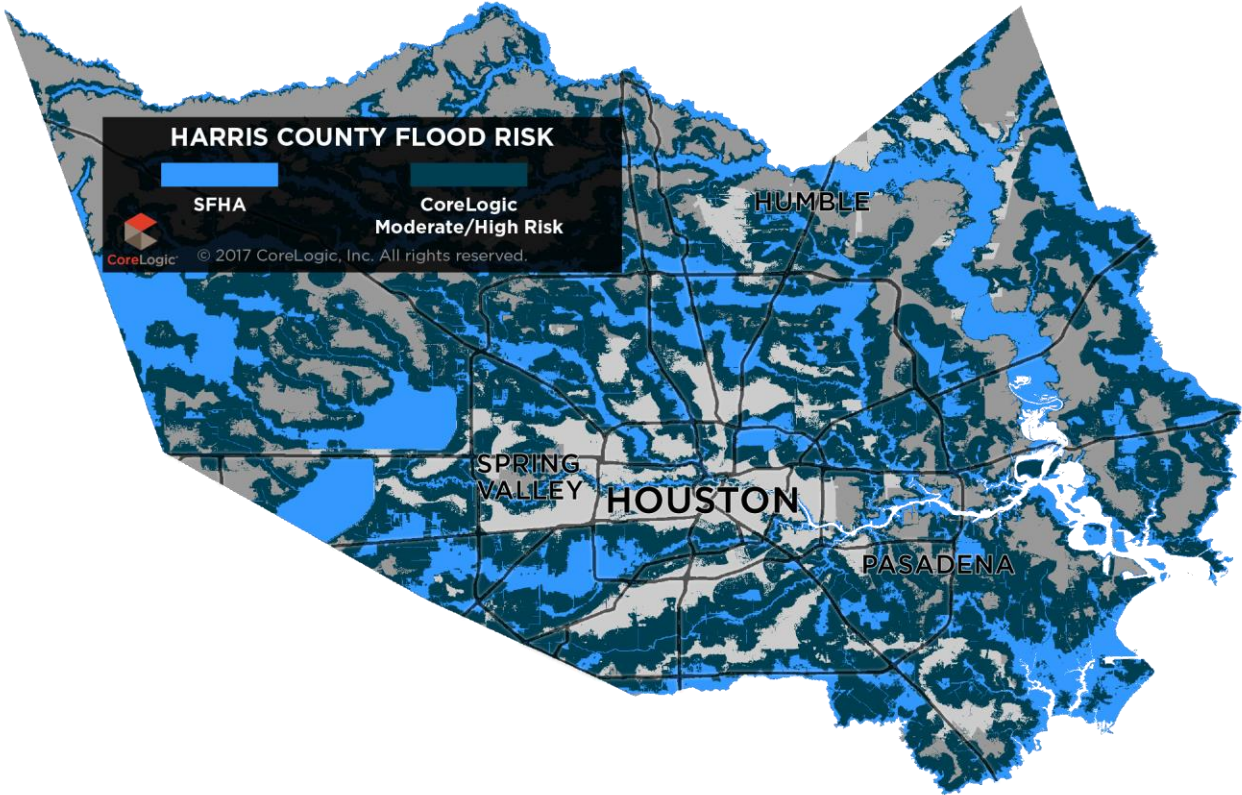- Year Built
- NumberOfStories
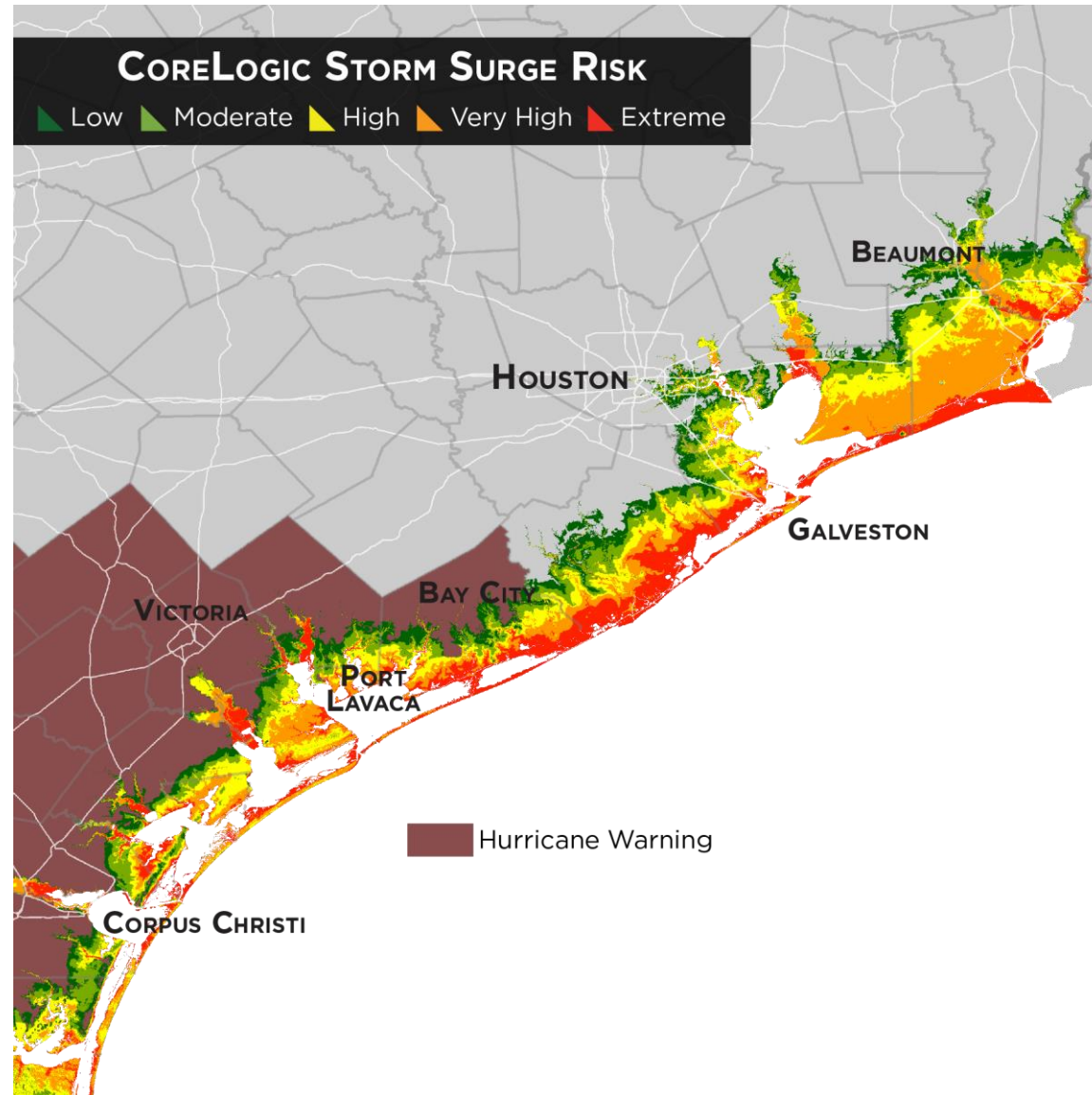- NumberOfFamilies

Value <> RC
Current RC is retro

Alternative: Hazard

- In FEMA PDMDA Individual Assistance County *(Retro)*
- Estimated Harvey Damage Loss $ *(Retro)*
- FEMA Flood Zone and NFIP(A,V)
- Flood Risk Score
- Total Hazard Damage Risk Score
- Total Hazard Frequency Risk Score
- Flash Flood Risk Score
- (Estimated Damage Loss $) /(Current Home Value) *(Retro)*

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Harvey - Alternative Hazard Variables – SFHA (Special Flood Hazard Area FEMA A,V) and CLGX Flood Risk Score

HARRIS COUNTY FLOOD RISK

SFHA

CoreLogic Moderate/High Risk

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HUMBLE

SPRING VALLEY

HOUSTON

PASADENA

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CLGX Surge Risk vs Harvey Hurricane Warning

Prospective Variables (Hazard Risk Scores)

90+ Day Delinquency Rate by Hazard Risk Damage Score Groups
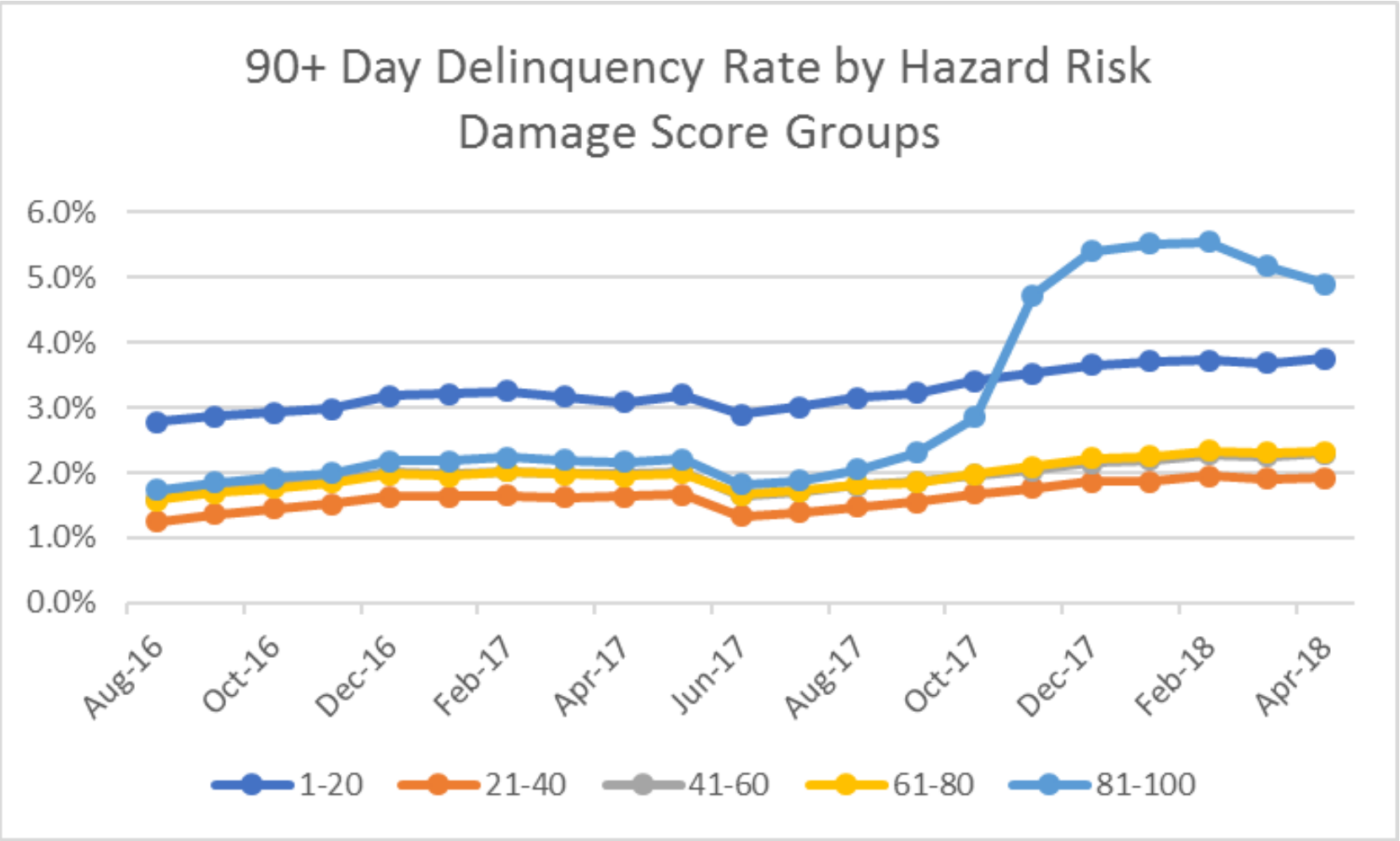
Full Model Results 90+ Day Delinquent

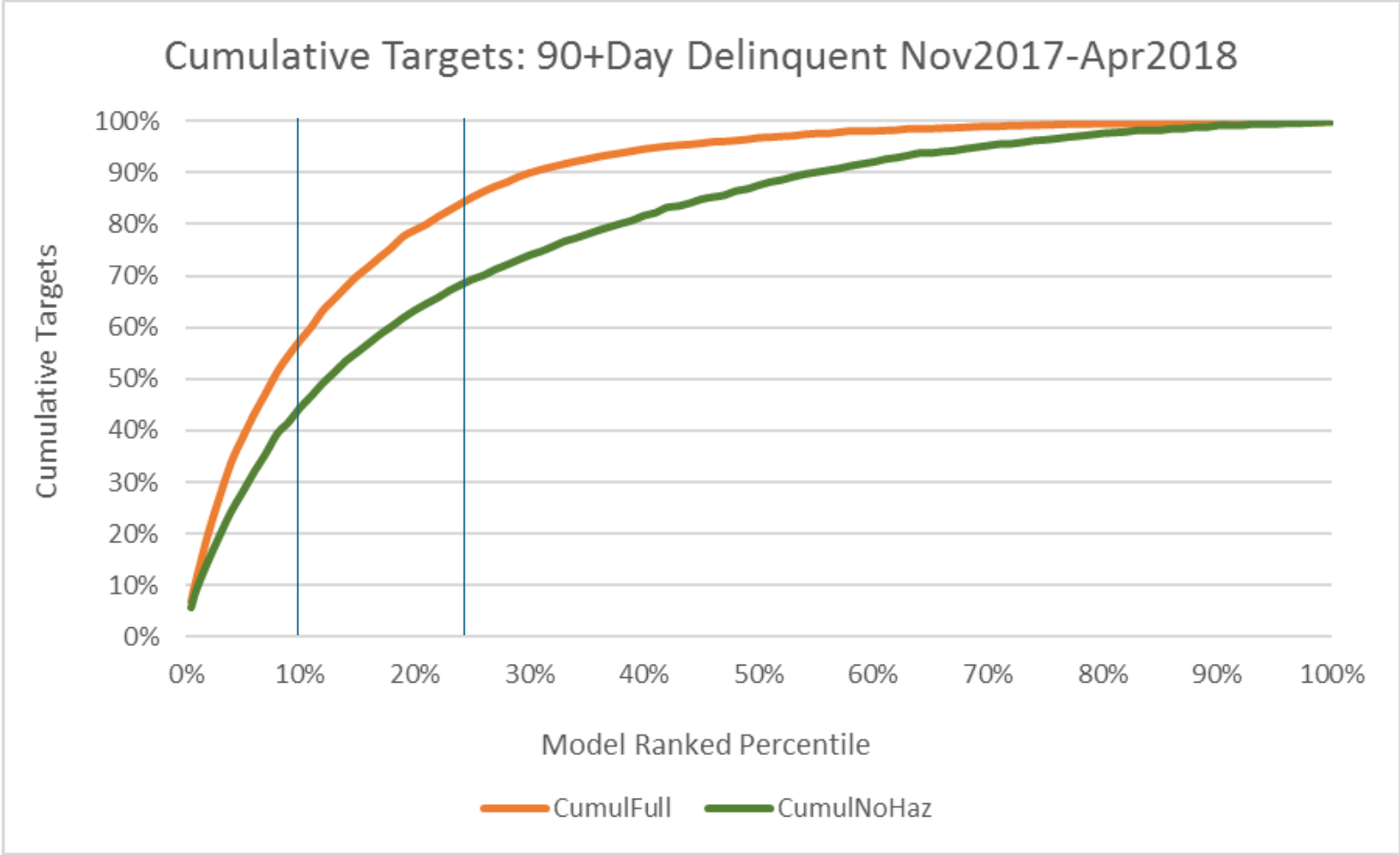Cumulative Targets: 90+Day Delinquent Nov2017-Apr2018
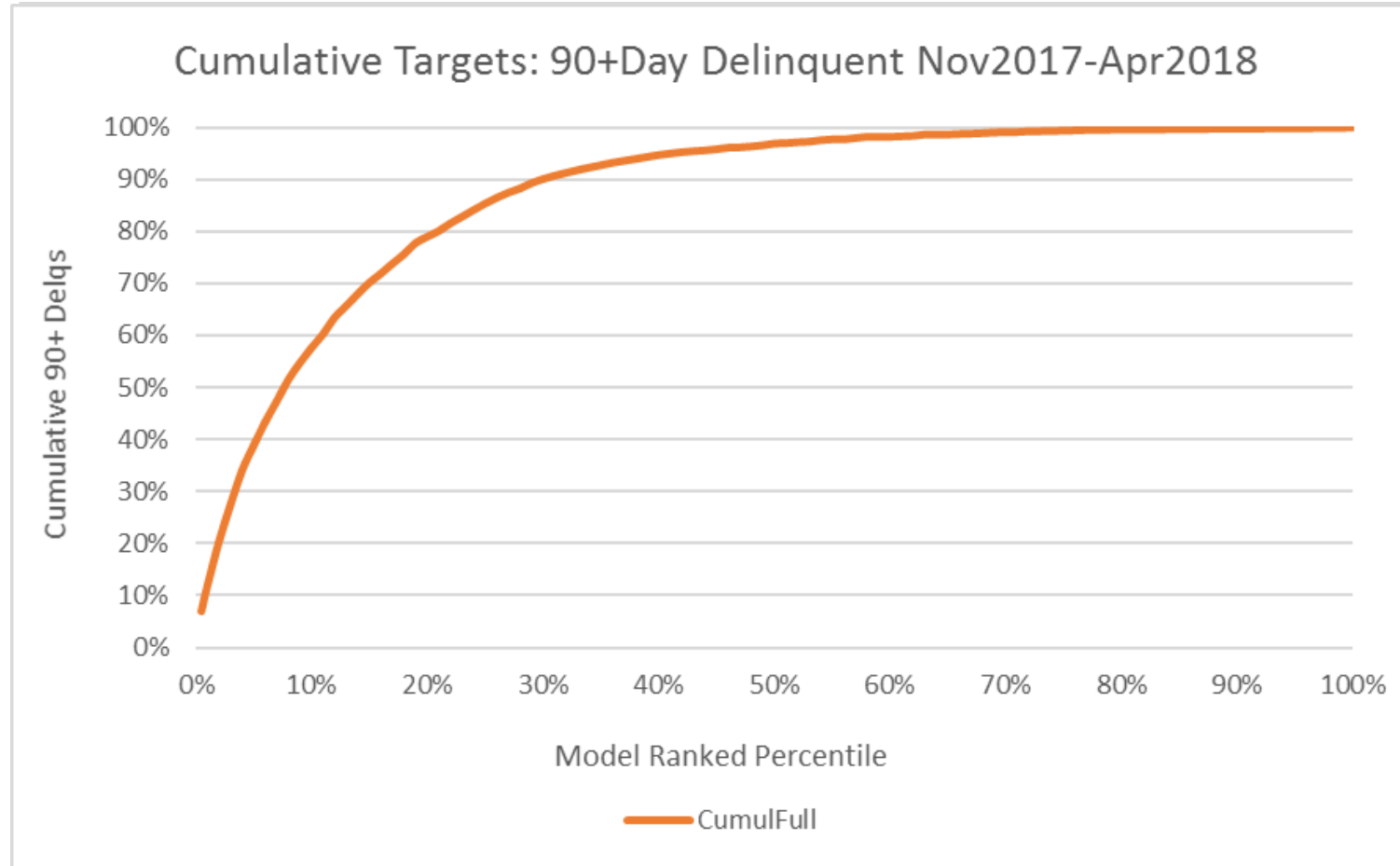
Cumulative Targets Model Rank Identified
Top10% 60%   Top 25% 85%

Model Results: Full versus Traditional No Hazard Variables

	Full	No Haz
Top 10%	58%	45%
Top 25%	85%	69%

Cumulative Targets: 90+Day Delinquent Nov2017-Apr2018

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Model Results Full versus Subsets (Traditional, Prospective)

Cumulative Targets: 90+Day Delinquent Nov2017-Apr2018

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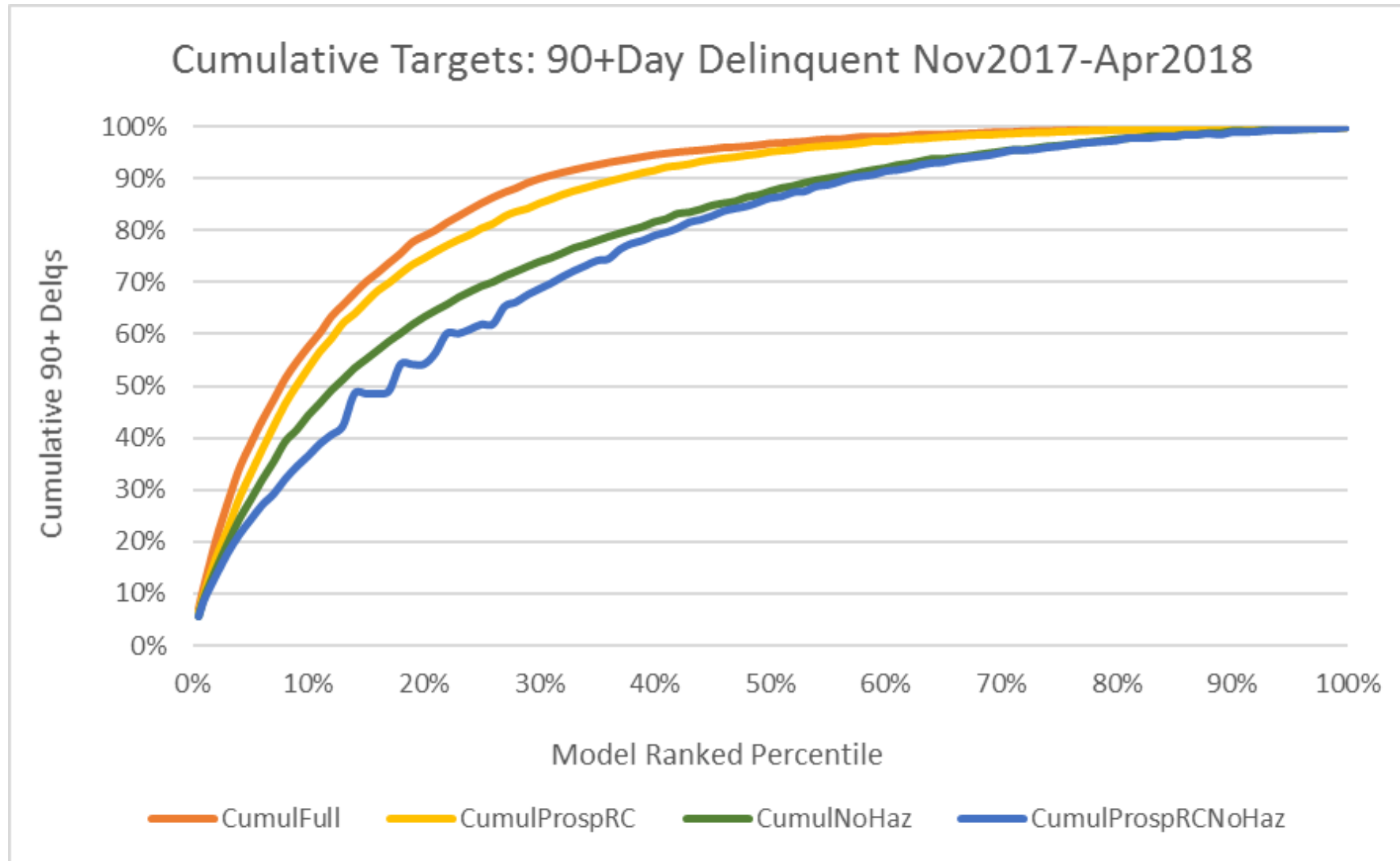
Some Variable Importance Measures: Average Gini Decrease in Accuracy across folds, p-values from Logistic

Rank	Variable	GDA
1	origination_amt	2039.9
2	LTV_EvntAdjMdl	2004.6
3	ValueEventMdl	1892.7
4	origination_spread	1823.3
5	ValueOrigMdl	1789.8
6	RCT	1779.0
7	LivingArea	1735.4
8	OFICO	1721.6
9	LTV3	1651.7
10	HPA	1648.9
11	YearBuilt	1362.7
12	HRSFrequencyScore	1193.7
13	HRSDamageScore	1164.0
14	FFScore	1107.4
15	uw_ratio_2	990.6
16	OrigYear	892.8
17	LossToValueMdl	707.0
18	HarveyTotalLoss	694.9
19	FRSLRiskScore	615.4
20	uw_ratio_1	558.7

Logistic Model Full
Hazard Variables Significance

Variable	p-value
FEMAIndiv	2 e-16
HarveyTotalLoss	2 e-16
HarveyDamage Y/N	2 e-16
LTV_EvntAdjMdl	0.001367
FloodRiskScore	1.88 e-11
NFIP FloodZone A*,V*	0.000464
HazardDamageRiskScore	9.64 e-08
HazardFrequencyRiskScore	0.002246
FlashFloodRiskScore	3.39 e-05

Synthesize: How to apply data and insights?

- Homeowner's Policy considerations
- Cancellation and Renewals
  - REO => no homeowner and no homeowner policy
- Rank book of business for policies to review for high risk policies that result in unexpected cancellation and premium loss
- Optimize Condition Reviews (New and Renewal)
  - Review homeowner's coverage needs
  - If homeowner is not adequately covered across risk ecosystem, unexpected risk retention and collateral loss and added costs in claims review and adjudication
- Alternative Data: Beyond mandatory flood insurance
  - Not in flood zones A*,V* but risks still present to homeowner
  - Portfolio Diversification

Synthesize: How to apply data and insights?

- U/W mortgages: Add alternative data to address natural hazard risks through price and origination decision

- Reserving – Post event identify impaired/risk of default
  - Banks
  - GSEs

- Servicers
  - On the hook in some contracts
  - Additional costs with delinquent loans even though no foreclosure

Thank you!

Innovate. Transform. Thrive.