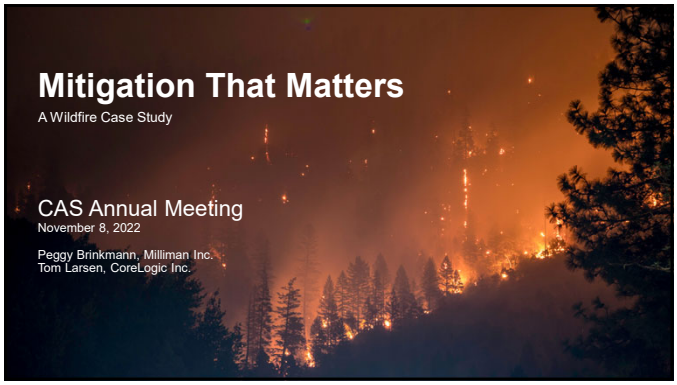

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Agenda

- Why Wildfire Mitigation is a Hot Topic
- Mitigation Approaches
- CAS White Paper
  - Methodology
  - Data
  - Results of Case Studies
- Lessons Learned and Future Work

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Hot Off The Press

According to data published by the Insurance Information Institute, an industry trade group, five of the ten most destructive wildfires in California history have occurred in the last five years.

LAW360

Pipeline wildfire in Arizona triples in size within a day, evacuations ordered

The blaze was reported Sunday morning and exploded to between 4,000 and 5,000 acres later in the day. A 57-year-old man was arrested in connection with the fire, officials said.

National

Massive Laguna Beach Wildfire Blazes Across 200 Acres, Destroys Over 20 Million Dollar Homes

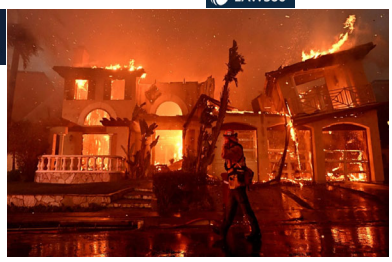
Nearly 1,000 homes destroyed in Colorado wildfire, officials say

The New York Times

How New Mexico's Largest Wildfire Set Off a Drinking Water Crisis

How New Mexico's Largest Wildfire Set Off a Drinking Water Crisis. In a community ravaged by fire, floods and contaminated drinking water,...

Seattle ranks worst in the world for air quality due to 'widespread smoke' from multiple wildfires



Milliman CoreLogic Fire Season Outlook (ca.gov) 3

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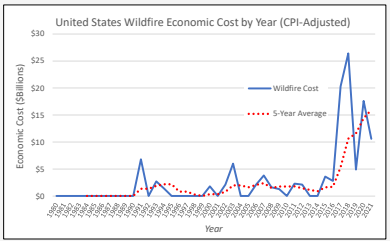
Economic Cost of Wildfire

Wildfires Cost Billions of Economic Damage, but not until recently



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See NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/monitoring/billions/mapping

4

Wildfire Risk by State

73% of Nationwide Wildfire Economic Costs occur in California

State	Wildfire Cost (Billions)	Percentage of U.S. Total
California	$87.3	73%
Colorado	$5.3	4%
Oregon	$5.0	4%
Montana	$2.9	2%
Texas	$2.9	2%
Idaho	$2.9	2%
Washington	$2.5	2%
Alaska	$2.0	2%
Tennessee	$1.6	1%
New Mexico	$1.4	1%
Utah	$1.3	1%
Arizona	$1.2	1%
Nevada	$1.1	1%

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See NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/monitoring/billions/mapping

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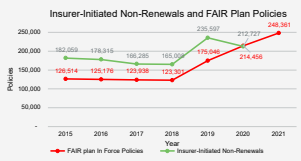
Growth in California Residual Market

Non-Renewals and the California FAIR Plan

FAIR Plan annualized increases (2018 to 2019)	
Insured value	36%
Expected losses	81%

The FAIR plan experienced relatively high growth specifically in wildfire exposed areas.

Indicated and Proposed Changes (Effective 02/2022)		
Line of Business	Indicated Change	Proposed Change
Fire	+78.2%	+52.0%
Allied	-39.4%	-25.8%
Total	+71.7%	+48.8%



Source:
- California Department of Insurance's "Data on Insurance Non-Renewals, FAIR Plan and Surplus lines (2015-2019)"
- California Department of Insurance's "Data on Insurance Non-Renewals, FAIR Plan and Surplus lines (2020)"
- FAIR plan filing MISF-132963111

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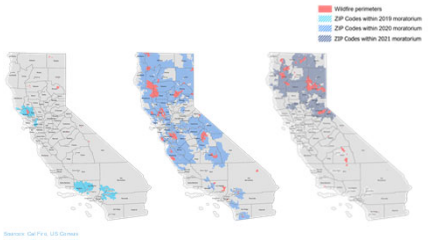
CDI Declared Moratoriums on Non-Renewals

Senate Bill 824 (2018)

Single Family Homes (in 000s)		
Year	Inside Moratorium	Outside Moratorium
2019	1,101	7,385
2020	1,642	6,844
2021	261	8,262



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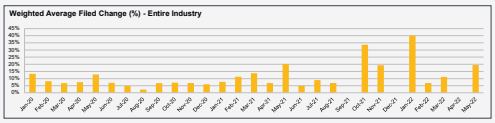
California Homeowners Rate Changes



Rate Impact for Entire Industry	Increase	Neutral (NA or 0)	Decrease	Total
Number of Filings	108	53	4	165
% of Filings	65.45%	32.12%	2.42%	100%

Based on 165 filings from 75 companies.
California 04.0 Homeowners filings effective between 01/01/2020 and 12/31/2022.
Count of Policyholders is for companies' average rate change, not all policyholders will be affected uniformly.

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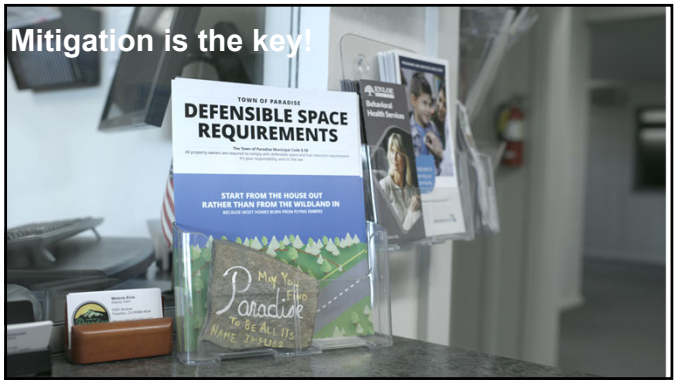

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Individual Mitigation - IBHS Wildfire Prepared Home

Defensible Space + Home Hardening

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Defensible Space

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#DefensibleSpace in Action

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Home Hardening

- Fire rated roofs
- Fire-resistive vents
- Enclose low elevation decks
- Fire-resistive siding
- Enclose eaves
- Enclose under-bay windows
- Fire-resistant deck
- Fire-resistive windows

Source: Wildfire-Ready – DISASTERSAFETY.ORG

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Utility Mitigation Efforts

Actions by utility companies

Source: Our Wildfire Safety Measures | Safety | Home - SCE

High fire risk inspections

- Ground inspections by crews
- Aerial inspections by helicopters and drones

Grid design and system hardening

- Replacing bare wire with insulated wire
- Replacing power poles with fire-resistant composite poles/install fire-resistant wraps
- Install fast-acting fuses
- "Undergrounding" wires

Situational awareness

- Weather stations
- Wildfire cameras

Vegetation management

- Inspect, trim, and remove trees

Public Safety Power Shutoffs (PSPS)

- Temporarily shut off power to neighborhood when there is a high risk for a fire

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Current State of Mitigation Rating Factors in California

Individual property/parcel mitigation

- 12 companies/groups offer discounts for various mitigations
- Up to 50% discounts for:
  - Building Codes, Exterior Sprinklers, Ember resistant Venting, Enclosed Eaves, Annual Brush Removal Contract, Wildfire Spray System, Monitored Heat Sensors, Fire Rated Roof, Thermal Shields, Metal Gutters, Multi-pane Windows, Noncombustible Fences, Defensible Space, Area under decks/porches cleared, Portable Firebreak system
- Up to 25% surcharges for:
  - Combustible Decks, Firewood within 30 feet, propane tank within 10 feet

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Current State of Mitigation Rating Factors in California

Community mitigation

- Fire Wise Community Discount
  - 7 companies/groups
  - Up to 20% discount
  - Community wildfire risk assessment
  - Three-year action plan
  - Execute individual and community risk reduction activities – debris removal in public areas, education, canvassing
- Shelter in Place Community Discount
  - 2 companies/groups
  - Up to 5% discount
  - All homes built to withstand wildfires

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CDI Regulation on Wildfire Mitigation

Consideration of Mitigation Factors; Wildfire Risk Models

- California Code of Regulations 2644.9 effective October 14, 2022
- New mandatory rating factors for
  - Community-level mitigation designations
  - Property-level mitigation
    - Defensible space
    - Building code/ordinance compliance
    - Class A roof
    - Enclosed eaves
    - Fire-resistant vents
    - Fire-resistant windows
    - Six inches of noncombustible vertical clearance a bottom of building

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Actuarially Sound Mitigation Credits Are Important

- Important to match rate to risk and incentivize homeowners and communities to mitigate
- But doing it wrong can adversely impact availability, affordability, reliability (i.e., market stability and solvency)

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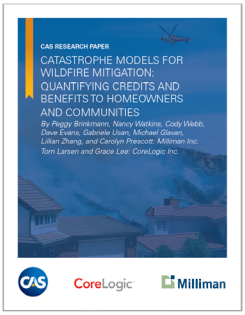
Casualty Actuarial Society Research Paper

- Produced by Milliman, and Corelogic on behalf of Casualty Actuarial Society
- Published October 25, 2022
- https://www.casact.org/publications-research/publications/cas-research-papers-and-briefs
- Discusses wildfire mitigation, catastrophe models, actuarial considerations for mitigation credits
- Case studies to illustrate analysis methodology and compare effects of different types of mitigation



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Actuarial Considerations

ASOP 12 – Risk Classification

- Completeness
- Representativeness
- Geographic granularity
- Analytical manageability
- Rating table simplicity and interpretability
- Interaction effects

Other

- Rate adequacy
- Base rate offset
- Interaction with territory factors
- Expenses
- Regulatory requirements and legal compliance
- Use of catastrophe models

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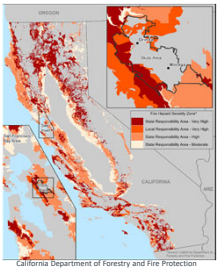
Case Study Overview



California Department of Forestry and Fire Protection

Study Area: City of Orinda and Town of Moraga

Data: CoreLogic wildfire model output by parcel and census block centroid

Analysis technique: Generalized Linear Models

Case Studies:
- Credits for Individual Mitigation
- Credits for Community Mitigation
- Quantification of Benefits of Community-Scale Mitigation Projects

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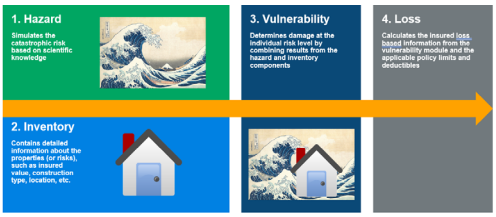
Data: Overview of Wildfire Catastrophe Models

Inputs include:
- Land cover/fuel
- Property characteristics
- Defensible space



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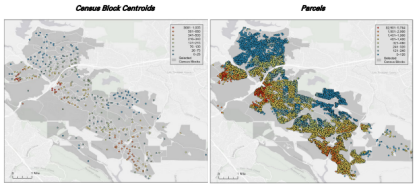
Model Input Data: Choosing Locations

Options include actual portfolio/buildings, grid points, territory centroids

For the case studies, we used:
- Census block centroids for estimating mitigation factors
- Representative portfolio for estimating aggregates



Source: Esri basemap data, 2010 U.S. Census Bureau TIGER, CoreLogic model

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Model Input Data: Choosing Property Characteristics

- Mitigation characteristics were based on what is considered in the CoreLogic model
- Census block centroids – model for possible all combinations of mitigation for the base risk
- Representative portfolio – use best estimates of actual distribution of mitigation characteristics, Coverage A, Year Built

Model Input Data		
Model Variable	Centroid Locations	Parcel Locations
Occupancy	Residential	Residential
Coverage A (Dwelling)	$400,000	Actual
Coverage B (Other Structures)	$40,000	7.5% of A
Coverage C (Contents)	$200,000	60.0% of A
Coverage D (Loss of Use)	$100,000	20.0% of A
Deductible	$1,000	0.5% of A
Structure Type	Frame, Noncombustible, Fire Resistive	Estimated Distribution
Year Built	1955	Actual
Number of Stories	1, 2	Estimated Distribution
Roofing Fire Class	Classes A, B, C, and Unrated	Estimated Distribution
Clearance—Noncombustible Zone	Yes, No	Estimated Distribution
Clearance—Lean, Clean, and Green Zone	Yes, No	Estimated Distribution
Clearance—Reduced Fuel Zone	Yes, No	Estimated Distribution
Fire-Resistive Siding	Yes, No	Estimated Distribution
External Fire Extinguisher	No	Estimated Distribution
Combustible Attachments	Yes, No	Estimated Distribution
Fire-Resistive Windows	Yes, No	Estimated Distribution

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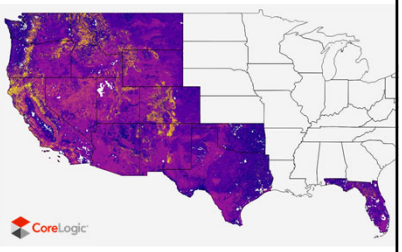
CoreLogic RQE® Wildland Fire model

- Over 3 million simulated events + all major historical wildfires
- Covers attritional and catastrophe wildland fire
- Fire and smoke modeling
- Geo-spatial wildfire behavior model integrates surface and crown fire spread
- Weather simulation captures spatial-temporal variability and extremes
- 3 risk views for fuel + moisture: long-term, below normal, & above normal
- Vulnerability parameters defined per IBHS recommendations



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Case Study 1 – Individual Mitigation Credits

How do individual mitigation actions impact expected wildfire losses?

Methodology:

- Analyze losses relative to the base, unmitigated risk
- Use GLMs to determine which variables interact with each other to design mitigation factor table
- Examine interactions between geography and mitigation variables to create territories

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Case Study 1 – Individual Mitigation Credits

Interaction Test Results

- Test for main effects first
- Fit individual models for each possible two-way interaction among the main effects

Interaction Number	Variable—Level	Coefficient	Standard Error	Pr>|t|
1	Roofing Fire Class B: Clearance—Lean, Clean, and Green (No)	-0.13	0.00	0.0000
1	Roofing Fire Class C: Clearance—Lean, Clean, and Green (No)	-0.15	0.00	0.0000
1	Roofing Fire Class U: Clearance—Lean, Clean, and Green (No)	-0.15	0.00	0.0000
2	Roofing Fire Class B: Clearance—Reduced Fuel Zone (No)	-0.11	0.00	0.0000
2	Roofing Fire Class C: Clearance—Reduced Fuel Zone (No)	-0.14	0.00	0.0000
2	Roofing Fire Class U: Clearance—Reduced Fuel Zone (No)	-0.13	0.00	0.0000
3	Roofing Fire Class B: Clearance—Noncombustible Zone (No)	-0.07	0.00	0.0000
3	Roofing Fire Class C: Clearance—Noncombustible Zone (No)	-0.09	0.00	0.0000
3	Roofing Fire Class U: Clearance—Noncombustible Zone (No)	-0.09	0.00	0.0000
4	Roofing Fire Class B: Combustible Attachments (No)	0.07	0.00	0.0000
4	Roofing Fire Class C: Combustible Attachments (No)	0.09	0.00	0.0000
4	Roofing Fire Class U: Combustible Attachments (No)	0.09	0.00	0.0000
5	Clearance—Lean, Clean, and Green (No): Clearance—Reduced Fuel Zone (No)	-0.26	0.00	0.0000
6	Clearance—Lean, Clean, and Green (No): Clearance—Noncombustible Zone (No)	-0.05	0.00	0.0000
7	Clearance—Lean, Clean, and Green (No): Combustible Attachments (No)	0.05	0.00	0.0000
8	Clearance—Reduced Fuel Zone (No): Clearance—Noncombustible Zone (No)	-0.04	0.00	0.0000
9	Clearance—Reduced Fuel Zone (No): Combustible Attachments (No)	0.04	0.00	0.0000
10	Clearance—Noncombustible Zone (No): Combustible Attachments (No)	0.37	0.00	0.0000

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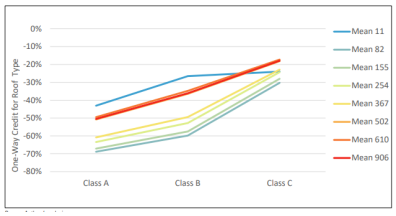
Case Study 1 – Individual Mitigation Credits

Testing for Interactions with Geography

Figure 4.4. Cluster credit by roof type



- K-means cluster of census block base risk AALs
- Test interactions with census block clusters
- Further group similar clusters into territories

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Case Study 1 – Individual Mitigation Credits

Findings

- Roof replacements are the most impactful mitigation action, but roof replacements are expensive and infrequent
- If the roof cannot be replaced, maintaining the clearance zones is the next most impactful action
  - Largest risk reduction observed from clearing the 30-100 zone, then the 0-5 zone, then the 100+ zone
- Relative impact of mitigation is sensitive to location – impact is greater for the geographic areas with higher base risk

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Case Study 2 – Community Mitigation Credits

How can impact of community mitigation efforts be quantified?

The risk to a community is based on its layout and fuel characteristics. If layout is a given, what can be done at a community level to impact fuel?

Methodology:

- Modify underlying fuel story to use main fuel type but decrease "load". For example, moderate and high timber litter load were modified to be low timber litter load
- Compare expected losses to scenario with current fuel load

This represents an aggressive community fuel maintenance project in which the fundamental nature of the landscape wasn't changed

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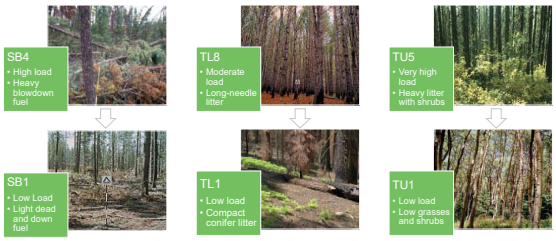
Case Study 2 – Community Mitigation Credits

Illustration of Fuel Category Modifications



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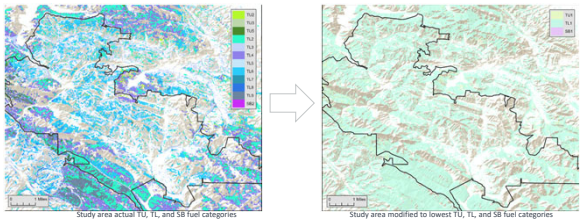
Case Study 2 – Community Mitigation Credits

Illustration of Fuel Category Modifications



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Case Study 2 – Community Mitigation Credits

Findings

The benefit of community mitigation is larger for

- Properties with less individual mitigation in place
- Properties in locations with higher risk

Individual Mitigation Credits—Benefit of Modified Fuel Scenario Compared to Standard

Mitigation Variables				Percentage Credit				AAL Dollar Difference			
Clearance—Reduced Fuel Zone (0ft–100 feet)	Clearance—Lean, Clean, and Green Zone (5–30 feet)	Clearance—Noncombustible Zone (0–5 feet)	Roof Fire Class	Territory Group A Low Risk	Territory Group B Medium Risk	Territory Group C High Risk	Territory Group A Low Risk	Territory Group B Medium Risk	Territory Group C High Risk
Yes	Yes	Yes	Class A	1%	2%	5%	90	94	326
			Class B	4%	6%	11%	8	11	84
			Class C	6%	13%	31%	1	23	121
			Unrated	9%	18%	38%	1	32	158
		No	Class A	3%	5%	9%	9	9	90
			Class B	6%	15%	16%	1	17	90
			Class C	9%	16%	35%	1	29	143
			Unrated	13%	22%	31%	1	43	177
	No	Yes	Class A	2%	4%	8%	8	8	40
			Class B	5%	8%	15%	8	16	85
			Class C	9%	16%	35%	1	28	139
			Unrated	13%	21%	31%	1	38	173
		No	Class A	1%	13%	35%	1	22	114
			Class B	11%	18%	38%	1	24	159
			Class C	17%	27%	36%	1	48	201
			Unrated	34%	36%	41%	2	61	264
No	Yes	Yes	Class A	2%	4%	7%	8	7	42
			Class B	5%	8%	14%	8	15	81
			Class C	8%	15%	34%	1	27	138
			Unrated	12%	21%	39%	1	37	169
		No	Class A	6%	12%	30%	1	21	111
			Class B	11%	18%	37%	1	33	155
			Class C	16%	26%	35%	1	47	197
			Unrated	23%	35%	41%	2	59	258
	No	Yes	Class A	6%	11%	19%	1	20	107
			Class B	10%	18%	37%	1	32	158
			Class C	16%	25%	34%	1	45	193
			Unrated	23%	32%	40%	2	58	227
		No	Class A	7%	13%	22%	1	24	128
			Class B	12%	21%	36%	1	37	171
			Class C	18%	28%	37%	2	51	211
			Unrated	26%	36%	43%	2	65	264

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Case Study 3 – Comparing Impacts

Measuring Results at the Community Level

How can we prioritize various mitigation projects?

Methodology:

- Use representative locations/property characteristics
- Compare expected losses under various scenarios
  - No mitigation
  - Current case
  - Individual clearance
  - Individual clearance + home hardening
- With and without community mitigation

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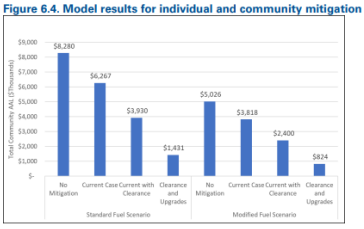
Case Study 3 – Comparing Impacts

Findings

Figure 6.4. Model results for individual and community mitigation scenarios



- The benefit of high adherence to individual clearance is similar to community-level fuel modification
- There are diminishing returns
- Home hardening reduces the risk so substantially that impact of community-level mitigation is minimal
- Communities need to weight costs against the estimated benefits

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Implementation Challenges

- Need to start with adequate rates!
- Getting data on property-level mitigations
- Getting current data on defensible space
- Getting data on community-level mitigation, and translating it into model inputs
- Avoiding overlap with territory and other rating plan factors

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Mitigation Credits are One Part of the Solution

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Lessons Learned

Wildfire is a complex risk that needs to be understood and mitigated by a variety of stakeholders including actuaries, catastrophe modelers, community leaders and fire experts, and policymakers. Mitigation matters, but it's important to quantify the impact of any efforts through a scientific methodology.

Catastrophe models are the best way currently to quantify and understand mitigation efforts, but transparency is key in order to understand the results of these models.

This study presents illustrative results only and is intended as a road map to better understanding the cost-benefit of mitigation credits; it is not prescriptive. Different geographies, property data, catastrophe models and other variables will affect the findings of this study.

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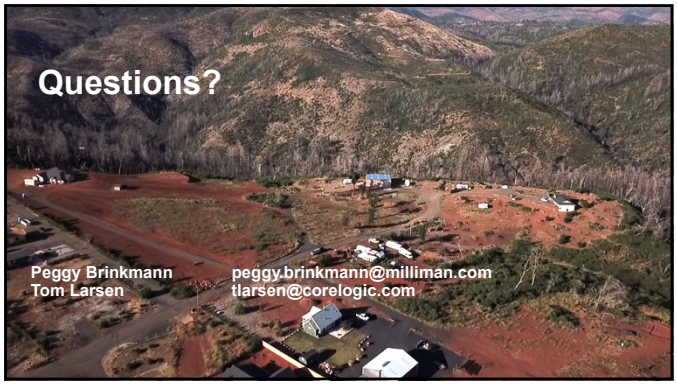
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tlarsen@corelogic.com

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