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Catastrophic Wildfire Risk:

6 Key Trends Driving Change in North America

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Setting the Scene

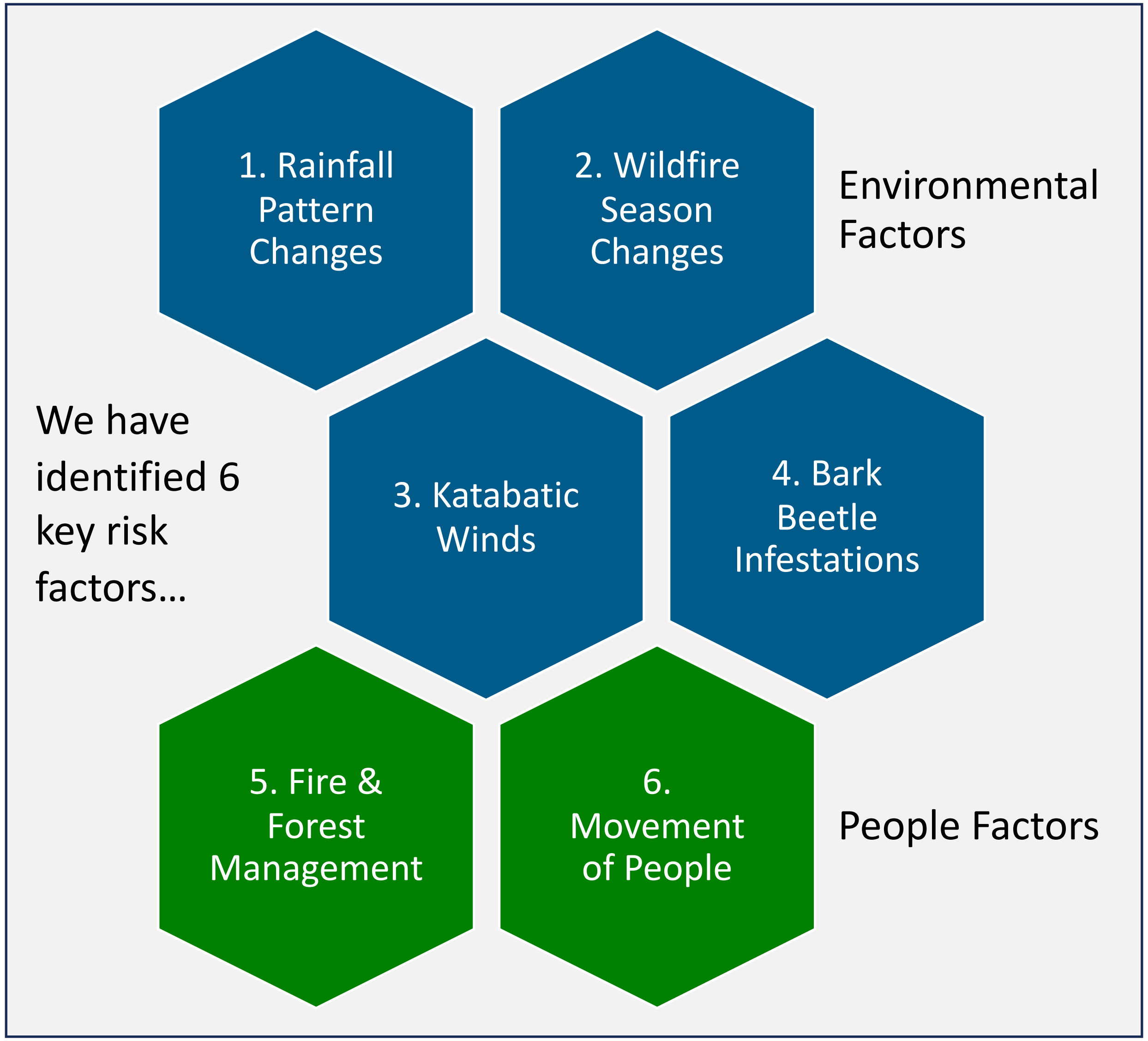
Overview

Setting the Scene

- Wildfires are not new. The increasing risk of catastrophic loss is**.**

- The 2017 and 2018 severe wildfires in California were a catalyst for a surge in scientific funding and interest.

- The **University of Portsmouth** carried out a literature review of this new research in 2022. The findings are informing Chaucer’s view of risk.



We believe these factors are driving the increasing likelihood of **catastrophic** fires in California, but also other key regions in North America.

This talk is a pre-cursor to the launch of a Chaucer White Paper on this topic

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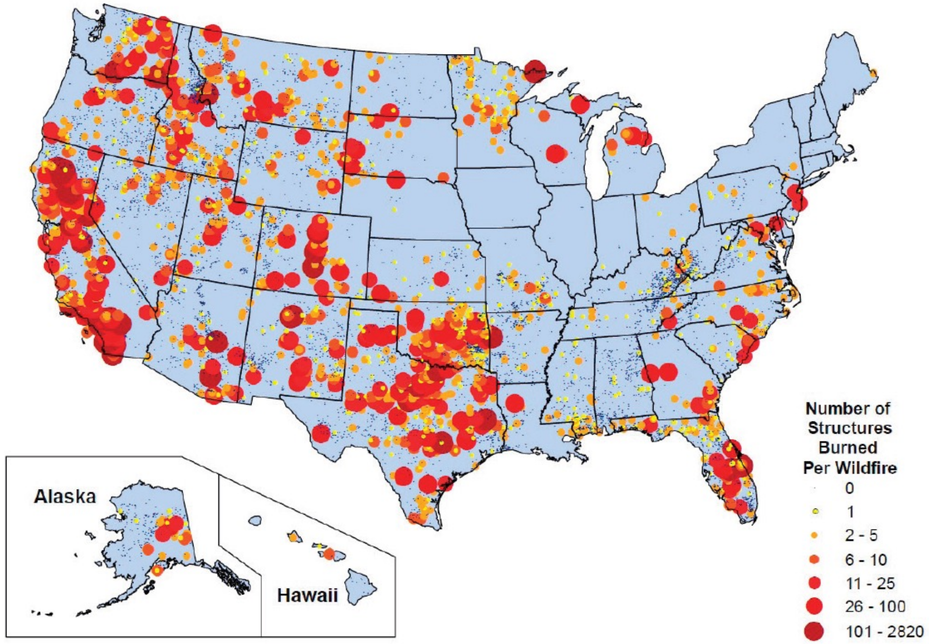
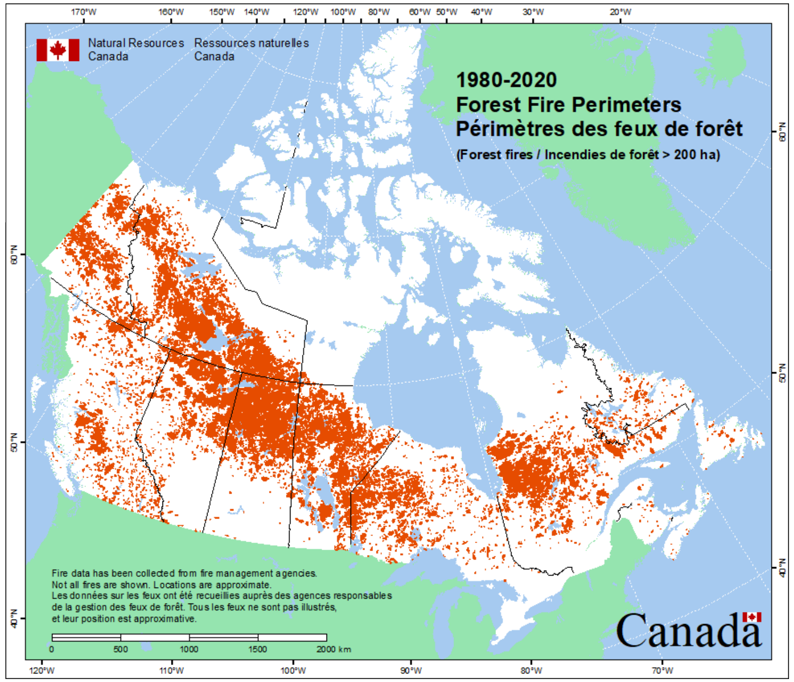
Overview
Setting the Scene

- Wildfires occur natural all over North America
- Most of them are not a concern for insurers; it is a confluence of factors that causes a normal fire to become severe and generate catastrophic loss
- Our discussion of these key factors will highlight four regions to watch for future catastrophic wildfires



Sources:
Top: *Structures burned 1999-2011, National Academies (US), 2017.*
Bottom: *Wildfire perimeters in Canada 1980-2020, Natural Resources Canada, 2021*



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Wildfire Research

U.S. Wildfire Risk Research

Background – Controls on wildfire behaviour

- Wildfires require the confluence of four factors in order for fires to be created and spread, these include
  - ignition points (both natural or human)
  - continuous dry fuels,
  - droughts or extended dry periods
  - appropriate weather conditions (wind to drive and spread the wildfire).
  - **Climate change is having a major impact on wildfire behaviour.**

- Climate change and anomalous weather events are likely to lead to an extended fire season and increasing fire frequency.

- **Anthropogenic factors play an important role in wildfire behaviour** through, fuel availability (land use, fire suppression) and human vulnerability (movement of people and wildland urban interfaces).

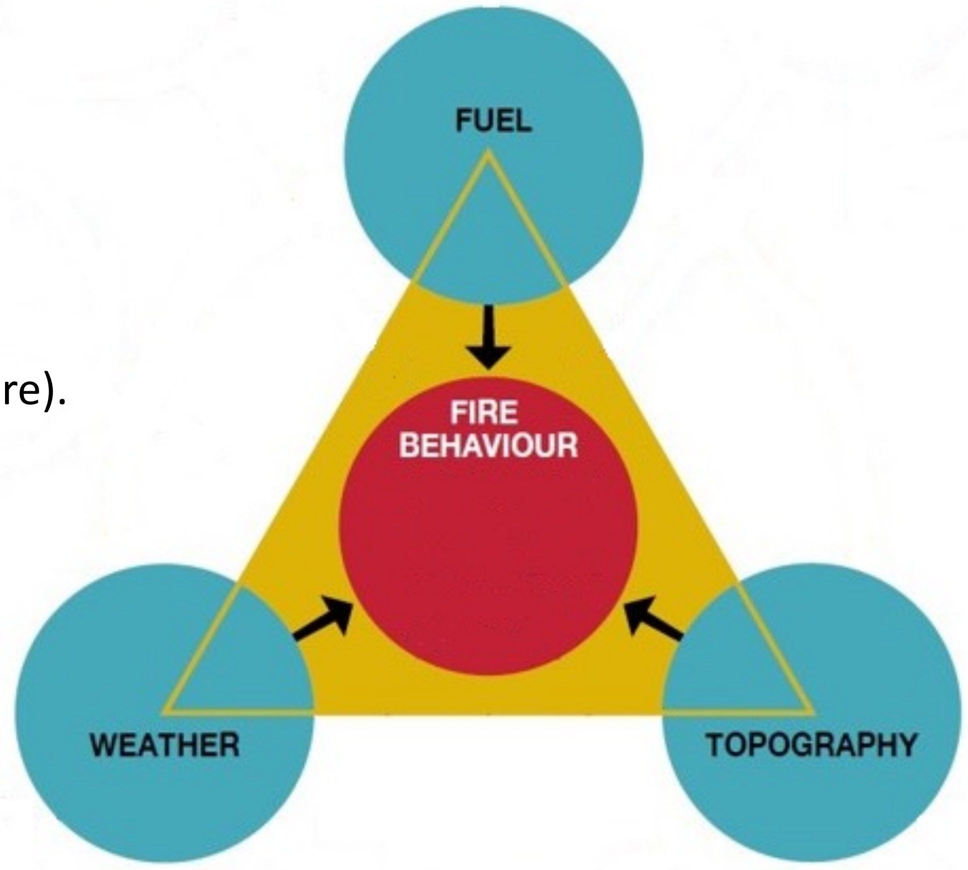

Figure adapted from UNEP (2022)

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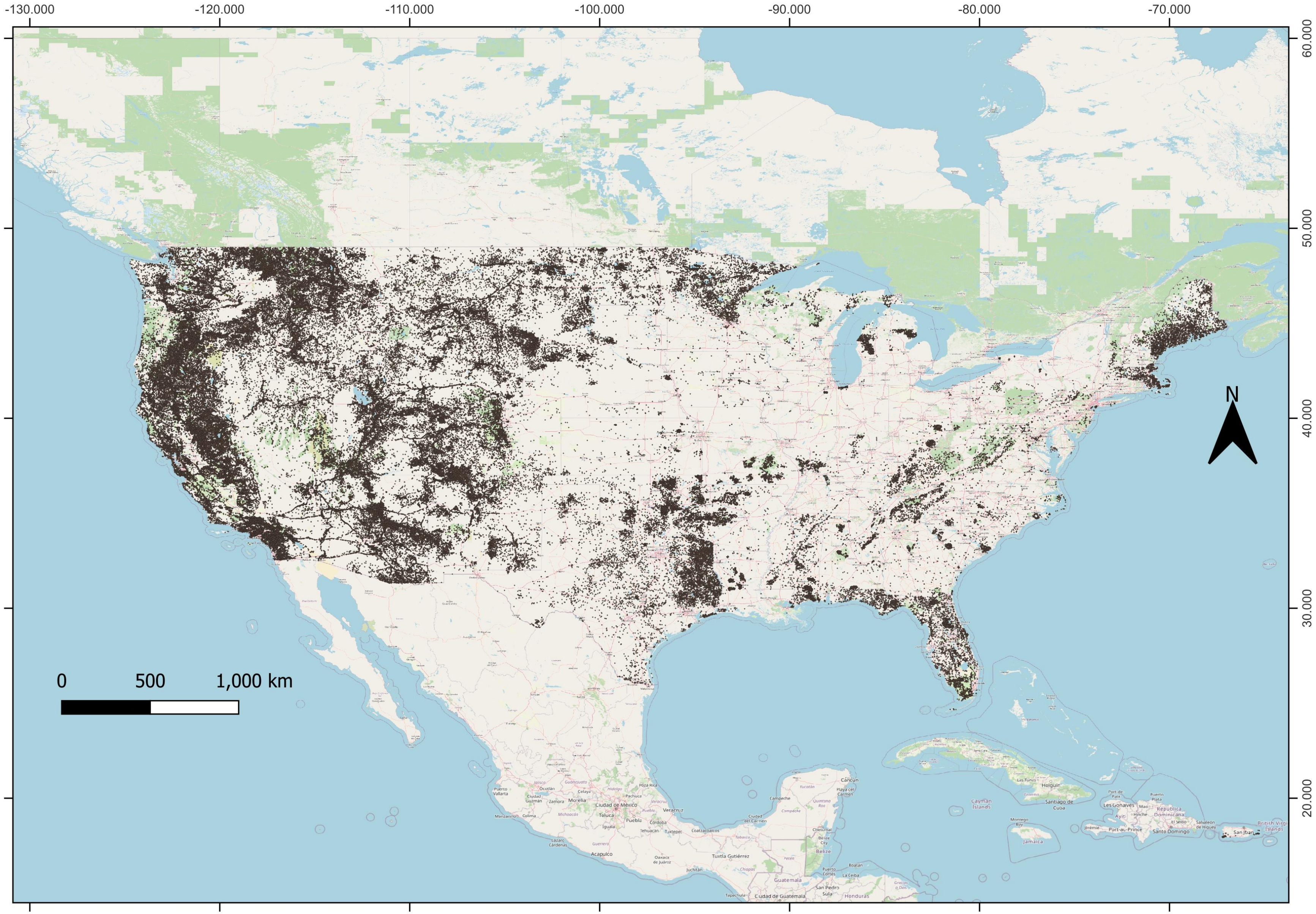
Background – Wildfires do occur across the U.S.

- Map showing the distribution of **all recorded wildfires** in the United States generated using fire location data from the National Interagency Fire Centre (https://www.nifc.gov).

- Fires are concentrated in the western and northwest US.

- There are hotpots in other parts of the US, including Florida and Texas.



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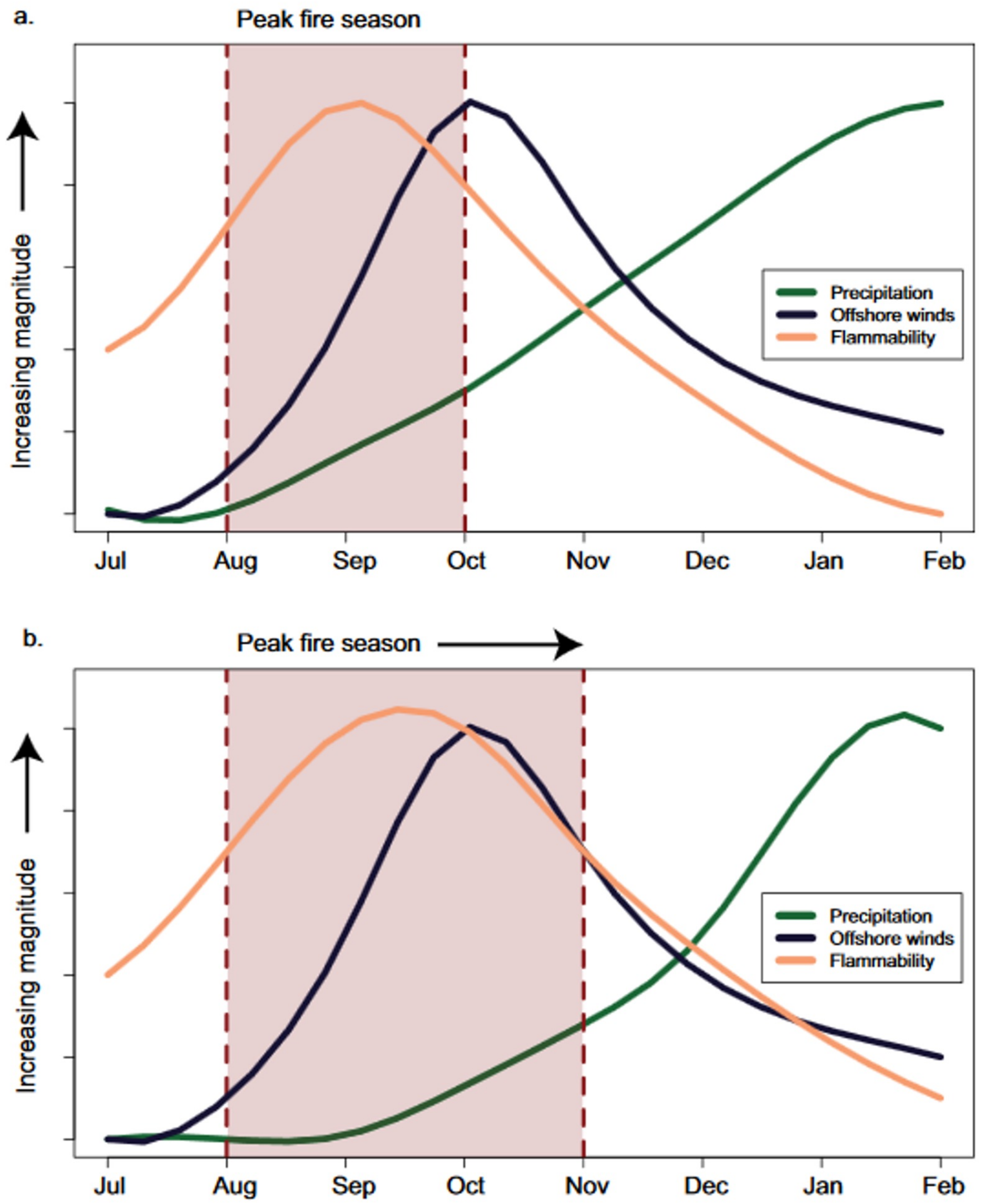
1. Rainfall Patterns

- There is evidence for significant changes in rainfall patterns across California. The wet season is becoming shorter and sharper.
- Precipitation has become increasingly concentrated into its core rainy season months (December–March) and the expense of the shoulder seasons (primarily autumn), or the tail months shown in figure on the right.
- Produces an
    - **extended dry period**
    - **delayed autumn precipitation**
- Lengthened fire season has profound implications for the region's wildfire risk.

Swain (2021)



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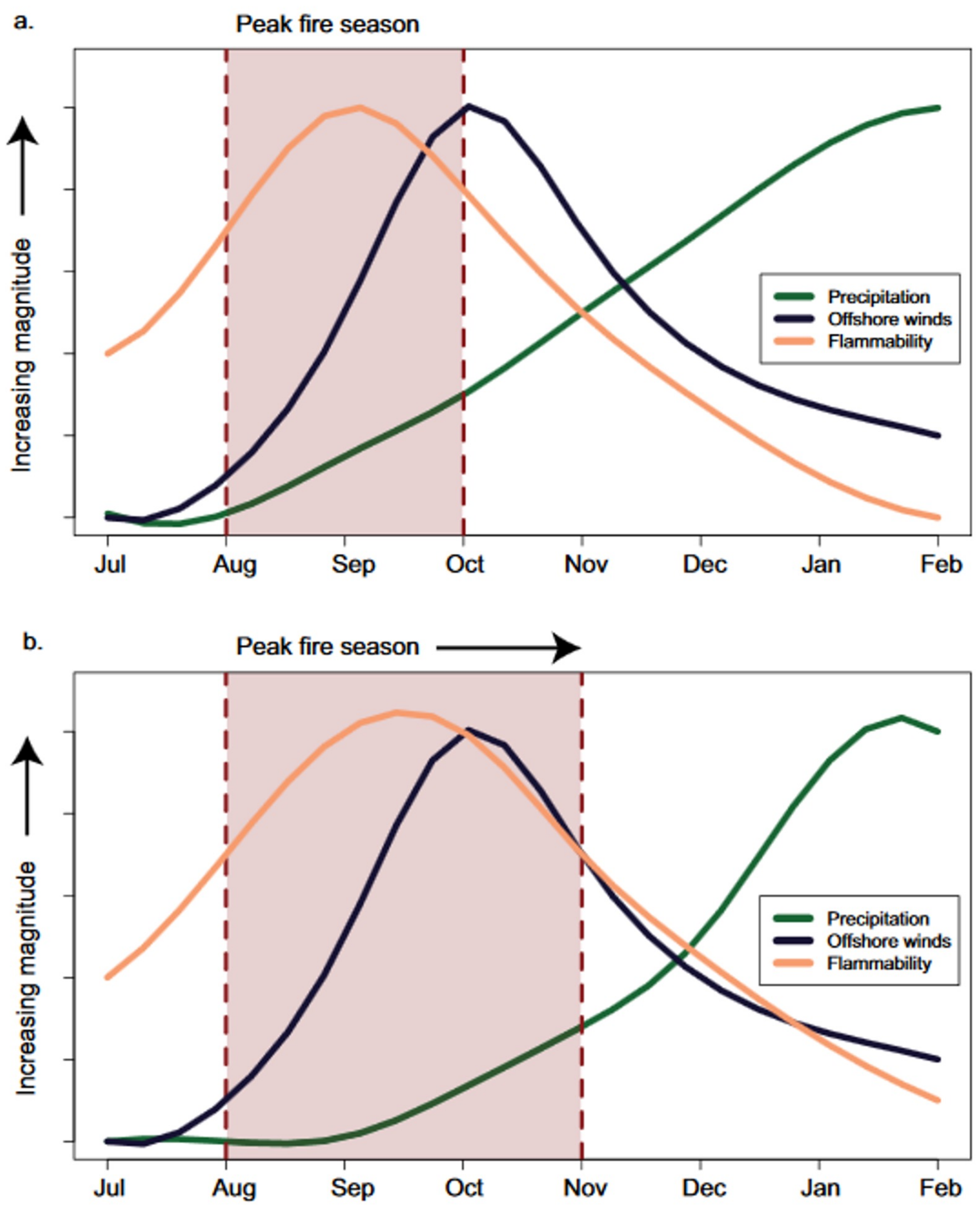
1. Rainfall Patterns

- Firstly, lower precipitation leads to:
  - extended periods of negative water balances with
  - low moisture levels in dead and dormant vegetation (including bark beetle infested woodland)
  - **drier fuels (greater flammability) and increased wildfire risk**.
- Secondly, delayed autumn precipitation by up to a month results in:
  - dry season coinciding with the arrival of the hot, dry offshore winds,
  - confluence between extremely dry vegetation and strong wind conditions that **significantly amplifies wildfire risk** in the autumn.

Swain (2021)



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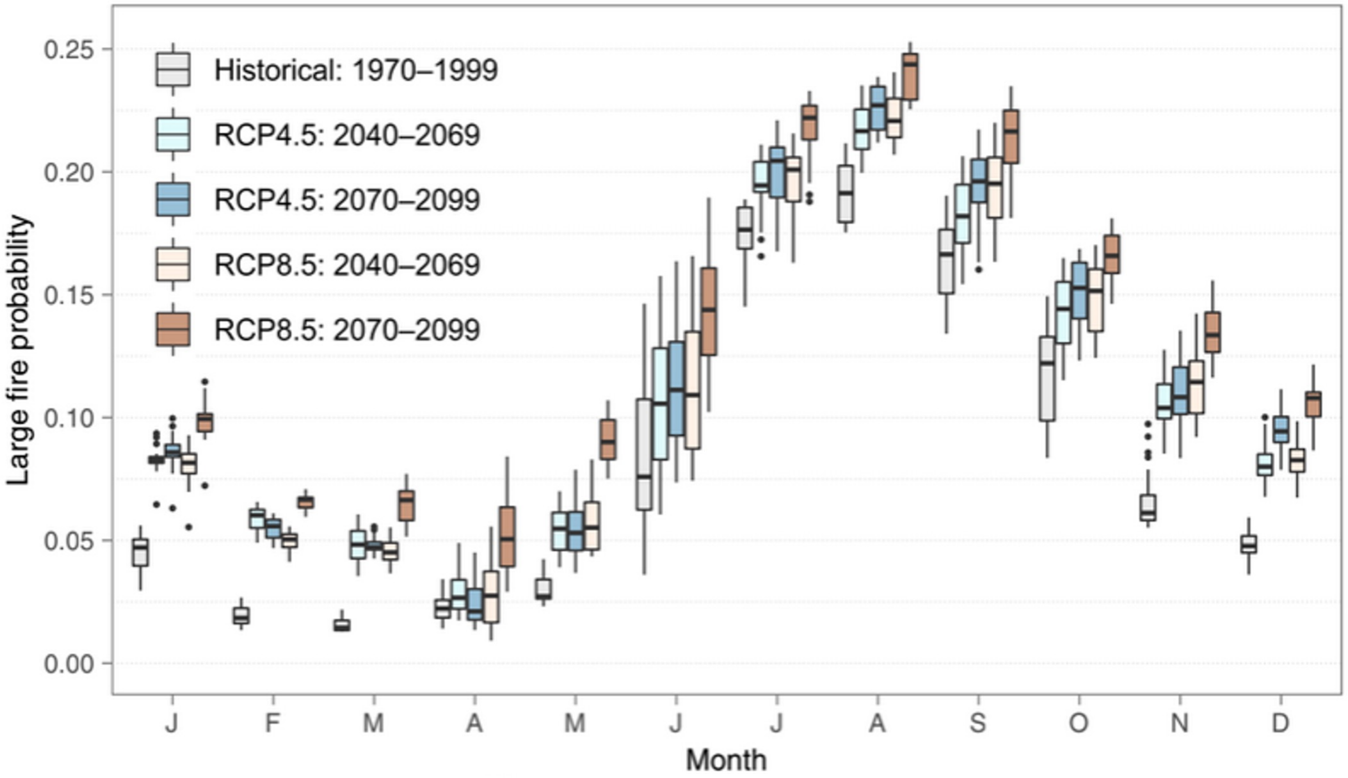
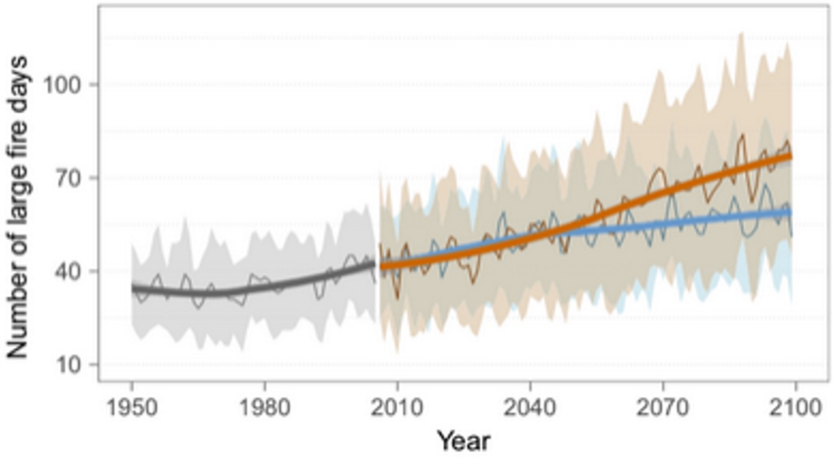
2. Wildfire Seasons are Changing

- **Increased likelihood of large fires** (large fire probability - LFP) in late season (September, October, November and December) compared to today, under both an RCP 4.5/8.5 emission scenario.

- Large fire season will be extended with an earlier onset (July) and delayed end (September).

- Under an RCP 4.5 emission scenario, number of **wildfire days are projected** increase from 36 days currently to 58 days. *(RCP = Representative Concentration Pathway)*





Dong et al. (2022)

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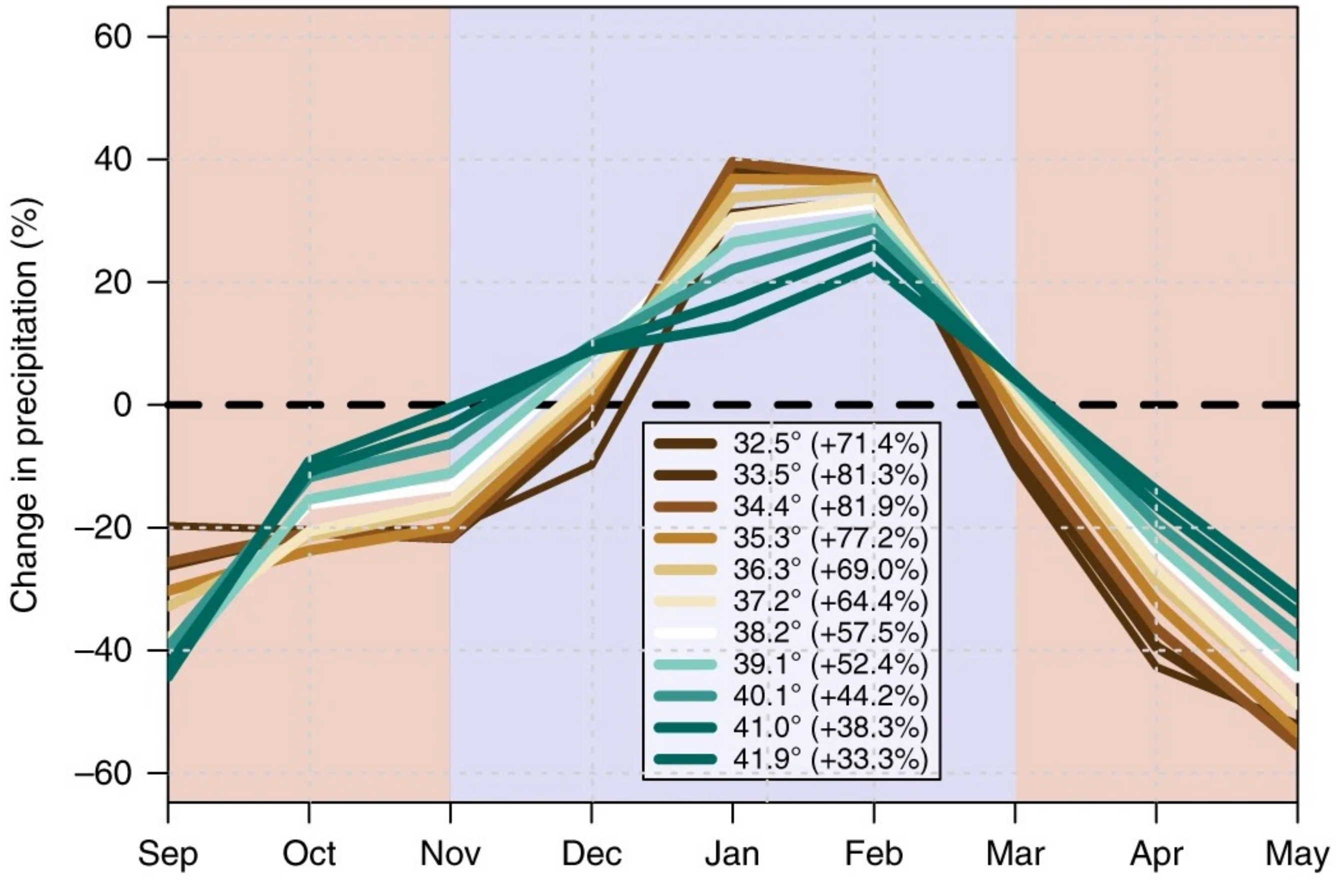
2. Wildfire Season (and climate whiplash!)

- Observations are corroborated by climate models which project further 'sharpening' of the winter rainy season with anthropogenic warming.
- Increases in precipitation volatility, or 'climate whiplash', with extreme wetness following extended droughts (Swain et al., 2018).
- Climate whiplash trends can exacerbate fire recurrence by intensifying autumn dryness and **promoting the growth of fast-responding vegetation during wet winter peaks that provide fuel to subsequent autumn wildfires.**



Swain et al. (2018)

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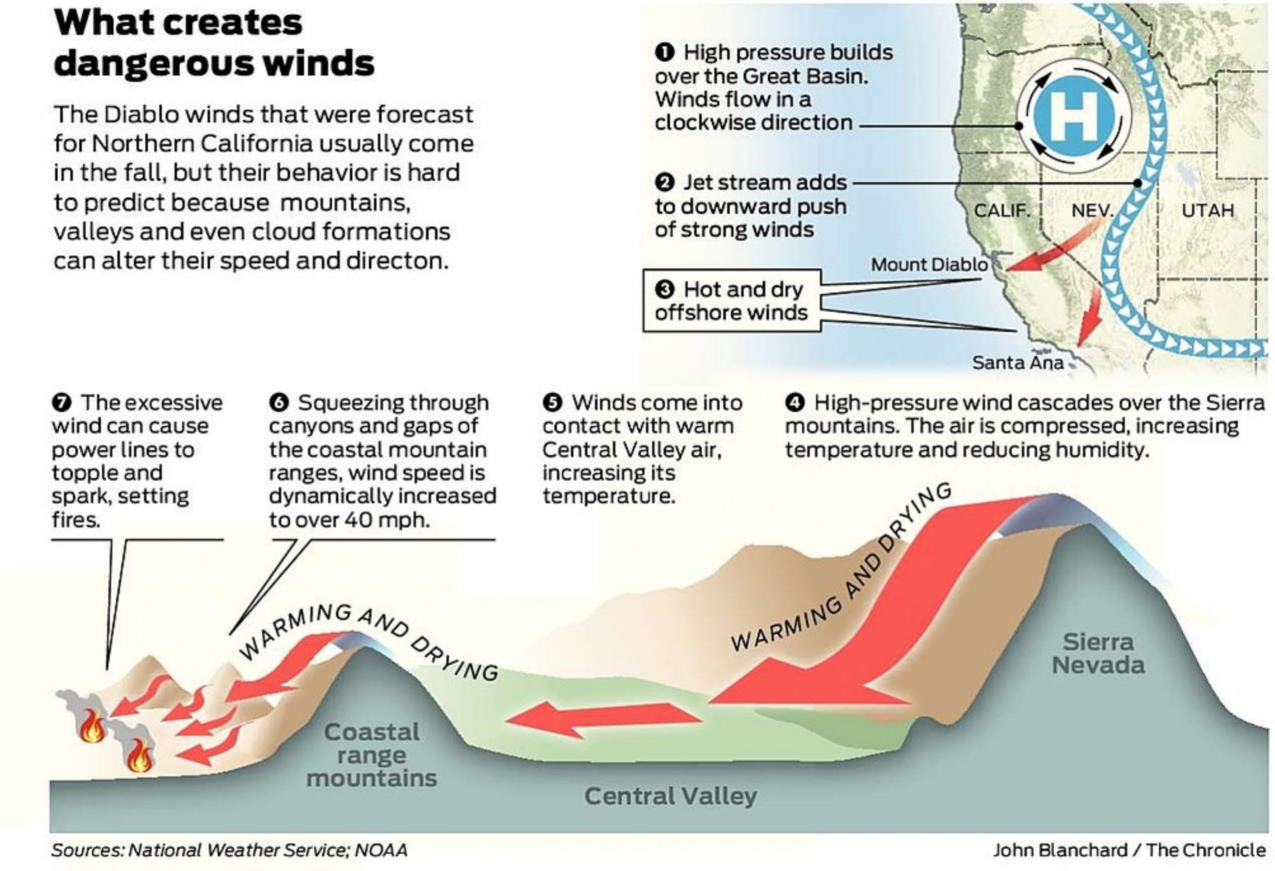
3. Katabatic and Special Winds

- A katabatic wind (a drainage wind) is the general name given to winds that result when a **cool, dry air mass flows downslope from a high-elevation region towards a lower coastal plains**.
- As the air sinks**, it is compressed, warming and drying it out and reducing its relative humidity**, and is further focused by local topography and valleys as they descend towards the sea (+5˚F per 1000 ft). Can reach 100 ˚ F.
- Air is squeezed further and is accelerated by local topography and valleys.



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3. Katabatic and Special Winds

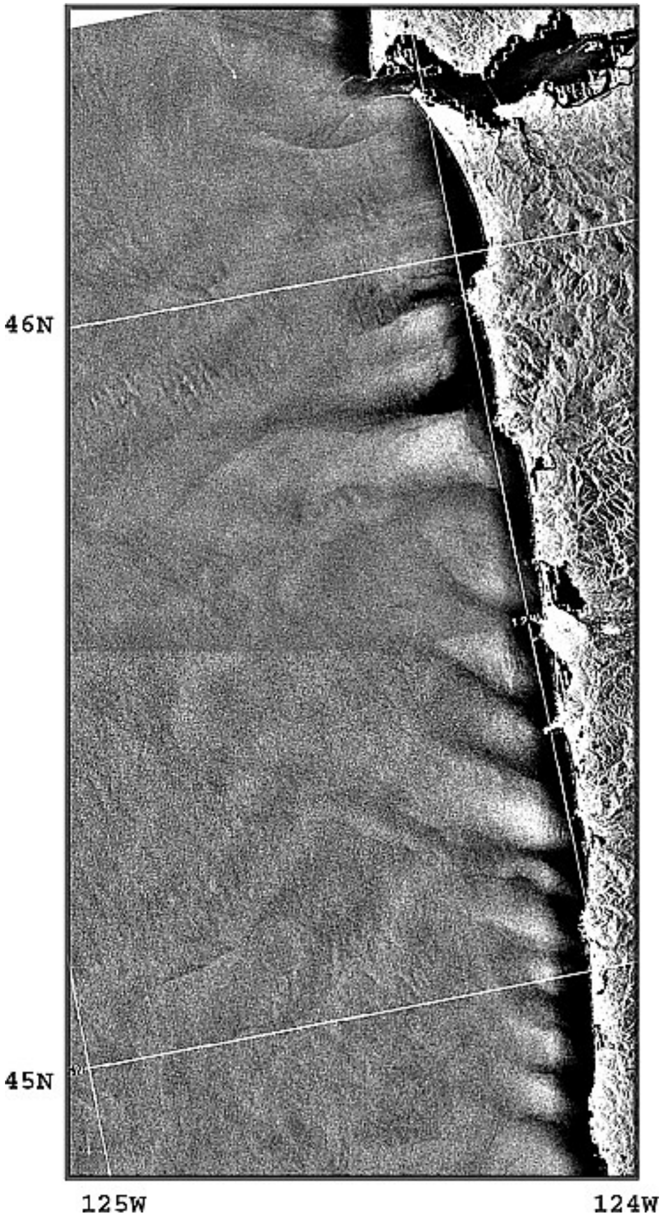
- These winds (California Diablo or Santa Ana winds) **can produce winds with speeds of 40-60 km/hr, and in extreme cases, wind speeds in excess of 100 km/hr have been recorded.**

- These dry, sometimes hot, winds quickly **reduce fuel moisture, greatly enhancing the risk of fire, and fan the flames of any fire once started**.

- Their **impact is greatest in the autumn months, when vegetation has already been drying out after a long dry summer period** and before the onset of the winter rainy season.

- Unusual, extreme winds played a critical role in initiating and supporting fires, with studies of weather and their influence of fire size, suggesting that high wind events as playing an important role in disproportionate fire growth.

- Satellite imaging of these winds over water on California coast, but these special winds occur all over U.S (not just California).



Li et al. (2007)

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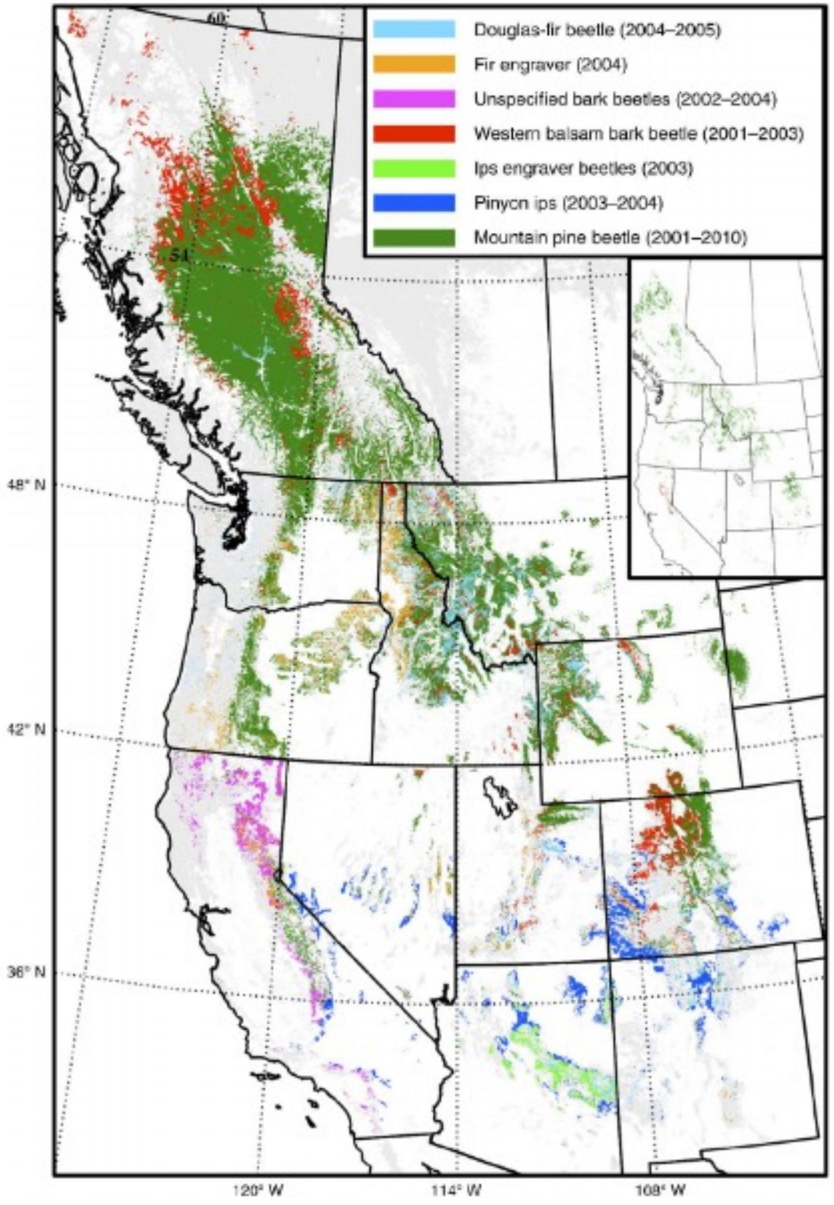
4. Beetle Infestation – Source of fuel

- Insect infestations are an increasing problem in American woodlands, where **climate change has:**
  - improved beetle survival rates
  - enabled migration of invasive species to high latitudes and elevations (previously inhospitable to them).
  - impede a tree’s ability to fight infestations and affects a tree's ability to respond to bark beetle invasions.

- Trees colonised and killed by bark beetles:
  - rapidly dry out and lose most of their water content within a year following a fatal attack
  - dead wood from beetle-killed trees is transferred to the forest floor leading to increased ground based fuel load.



Meddens et al. (2012)

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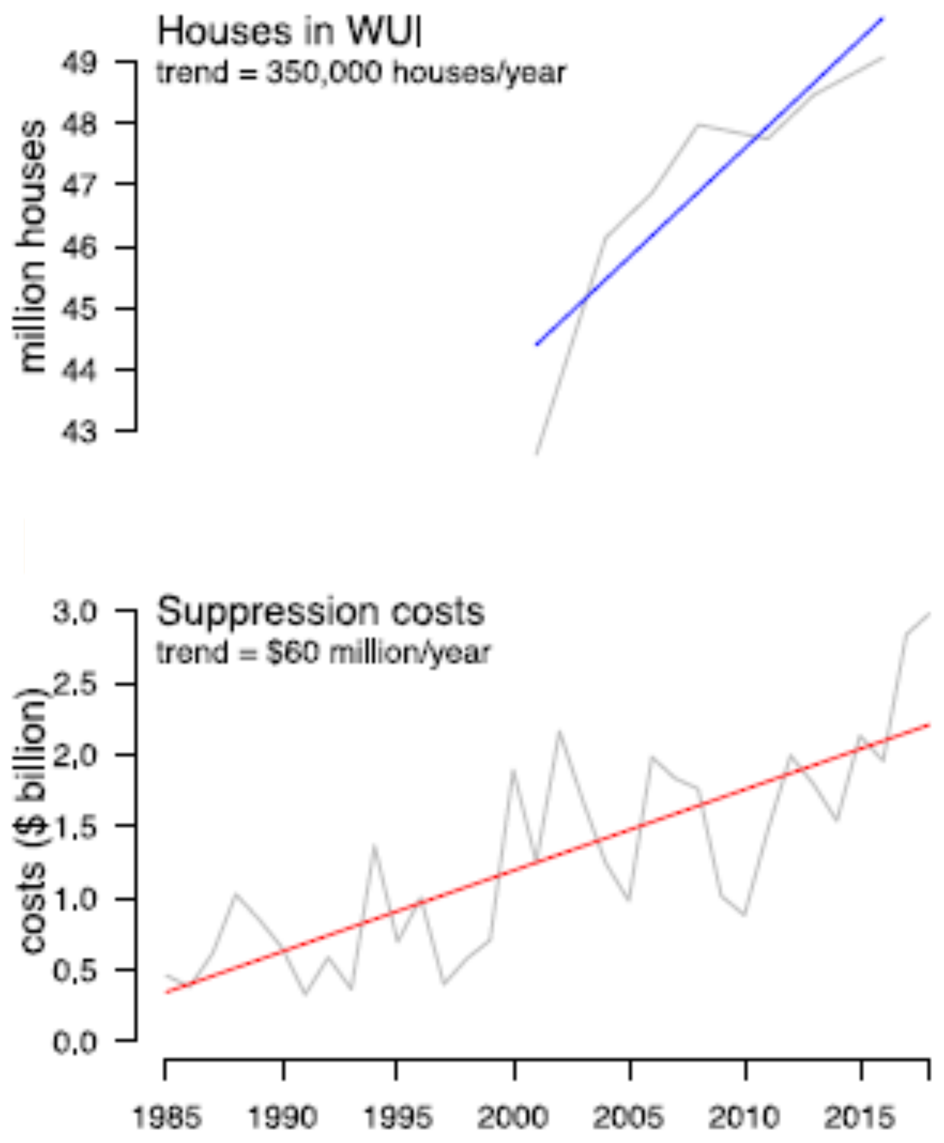
5. Forest Management - Consequences

- Increases in burned area in public and private US lands have been driven in part by rising fuel aridity. *Though analysis of California fires shows little to no correlation between burned area and insured loss.*

- The number of homes in the WUI has also risen quickly, which has contributed to rising suppression costs incurred by the federal government.

- Estimates of currently approximately 50 million homes in the wildland–urban interface in the United States, **a number that is increasing by about 1 million houses every 3 years** (similar to the 350,000 houses per year shown).



Burke et al. (2021)

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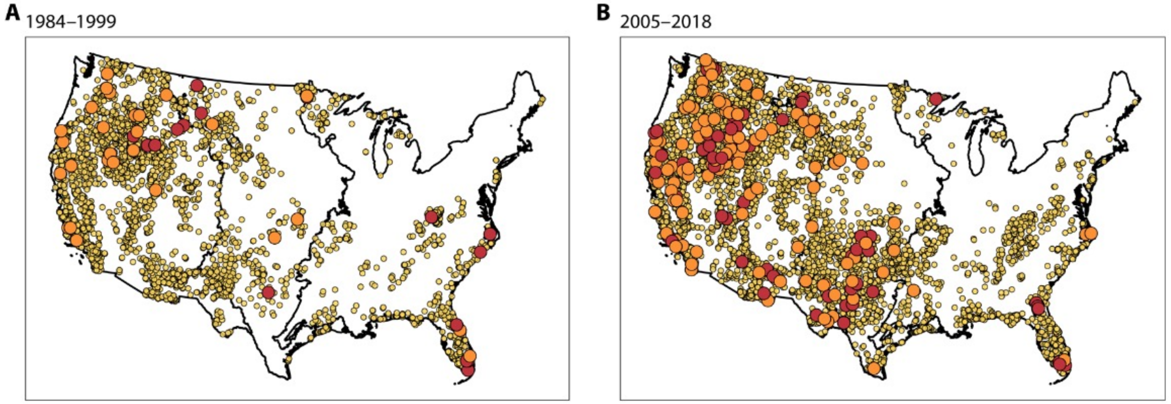
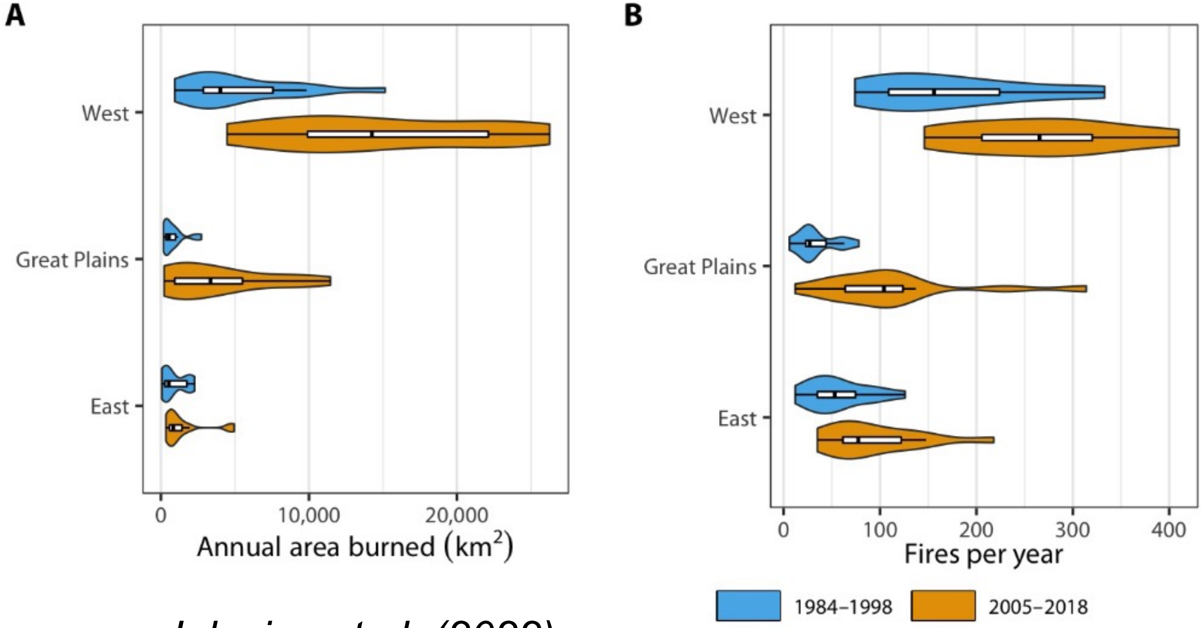
5. Forest Management - Consequences

- The annual number of fires across the USA in the 2005–2018 period has nearly doubled in the West and East and quadrupled in the central Great Plains with respect to 1984–1999 records.

- The increase in wildfire activity shows the increased number of wildfire incidents across the USA, which illustrates the growth in area burned and number of fires per year between the periods 1984-1998 and 2005-2018.

- While there are numerous factors contributing to this change, a significant one a change in fire suppression practices between reporting periods. This marked the end of the ‘10 am rule’ by the US Forestry Services.





Iglesias et al. (2022)

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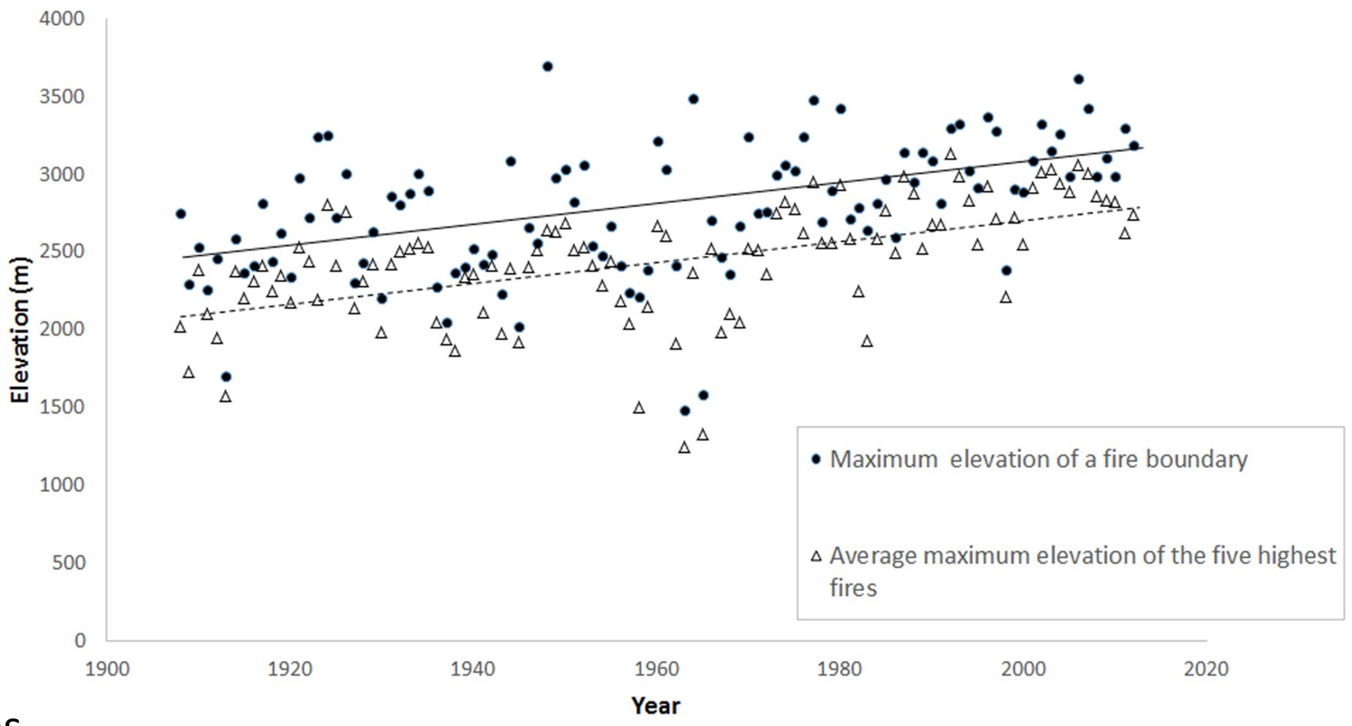
5. Forest Management - Fires migrating to higher elevations

- Wildfires are beginning to encroach on high elevation zones, not previously considered a fire risk.
- This stems from:
  - early loss of snow packs
  - water deficit that keeps vegetation dry
  - increased fuel availability
  - connectivity between fuel sources at higher elevations
  - limited fire suppression activities
  - frequent lightning ignitions
- all may contribute to the increased pattern of wildfires seen at higher elevations.



Schwartz et al. (2015)

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5. Forest management – Difference in fires on private, state and federal land.

- Number of fires on these non-federal lands (44,568) accounted for 76% of total fires.
- Of the federal acreage burned nationwide in 2020:
  - 68% (4.8 million acres) burned on FS land
  - 32% (2.3 million acres) burned on DOI land.
- 70% of the nationwide acreage burned by wildfires was on federal lands (7.1 million acres).
- The other 30% of the acreage burned occurred on state, local, or privately owned lands.

Table 1. Annual Wildfires and Acres Burned

	2016	2017	2018	2019	2020
Number of Fires (thousands)					
Federal	12.6	15.2	12.5	10.9	14.4
FS	*5.7*	*6.6*	*5.6*	*5.3*	*6.7*
DOI	*6.8*	*7.3*	*7.0*	*5.3*	*7.6*
Other	*<0.1*	*1.2*	*0.1*	*0.2*	*<0.1*
Nonfederal	55.2	56.4	45.6	39.6	44.6
Total	**67.7**	**71.5**	**58.1**	**50.5**	**59.0**
Acres Burned (millions)					
Federal	3.0	6.3	4.6	3.1	7.1
FS	*1.2*	*2.9*	*2.3*	*0.6*	*4.8*
DOI	*1.7*	*3.3*	*2.3*	*2.3*	*2.3*
Other	*<0.1*	*<0.1*	*<0.1*	*<0.1*	*<0.1*
Nonfederal	2.5	3.7	4.1	1.6	3.1
Total	**5.5**	**10.0**	**8.8**	**4.7**	**10.1**

Source: National Interagency Coordination Center (NICC) Wildland Fire Summary and Statistics annual reports.

Hoover, K., & Hanson, L. A. (2021). Wildfire statistics. Congressional Research Service. https://apps.dtic.mil/sti/citations/AD1143321

FS = Forest Service; DOI = Department of the Interior.

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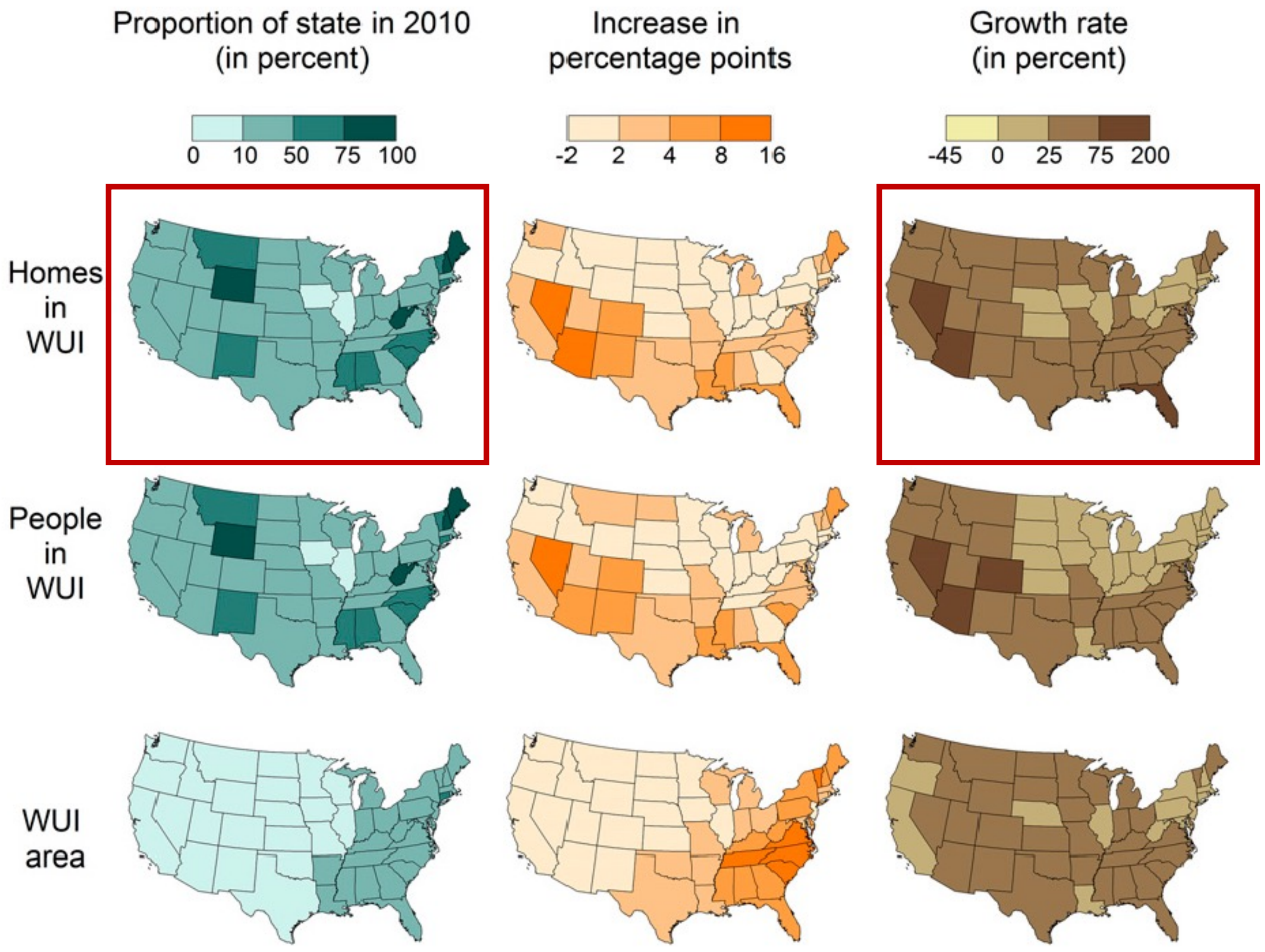
6. Movement of People (into the WUI) – Many changes are taking place

- There are two main types of wildland urban interface (WUI):
  - intermix - the area where houses and wildland vegetation directly intermingle.
  - interface - where settled areas abut wildland areas.

- Between 1990 and 2010 new homes built in wildland urban interface settings grew 41%, from 30.8 to 43 million and this growth continues to this day.

Figure shows regional differences in WUI growth by state for the contiguous USA, between 1990 to 2010.



Radeloff et al. (2018)

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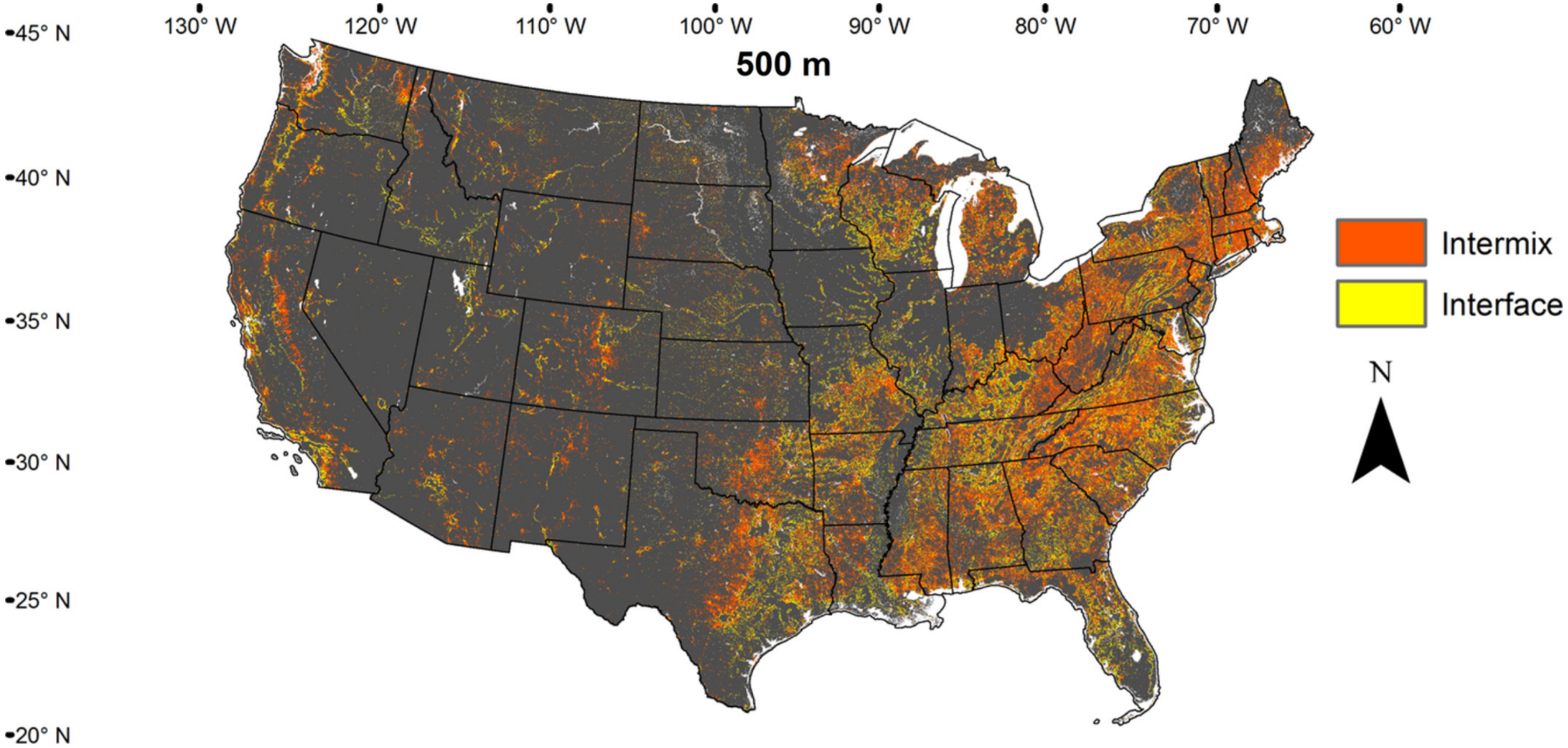
6. Movement of People (into the WUI) – Different Types

- The majority of WUI is in the eastern United States, for all neighbourhood sizes.
- WUI is less extensive in the western states, the Great Plains, and agricultural regions in the Midwest, despite that being where we associate the highest wildfire risk
- In the western United States, WUI is concentrated around less densely populated areas, particularly in mountain ranges.



Carlson et al. (2022) using Microsoft building data and US National Land Cover Dataset (NLCD).

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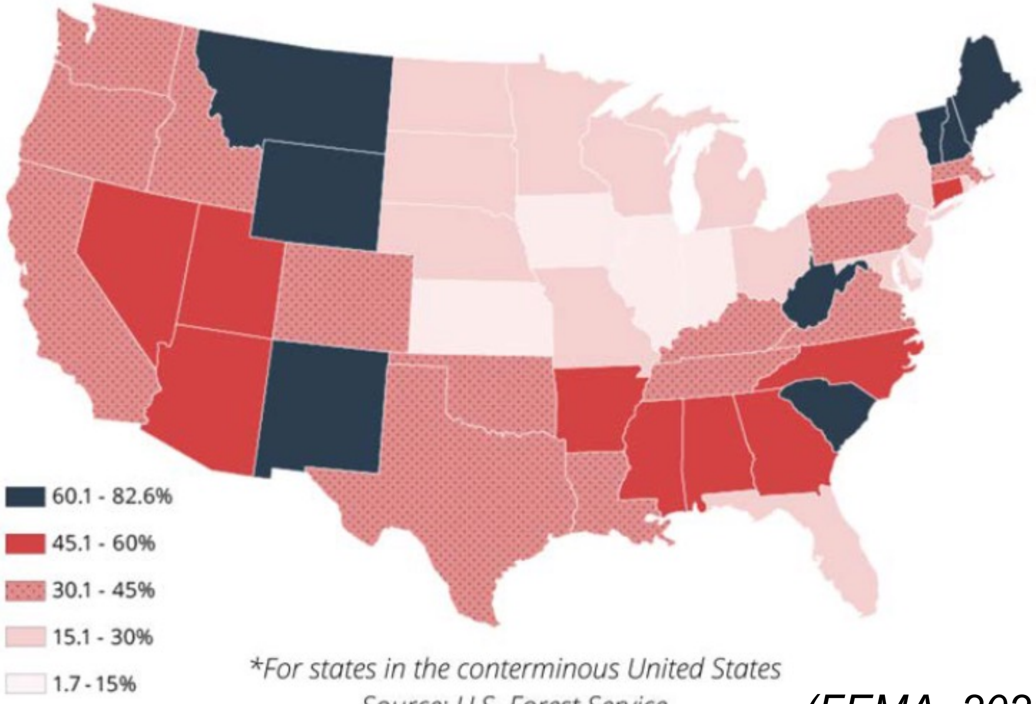
6. Movement of People (into the WUI) – Absolute and Relative Differences

- WUI areas have expanded considerably since 1990, reflecting a growing desire to build homes near natural amenities.
- The highest absolute gains in WUI area occurred in the East, whereas high gains in houses and people in the WUI were most common in the South and Southwest.
- Increased population and expanding WUI makes urban conflagrations more likely.
- More than 46 million homes, with an estimated value of $1.3 trillion now at risk from the impacts of wildfire (USFA, 2022)

States with the greatest number of houses in the WUI:
1. California 2. Texas 3. Florida 4. North Carolina 5. Pennsylvania

Number of houses in the WUI relative to the total houses in the state*



**For states in the conterminous United States*
Source: U.S. Forest Service

(FEMA, 2022)

What does this mean for Insurance?

What Does This Mean For Insurance?

Using research in California to understand North America wide risk

- The wildfire risk across the U.S. is varied. The last 25 years has given rise to large insured loss events outside California and the West a number of times: Tennessee, Texas, Colorado, Alberta, etc.

Key Risk Factors Present Across North American WF Regions

	Environmental Factors				People Factors		Assessment		
Wildfire Regions	**Wildfire season** (longer droughts, and more severe heatwaves; delay in cooler autumn/winter temps)	**Rainfall Pattern Changing**	**Special Winds** (Chinook, Santa Ana, etc)	**Bark Beetles Infestations**	**Forest Management & Suppression** (unnatural fuel loads, and higher density)	**Large Movement of People into WUI** (puts exposure into wildfire hazard areas)	**Risk Factors**	**Relative Risk to Property**	**Increased risk of severe wildfires?** (assessment of the likely change in the WF risk of these regions given changes in key risk factors)
Western States	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**6**	**Extreme**	**Yes**
Southern Rockies	Y	Y	Y	Y		Y	5	Very High	Yes, signficant
British Columbia & Alberta	Y		Y	Y	Y	Y	5	Very High	Yes, signficant
Appalachians		Y	Y	Y	Y	Y	5	Very High	Yes, significant
South (TX, OK)		Y		Y	Y	Y	4	High	Yes, somewhat limited
Northern Rockies	Y		Y	Y			3	Moderate	Unlikely, low population
East Coast States & QC			Y		Y	Y	3	Moderate	Unlikely, few environmental factors
Florida					Y	Y	2	Low	Not likely, few environmental factors
Northern States & ON					Y		1	Very Low	No, few factors to increase the risk
Analysis Based on & Source	*6th IPCC Report on State of the Science, 2021*	*6th IPCC Report on State of the Science, 2021; Fernandez and Zegre, CC impacts over Appalachian Region, 2019*	*FEMA, Design Guide to Improving Critical Facility Safety from Flooding and High Winds, 2007*	*Meddens, A. et al (2012), and US Forest Services (2011)*	*R.A.Houghton et al (2000) - role of fire and fire management in US forest carbon storage*	*Radeloff, V.C., et al (2018) - Rapid growth of US WUI raises WF risk*			

- The conditions present to drive the factors we've identified exist in many other regions in North America that are concerns for insurers. As a result we have highlighted four of them as being areas to watch and focus on: Southern Rockies, BC & AB, Appalachians, Texas & Oklahoma.

Table:
Qualitative assessment of U.S. wildfire prone areas highlighting which risk factors they share with the West. Taken from the draft Chaucer White Paper on North America Wildfire risk.

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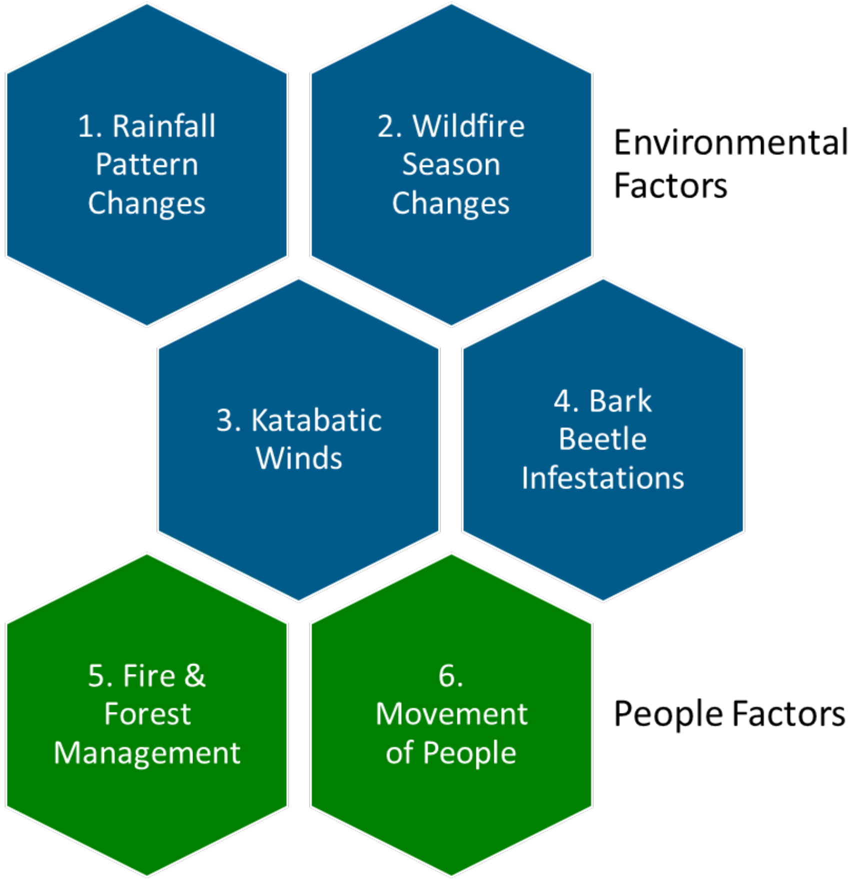
What Does This Mean For Insurance?
Summary of key takeaways



1. Wildfire risk is changing and it is being driven by both environmental and people factors

2. Climate change is a significant contributor to these changes, and is increasing wildfire risk

3. Catastrophic wildfire risk is not just a California problem

4. Areas to watch for future catastrophic wildfire risk: Southern Rockies, BC & Alberta, the Appalachians, and Texas & Oklahoma

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