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Research Brief for Resource Managers

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October 2024	Jon Keeley	-	jon_keeley@usgs.gov

USGS Western Ecological Research Center | Central and Southern California Region

Climate and weather drivers in southern California Santa Ana Wind and non-Santa Wind fires

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Wildfires in the western United States have become larger and more frequent in recent decades due to a combination of factors including population growth, fire management practices, and climate change. While climate change is making wildfires worse overall, the specific causes vary by region. Wildfires in Southern California have been intensively studied to better understand their causes and predict dangerous fire conditions. Researchers have identified two main types of wildfires in the region: Santa Ana Wind (SAW) fires and non-SAW fires. Each type has distinct characteristics and drivers, which are crucial for effective fire management and prediction.

Santa Ana Wind fires, occurring mainly in fall and winter, are often the largest and most destructive. These fires are driven by strong, dry winds from the northeast, known as Santa Ana winds. Most SAW fires are caused by human activities, with power line failures being a significant source of ignitions. Alarmingly, the probability of a fire starting during Santa Ana wind conditions has increased over the past 70 years. This could be due to population growth and expansion of the electrical grid, rather than climate change alone.

Management Implications

- Better prediction tools could help fire managers prepare for dangerous conditions
- Understanding the differences between SAW and non-SAW fires is important for effective fire management
- Reducing human-caused ignitions, especially during high-risk weather, could significantly decrease fire damage

Non-SAW fires, while generally smaller, are much more frequent and collectively burn more total area over time. These fires predominantly occur in summer and early fall, with September seeing substantial burning from both fire types. Long-term drought conditions play a significant role in determining how large these fires grow. Interestingly, non-SAW fires tend to be more common in interior landscapes, while SAW fires dominate in the southern part of the region.

In our efforts to predict fire danger, we coupled CAL FIRE (California Department of Forestry and Fire Protection) FRAP (Fire and Resource Assessment Program) fire data with hourly climate data from four stations, and with regional indices of SAW wind speed, and with seasonal

drought data from the Palmer Drought Severity Index. We found that different tools work better for SAW fires versus non-SAW fires. Commonly used fire danger indices like the Fire Weather Index (FWI) have some value in forecasting fire potential but are limited in their ability to predict actual fire size or the likelihood of extremely large "megafires" over 25,000 acres. Drought conditions, as measured by indices like the Palmer Drought Severity Index (PDSI), are a key factor in determining fire size, especially for non-Santa Ana wind fires. For Santa Ana wind-driven fires, the strength of the Santa Ana winds themselves is the most important predictor of extreme fire growth.

For SAW fires, the Santa Ana Wind Regional Index, which measures regional mean wind speed during periods of consistent northeasterly winds, is the most crucial factor in predicting fire size. For non-SAW fires, long-term drought conditions, as measured by the Palmer Drought Severity Index, matter most.

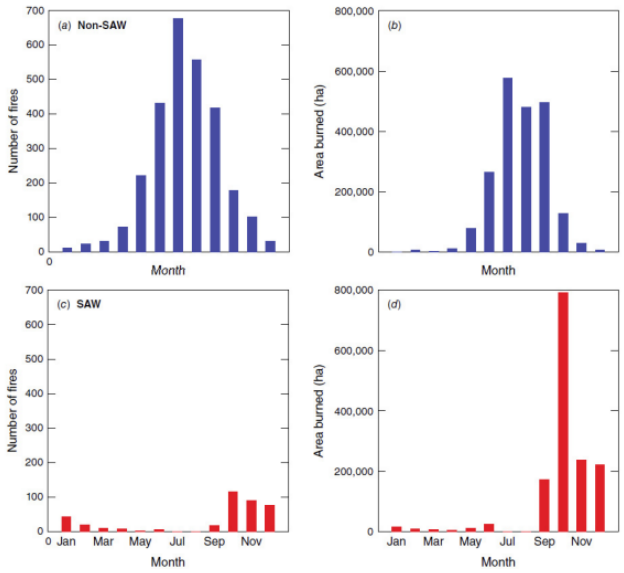
The study also examined the concept of "megafires" - fires larger than 25,000 hectares (about 61,775 acres), which are often the most destructive. Predicting these extreme events is particularly challenging, but the research suggests that conditions in the days before and after ignition, not just on the day of ignition, are important to consider.

Climate change is exacerbating fire conditions through warmer temperatures and drier conditions. However, human activities remain a critical factor, especially for SAW fires which depend on human-caused ignitions coinciding with extreme wind events.

This research highlights the complexity of wildfire dynamics in Southern California and the importance of tailored approaches for different fire types. By improving our ability to predict dangerous fire conditions for both SAW and non-SAW fires, fire managers can better prepare for potential fire events. Additionally, reducing human-caused ignitions, especially during high-risk weather conditions, could significantly decrease fire damage in the region. As climate change continues to influence fire regimes, this kind of detailed understanding becomes ever more crucial for protecting communities and ecosystems in fire-prone areas.

	Non-SAW			SAW		
	1950–1984	1985–2020		1950–1984	1985–2020	
N	11,239	11,509		1540	1635	
Total area burned (ha)	803,470	1,299,600		593,800	867,900	
Mean fire size (ha)	71	112	$P = 0.020$	385	531	$P = 0.451$
Unknown ignitions (%)	48	12		45	4	
Lightning (%)	4	22		0	0	
Equipment use (%)	3	22		<1	24	
Debris burning (%)	6	46		25	1	
Arson (%)	6	18		14	18	
Powerline (%)	4	7		22	45	

Area burned by non-SAW and SAW fires in the first half and second half of the 71 year record; mean fire size was compared with a two sample t-test.



Monthly distribution of (a, c) number of fires and (b, d) area burned for non-SAW and SAW fires in the South Coast region.