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Publication Date

2024-06-28

Climate Change Kids:
Impacts of a Burning State on California's Next Generation

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March 20, 2024

More than a distant concern for future generations, climate change is a fact of life for today's Californians. Wildfires are one particularly salient way that climate change upturns lives in the state, with fires becoming increasingly destructive and difficult to control in recent years.^{1,2} This study aims to quantify one potential impact that climate disasters, as exemplified by wildfires, have on the mental wellbeing of California's youth. In particular, I ask: What is the impact of wildfires on the academic performance of affected K-12 students in California? Furthermore, how might a school's pre-existing vulnerability factors, in this case the percentage of students classified as socioeconomically disadvantaged (SED), exacerbate that effect? To answer these questions, I sample schools that were directly affected by wildfires as well as corresponding schools of similar region and demographics that were not impacted by fires between 2007 and 2017. By comparing test performance between each fire-affected school and its control from before and after the relevant fire, I determine whether the occurrence of a fire hinders students' academic achievement, which may be one indicator of overall youth wellbeing in response to climate disasters.

Background and Significance

Existing preliminary research suggests that climate change has already had a definitive negative impact on people around the world, both directly via trauma from loss of life and property, as well as indirectly via general awareness of climate change as an existential threat.³

¹ Turco, Marco, John T. Abatzoglou, Sixto Herrera, Yizhou Zhuang, Sonia Jerez, Donald D. Lucas, Amir AghaKouchak, and Ivana Cvijanovic. 2023. "Anthropogenic Climate Change Impacts Exacerbate Summer Forest Fires in California." *Proceedings of the National Academy of Sciences* 120 (25): e2213815120. <https://doi.org/10.1073/pnas.2213815120>.

² Smith, Hayley, and Alex Wigglesworth. "California Fires Are Burning Faster, Hotter, More Intensely - and Getting Harder to Fight." *Los Angeles Times*, July 13, 2021. <https://www.latimes.com/california/story/2021-07-13/california-fires-are-burning-hotter-faster-than-even-putting-the-m-out-if-getting-harder>.

³ Lawrance et al., *The Impact of Climate Change on Mental Health: Current Evidence*.

Documented direct negative impacts include increased risk for suicide, depression, post-traumatic stress disorder (PTSD), anxiety, substance abuse, and severe distress following climate related disasters such as floods, hurricanes, and fires.^{4, 5, 6} Studies have similarly linked droughts and periods of increased temperature to elevated suicide risk and admissions to psychiatric facilities.⁷ Indirect impacts to mental health include what environmental philosopher Glenn Albrecht terms “psychoterratic” syndromes, or mental health issues that arise from awareness of a natural world that is rapidly changing for the worse.⁸ Examples of psychoterratic syndromes include eco-anxiety, ecological grief, solastalgia, and ecoparalysis. Eco-anxiety and ecological grief may manifest, respectively, as feelings of loss for an environment that may never recover and anxiety over one’s own perceived inability to fix the issue.^{9, 10} Solastalgia, similar to nostalgia, may occur when an individual notices changes in their home environment over time and experiences longing for what once was.¹¹ All of the above syndromes may result in ecoparalysis, where one becomes overwhelmed by fear of the future and guilt at one’s own

⁴ Lawrance, Emma L., Rhiannon Thompson, Jessica Newberry Le Vay, Lisa Page, and Neil Jennings. 2022. “The Impact of Climate Change on Mental Health and Emotional Wellbeing: A Narrative Review of Current Evidence, and Its Implications.” *International Review of Psychiatry* 34 (5): 443–98. <https://doi.org/10.1080/09540261.2022.2128725>.

⁵ Obradovich, Nick, Robyn Migliorini, Martin P. Paulus, and Iyad Rahwan. 2018. “Empirical Evidence of Mental Health Risks Posed by Climate Change.” *Proceedings of the National Academy of Sciences* 115 (43): 10953–58. <https://doi.org/10.1073/pnas.1801528115>.

⁶ Palinkas, Lawrence A, and Marleen Wong. 2020. “Global Climate Change and Mental Health.” *Current Opinion in Psychology, Socio-Ecological Psychology*, 32 (April): 12–16. <https://doi.org/10.1016/j.copsyc.2019.06.023>.

⁷ Obradovich et al. *Empirical Evidence of Mental Health Risks*.

⁸ Albrecht, Glenn. 2011. “Chronic Environmental Change: Emerging ‘Psychoterratic’ Syndromes.” In *Climate Change and Human Well-Being: Global Challenges and Opportunities*, edited by Inka Weissbecker, 43–56. *International and Cultural Psychology*. New York, NY: Springer. https://doi.org/10.1007/978-1-4419-9742-5_3.

⁹ Ibid.

¹⁰ Cunsolo, Ashlee, and Neville R. Ellis. 2018. “Ecological Grief as a Mental Health Response to Climate Change-Related Loss.” *Nature Climate Change* 8 (4): 275–81. <https://doi.org/10.1038/s41558-018-0092-2>.

¹¹ Albrecht, Glenn. *Chronic Environmental Change*.

inaction to the point where one feels apathetic and unable to contribute at all to their own environmental goals. For some, these feelings manifest severely enough to interfere with their overall wellbeing and day-to-day life.^{12, 13}

Vulnerable groups, including those with pre-existing mental illness, those living in poverty, minority individuals, and children, are more adversely mentally affected by climate change than the general population; unfortunately, these groups are also studied the least.¹⁴ Children and adolescents, for instance, will face the brunt of the consequences of climate change as they grow up, but are also critically understudied due to difficulties with data collection and ethical considerations.¹⁵ Literature suggests that children have more extreme reactions to natural disasters than adults, likely due to the ensuing upheaval of social support networks, education, and general stability occurring at a key period of the child's development.¹⁶ These reactions may include symptoms of PTSD such as panic attacks, nightmares, and phobia development.¹⁷ Direct exposure to disasters may also lead to impaired cognitive and emotional regulation skills, effects which may persist into adult life if left unaddressed.¹⁸

¹² Lawrence et al., *The Impact of Climate Change on Mental Health: Current Evidence*.

¹³ Coffey, Yumiko, Navjot Bhullar, Joanne Durkin, Md Shahidul Islam, and Kim Usher. 2021. "Understanding Eco-Anxiety: A Systematic Scoping Review of Current Literature and Identified Knowledge Gaps." *The Journal of Climate Change and Health* 3 (August): 100047. <https://doi.org/10.1016/j.joclim.2021.100047>.

¹⁴ Lawrence et al., *The Impact of Climate Change on Mental Health: Current Evidence*.

¹⁵ Burke, Susie E. L., Ann V. Sanson, and Judith Van Hoorn. 2018. "The Psychological Effects of Climate Change on Children." *Current Psychiatry Reports* 20 (5): 35. <https://doi.org/10.1007/s11920-018-0896-9>.

¹⁶ Clayton, S., Manning, C. M., Krygsman, K., & Speiser, M. 2017. *Mental Health and Our Changing Climate: Impacts, Implications, and Guidance*. Washington, D.C.: American Psychological Association, and ecoAmerica. <https://ecoamerica.org/wp-content/uploads/2017/03/ea-apa-psych-report-web.pdf>.

¹⁷ Ibid.

¹⁸ Burke et al. *Effects of Climate Change on Children*.

California youth are in no way immune to issues at the intersection of climate change and mental health. A 2022 survey by Blue Shield indicates that 80% of Californians ages fourteen to twenty-four have experienced some negative mental health impacts such as increased feelings of stress or hopelessness due to their awareness of climate change news.¹⁹ This sensitivity to the climate crisis is not surprising, given California's frequent run-ins with drought, floods, and especially catastrophic wildfires.^{20, 21} In western North America, climate change has led to increased extreme hot temperatures.²² These extreme hot and dry spells manifest as longer and more severe fire seasons that ultimately enable more frequent and widespread wildfires.²³ California knows this particular manifestation of climate change all too well, and indeed research has linked the state's increasingly catastrophic summer fire seasons to anthropogenic causes.²⁴

To put the scale of California's wildfire crisis into perspective, five times more land burned in summer wildfires in the state's northern and central regions between 1996 and 2021 than between 1971 and 1995.²⁵ Eight of the ten largest wildfires in the state's history have

¹⁹ Blue Shield of California. 2022. "New Poll Finds Climate Change Is Taking a Toll on Gen Z Mental Health While Also Inspiring Youth to Take Action." Blue Shield of California News Center. Accessed January 26, 2024. <https://news.blueshieldca.com/2022/04/21/new-poll-finds-climate-change-is-taking-a-toll-on-gen-z-mental-health-while-also-inspiring-youth-to-take-action>.

²⁰ "California Weather, Drought and Fires." The New York Times. Accessed February 25, 2024. <https://www.nytimes.com/spotlight/california-fires-drought-weather-climate>.

²¹ "Drought, Fire, Flood." Local Government Commission. Accessed February 26, 2024. <https://civicwell.org/wp-content/uploads/2022/06/Drought-Fire-Flood-1.pdf>.

²² IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32, doi:10.1017/9781009157896.001.

²³ Turco et al., *Anthropogenic Climate Change Impacts*.

²⁴ Ibid.

²⁵ Ibid.

occurred in the last ten years.²⁶ The physical and economic impacts of these wildfires are immense. One 2020 study found, for example, that costs to physical capital and health caused by California’s 2018 fire season alone totaled around \$148.5 billion.²⁷

In the face of such large-scale devastation, how does youth mental health fare in the aftermath of a wildfire? Just as with disaster literature in general, research on this topic is limited due to difficulties collecting data on underage individuals, especially in a manner that is ethical in the wake of a traumatic experience.²⁸ Studies from around Europe and North America indicate that children and adolescents may experience the onset of PTSD, major depressive disorder (MDD), and anxiety in the months and sometimes years after being impacted by a wildfire.²⁹ Other responses include increased substance abuse and delinquency rates for adolescents and developmental regression in younger children.³⁰ These results are reflected in a case study of the Camp Fire, which devastated Paradise, California in 2018, leading to the evacuation of thirteen K-12 schools and nearly five thousand students and staff.³¹ Interviewed school staff described their students post-fire as short-tempered and sensitive to triggers like windy days, alarms, and smoke; difficulty focusing on schoolwork was so prominent that some teachers dubbed the phenomenon “fire brain”.³²

²⁶ CalFire. 2022. “Statistics.” Accessed March 19, 2024. <https://www.fire.ca.gov/our-impact/statistics>.

²⁷ Wang, Daoping, Dabo Guan, Shupeng Zhu, Michael Mac Kinnon, Guannan Geng, Qiang Zhang, Heran Zheng, et al. 2021. “Economic Footprint of California Wildfires in 2018.” *Nature Sustainability* 4 (3): 252–60. <https://doi.org/10.1038/s41893-020-00646-7>.

²⁸ Adu, Medard K., Belinda Agyapong, and Vincent I. O. Agyapong. 2023. “Children’s Psychological Reactions to Wildfires: A Review of Recent Literature.” *Current Psychiatry Reports* 25 (11): 603–16. <https://doi.org/10.1007/s11920-023-01451-7>.

²⁹ Ibid.

³⁰ Ibid.

³¹ Hamideh, Sara, Payel Sen, and Erica Fischer. 2022. “Wildfire Impacts on Education and Healthcare: Paradise, California, after the Camp Fire.” *Natural Hazards* 111 (1): 353–87. <https://doi.org/10.1007/s11069-021-05057-1>.

³² Ibid., 373.

Altogether, preliminary evidence suggests that climate change is having an overall detrimental effect on the mental health of people across the world. Young people seem especially burdened by both the direct and indirect effects of climate change and its associated disasters. In California, wildfires are one devastating way that climate change impacts young people's lives. Interviews and qualitative data suggest that the state's increasingly severe fire seasons are having a negative effect on the mental wellbeing of young students. Notably lacking in this area is California-specific quantitative evidence, not gathered via interview, survey, or self-reporting, which can corroborate these findings.

Despite all the emerging evidence connecting the two, the intersection of climate change and mental health is largely unaddressed in the public policy space. Lawrence et al. put it best in their 2021 literature review: “[M]ental health has never been a subject of discussion in any official side events at the Conference of Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) to date. This is particularly concerning considering that cases of psychological traumas from any form of disaster exceed those of physical injury by 40–1”.³³ Though the most recent COP28 in November 2023 did feature a single side event discussing climate change's connection to mental health, the overall lack of focus on the subject still contrasts sharply with the scale of the issue.³⁴ California is widely considered an ambitious leader in the climate policy space that other states and countries look to for guidance in fighting the climate crisis.³⁵ If the state wishes to continue leading by example, it must gain a better

³³ Lawrence et al., *The Impact of Climate Change on Mental Health: Current Evidence*. 6.

³⁴ “COP28 Schedule & Agenda - Thematic Program - COP28 UAE.” 2023. Accessed February 25, 2024. <https://www.cop28.com/en/schedule>.

³⁵ Mazmanian, Daniel A., John L. Jurewitz, and Hal T. Nelson. 2020. “State Leadership in U.S. Climate Change and Energy Policy: The California Experience.” *The Journal of Environment & Development* 29 (1): 51–74. <https://doi.org/10.1177/1070496519887484>.

understanding of climate change's psychological impacts, a process crucial for building more resilient California communities that can better adapt to increasingly severe weather conditions.

Understanding the link between climate change and human wellbeing is also essential from a cost-benefit analysis perspective. Today, the toll climate change takes on human health and happiness is largely overlooked when quantifying the value of green policies and in assessing the potential damages of other projects that are not so environmentally friendly. Overlooking the social and psychological impacts of climate change ignores these very real costs and may lead to an underestimation of the benefits of climate policies, a misstep with ramifications that extend far into the future. Today's children are tomorrow's workers, parents, and decision makers. Learning more about how children are affected by climate change and how they can best be supported in an ever-changing world is an investment in happier, healthier, and more productive adults in California's future.

Theory, Causal Mechanisms, and Hypotheses

In line with previous research, I expected that occurrence of a wildfire would hurt academic performance for K-12 students. I also expected that this damage would be worse for students who, in addition to being impacted by a fire, also attended a school that had a majority socioeconomically disadvantaged (SED) student body. Operationally, though this study ultimately seeks to understand how wildfires impact students as individuals, analysis was conducted at the school level as that is the smallest unit for which data was available. I expected that schools that fell within the boundary of a wildfire would see a decrease in standardized test performance two years post-fire, compared to similar schools in those same testing years that were not impacted by a fire. Additionally, I anticipated that this decrease in scores would be

larger for fire-affected schools that had majority SED populations as opposed to fire-affected non-majority SED schools.

This study mainly assesses the impacts of two independent variables, the first being the occurrence or non-occurrence of a wildfire, and the second being majority SED or non-majority SED status. The dependent variable is a school's academic performance, as measured by average state standardized test scores, for both English Language Arts (ELA) and Mathematics, across all grades in a given year. The implied causal mechanism, as supported in particular by the Camp Fire case study, is that when a fire passes through a town, it may either directly impact students by burning down their school building and/or homes or indirectly impact them via the trauma of evacuation and the fear of losing life and property.³⁶ In the direct case, students lose teaching materials and classrooms, making it difficult to continue class instruction until these resources are restored.³⁷ In the indirect case, even if the classroom and its materials are all intact, students may be distracted by the lasting negative mental health impacts of surviving a fire and find it hard to focus on learning, ultimately leading to declines in academic performance.³⁸ A school having a mostly SED student body suggests that the school is located in a disadvantaged community and as such may lack the same funding and resources that schools in wealthier communities have. If a school is already low on resources before a fire, it stands to reason that the school will find it even harder to rebuild and recover post-fire than the average school. Consequently, students at these majority SED schools may experience larger drops in academic performance than their minority SED counterparts.

³⁶ Hamideh et al. *Wildfire Impacts on Education*.

³⁷ Ibid.

³⁸ Ibid.

Research Design and Data

To test these hypotheses, I located twenty schools that fell within the boundaries of wildfires in the last ten years pre-COVID and then found twenty control schools that were similar to their corresponding fire-affected school in baseline test scores, region, and other demographic characteristics. I then compared changes in test scores between each control school and each affected school from before and after the relevant wildfire to determine whether a fire's occurrence had any significant impact on the academic success of affected students.

To determine which schools were affected by wildfires and which were not, I only defined a wildfire as having occurred at a school if the school site fell within the geographic boundary of a wildfire. I used the California Department of Forestry and Fire Protection's (CalFire) Historic Fire Perimeter database, the most complete digitized geographic database of California wildfire borders spanning from as far back as the late 1800s to as recently as the 2022 fire season.³⁹ I filtered this database to only include fires that occurred between 2007 and 2017 and burned greater than or equal to 1,000 acres. This time frame prioritizes recency and acknowledges that many of the worst fires in California history have occurred in the last decade, while also avoiding the COVID-19 pandemic, which would have introduced a substantial data gap and confounding variable into my analysis.⁴⁰ The 1,000 acre cutoff was based mostly on the United States Environmental Protection Agency's (U.S. EPA) wildfire tracker, a climate change indicator based on the frequency and severity of wildfires across the U.S. In the Western U.S., a

³⁹ CalFire. 2022. "Historic Fire Perimeters." Accessed March 19, 2024.
<https://www.fire.ca.gov/what-we-do/fire-resource-assessment-program/fire-perimeters>.

⁴⁰ CalFire. *Statistics*.

fire qualifies for tracking if it is greater than or equal to 1,000 acres.⁴¹ After obtaining the fire data, I overlaid a current map of the locations of every California public school, as obtained from the California Department of Education's (CDE) Geo Hub.⁴² After filtering this database to show only schools that fell within the above fire perimeters and then removing any schools that did not yet exist at the time of the relevant fire, twenty fire-affected schools remained.

To determine which schools were considered especially vulnerable due to socioeconomic disadvantage, I defined schools as "majority SED" if greater than 50% of students in the pre-fire were given SED status by CDE.⁴³ Otherwise, schools were defined as "minority SED". Using CDE's DataQuest and California School Dashboard databases, I determined that fifteen of the selected fire-affected schools were majority SED and five were minority SED.^{44, 45} Though CDE reports schools' SED data as a continuous percentage of students, I ultimately categorized schools binarily to enable comparison between groups of schools. With a small initial sample size of affected schools, splitting schools into more than two groups would mean each group only has a couple schools in it, making it difficult to draw any conclusions from my findings.

Test performance in this study was measured specifically as the percentage of students tested at a school that either met or exceeded state testing standards for the given subject in the

⁴¹ US EPA, OAR. 2016. "Climate Change Indicators: Wildfires." Reports and Assessments. July 1, 2016. <https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires>.

⁴² CDE. 2024. "California Department of Education Geo Hub." Accessed March 19, 2024. <https://data-cdegis.opendata.arcgis.com/>.

⁴³ A few notes about SED status: An SED student is defined by CDE as either qualifying for free or reduced price lunch in California or as having parents that did not graduate high school. California began reporting SED statistics at the school level in 2014. If a school's pre-fire year was prior to 2014, I used 2014 data on that school's SED level because it is the oldest data available.

⁴⁴ CDE. 2024. "DataQuest." Accessed March 19, 2024. <https://dq.cde.ca.gov/dataquest/>.

⁴⁵ CDE. 2024. "California School Dashboard." Accessed March 19, 2024. <https://www.caschooldashboard.org/>.

given year. Using this metric, rather than raw test scores, allowed for comparison between students who took the older California Standardized Testing and Reporting (STAR) exam between 2007 and 2013 and those who took the California Assessment of Student Performance and Progress (CAASPP) exam in more recent years.⁴⁶ For each of the twenty affected schools I recorded test performance across three years, from one year prior to the relevant wildfire to one year afterwards, for both English Language Arts (ELA) and Mathematics. Since schools were not all affected by fires in the same year, I aligned each school's timeline so that the year of any given fire was "year t", with "year t-1" representing the prior year and "year t+1" representing the following year. This way, I could compare changes over time between schools regardless of when their fire occurred. In addition to collecting test performance and SED percentage data, I also recorded each school's locality (i.e. rural versus urban), county, school type (e.g. elementary versus high school, etc.), and racial makeup from the pre-fire year. All of this data was also compiled from CDE's Geo Hub, DataQuest, and the California School Dashboard.

Using these same data sources, I selected twenty unaffected schools to serve as controls that affected schools could be compared to. Each affected school was matched to a control school that was similar primarily in pre-fire test performance and SED level, though I also strived to find control schools that were similar in geographic proximity (i.e. fell within the same county), locality, and racial demographics.⁴⁷ Controls also had to be the same school type as their corresponding affected school. For example, I only compared elementary schools to other

⁴⁶ CDE. 2023. "Standardized Testing and Reporting (STAR) - Programs No Longer Administered by CDE." Accessed March 19, 2024. <https://www.cde.ca.gov/re/pr/star.asp>.

⁴⁷ Notes on the control selection process: Though I ultimately sorted schools into majority and minority SED groups, I did use CDE's continuous percentage data when selecting a control school for each affected school to ensure that the pairs were as closely matched as possible. What was considered a "similar" enough school varied from case to case. The best matched pairs fell within a ten percentage point difference in baseline test scores and SED proportions. Most matches fell within a twenty point difference for all key criteria.

elementary schools and continuation schools to other continuation schools to avoid controls being of a different age group than their affected counterparts.⁴⁸ *Figure 1*, below, depicts the locations of each of the affected and unaffected schools chosen for this study as well as all wildfires over 1,000 acres that burned in the time period of interest.

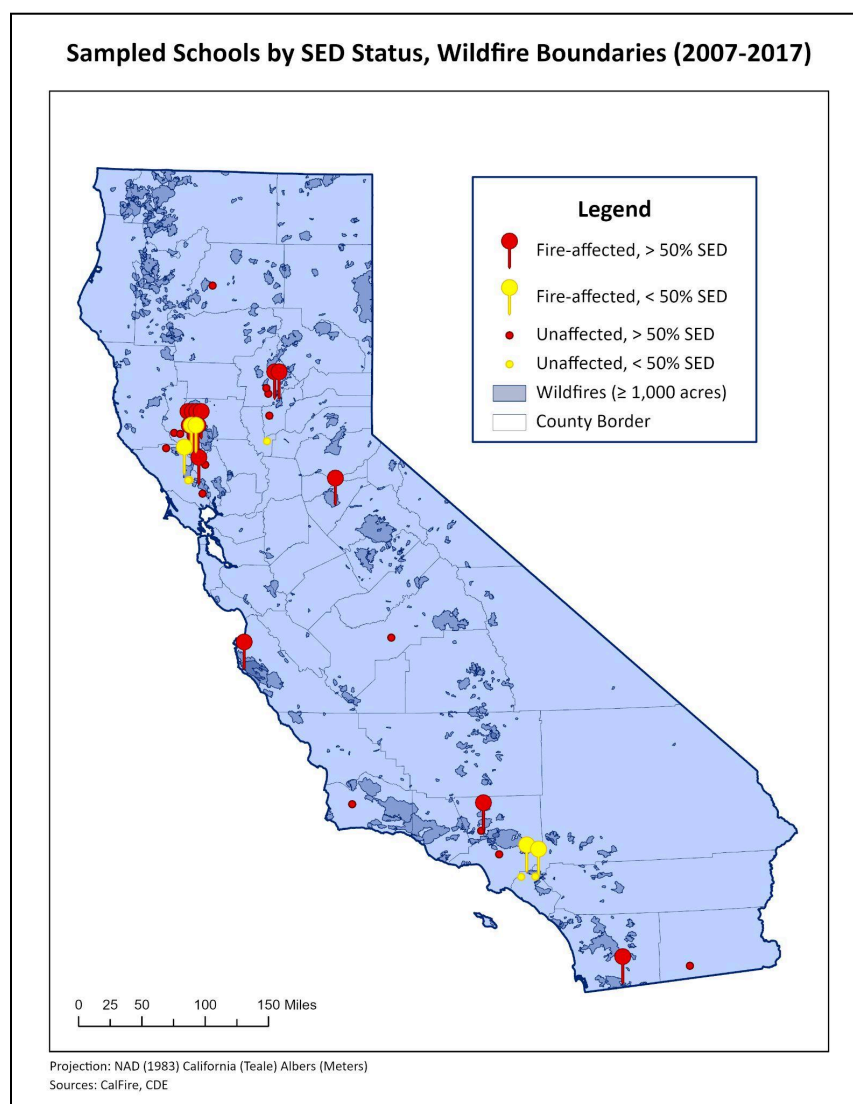


Figure 1. Locations of schools and wildfires that met the criteria for inclusion in this study.

⁴⁸ Outside of the control selection process, I did not account for potential differences in wildfire response across different ages in this study. There is certainly an argument to be made, however, that wildfires may impact younger children, older children, and adolescents differently. This particular line of inquiry is one that future research could focus more closely on.

At the end of the school selection process I had selected forty schools overall, which I analyzed in two groups: majority SED schools and minority SED schools. I averaged test performance for both affected and unaffected schools within the majority SED group and charted those averages to see how performance for affected majority SED schools changed over time in comparison to unaffected majority SED schools. I then repeated this process, separately charting the averages over time for affected and unaffected minority SED schools. I also compared the averages of a few individual schools and their corresponding controls as a means of further investigating a few characteristics that may impact a school's response to a wildfire. In particular, I compared the most SED and least SED school as well as the most rural and the most urban school.⁴⁹ Due to the small-n nature of my study, I did not conduct any tests for statistical significance and my analysis only looked at simple differences in performance over time.

There are a few key limitations to note with my data and measures. Using perimeter data alone to define whether a school is affected by a fire, for instance, does not take into account fire severity and does not necessarily reveal whether a particular school building actually burned down or not. This indicator also does not account for schools and students that may have been indirectly affected—but still harmed—by fires. Examples of indirect impacts include school closures due to poor air quality, evacuations or evacuation threats, and general trauma induced by the fear of a nearby fire.

Furthermore, using standardized test scores as a proxy for academic success also has limitations. Test scores are just one aspect of a student's overall success and an even narrower indicator of a young person's general wellbeing. An individual can excel academically while still struggling mentally; likewise, a student can be a poor test taker but thrive in other important

⁴⁹ For this comparison I also used continuous SED percentage data to determine which schools had the highest and lowest proportion of SED students.

areas both inside and outside of school. Measuring test performance as the percentage of students that met or exceeded state testing standards, while allowing for easier comparisons across schools and years, also leads to a loss of data fidelity for lower-performing schools. For example, CDE reports CAASPP test scores as falling into one of four categories: “Standard Exceeded”, “Standard Met”, “Standard Nearly Met”, and “Standard Not Met”.⁵⁰ The older STAR exam similarly had multiple score categories that fell below meeting state standards.⁵¹ In this study, students that nearly met standards were treated the same as those who fell far below standards. For schools that underperform in general, any notable gains or losses in student achievement after a fire are effectively invisible if performance remains under the threshold of state standards the whole time.

Another loss of detail with standardized testing data resulted from CDE’s redacting of scores when fewer than eleven students test at a school in a given grade level and testing year. Many rural schools and special schools like juvenile courts and continuation schools are small enough that this became an issue, and indeed a few schools were removed from consideration early on because they had no available testing data. Given that this study seeks to address how different communities may respond differently to wildfires, it’s important to keep in mind that leaving out some of the smallest and potentially most vulnerable schools due to lack of data may render some important findings missing.

⁵⁰ CDE. 2024. “Smarter Balanced ELA and Mathematics Scale Score Ranges - CAASPP Reporting.” Accessed March 19, 2024. <https://caaspp-elpac.ets.org/caaspp/ScaleScoreRangesSB>.

⁵¹ EdData. 2014. “Understanding California’s Standardized Testing and Reporting (STAR) Program.” Accessed March 19, 2024. [https://www.ed-data.org/article/Understanding-California's-Standardized-Testing-and-Reporting-\(STAR\)-Program](https://www.ed-data.org/article/Understanding-California's-Standardized-Testing-and-Reporting-(STAR)-Program).

Findings and Analyses

Overall, I found no consistent, substantial difference in how test performance changed from pre to post-fire between affected and unaffected schools. Test performance for affected schools of both majority and minority SED status did see a slight dip of a few percentage points in the year of the relevant fire, with performance rebounding the following year to slightly higher than baseline levels. This observation on its own would imply that student test performance is slightly hindered in the few months after a fire's occurrence but also that this effect fades by the time a full year has passed.⁵²

However, findings for control schools muddy the significance of this result. Majority SED unaffected schools saw the same dip and rebound as their affected counterparts, which on the surface suggests that this pattern is unrelated to fire occurrence. Even this conclusion, however, is complicated by the fact that minority SED unaffected schools did not follow the dip and rebound pattern at all, unlike their affected counterparts. *Figure 2* and *Figure 3*, below, summarize these observations. Due to the lack of a consistent pattern in findings across the board, it is most reasonable to conclude that my results are inconclusive. Because neither majority SED nor minority SED schools saw a consistent drop in performance over time, my hypotheses are not supported.

⁵² All fires in this study occurred in the summer and fall months whereas state testing most often occurs in the spring. Therefore, for fire-affected schools in this study, tests taken "Year of Fire" were taken in the spring after the fire had occurred, only a few months later.

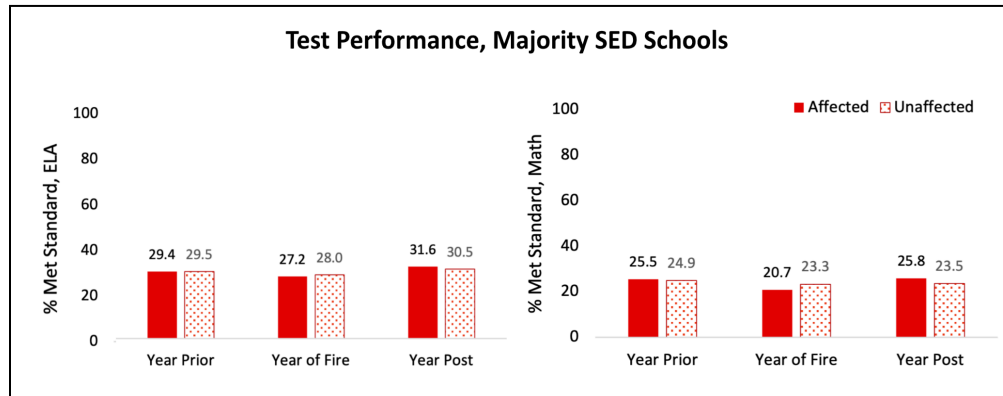


Figure 2. Changes in test performance over time for affected and unaffected majority SED schools.

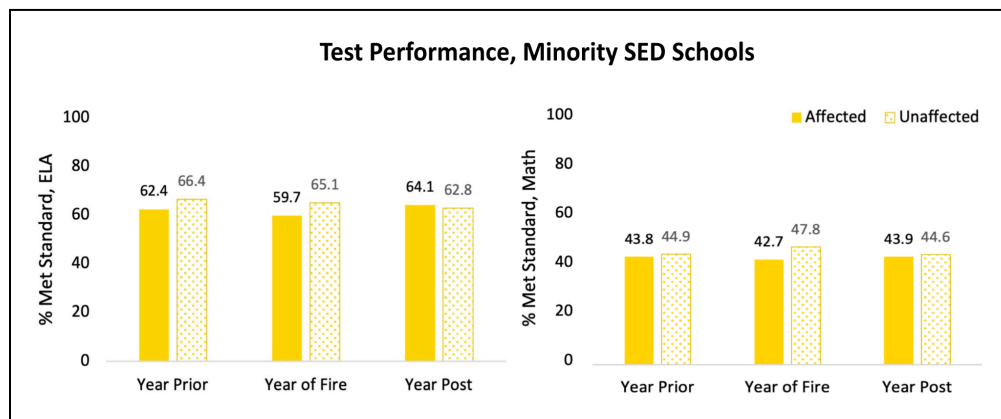


Figure 3. Changes in test performance over time for affected and unaffected minority SED schools.

Though my results are inconclusive, I do propose one possible explanation for the observed dip and rebound pattern and its appearance in both affected and unaffected schools. As my original causal mechanism argues, the dip in performance in the fire year may be linked to losses of life, property, and learning materials resulting from a fire. Though I expected the drop in scores to persist into the following year, it's possible that an outpouring of aid from surrounding communities, state and federal governments, and other relief organizations may actually enable a relatively quick restoration of classrooms and teaching materials, providing enough student support to boost academic performance back to where it was pre-fire.

As for why unaffected majority SED schools also saw the same dip and rebound as affected schools, this issue may stem from the methods I used to choose control schools. When screening for appropriate unaffected schools, I prioritized geographic proximity to the corresponding affected school so that each pairing would come from a similar climatic region and local culture. If a pair of schools were too close together, it's likely that even the unaffected school was actually affected by the same fire via drifting smoke or evacuations despite not falling within the burn area. If this is the case, then it follows that some of the unaffected schools studied would exhibit the same pattern as the affected schools. These potential explanations are not supported by evidence, but they do suggest that clearer quantitative links between fires and academic performance may reveal themselves if more factors are taken into consideration.

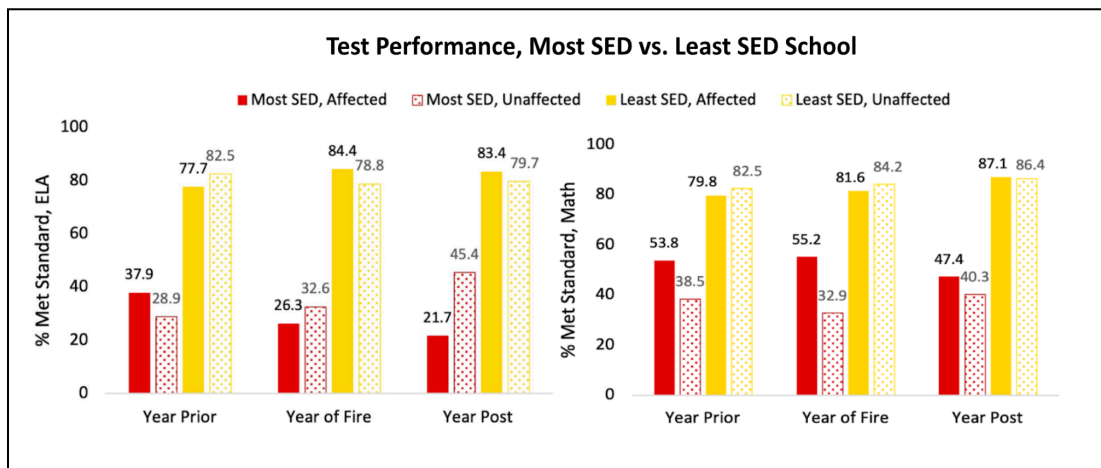


Figure 4. Changes in test performance over time between the school with the highest percentage of SED students and the school with the lowest percentage. The two corresponding control schools are also displayed for reference, as represented by the patterned bars.

Though there was not a clear difference in changes in test performance between majority and minority SED schools when assessing all schools on average, comparing only the most SED and least SED school revealed a distinct divide. Notably, I found that the most disadvantaged school studied saw a net decrease in test performance for both ELA and Math over time, whereas

the least disadvantaged school saw a net increase in performance for both subjects in spite of the fire's occurrence. The two corresponding control schools did not seem to track with the affected schools as they did when all schools were assessed on average. This suggests that the contrast seen between the performance of the most SED and least SED affected schools might relate to the fire's occurrence. *Figure 4*, above, depicts this finding.

This case, while not supporting my hypothesis that both majority SED and minority SED schools would see a consistent decrease in test performance post-fire, does seem to indicate that schools respond differently to wildfires based on the level of resources available to them. Though my earlier proposal suggested that aid may help schools rebound after a fire, it's also plausible that the most highly disadvantaged communities will still struggle to rebuild and recover, both physically and psychologically, in the wake of a fire. If a community is historically disadvantaged and overlooked, it may receive less aid, or the aid received may not be enough to meet the community's needs. Conversely, if a community is very well off and has no shortage of access to recovery resources, its schools may recover even faster than average, with no dip in performance at all. This could explain why the most SED affected school saw scores fall over time while the least SED school was able to generally increase its performance even after the fire occurred.

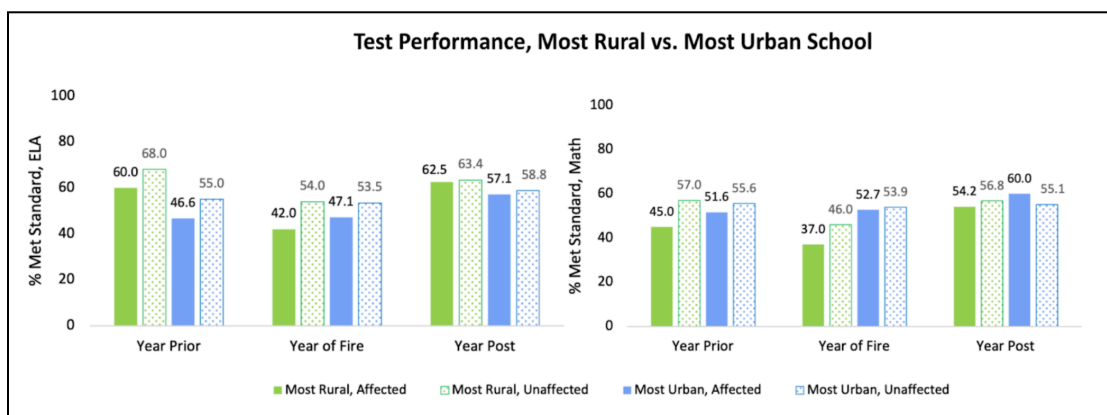


Figure 5. Changes in performance over time between the most rural and most urban school studied.

The other case comparison I conducted was between the most rural school and the most urban school studied. I chose this comparison in particular because I wondered if proximity to a population center, and all the support and resources that towns and cities provide, might influence how a school is able to respond to a fire. There were multiple schools that were classified by CDE as being the same level of distantly rural as well as two schools that could have qualified as the most urban, so I chose the pair of schools that had the most similar percentage of SED students to control for socioeconomic status.⁵³ When looking at the two affected schools alone, the rural school saw a significant drop in performance in the year of the fire but rebounded to levels higher than baseline afterwards in both ELA and Math. The most urban school, by contrast, saw a steady increase in scores both immediately after the fire and in the year following. Both the rural control school, and to a lesser extent the more urban control school, experienced a dip and rebound effect over time. *Figure 5*, above, depicts this comparison.

Just as with my findings across all schools, it's impossible to concretely infer anything from these observations alone. However, I again propose that these findings at least hint at differences in resources available to rural and urban schools. Perhaps rural schools, with less consistent access to population centers, rely more on one-time disaster relief after a fire, leading to the dip and rebound described earlier. More urban schools may have long term resources to draw from as they are located nearer to cities. Because of this easier access to a more stable supply of resources, academic performance may not fall at all, even in the year of the fire. As with my findings on average, though, the dip and rebound effect seen in the rural school was mirrored by its control. This again could suggest that the methods used for selecting controls led to these schools not being as unaffected by fires as initially thought. Overall, though the results

⁵³ Note that none of the schools studied were located in truly urban areas. The “most urban” schools, in comparison to distantly rural schools, were located in large suburbs surrounding medium sized cities.

from this particular comparison are unclear, aspects of my findings point to directions for future research.

Conclusion and Implications

Climate change is a very real and present threat to the physical and mental wellbeing of Californians. Young people in particular are especially vulnerable to these negative impacts. To better understand and quantify how climate related disasters may be affecting California's youth, I focused on wildfires, one key manifestation of climate change in the state, and their impact on standardized test performance, one indicator of youth wellbeing. I also incorporated socioeconomic status and locality to investigate how pre-existing vulnerability factors may lead to differing disaster responses. I examined twenty schools that were impacted by wildfires in the last decade pre-COVID, comparing changes in their test performance from before and after a fire to that of twenty similar but unimpacted schools.

Ultimately, there was no clear difference in test scores on average from pre to post-fire between affected and unaffected schools, though an interesting dip and rebound effect was observed in multiple instances. Many affected schools, and perhaps many unaffected schools as well due to flaws in the process of choosing controls, may have exhibited this pattern if an influx of post-fire aid enabled them to recover relatively quickly. Case comparisons of only the most and least SED schools as well as the most urban and most rural schools, while inconclusive as a whole, hint that there may be differences in schools' ability to recover from a wildfire depending on the community's socioeconomic status and proximity to a larger population center.

All in all, though my hypotheses were not supported because most cases did not see a clear and consistent drop in performance over time, my results both on average and in the two

special cases give reason to suspect that fires may be linked in some instances to losses in academic success in the following months. Most clearly, though, my findings highlight the need for more research at the intersection of wildfires and academic performance. In particular, future studies must account for indirect fire impacts when determining which schools should be considered affected and which can confidently be labeled as unaffected. It stands to reason that even if a school did not fall within a fire's burn perimeter, its students may have still stayed home or evacuated altogether. Close encounters with a dangerous fire can affect a young person's mental state even if their own home or school were technically spared. Future research may yield clearer results by considering some of these potential situations. Longer time frames of study are also essential to future studies on this topic. Evaluating one year pre-fire through one year post-fire provides only a narrow window into schools' test performance trends. Though many schools saw a rebound in scores one full year post-fire, extending the study period out farther may reveal a different story. Tracking the same cohort of students over time may also yield different results, since this study did not account for impacts to findings from students leaving a school in the aftermath of a fire.

Existing literature makes clear that climate change and wildfires are detrimental to young people's wellbeing. It's also clear that very little is being done to address this growing issue. While it's essential that more in-depth research is conducted on this topic, it is equally important in the meantime to continue working to mitigate the worst effects of climate change by pushing for clean energy and greenhouse gas reduction policies in California and around the world. At the same time, while these mitigation efforts help minimize disaster risk long term, adaptation efforts are crucial to preparing Californians for the many climate-related disasters which will inevitably occur. Though my own findings are not conclusive, they do hint that factors such as

SED level and easy access to recovery resources may lead to differences in disaster responses between communities. In order to best aid in recovery efforts, policymakers must ensure there are protocols in place to foster preparedness and resilience across California before disasters occur. In the event of a wildfire or other catastrophe, communication between federal, state, and local governments is essential to addressing the unique needs of the state's many diverse communities, be they urban or rural, advantaged or disadvantaged.

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