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Letter
Wildfire Exposure Increases Pro-Environment Voting within Democratic but Not Republican Areas

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One political barrier to climate reforms is the temporal mismatch between short-term policy costs and long-term policy benefits. Will public support for climate reforms increase as climate-related disasters make the short-term costs of inaction more salient? Leveraging variation in the timing of Californian wildfires, we evaluate how exposure to a climate-related hazard influences political behavior rather than self-reported attitudes or behavioral intentions. We show that wildfires increased support for costly, climate-related ballot measures by 5 to 6 percentage points for those living within 5 kilometers of a recent wildfire, decaying to near zero beyond a distance of 15 kilometers. This effect is concentrated in Democratic-voting areas, and it is nearly zero in Republican-dominated areas. We conclude that experienced climate threats can enhance willingness-to-act but largely in places where voters are known to believe in climate change.

Despite the severity of the climate threat, global climate policymaking remains anemic. One political barrier to policy enactment has been the temporal mismatch between short-term climate policy costs and long-term climate policy benefits (Jacobs 2011; Levin et al. 2012). However, as the time horizon for realized climate change moves closer, weather extremes and climate-related hazards could reshape the politics of climate change by making salient the costs of policy *inaction.* Already, climate change has begun to noticeably disrupt economic, social, and environmental conditions across the globe, including in the United States (Abatzoglou and Williams 2016; Diffenbaugh, Swain, and Touma 2015).

Yet, it remains unclear whether first-hand climate change experiences are reshaping the public's climate policy preferences or political behaviors. Some scholars find that climate concerns modestly increase with experienced temperature extremes (Bergquist and Warshaw 2019; Brooks et al. 2014). Others find no effects (Brulle, Carmichael, and Jenkins 2012; Mildenberger and Leiserowitz 2017), only ephemeral effects (Deryugina 2013; Egan and Mullin 2012; Konisky, Hughes, and Kaylor 2016), or that effects are limited to particular political subgroups (Hamilton and Stampone 2013). Evidence for the relationship between climate-related hazards and reported attitudes is similarly mixed. Some studies find that experiencing hazards increases intention to engage in mitigation and adaptation policies (Demski et al. 2017; Spence et al. 2011) and climate risk perceptions (Lujala, Lein, and Rød 2015). Others, though, find little or no effect of hazards such as flooding or fire (Brody et al. 2008; Whitmarsh 2008). It also remains unclear whether attitudinal shifts, even if they do occur, translate into shifts in realized political behaviors (Rudman, McLean, and Bunzl 2013).

These mixed empirical findings reflect systematic differences in how climate threats and responses are measured and in approaches to causal identification (Howe et al. 2019). They also reflect different theoretical expectations about political responsiveness to experienced threat. From one perspective, experiencing climate-related hazards may heighten the salience of related social and economic risks, irrespective of an individual's political identity (Slovic and Weber 2013). Alternatively, an individual's response to experiencing a climate change impact may be conditioned by preexisting beliefs and identities (Howe and Leiserowitz 2013; Myers et al. 2013), including party or ideological commitments (Hamilton et al. 2016; Marquart-Pyatt et al. 2014) and beliefs in anthropogenic climate change (Brody et al. 2008; Capstick and Pidgeon 2014). For example, wildfire exposure has a stronger effect on climate attitudes among respondents who believe in the scientific consensus around climate change (Lacroix, Gifford, and Rush 2019). Alternatively, climate-related political behaviors may be overshadowed by other factors that influence political preferences during crises, including public evaluation of government performance (Bechtel and Hainmueller 2011; Malhotra and Kuo 2008) and political participation (Jenkins 2019). All the same, empirically

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many members of the public have linked wildfires to climate change (Brenkert-Smith, Meldrum, and Champ 2015), with a recent survey showing 69% of Californians believe that climate change is making wildfires worse.[1]

Scholars have also examined the psychological mechanisms through which the public responds to climate-related threats. For example, a rich literature elaborates how individuals and communities manage wildfire risks. These studies highlight response heterogeneity, including as a function of community-level discourse, social interactions, and norms (Brenkert-Smith, Champ, and Flores 2006; Brenkert-Smith et al. 2013; Dickinson et al. 2015). Resulting wildfire responses, in the aggregate, are not always efficient. For example, government wildfire management often responds to recent salient wildfire events rather the actual distribution of future wildfire risks (Anderson et al. 2018; Wibbenmeyer, Anderson, and Plantinga 2019).

In this paper, we evaluate the links between experiencing a climate-related hazard and realized political behavior. Our study offers two major advances over prior work. First, existing research on experienced climate change has exclusively used survey outcomes to measure individual attitudes or behavioral intentions (Howe et al. 2019). By contrast, we estimate the effect of an actual climate-related hazard (wildfires) on a realized political behavior that directly influences policy (ballot initiative support). Specifically, recognizing limits to generalization, we study how wildfire exposure at the census block group level shapes voting outcomes on a series of Californian environmental ballot initiatives between 2006 and 2010. Second, we use location (block group) and year fixed effects in order to exploit idiosyncratic variation in when wildfires are experienced by voters in each block group. As a result, only time-varying confounders within block groups could bias the results—and only when they cannot be explained by statewide change over time. Including observed time-varying covariates expected to relate most strongly to wildfire risk and to attitudes (e.g., rainfall, democratic vote share, population density, etc.) have no effect on our estimates. Further, we use sensitivity analyses to show that even unobserved confounding multiple times stronger than these covariates would not substantially alter our conclusions.

Overall, we find that Californians who experience a wildfire within 5 kilometers of their census block group are 5–6 percentage points more likely to vote for costly climate-related policy reforms, relative to those at least the median distance away (35–40 kilometers). This effect decays with distance, falling below 1 percentage point beyond a distance of 15 kilometers. Moreover, this effect is highly heterogeneous depending on partisan identity: it is concentrated in the block groups that are most Democratic, while areas dominated by Republican voters show no detectable effect of wildfire. These findings are consistent with some survey-based work on wildfire exposure in emphasizing heterogeneity in public responsiveness as a function of priors about climate change (Lacroix, Gifford, and Rush 2019; Marlon et al. 2020); however, other observational research has found mixed relationships between individual climate experiences and climate-related beliefs and behaviors (Dessai and Sims 2010; Howe et al. 2019; Kreibich 2011). For example, Javeline, Kijewski-Correa, and Chesler (2019) find that both risk exposure and adaptation intentions related to sea-level rise are independent of climate change attitudes. By contrast, we find that responsiveness to climate-related impacts is concentrated in populations that, among other features, are far more likely to believe in anthropogenic climate change (e.g., Dunlap, McCright, and Yarosh 2016). In turn, our results suggest that as the effects of climate change become more evident, support for climate mitigation policies may remain weaker in areas with lower preexisting climate beliefs.

METHODS

We prepare an original panel of political and wildfire data in California. Electoral outcome and voter registration data available from the California Secretary of State provide precinct-level outcomes for all national elections between 2002 and 2010. The precinct level is the smallest unit with electoral return data in California. However, Californian electoral precinct boundaries and names change over time. We convert all data to 2000 census block group geographies. Official conversion files allow us to compute the overlap between election precincts in each year and the 2000 census block groups. We then aggregate the electoral precinct data to the 2000 census block groups. That is, for any variable expressed as a count or total in each precinct (e.g., the number of votes in support of a ballot initiative), we sum these values across the precincts that contribute to a given block group, weighting each by the fraction of the precinct overlapping with that block group.

Measure of Environmental Support

Our dependent variable is the proportion of voters supporting four pro-environment ballot initiatives in each block group, across three unique elections. The four ballot measures we consider constitute all the measures that clearly reflect support for costly climate-related policies. We review these briefly. In 2006, Californians voted on Proposition 87, which proposed a new four billion dollar program to support clean energy alternatives, funded by a 1.5% to 6% tax on Californian oil producers. It was rejected 55% to 45%. In 2008, Californians voted on Proposition 10, which proposed a support program for research, education, and deployment of alternative fuel technologies, which was rejected 59% to 41%. Californians

[1] Jennifer Marlon and Abigail Cheskis. 2017. "Wildfires and climate are related—are Americans connecting the dots?" Yale Project on Climate Change Communication. https://climatecommunication.yale.edu/news-events/connecting-wildfires-with-climate/.

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also voted on Proposition 7, which proposed to require increased utility purchases of renewable energy and was rejected by 64% to 34%. We create a single measure of pro-environment voting behavior for 2008 by averaging support for Proposition 10 and Proposition 7. In 2010, Californians voted on Proposition 23, which sought to suspend California's Global Warming Act of 2006 (rejected, 62% to 38%). Critically, we do not assume that support for these four initiatives measures the same thing—that is, that they would have similar levels of support in the absence of the treatment. In particular, we allow for an arbitrary intercept shift in the level of support across proposals. In Appendix A.1, we provide additional details on each proposition, including information on the costs as presented contemporaneously to the public.

Treatment Measurement

We extract wildfire perimeter data from the Monitoring Trends in Burn Severity dataset, an interagency US government effort tracking large fires via Landsat satellite data. We then spatially merge the wildfire perimeter data to the census block group data to determine each block group's distance from wildfires. Our primary estimates consider wildfires that burned at least 5,000 acres, over each two-year period preceding a federal election (see Appendix A.2 for details). The 5,000 acre threshold covers 94% of the state's total burned area over this period; it was chosen after prior examination of separate, satellite-based data to eliminate numerous smaller events too small to threaten the public. The two-year window is used to correspond to the timing of election cycles and thus the measurement of our outcomes as well as potential confounders.

Unconditionally, these wildfires do not occur at random with the same probability in all census block groups; they are more common in rural and peri-urban areas—what fire scholars describe as the wildland-urban interface. Overall, without conditioning we see that block groups with wildfires have only one-eighth the population density of those without (t = 83 for the difference in means; see also Figure 7 in Appendix A.8). Areas with wildfires are also more conservative on average: mean Democratic vote share among areas with a wildfire (as has just been defined) is 42%, compared with 63% in areas without wildfires (t = 23 for the difference in means). Naive estimates that merely compare voting behavior in places that did and did not experience wildfires are thus uninformative as to the effect of wildfire, instead only showing how places more or less prone to wildfire tend to differ (see Appendix A.3).

Confounding, Sensitivity, and Estimation

We minimize confounding through a strategy of conditioning on block group and year such that only time-varying covariates within block groups and not already captured by the secular time trend can potentially generate confounding bias. One type of time-varying potential confounder we might remain concerned about is political attitudes, such as partisan preferences, that could certainly influence environmental support and may for unknown reasons also relate to fire risk. We consider Democratic vote share (DemVoteShare) as a proxy for such attitudes and employ it with a lag to avoid concerns that it was affected by wildfire itself, though all results are similar without lagging. Another source of potential time-varying confounding would be environmental changes in fire risk, particularly due to variation in precipitation, which could also potentially affect environmental attitudes directly. For this, in each block group we sum the total precipitation over the two years leading up to the election (Precip2yr). We also compute the deviation from historical average rainfall, (PrecipDeviation).[2] Our approach does not require an assertion of precisely zero confounding. Rather, we eliminate as much confounding as possible through conditioning on block group and year (and optionally the covariates just described), after which sensitivity analyses reveal how the estimate would vary under postulated degrees of confounding, including confounding multiple times stronger than such observed factors as precipitation or Democratic vote share.

Coming to estimation, consider a particular block-group-level voting outcome in a given year, Y_{it}. For each block group at each election, Wildfire2yr_{it} equals 1 if a wildfire occurred within the block group's spatial perimeter in the preceding two-year period and equal to 0 otherwise. We estimate the effect of wildfire exposure on voting outcomes using a (two-way, fixed effects) model of the form

$$\begin{aligned}\text{Support}_{it} = \gamma_i + \omega_t + \alpha\ \text{Wildfire2yr}_{it} + \beta_1 \text{DemVoteShare}_{it} \\ + \beta_2\ \text{Precip2yr} + \beta_3\ \text{PrecipDeviation} + \eta_{it},\end{aligned} \tag{1}$$

where Support_{it} is environmental ballot measure support i in year t, γ_i are block-group fixed effects, ω_t are election-year fixed effects, and η_{it} is the error term. The key parameter of interest is α, the coefficient on Wildfire2yr_{it}. Including the Democratic vote share and precipitation variables in these models does not change the result and allows them to play useful roles as benchmarks for relative confounding in the sensitivity analysis below.

RESULTS

We find that block groups exposed to a wildfire larger than 5,000 acres have 6.0 percentage point higher support for environmental ballot initiatives (t = 11.5,

[2] PrecipDeviation is given by the rainfall in the prior two years, minus (twice) the average annual rainfall over the years 1981 to 2010, divided by the latter. We also note that the effect of rainfall or drought on environmental support may be a causal question of direct interest, but here we are only concerned with its potential for confounding the estimated effect of wildfire.

[3] If all wildfires are analyzed regardless of size, the average effect estimate is still substantial but, as expected, somewhat smaller at 4.7 percentage points, t = 10, 95% CI [3.7, 5.6]. If we instead examine whether a wildfire occurred within the prior one year rather than two, the estimate is similarly 5.0 percentage points, with 95% CI [3.5, 6.4].

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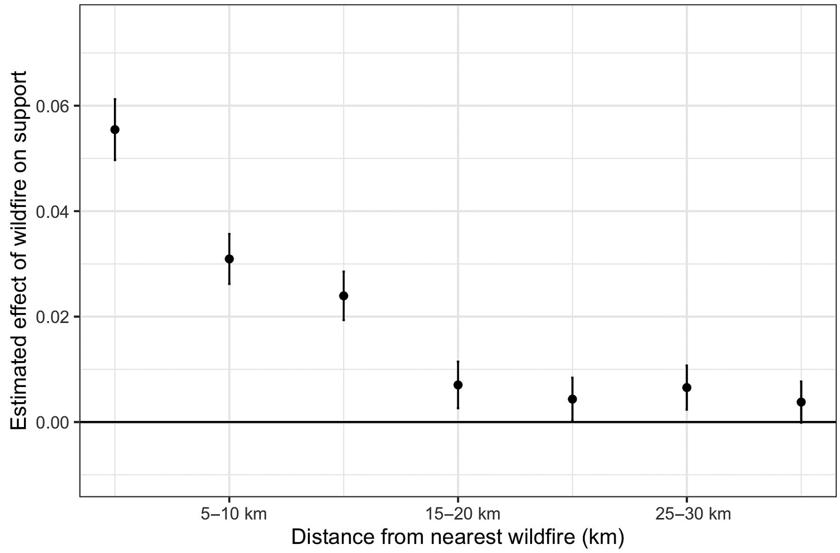
FIGURE 1. Estimated Effect of Wildfire Exposure on Pro-Environment Voting, by Distance



Note: Estimates compared with response at the median distance (35–40 kilometers). All estimates derived from a linear model with block-group and year fixed effects and controlling for Democratic vote share in Congressional elections four years prior. Error bars show 99% confidence intervals, using standard errors clustered on block group.

95% CI [5.0, 7.1]).[3] We then examine how effects vary with distance from the fire with the same model but replacing the wildfire variable with a series of indicators that measure the minimum distance between each block group and a wildfire. The indicator variable for block groups near the median wildfire distance (35–40 kilometers) is omitted so that each coefficient estimate reports a difference relative to the median distance. Figure 1 plots these results. Experiencing a wildfire very near one's block group (0 to 5 kilometers) has the largest estimated effect on pro-environment voting relative to the median distance (5.5 percentage points, $t = 24.8$; 95% CI [5.1, 6.0]). This estimate decays monotonically down to just 0.4 percentage points ($t = 2.5$) at 30 to 35 kilometers away, the last group closer than the median distance (see Appendix A.4, Table 3 for numerical results). Figure 5 in A.5 re-expresses these results as the expected *level* of support at each distance—that is, a dose-response curve, to facilitate any chosen comparison rather than comparing each distance with the median.

Finally, because wildfires are statistically rare, we have limited ability to investigate whether the effect varies based on the degree of prior exposure. However, Figure 6 in Appendix A.6 shows the result when limited to the 293 block groups that had wildfires prior to the 2006 electoral cycle, suggesting little or no effect in this group, albeit with lower precision due to the reduced sample size.

Heterogeneity by Political Ideology

A key question is what places are more or less responsive to this threat. Figure 2 shows the estimated effect of wildfire by distance from the same model as above, splitting the data into three groups: those where Democratic vote share was lower (20–40%), middling (40–60%), or higher (60–80%). The effect of wildfire is heavily concentrated in the most Democratic group and near zero in the most Republican group, with the less extreme areas falling in between.

While the effect of wildfire in each group is identifiable under the same assumptions as the entire group, we emphasize that the *differences* between these lines cannot be attributed to partisan preferences alone and may be due to other characteristics associated with Democratic vote share. One covariate of particular interest is population density, or various related concepts for which we take it as a proxy. Figure 8 in Appendix A.8 shows that while there are large differences in the effect of wildfire depending on Democratic vote share, there is little difference when further stratifying on population density.[4]

Risks of Confounding

For omitted time-varying variables to cause confounding bias in this setting, they must vary over time within block group and not be captured by the statewide changes over time. The potential time-varying confounders of greatest concern to us based on domain

[4] We also note that the strong correlation of population density with Democratic vote share in the overall sample ($r = 0.35$) vanishes entirely ($r = -0.001$, $p = 0.98$) when we look only at places with wildfires at some time. Appendix A.8 explains why this occurs and shows that, consequently, the distribution of population density is nearly the same for more Democratic and more Republican areas that have had wildfires.

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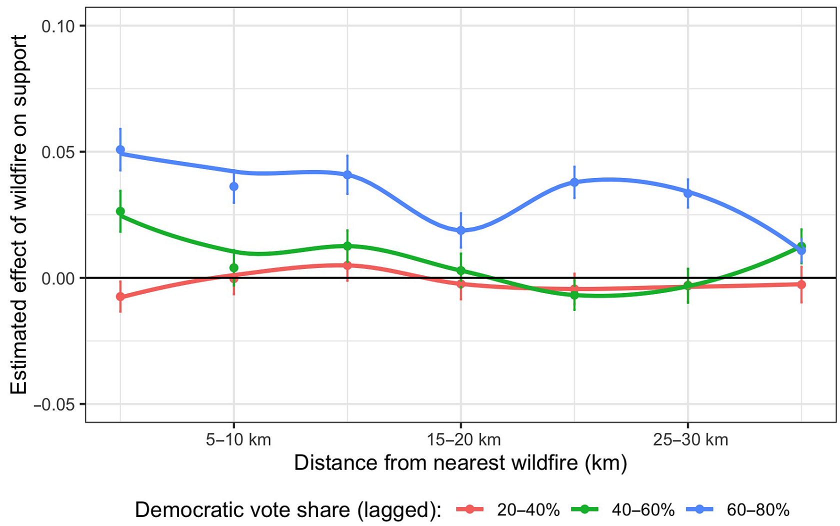
FIGURE 2. Estimated Effect of Experiencing a Wildfire at Various Distances, by Democratic Vote Share



Note: Error bars show 95% confidence intervals, using standard errors clustered on block group.

knowledge were political attitudes and changes in environmental conditions leading to wildfire risk, particularly precipitation level and variation. We observe variables that speak to both: Democratic vote share in each year, the level of precipitation in the prior two years, and deviation in precipitation from the historical average. While these were included in the above models to assuage concerns that they may be confounders, doing so did not appreciably alter the estimates. Population density and total registered voters are also potentially time-varying, albeit unlikely to change fast enough to have an influence on estimates. Including these variables also has no effect on estimates.

We also consider a placebo outcome using support for ballot measures on housing bonds, for which we expect little to no effect of wildfire. In models otherwise identical to those above, we find that wildfire does not predict a change in support for housing bonds with a coefficient of –0.2 percentage points ($t = 0.55$, 95% CI [–1.0, 0.6]). See Appendix A.7 for details.

Finally, more worrying than observed covariates is the potential for unobserved confounders due to variables we could not think of or measure. It is not necessary to have precisely zero confounding bias in order to arrive at our research conclusions, but it is important to determine how severe confounding would have to be to have meaningfully altered our conclusions through sensitivity analysis. Following Cinelli and Hazlett (2020), the contours in Figure 3 show the effect estimate as adjusted for varying possible degrees of confounding. Confounding is indexed by the proportion of residual variance in wildfire (the treatment) it can explain (on the horizontal axis) and the proportion of residual variance in environmental support it explains (vertical axis). The dashed line shows combinations of these two strengths at which confounding explains away the entire effect, making the adjusted estimate zero. Of particular note are the benchmark bounds (diamonds). These show how confounding "as strong as" (able to explain as much of the treatment and outcome residual variation as) observed covariates would alter the estimate. Even confounding as strong as precipitation in the prior two years (Precip2yr) or the deviation from historical rainfall (PrecipDeviation) would bring the estimate approximately from the unadjusted value of 6 percentage points down to approximately 5 percentage points. Confounding as strong as Democratic vote share—or even ten times as strong ($10 \times$ dem.vote share)—would have a still smaller effect. Therefore, any confounding able to substantially alter the conclusions reached would need to explain far more of wildfire occurrence and environmental attitudes than is explained by even these theoretically important variables.[5]

CONCLUSION

In summary, the haphazard and unpredictable nature of wildfire timing in California provides an empirical opportunity to evaluate the effect of experienced environmental threats on real-world climate-related political behavior. Block groups that experience a wildfire within their boundaries show higher support for environmental ballot initiatives in subsequent elections by 6 percentage points relative to those without one. Block groups that are nearer to wildfires experience larger estimated effects than those farther away: those within 5, 10, or 15 kilometers of a wildfire boundary show

[5] Note that the horizontal position of the benchmarks on this plot also provides a balance test, showing that each variable has a very weak conditional relationship with wildfire. Measuring imbalance in this way directly speaks to how worrying a potential imbalance would be by showing "how confounders as strong as these covariates" would influence estimates provides.

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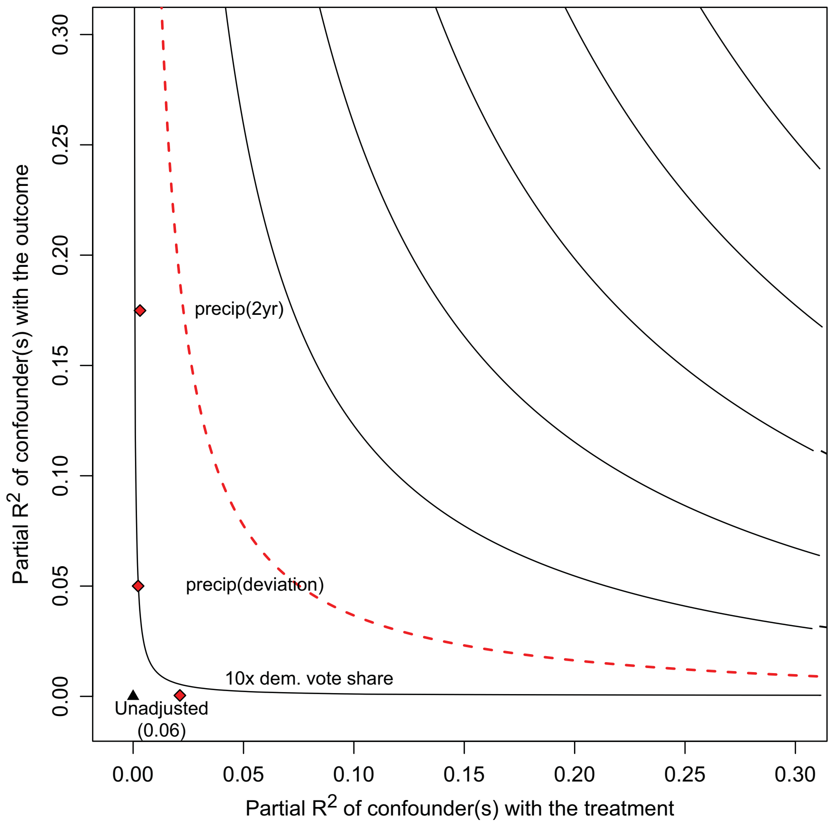
FIGURE 3. Effect Estimates at Varying Degrees of Postulated Confounding, with Benchmark Bounds



estimated effects of 5.5, 3.1, and 2.4 percentage points, respectively, each highly significant ($t > 11$), while the effect dissipates beyond 15 kilometers.

Moreover, the effect of wildfire strongly varies with the political identities composing these block groups. Voting behavior is most severely affected by wildfire in the most Democratic census block groups and largely unaffected in the most Republican census block groups. Experiences with climate change thus enhance willingness to act in groups that are more likely to be climate-concerned and to believe in human causes of climate change (see also Zanocco et al. 2018). The same events did little to mobilize those in highly Republican areas, who are expected to be more skeptical and less climate-concerned. Whether wildfire exposure altered the outcomes of these particular ballot measures or not, climate impacts thus appear to intensify the climate commitments of existing supporters rather than creating new political supporters.

Fully investigating the mechanism by which this effect occurs requires separate research and a variety of designs. One conclusion we can reach, however, is that the effect is not through a change in turnout. Appendix A.9 shows the estimated effect of wildfire on voter turnout at varying distances. Wildfires within 15 kilometers appear to reduce turnout, but only by approximately 1 percentage point. While substantively interesting unto itself, this is too small an effect on turnout to account for the observed effect on environmental support.

By using realized vote share on costly ballot initiatives, these results capture the effect of wildfire exposure on a real-world political behavior that can directly influence policy. As in any analysis of real-world events, generalizing these results to other types of events or to other places and periods would require caution. However, we find that climate-related effects have already shaped realized political behavior. In the case of Californian wildfires between 2006 and 2010, wildfire exposure increased voting for costly climate-related policies, an effect that was concentrated among Democratic areas where voters were more likely to believe in climate change.

SUPPLEMENTARY MATERIALS

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S0003055420000441. Replication materials can be found on Dataverse at: https://doi.org/10.7910/DVN/OVEGLS.

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