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Natural Disasters and Political Engagement: Evidence from the 2010–11 Pakistani Floods

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ABSTRACT

How natural disasters affect politics in developing countries is an important question, given the fragility of fledgling democratic institutions in some of these countries as well as likely increased exposure to natural disasters over time due to climate change. Research in sociology and psychology suggests traumatic events can inspire pro-social behavior and therefore might increase political engagement. Research in political science argues that economic resources are critical for political engagement and thus the economic dislocation from disasters may dampen participation. We argue that when the government and civil society response effectively blunts a disaster's economic impacts, then political engagement may increase as citizens learn about government capacity. Using diverse data from the massive 2010–11 Pakistan floods, we find that Pakistanis in highly flood-affected areas turned out to vote at

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substantially higher rates three years later than those less exposed. We also provide speculative evidence on the mechanism. The increase in turnout was higher in areas with lower *ex ante* flood risk, which is consistent with a learning process. These results suggest that natural disasters may not necessarily undermine civil society in emerging developing democracies.

Keywords: Natural disasters; electoral behavior; voter turnout; Pakistan

How do natural disasters affect politics in developing countries? Addressing this question is important given the fragility of fledgling democratic institutions in some of these countries as well as likely increased exposure to natural disasters over time due to climate change (Intergovernmental Panel on Climate Change, 2013). The existing social science literature makes contradictory predictions. On the one hand, research from sociology and psychology suggests that traumatic events such as natural disasters can inspire pro-social behavior and therefore might increase political engagement (e.g., Bardo, 1978; Bolin and Stanford, 1998; Rodriguez *et al.*, 2006; Toya and Skidmore, 2014). If this is the case, then disasters might enhance the quality of government by increasing accountability pressures and selecting for a higher-quality political class (e.g., Besley, 2007; Putnam *et al.*, 1994). On the other hand, political scientists have argued that economic resources are critical ingredients for civic engagement (e.g., Verba *et al.*, 1995). Kosec and Mo (2015) find that economic shocks resulting from natural disasters can reduce citizen aspiration levels, which are positively correlated with various forms of civic engagement. Disasters may therefore dampen participation. Moreover, scholars from a range of disciplines have suggested that economic shocks create opportunities for violent non-state actors to appeal to citizens (e.g., Collier and Hoeffler, 2004; Dal Bo and Bo, 2011; Dube and Vargas, 2013), which may also discourage citizens from working within democratic political channels (Hendirx and Salehyan, 2012; United States Agency for International Development, 2011).

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We argue that when the government and civil society response effectively blunts a disaster's economic impacts, mass political engagement should increase.[1] Conditional on economic harms being mitigated, at least three theoretical pathways suggest that natural disasters should increase political participation.

First, natural disasters lead to the grassroots creation of self-help organizations in many societies (e.g., Hawkins and Maurer, 2010; Yamamura, 2010). In many places such civic associations help train citizens in basic functions of self-governance as well as reveal the positive outputs from collective action, both features that should be positively correlated with political engagement (e.g., Banks, 1997; Putnam *et al.*, 1994). In addition, an extensive psychological literature has argued that natural disasters encourage altruistic and pro-social behavior such as search and rescue or providing food and shelter for victims (e.g., Bardo, 1978; Bolin and Stanford, 1998; Levine and Thompson, 2004; Rodriguez *et al.*, 2006; Toya and Skidmore, 2014; Vollhardt, 2009).[2] In models of voting, where turnout is driven in part by concerns with the welfare of other citizens, such changes would be expected to increase participation (e.g., Myatt, 2015).

Second, natural disasters appear to be positively correlated with some indicators of social capital (e.g., Yamamura, 2016). Critically, the relationship appears to depend on the efficacy of government response. The correlation between self-reported damage from earthquakes and self-expressed interpersonal trust in Latin America, for example, is strongly negative in places where governments respond poorly to natural disasters (as judged by researchers), but the correlation reverses sign among those who feel the government response was effective (Carlin *et al.*, 2014). And even though the impact of social capital broadly defined on political participation is contested (e.g., Atkinson and Fowler, 2012), the majority of the literature expects it to be positive.

Third, personal exposure to natural disasters may make salient the importance of government action and policies that ameliorate economic harm. This, in turn, might make citizens more engaged with the voting process, given a better understanding of the stakes of democratic politics (e.g., Hajnal and Lewis, 2003; Jackman, 1987; Pacek *et al.*, 2009). Recent models of voting

[1]Our argument is similar to that of Kosec and Mo (2015), who find that flood relief from the government can mitigate the negative effects of economic shocks on aspiration levels. They also study the political effects of the 2010 Pakistani floods. This study is distinct in that our dependent variable is turnout, whereas the dependent variable in Kosec and Mo (2015) is aspiration level. Kosec and Mo (2015) show that aspirations are politically meaningful because they are positively correlated with reports of *past* turnout before the floods. They do not examine how disasters affect *future* turnout (i.e., after the floods).

[2]Rodriguez *et al.* (2006), for example, conducted extensive field research in the aftermath of Hurricane Katrina in New Orleans in 2005 and found that instances of pro-social behavior greatly outnumbered instances of anti-social behavior.

suggest that turnout should be increasing in the extent to which citizens think the choice of government matters for future welfare (Myatt, 2015).

Taken as a whole these three mechanisms suggest that if the government and civil society response to a disaster is sufficiently effective to blunt its economic impacts, and therefore counteract the potential negative effects described above, then natural disasters should (a) increase political participation, and (b) increase engagement by stimulating citizen learning.

We explore these hypotheses in the context of Pakistan, an extremely important country of study for practical and epistemological reasons. On the practical side, Pakistan is of immense geopolitical relevance. Understanding the drivers of its politics is thus important in its own right. On the epistemic side, previous research in this area has focused on advanced economies such as the United States (e.g., Achen and Bartels, 2004; Gasper and Reeves, 2011; Healy and Malhotra, 2010; Sinclair *et al.*, 2011) and Germany (Bechtel and Hainmueller, 2011). In the closest U.S.-based study to ours Sinclair *et al.* (2011) show that registered voters in New Orleans who experienced large-scale flooding were more likely to participate in the following year's mayoral election due to receiving more political information from politicians and interest groups than less-affected citizens. Few studies have departed from the Organization of Economic Co-operation and Development (OECD) context. They examined relatively well-established democracies (e.g., Cole *et al.*, 2011 on India and Gallego, 2012 on Columbia) and explore vote choice — not participation — as the focal dependent variable.

Specifically, we examine the 2010–11 floods in Pakistan. The 2010 floods affected more than 20 million people, caused between 1,800 and 2,000 deaths, and damaged or destroyed approximately 1.7 million houses, making it the worst flood in Pakistan's modern history.[3] The 2010 floods were driven by an unusual monsoon storm that dropped historically unprecedented levels of moisture on the mountainous northwest regions of the country. Khyber Pakhtunkhwa (KPK) province, for example, received 12 feet of rain from July 28 to August 3, four times its average annual total (Gronewold, 2010). Those exceptionally high rainfall rates triggered flash floods that vastly exceeded anything in historical memory. As the water drained from KPK during the first week of August, a more typical monsoon storm inundated the Indus flood plain, rendering it incapable of absorbing the dramatic inflows from the mountainous regions and overwhelming water management structures. The following year Pakistan was again hit by an unusually strong monsoon, causing another round of devastating floods in the southern plains. In both cases the surging waters hit some places more than others due to the unpredictable combination of

[3]The EM-DAT International Disaster Database records approximately 20.4 million people affected and 1,985 killed from the 2010 floods.

human action, prior differences in soil moisture, micro-topographic differences, and complex fluid dynamics.

Leveraging that plausibly exogenous variation along with diverse data sources — multiple measures of *ex ante* flood risk, geo-spatial flood measures, an original survey of 13,282 households conducted in January–March 2012, and constituency-level voting results from the last three national elections (2002, 2008, and 2013) — we show that Pakistanis living in flood-affected places had substantially higher levels of political participation than their unaffected peers. They turned out to vote at higher rates in the 2013 general elections and exhibited a greater increase in electoral participation relative to the last election (2008). These effects are substantively large. Our estimates suggest that moving from no flooding to the median level of flooding among affected constituencies (7.9% of the population affected) would lead to a 0.5 percentage point increase in turnout. Moving from the median to the 90th percentile in flooding (42% of the population affected) would lead to a 2.2 percentage point increase in turnout. These effects are in line with those observed in door-to-door get-out-the-vote campaigns in the United States and therefore substantively meaningful.

Because of the limited area affected by the floods, the overall impact of the flooding was small. Once past political competition is accounted for, approximately 4% of the 11 percentage point increase in turnout between the 2008 and 2013 general elections (i.e., from 44% to 55%) can be attributed to the impact of the 2010–11 floods. While the floods were unlikely to have changed the election result, they clearly shifted the behavior of those who were heavily affected. For districts above the 75th percentile of flooding (22% of the population affected), for example, the impact of the floods accounted for a 2.5 percentage point increase in turnout, roughly 17% of the increase in turnout in these areas.

Some speculative evidence supports the hypothesis that flood exposure increased participation via citizen learning. The effect of flood damage on turnout is greatest in areas with the lowest *ex ante* flood risk, which are precisely those places where citizens relatively unfamiliar with floods would learn most about the importance of government action. We also rule out three alternative mechanisms: (1) differential trends in urban areas as part of the democratization process in Pakistan; (2) the floods merely changed the composition of the electorate due to disaster-induced migration; and (3) incumbents simply engaged in turnout buying.

We make several scholarly contributions. First, we investigate the political economy of natural disasters in a country outside the developed world, one with fragile democratic institutions and which is of significant strategic and policy importance. Second, we introduce a new set of mechanisms to the study natural disasters' political consequences. Previous research focuses on two channels. The economic channel, which has primarily been studied in non-democracies, argues that natural disasters create economic shocks which decrease the opportunity cost of rebellion for citizens (and therefore increase the likelihood of rebellion), thereby increasing the responsiveness of the state to citizen demands (e.g., Acemoglu and Robinson, 2001; Besley and Persson, 2010, 2011; Brückner and Ciccone, 2011). The political channel, mainly investigated in established democracies, argues that natural disasters provide a strong signal of a government's type, giving citizens the opportunity to exercise electoral accountability (e.g., Bechtel and Hainmueller, 2011; Cole *et al.*, 2011; Gasper and Reeves, 2011; Healy and Malhotra, 2010). Neither body of literature considers the possibility that the experience of the disaster and associated response may have direct effects on political participation. Third, we provide a clear example of why using natural disasters to instrument for economic shocks can be a problematic empirical strategy for outcomes influenced by politics. Natural disasters are not pure economic shocks; these events change many features of the political environment, and the extent to which they do so can be influenced by government action.

The Pakistani Floods 2010–2011: A Major Natural Disaster with Relatively Good Response

As the flooding in Pakistan began in July 2010 almost all observers expected the disaster to take a massive human and political toll. The scale of the 2010 floods dwarfed any Pakistani natural disaster in recent memory, affecting more than 20 million people (about 11% of the total population), temporarily displacing more than 10 million people, and killing at least 1,879, with the 2011 floods affecting another 5 million, displacing another 660,000 people, and killing at least 505 more (Center for Research on the Epidemiology of Disasters (CRED), 2013; Dartmouth Flood Observatory (DFO), 2013). A Fall-2010 survey of 1,769 households in 29 severely flood-affected districts found that 54.8% of households reported damage to their homes, 77% reported at least one household member with health problems, and 88% reported a significant reduction in household income (Kirsch *et al.*, 2012). Figure 1 shows the combined maximal extent of the 2010 and 2011 floods.

While the scale of the disaster was unprecedented, it was not nearly as bad as many observers predicted at the time. By mid-August the death toll from the floods was estimated to be about 1,600 people. An editorial in *The Economist* on August 21 expected that number to increase dramatically, arguing that "it is no more than the plain truth that the worst is yet to come — in terms of hunger, disease, looting and violence as victims scramble to save themselves and their families." Journalists worried that the unfolding disaster

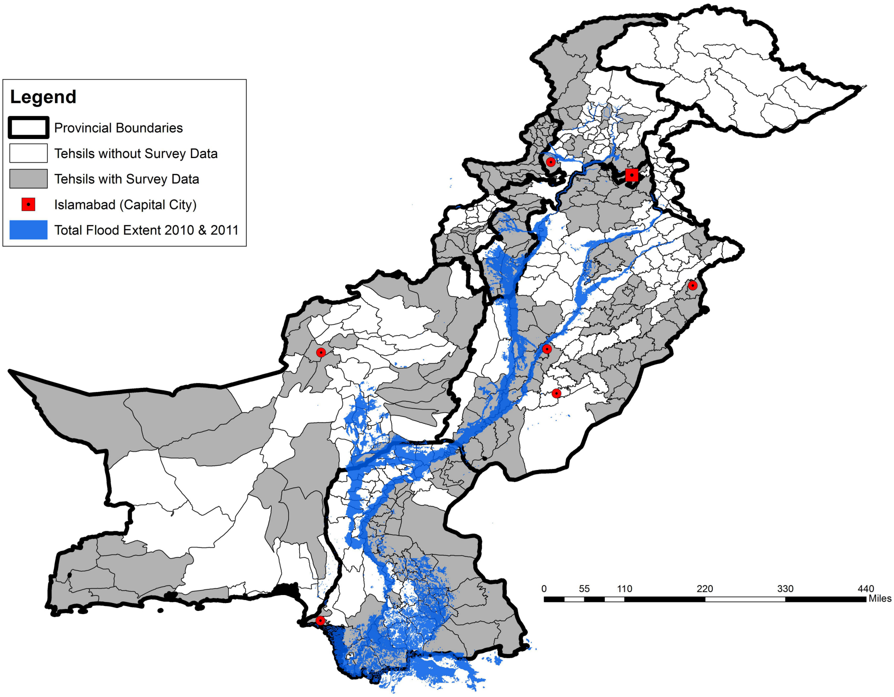

Figure 1: Maximal composite flood extent in 2010 and 2011 and surveyed tehsils. Combined maximal flood extent of the 2010 and 2011 Pakistani floods. Grey colored tehsils indicate locations that were sampled for the 2012 district representative survey. Flood data (area in blue) was taken from UNITAR's Operational Satellite Applications Programme (UNOSAT).

would be a boon for militant organizations.[4] Typical headlines at the time described a situation in which militants could step in and win loyalty by providing badly needed services:

- "Militant groups have 3000 volunteers working around the country." *Christian Science Monitor*, August 6.
- "Pakistani flood disaster gives opening to militants." *Los Angeles Times*, August 10.

[4]Militant organizations played to this concern, with a Tehrik-i-Taliban Pakistan (TTP) spokesman famously offering to contribute $20 million to the relief effort if the Pakistani government would eschew any Western aid (Associated Press of Pakistan (APP), 2010).

- "'Hardline groups step in to fill Pakistan aid vacuum." *BBC News*, August 10.
- "Race to provide aid emerges between West and extremists." *Der Spiegel*, August 16.
- "Pakistan's floods: a window of opportunity for insurgents?" *ABC News*, September 8.

Yet none of that came to pass because, as described in detail below, there was an extremely effective response by government and civil society. The floods also did not have any substantial impact on support for militancy, which many expected and which would have indicated a negative effect on engagement with politics through traditional channels.[5] Though the death toll increased by 20% from mid-August onward, there were no large-scale disease outbreaks, and there was little looting or violence. When the UN Environmental Program modeled risks from a 1 in 100 year flood in Pakistan using historical worldwide data, they predicted mortality four times greater than was actually observed (Maskrey, 2011, p. 30).

Background on the Floods

The 2010 disaster was a significant outlier in Pakistan's flood history. Figure 2 shows standardized values for the number affected, displaced, and killed for floods over the past few decades. The upper part of the figure presents data from the International Disaster Database (EM-DAT) hosted by the Center for Research on the Epidemiology of Disasters (2013) (data range 1975–2012) and the lower graph draws on data from the Global Active Archive of Large Flood Events of the Dartmouth Flood Observatory (DFO) (2013) (data range 1988–2012). In terms of the number affected and the number temporarily displaced, the 2010 floods were the largest in the modern history of Pakistan by several orders of magnitude, and almost twice as devastating as the next largest flood according to the EM-DAT.[6]

Commensurate with the devastation, the 2010–11 floods also led to an unprecedented reaction by the central, provincial, and district governments as well as by Pakistani civil society and the international community (Ahmed, 2010). Pakistan's Economic Affairs Division took the overall lead on donor coordination, while Pakistan's National Disaster Management Agency (NDMA)

[5] Using an endorsement experiment we find no evidence that the floods led to increased support for militancy. Support for militants in 2012 was actually somewhat lower in heavily flooded areas controlling for a range of geographic and demographic variables, though the results are only modestly statistically significant. Detailed results available from authors.

[6] The next largest was the 1992 flood which affected 12.8 million, temporarily displaced 4.3 million, and killed at least 1,446 people.

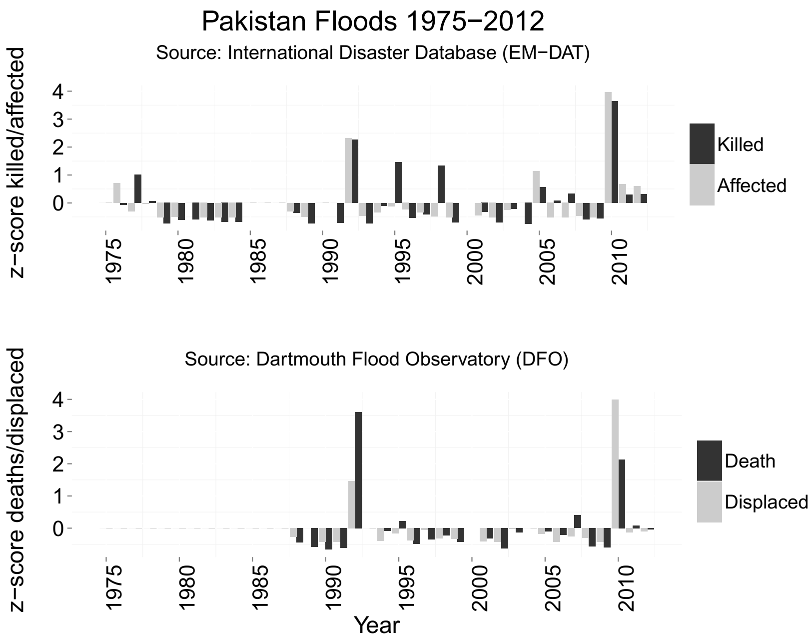

Figure 2: Standardized impact of floods in Pakistan 1975–2012.
Standardized values for the number affected, displaced, and killed for each flood between 1975 and 2012.

directed and coordinated the various relief efforts. The NDMA maintained close working relationships with relevant federal ministries and departments, Pakistan's armed forces,[7] and donor organizations supporting the relief efforts to ensure that resources were mobilized consistent with local needs. At the provincial level, the chief minister of each province was responsible for making sure that various line ministries and the Provincial Disaster Management Authorities acted in concert with each other and with the international and domestic relief efforts (National Disaster Management Agency, 2011; Office for the Coordination of Humanitarian Affairs (OCHA), 2010).

In response to the Pakistani government's appeal to international donors for help in responding to the disaster, the United Nations launched its relief efforts calling for $460 million to provide immediate assistance such as food, shelter, and clean water. Countries and international organizations from around the world donated money and supplies, sent specialists, and provided equipment to supplement the Pakistani government's relief efforts. According

[7]The military deployed troops in all affected areas together with 21 helicopters and 150 boats (Khan and Mughal, 2010).

to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) (2010), by November 2010, a total of close to $1.792 billion had been committed in humanitarian support, the largest amount by the United States (30.7%), followed by private individuals and organizations (17.5%) and Saudi Arabia (13.5%).[8]

In addition, spontaneous, localized self-help efforts emerged during the initial phase of the crisis and continued throughout. These included victims' and their kin's own efforts to save their belongings as well as survivor-led repairs of local access roads and bridges after the floods receded. This was in addition to an enormous civil society response that tended to spontaneously coalesce at very local levels (mohallas, union councils, villages, etc.). Such local groups collected and distributed truckloads of relief items. Along with non-governmental organizations they set up collection sites for donations of goods and cash and then distributed the collected resources. Individual philanthropists, professional bodies, and even chambers of commerce donated money and supplies to the victims. Scholars associated with Pakistan's Sustainable Development Policy Institute note the importance of these local forms of assistance, but contend that they are virtually unknown (and thus poorly documented) beyond the local level (Shahbaz *et al.*, 2012). Such volunteerism was not unique to the 2010 flood; rather, it is a common feature in Pakistan's domestic response to major disasters. Halvorson and Hamilton (2010), for example, document extremely high levels of volunteerism following the 2005 Kashmir earthquake.[9]

Together, the government's and civil society's effort and the massive influx of foreign aid was quite effective compared to responses to previous natural disasters. The ratio of people killed to 1,000 people affected from the EM-DAT data, and the ratio of deaths to 1,000 people displaced for each flood between 1975 and 2012 from the DFO data, provide proxies for the effectiveness of the government's response. For the 2010 flood, the ratios are 0.10 and 0.19, respectively, which is the smallest ratio in the DFO series (1988–2012) and the seventh smallest in the EM-DAT series (1975–2012).[10] Strikingly, the 2010 ratio is only 21% of the median ratio of killed to 1,000 displaced in the DFO data, so roughly one-fifth as many people died as would have been expected, given the median response in the last 37 years. Overall, the government's performance in handling the immediate challenge from the 2010 floods appears to have been quite good, implying that death and temporary

[8]By April 2013, this total had increased to more than $2.653 billion with the three largest donor groups being the United States (25.8%), private individuals and organizations (13.4%), and Japan (11.3%) (UNOCHA, 2013).

[9]It is also not unique to Pakistan. Scholars have documented similar behavior elsewhere in South Asia (e.g., Ghosh, 2009; Haque, 2004; Rahman, 2006).

[10]Compared to the 1992 flood, the only flood of comparable magnitude in the last 30 years, the 2010 ratio is 72% smaller in the DFO data and 8% smaller in the EM-DAT data.

migration cannot account for the large changes in political participation reported here.[11]

As would be expected given the qualitative discussion above, we find no quantitative evidence that flood-affected areas suffered medium-term negative economic impacts relative to other areas. Using the nationally representative survey detailed in Appendix C we found that flood exposure had no impact on self-reported income or expenditures in 2012 and only a small negative effect on household assets, with that effect concentrated in farming households.[12] Moreover, using nightlight satellite imagery and micro-data from two waves of the Punjab Multiple Indicator Cluster Survey (MICS), one before and one after the floods, we find little evidence that the 2010–11 floods led to differential economic changes across the flood gradient.[13]

Data Sources and Measurements

We leverage three data sources in our analysis: (1) geocoded data on the floods; (2) constituency level results from the 2002, 2008, and 2013 National and Provincial Assembly elections; and (3) a range of geo-spatial variables that predict *ex ante* flood risk. Appendix C describes the original survey of Pakistan we conducted in early 2012 which is referenced in the text but not part of the main analyses presented here. Summary statistics of all variables for each data set are provided in Appendix Table A.1.

Data Sources

Geocoded Flood Data

Geo-spatial data on the 2010 and 2011 floods come from the United Nations Institute for Training and Research's (UNITAR) Operational Satellite Applications Program (UNOSAT) (United Nations Institute for Training and Research, 2003). These data combine multiple different sources and are the most precise data we know of on those floods, providing estimates of flood extent at 100 m×100 m resolution. We overlapped various UNOSAT images to generate a layer of maximal flood extent in 2010, 2011, and 2012.

[11]For comparison, Hurricane Katrina killed 1,833 people in the Gulf Coast in 2005 even though many fewer people were directly affected (approximately 500,000 according to the EM-DAT database).

[12]Results available from authors.

[13]Results available from authors.

Electoral Data

We collected constituency-level voting data published by the Election Commission of Pakistan (ECP) from the 2002, 2008, and 2013 National Assembly (NA) and Provincial Assembly (PA) elections. Both assemblies consist of members elected in single-member first-past-the-post elections at the constituency level (272 for the NA and 577 for the PA in the four main provinces) with a number of seats reserved for women and minorities (70 in the NA) that are allocated among parties according to a proportional representation scheme. Most candidates align with a party during the campaign, and those affiliations are recorded in the voting data, but some run as independents and affiliate with a party for coalition formation purposes after the election is complete. Candidates in the 2013 election campaigns combined appeals to national issues and party platforms with locality-specific appeals and promises of patronage, with the mix varying by candidate. The candidates' 2013 appeals are commonly understood to have been more focused on national policies than in previous elections.

For each constituency we recorded the number of registered voters, total number of votes cast, total number of valid votes cast, and the number of votes received by each candidate on the ballot. In the analysis below we focus on PA constituencies which are substantially smaller than NA constituencies and therefore entail less aggregation of our flood data. All core results are substantively similar at the NA level, though less precisely estimated in some cases.

Treatment Variable: Flood Exposure

We measure flood exposure with objective measures based on geo-spatial data. Figure 1 shows the combined maximum flood extents in 2010 and 2011 overlaid on a map of Pakistan with the 216 tehsils in which we surveyed highlighted in grey.[14]

Using the 2010 Landscan gridded (5 km $\times$ 5 km resolution) population data (Oak Ridge National Laboratory, 2008), we calculate the percent of the population exposed to the floods for each of the 409 tehsils and each of the 577 single-member PA constituencies.[15] The UNOSAT data underestimate the floods' impacts in steep areas where the flood waters did not spread out enough to be identified with overhead imagery but where contemporaneous accounts clearly show there was major damage at the bottom of river valleys. In Upper Dir district in KPK, for example, the UNOSAT data show no flooding.

[14]The tehsil is the third-level administrative unit in Pakistan, below provinces and districts.

[15]We also calculated the percent of area flooded for each of the geographic units. The two measures are highly correlated ($r = 0.85$) and all reported results are qualitatively similar using the area-based instead of the population-based measure.

Contemporaneous media accounts and survey-based measurements, however, clearly indicate the floods did a great deal of damage to structures that were placed well above the normal high-water mark but still very close to rivers (e.g., Agency for Technical Cooperation and Development, 2010). If the floods had an impact on citizen attitudes and behavior, as we hypothesize, then this kind of measurement error will attenuate our estimate of flood impacts because we are counting places as having low values on the treatment where the floods actually had substantial effects.

Outcome Variables: Political Behavior

Based on the constituency-level electoral returns, we construct two measures of political behavior: turnout and candidate vote shares. Turnout is defined as the proportion of total votes cast out of all registered voters in a constituency. All results are robust to measuring turnout as only based on valid votes cast out of all registered voters in a constituency. Candidate vote shares are calculated by dividing the number of votes for each candidate by the number of valid votes in the constituency.

Control Variables

In addition to the regression-specific controls highlighted in the following section, we include two main groups of control variables in all specifications: a measure of *ex ante* flood risk and geographic controls.

Ex Ante *Flood Risk*

We use risk data developed by the UN Environmental Program (UNEP) to measure *ex ante* flood risk. These data estimate risk based on hydrological models combined with data on historical disasters, ground cover, rainfall, soil type, and topography. The UNEP data estimate flood risk on a 0 (low) to 5 (extreme) scale for 10 km×10 km grid cells worldwide.[16] Since these grid cells are too large to nest neatly within PA constituency boundaries we estimate the area-weighted flood risk for each constituency. If 50% of the area of a constituency was in a 0 cell and 50% was in a 1 cell, then the constituency would receive a value of .5 on for *ex ante* flood risk, and so on.

Geographic Controls

In addition to the *ex ante* flood risk, we include in all our regressions the following four control variables for each geographic unit: distance from the unit

[16] For details on the methodology see Herold and Mouton (2011).

centroid to the nearest major river, an indicator for units bordering a major river, the mean elevation, and the standard deviation of a unit's standard deviation. Major rivers include the Indus and its main arms (i.e., Chenab, Jhelum, Kabul, Ravi, and Sutlij). Because there was significant flooding in 2012 in a few areas though not nearly so extensive at in 2010–11, less than 10% of constituencies saw any meaningful flooding in 2012, we also control from flooding in 2012 in all specifications.

Empirical Strategy

Identification

Our identification strategy for assessing flood impacts throughout this paper relies on the observation that whether and how much any individual or region was affected by the floods had a large random component due to topographical factors, levy breaks, and strategic dam destructions which had unpredictable consequences on subsequent flows (e.g., Waraich, 2010). Once we control for observables that citizens could have used to predict flood exposure, and thus may have impacted economic outcomes or settlement patterns — risk estimates based on topography and hydrology, distance to major rivers, elevation, and steepness of terrain — the remaining variance in flooding should be conditionally independent of other factors influencing the outcomes we study.

The correlation between *ex ante* risk and flooding in 2010–11 is modest at best (see Figure 3, which plots average flood risk against observed exposure in 2010–11). Each column reports a different level of geographic aggregation: tehsils, NA constituencies, and PA constituencies. The top row shows exposure measured in terms of proportion of area exposed and the bottom row shows the proportion of the population exposed. Across all six scatter plots it is clear that there is tremendous variance in flood exposure at all but the lowest levels of flood risk. Only 10–12% of the variance in the proportion of the population exposed in 2010–11 could have been predicted with a cubic polynomial model of *ex ante* flood risk.

Estimation Strategy

Our estimation strategy at the constituency level is inspired by two observations. First, conditional on a combination of regional fixed-effects and constituency-level geographic controls, we can isolate the impact of local variation in flood intensity on electoral turnout. In doing so, we need to control for a range of locality-specific confounders. We might worry, for example, that it is easier for politicians to deliver patronage to constituencies close to rivers (which are most likely to be flooded) through a combination of water

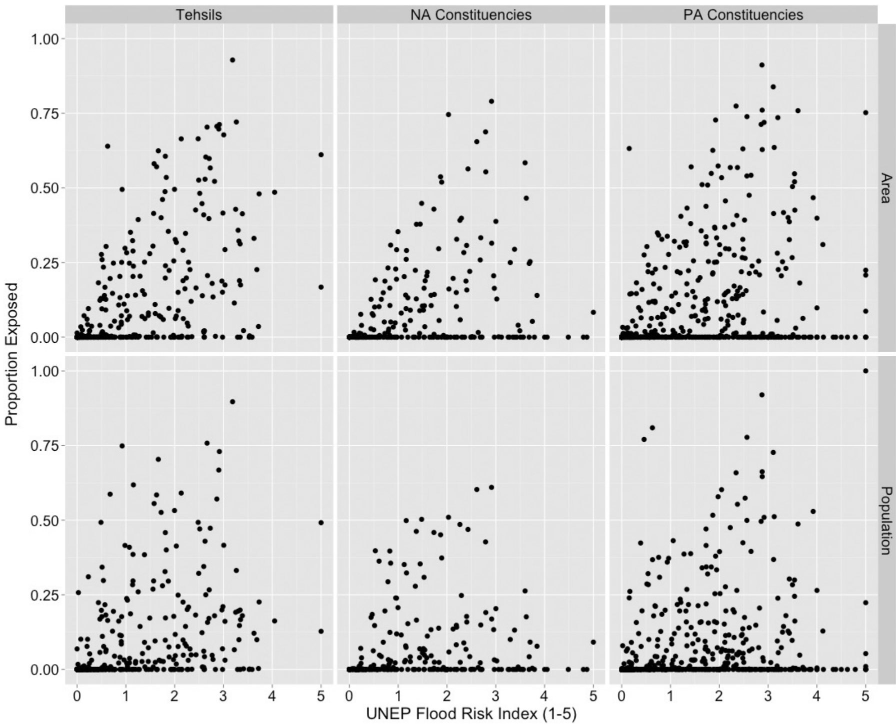

Figure 3: Scatter plots of UNEP flood risk versus effective flood exposure 2010/11.

Correlation between *ex ante* flood risk from the UN Environmental Program (UNEP) and exposure measures. Exposure area was calculated from UNITAR's Operational Satellite Appliations Programme (UNOSAT) data. Population *(objective)* exposure was calculated using 2010 Landscan population data along with UNOSAT flooded area data.

management projects and prior flood relief, making them more likely to turn out. To avoid confounding flood exposure with fixed characteristics of constituencies we control for a range of geographic factors. We also show that our results are consistent within subsets that are more similar in proximity to rivers.

Second, controlling for past turnout at the locality level can help estimate the impact of events on voting. In developed democracies individual turnout decisions are highly consistent from election to election (Denny and Doyle, 2008; Fowler, 2006), and past turnout in an area is an excellent predictor of future turnout in that area (Fujiwara *et al.*, 2013). Given that fact, we follow the logic of Gerber and Green (2000) and Gerber *et al.* (2008), who use lagged dependent variable models to improve precision in their estimates of the marginal impact of exogenous events. In their studies, the exogenous events were experimental treatments. In our case, it is the variance in flooding conditional on *ex ante* flood risk and our geographic controls.

In Pakistan, individual turnout decisions are likely not as consistent as in more developed polities, so there is no obvious right way to execute this strategy. In particular, the 2002 and 2008 elections were held under very different circumstances with different configurations of parties. The 2002 election was held to transition out of a military dictatorship and a number of prominent politicians, including the current prime minister, were bared from running. The 2008 election was the first completely democratic contest, but the results were heavily influenced by the assassination of Benazir Bhutto, the leader of the Pakistan People's Party (PPP), two weeks before the originally planned vote, and by the subsequent delay to allow the PPP to choose another leader. Since the array of parties in the 2002 and 2008 elections were not obviously comparable to those in the 2013 election we show all results three ways: (a) without controls for previous voting; (b) with controls for trends from 2002 to 2008; and (c) with controls for levels in 2002 and 2008. Note that controlling for trends imposes the condition that the relationship between voting in 2008 and voting in 2013 is symmetric with the relationship between voting in 2002 and voting in 2013. It is therefore a less flexible specification than controlling for levels in both elections.

Our preferred specification is therefore:

$$y_{2013} = \alpha + \beta_1 F_i + \beta_2 R_i + \delta_1 y_{2008} + \delta_2 y_{2002} + \gamma_d + \mathbf{B}\mathbf{X_i} + \epsilon_i \qquad (1)$$

where y_{2013} is a measure of voting behavior (turnout, vote choice) in the 2013 election, F_i is a measure of flood impact, R_i is the UNEP measure of *ex ante* flood risk, the y_{2008} and y_{2002} variables capture the voting behavior in question in the previous two elections, and $\mathbf{X_i}$ is our vector of geo-spatial controls plus the proportion of population affected in the smaller 2012 floods that occurred before the 2013 general elections. γ_d is a unit fixed effect for the division, a defunct administrative unit that was larger than the district but smaller than the province. We control for the 27 divisions instead of districts because, outside of Punjab, PA constituencies are often aligned with district boundaries or contain multiple districts.[17] The geo-spatial controls plus division fixed-effects account for 66.2% of the variance in the percentage of the population affected in PA constituencies. We cluster standard errors at the district level to account for the high probability that the cross-constituency variance in turnout changes is correlated within districts as campaign activities in Pakistan are generally managed at the district level.

[17] 57% of districts have four or fewer PA constituencies. Hence, using district fixed effects would essentially limit our results to being estimated off the large districts. For transparency all main results are shown without any unit fixed-effects, province fixed-effects, and division fixed-effects.

If the impact of the floods on electoral behavior works through the suggested theoretical mechanisms, as opposed to a response to service delivery or an economic shock, we would expect two patterns:

1. There should be no consistent impact on the incumbent or the main opposition party's vote share; and
2. The impact should be strongest in places that were genuinely surprised by the flooding.

Put more starkly, none of the theoretical mechanisms necessarily predict changes in vote shares, but they do indicate that surprised constituencies will have higher turnout due to the greater informational and psychological impact of the floods. To assess prediction (1) we re-run Equation (1) on the national and the provincial level incumbent vote shares. To assess prediction (2) we interact our flood exposure measures with the UNEP measure of *ex ante* flood risk, resulting in the following estimation equation:

$$\begin{aligned} y_{2013} = {} & \alpha + \beta_1 F_i + \beta_2 R_i + \beta_3 (F_i \times R_i) + \delta_1 y_{2008} \\ & + \delta_2 y_{2002} + \gamma_d + \mathbf{BX_i} + \mathbf{CP_i} + \epsilon_i. \end{aligned} \tag{2}$$

Here β_3 captures the change in the impact of flooding on different voting outcomes as one moves across levels of *ex ante* risk. For thoroughness we estimate both the continuous interaction between flood exposure and *ex ante* risk as well as that between flood exposure and a dummy variable for whether flood risk is greater than 1 on the 0–5 UNEP scale (roughly the median of the scale).

To be clear, this approach cannot separately identify the effect of response from that of harm, similar to other papers in this literature. We provide suggestive evidence that the result is not a simple gratitude reaction in Appendix B, where we show that controlling for relief spending does little to attenuate the estimated impact of flood exposure on turnout. Those results must be taken as suggestive, however, as the assignment of relief spending was not, obviously, independent of harm and relief spending was recorded at higher levels of spatial aggregation than voting.

Results

In this section we report the main results on turnout and then show they are robust: (1) across sub-samples; (2) to a quadratic functional form; and (3) a placebo test. We also provide evidence on the impact of flooding on vote share. Overall we find that flood exposure significantly and positively increased turnout in the 2013 elections. We then turn to more speculative evidence on the mechanisms, showing that these effects are strongest in constituencies that had the lowest *ex ante* flood risk and therefore experienced the strongest shocks.

Impact on Electoral Behavior

Turnout

Our main results are based on official election data recorded 21–33 months after the floods. Table 1 shows the impact of flood exposure on constituency-level turnout in the 2013 PA elections. All regressions include controls for *ex ante* flood risk and geographic controls. To make clear how controlling for past turnout impacts the conditional correlation between flood exposure and turnout Columns 1–3 do not include controls for past turnout, Columns 4–6 control for the change in turnout in the constituency from 2002 to 2008, and Columns 7–9 control independently for the levels of turnout in 2002 and 2008. Within each block we show the results with no fixed effects, with province fixed effects to partial out any uncontrolled heterogeneity across the first-level administrative sub-unit which in Pakistan is responsible for most service delivery, and division fixed-effects to control for such factors at a finer geographic scale. Estimates are fairly stable and consistent across different specifications. In our preferred specification, Column 9, increasing the share of the population exposed to the flood from 0% to 100% increased turnout by 6.6 percentage points. This is a substantively large effect, given that the mean turnout change between 2008 and 2013 was 10.3 percentage points. Further, the effect size represents over one-half a standard deviation of the dependent variable.

Examining how the coefficients change across specifications is helpful for understanding potential biases. It is possible that places which show flooding would be expected to experience greater changes in turnout than the places that do not, perhaps due to past experiences or issues related to geography. Some of this concern is addressed by controlling for *ex ante* flood risk, but one might also want to control for previous trends in voting behavior. Comparing across specifications with the same fixed-effects (e.g., Column 1 vs. Columns 4 and 7) shows that controlling for trends makes the results substantively larger, which is the opposite of what would happen if the main result were identifying either reversion to mean from previous trends or some kind of secular tendency in places likely to be flooded.

In standardized terms a one standard deviation increase in the proportion of a constituency's population flooded (0.146) led to a 0.96 percentage point increase in turnout. This is a modest average increase in electoral mobilization. Compared to recent U.S. presidential elections this increase in absolute terms is roughly 1/6th of the 5.4 percentage point increase in turnout between 2000 and 2004, and greater than half the 1.4 percentage point increase in

Table 1: Main result with different controls for past turnout.

	Turnout 2013 (mean = 0.541; sd = 0.104)								
	Controls			Controls and turnout trend			Controls and turnout levels		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% Pop. Exposed	0.097	0.147	0.066	0.117	0.165	0.084	0.118	0.130	0.066
	(0.033)	(0.028)	(0.026)	(0.039)	(0.033)	(0.026)	(0.034)	(0.030)	(0.022)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.301	0.465	0.613	0.345	0.488	0.636	0.548	0.604	0.706
Observations	556	556	556	556	556	556	556	556	556
Clusters	109	109	109	109	109	109	109	109	109

Notes: Outcome variable is turnout in the 2013 election. Models 4 through 6 control for previous turnout using a trend variable ($trend$ = $\text{turnout}_{08} - \text{turnout}_{02}$). Models 7 through 9 control for previous turnout through 2002 and 2008 turnout level variables (turnout_{02}, turnout_{08}). All regressions include controls for *ex ante* UNEP flood risk, distance to major river, dummy for constituencies bordering a major river, std. dev. of the constituency's elevation, and mean constituency elevation, as well as the percentage of the population affected by flooding in 2012. Unit of observation is a Provincial Assembly constituency. Standard errors are clustered at the district level and reported in parentheses.

turnout between 2004 and 2008, typically attributed to an unusually motivated electorate turning out in support of a historic candidate. The fact that we find no significant flood effect on the number of registered voters, but a significant impact on the number of votes cast, further supports our theoretical argument (see Appendix Table B.5, which shows components of turnout for different subsets of the data).[18] The increase in turnout is not due to lower registration but due to an increase in the number of votes cast in flooded constituencies, which is what we would expect if the floods increased civic engagement.[19] Since controlling for past levels is more flexible then controlling for trends and is more conservative (in that it yields smaller estimates) all subsequent results include controls for levels.

Sensitivity to Sub-samples and Functional Form

One potential concern with the main result is that it may be an artifact of pre-existing differences between places in the flood plain and those outside of it. Table 2 therefore shows results for the full sample (Columns 1–3) as well as for two sub-samples: places near major rivers, which we define as constituencies bordering major rivers and ones immediately adjacent to those (Columns 4–6), and only constituencies bordering major rivers (Columns 7–9). This essentially restricts the analysis to areas that were proximate to major water sources in case the effects we observe are driven by systematic differences between such places and those further away that are not accounted for by our controls. Without fixed-effects or with province fixed-effects the results become substantively smaller but remain statistically significant as the sample is restricted (Columns 1 vs. 4/7 or Columns 2 vs. 5/8), suggesting that some share of the main result in those specifications was driven by underlying differences between places in the flood plain and those outside of it. However, once division fixed effects are included (Columns 3 vs. 6/9) these differences disappear and all estimates are similar in magnitude and statistical significance across subsets. This consistency provides evidence that the effect of flood exposure is identified off variation in flooding across areas with similar propensity to flood and not off differences between constituencies closer to potential flooding sources (those in the flood plain) compared to those further away.

A second potential concern with these results is that there may be some significant non-linearity in the relationship between flood exposure and turnout.

[18] Note that in the Appendix table the coefficients on votes cast and registration are sensitive to the fixed effects being used, which is not the case for the overall turnout numbers. Once province or division fixed effects are included votes cast increased using either measure. Registered voters drop insignificantly with province fixed effects and increase insignificantly with division fixed effects).

[19] Put differently this is not a change in turnout driven by changes in the denominator.

Table 2: Main result for different subsets.

	Full sample			Near major rivers			Neighboring major river		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% Pop. Exposed	0.118	0.130	0.066	0.092	0.110	0.062	0.063	0.081	0.068
	(0.034)	(0.030)	(0.022)	(0.033)	(0.027)	(0.023)	(0.027)	(0.024)	(0.024)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.548	0.604	0.706	0.547	0.612	0.752	0.584	0.624	0.707
Observations	556	556	556	389	389	389	209	209	209
Clusters	109	109	109	77	77	77	63	63	63

Notes: Outcome variable is turnout in the 2013 election. Unit of observation is a Provincial Assembly constituency. All models control for previous turnout through 2002 and 2008 turnout level variables (turnout_{02}, turnout_{08}). All regressions include controls for *ex ante* UNEP flood risk, distance to major river, dummy for constituencies bordering a major river, std. dev. of the constituency's elevation, mean constituency elevation, and the percentage of the population affected by flooding in 2012. Standard errors are clustered at the district level and reported in parentheses.

To test for that possibility Appendix Table B.1 adds a squared term for flood exposure to all the specifications from Table 2. The squared term is rarely significant in any subset and while the test for joint significance of the linear and squared terms rejects the null of no joint effect ($p < .05$ in all specifications), the actual improvement in r-squared is quite modest. Marginal effects calculations in the Appendix show that at high levels of flood exposure the marginal impact of flood exposure is substantively large and strongly statistically significant in almost all specifications. It seems unlikely that our linear specification is leading to erroneous inference.

Placebo Test

If our identifying assumptions about isolating the exogenous component of the 2010–11 floods are valid, then there should be no consistent relationship between flood exposure in 2010–11 and turnout in previous years. Table 3 shows the conditional correlation between flood exposure and turnout in 2002, turnout in 2008, and the trend across samples (Panel A vs. Panel B vs. Panel C), with different types of fixed effects.

The placebo test is fairly clean but there is a statistically significant negative correlation between the change in turnout from 2002 to 2008 and the level of flooding in 2010–11 in the full sample for the fixed effects models. That relationship is statistically insignificant and becomes smaller in magnitude as the sample is restricted (Columns 7–9 in Panel A vs. Panels B/C). In Panel A the coefficients are negative and weakly significant while in Panels B and C they are negative and statistically insignificant. These patterns suggest that the flood treatment is not simply capturing an omitted aspect of the constituencies that is also positively related to turnout. It is particularly informative that in the model with division fixed effects the placebo regression on past changes shows a conditional correlation that gets closer to zero as the sample is restricted, whereas in the same model for 2013 turnout there is no change across subsets (Table 2, Columns 3/6/9). It is therefore unlikely that some long-run relationship between flood risk and voting patterns is responsible for our findings.

Vote Share

We next test whether partisan swings drive the result. Table 4 presents the effect of the floods on major party vote shares in the 2013 PA elections. Panels A–C show the estimates for three different outcomes: the provincial incumbent party's vote share (i.e., the PPP in Balochistan and Sindh, the PML-N in Punjab, and the ethnic Awami National Party (ANP) in Khyber Pakhtunkhwa (KPK)) (Panel A), the national ruling party (i.e. the PPP) (Panel B), and the

Table 3: Placebo regressions with different controls for past turnout for different subsets.

	Turnout 2002			Turnout 2008			Turnout difference 08−02		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Full sample									
% Pop. Exposed	−0.046	0.046	0.024	−0.103	−0.037	−0.040	−0.058	−0.082	−0.064
	(0.038)	(0.035)	(0.021)	(0.046)	(0.039)	(0.042)	(0.034)	(0.034)	(0.036)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.247	0.426	0.569	0.247	0.382	0.502	0.063	0.134	0.277
Observations	565	565	565	565	565	565	565	565	565
Clusters	109	109	109	109	109	109	109	109	109
Panel B: Near major rivers									
% Pop. exposed	−0.061	0.019	0.021	−0.105	−0.031	−0.035	−0.044	−0.049	−0.056
	(0.040)	(0.032)	(0.024)	(0.052)	(0.043)	(0.048)	(0.036)	(0.035)	(0.042)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.257	0.425	0.621	0.199	0.339	0.492	0.033	0.060	0.198
Observations	394	394	394	394	394	394	394	394	394
Clusters	77	77	77	77	77	77	77	77	77

(*Continued*)

Table 3: (*Continued*)

	Turnout 2002			Turnout 2008			Turnout difference 08−02		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel C: Neighboring major rivers									
% Pop. exposed	−0.027	0.052	0.017	−0.058	0.025	−0.003	−0.031	−0.026	−0.020
	(0.044)	(0.038)	(0.031)	(0.058)	(0.041)	(0.049)	(0.039)	(0.038)	(0.044)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.353	0.547	0.648	0.224	0.410	0.508	0.046	0.056	0.139
Observations	212	212	212	212	212	212	212	212	212
Clusters	63	63	63	63	63	63	63	63	63

Notes: Unit of observation is a Provincial Assembly constituency. All regressions include controls for *ex ante* UNEP flood risk, distance to major river, dummy for constituencies bordering a major river, std.dev. of the constituency's elevation, and mean constituency elevation. Standard errors are clustered at the district level and reported in parentheses.

main opposition's vote share (i.e., the PML-N) (Panel C). The columns indicate different administrative subsets of constituencies: Column 1 presents the results for all PA constituencies in Pakistan's four regular provinces, Column 2 for the two smaller provinces Balochistan and KPK, Column 3 for Punjab, the largest province, and Column 4 for Sindh province. For succinctness we show the results with and without division fixed effects. All regressions include geographic controls.[20]

We see no consistent evidence that the floods led to an increase in vote share for the ruling provincial parties, the ruling national party, or the main national opposition. The effects are inconsistent across subsets and fail to reach conventional levels of statistical significance once fixed effects are included. It therefore seems highly unlikely that the turnout results completely reflect a partisan response which rewarded those in power for effectively addressing the floods.

The implications of the fact that the incumbent party was neither punished nor rewarded after such a historic event for theories of democratic accountability is a difficult question in this context. The challenge is that the national ruling party at the time of the floods was the Pakistan People's Party (PPP). They were responsible for working with the Army to coordinate relief by national-level bodies and relief from international organizations. However, the relief effort within provinces was managed by the provincial governments. In Punjab (roughly half the population) the provincial government in charge of relief was the Pakistan Muslim League Nawaz (PML-N). In Sindh and Balochistant (roughly 30% of the population) and Balochistan it was the PPP. In Khyber Pakhtunkhwa (KP, roughly 20% of the population) it was the Awami National Party — a secular Pashtun nationalist party — in 2010 and a new national party, the Pakistan-Tarek-Insaf, in 2013. Given that complexity, it would have been hard for a voter to know which party to reward or punish, akin to the concept of "clarity of responsibility" (Powell Jr. and Whiten, 1993). It is impossible to tell from our data whether the lack of partisan swing reflects the ambiguous responsibility in this context or a general failure to reward good performance.

Evidence on Mechanisms

Turning to mechanisms, we examine whether the impact of flood exposure on turnout varies with *ex ante* flood risk in ways that are consistent with the learning mechanism. As explained above, we would expect the treatment

[20]Results are almost identical if we include political controls: the outcome variable in 2008, the degree of political competition in the 2008 elections, a series of dummy variables indicating which major party represented the constituency between 2008 and 2013, and interaction terms between the party dummies and political competition. The only substantive difference of note is that the coefficient in Panel B (Column 1) is about 10% smaller.

Table 4: Vote share regressions.

	National		Balochistan and KPK		Punjab		Sindh	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Provincial incumbent's vote share 2013								
% Pop. Exposed	−0.061	0.065	0.051	0.046	−0.021	0.098	0.086	0.015
	(0.087)	(0.062)	(0.067)	(0.153)	(0.139)	(0.163)	(0.098)	(0.074)
Division FE		X		X		X		X
R-Squared	0.405	0.682	0.482	0.570	0.178	0.233	0.551	0.743
Observations	565	565	149	149	288	288	128	128
Clusters	109	109	50	50	36	36	23	23
Panel B: PPP vote share 2013								
% Pop. Exposed	0.219	0.048	0.146	0.149	−0.036	−0.037	0.086	0.015
	(0.074)	(0.048)	(0.082)	(0.112)	(0.101)	(0.103)	(0.098)	(0.074)
Division FE		X		X		X		X
R-Squared	0.501	0.716	0.270	0.486	0.218	0.272	0.551	0.743
Observations	565	565	149	149	288	288	128	128
Clusters	109	109	50	50	36	36	23	23

(Continued)

Table 4: (*Continued*)

	National		Balochistan and KPK		Punjab		Sindh	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel C: PML-N vote share 2013								
% Pop. Exposed	−0.102	0.021	−0.102	−0.038	−0.021	0.098	0.091	0.015
	(0.081)	(0.059)	(0.110)	(0.112)	(0.139)	(0.163)	(0.056)	(0.054)
Division FE		X		X		X		X
R-Squared	0.427	0.657	0.309	0.385	0.178	0.233	0.212	0.275
Observations	565	565	149	149	288	288	128	128
Clusters	109	109	50	50	36	36	23	23

Notes: Unit of observation is a Provincial Assembly constituency. All regressions include geographic controls, i.e., *ex ante* UNEP flood risk, distance to major river, dummy for constituencies bordering a major river, std. dev. of the constituency's elevation, mean constituency elevation, and the percentage of the population affected by flooding in 2012. Results are almost identical if we include political controls, i.e., the outcome variable in 2008, the degree of political competitiveness in 2008 elections, a series of dummy variables indicating which major party represented the constituency between 2008 and 2013, and interaction terms between the party dummies and political competition. Electoral data collected at the constituency level from the 2002, 2008, and 2013 National Assembly and Provincial Assembly elections. Standard errors are clustered at the district level and reported in parentheses.

to have the largest effect where the floods "suprised" people. To assess this we re-estimate the models shown in Table 1, but include an interaction term between the UNEP *ex ante* flood risk and our measures of flood exposure. Table 5 presents the full results two different ways. Panel A shows the results across different sets of controls for the continuous interaction between flood exposure and *ex ante* risk. Panel B shows how the slope of the relationship shifts for places above and below a flood risk of 1 on a 0–5 scale, approximately the median of the risk distribution.

Once controls for the level of turnout in the past two elections are included (Columns 7–9) it is clear that the flood impact on turnout varies by the *ex ante* flood risk of a constituency: the lower the *ex ante* flood risk of a constituency, the greater the impact of the floods on turnout. In very low risk (*ex ante* flood risk = 0) constituencies, moving across the possible range of proportion of population flooded led to a substantively large 11.5 percentage point increase in turnout. In standardized terms a one std.dev. increase in flood exposure (.146) predicts a 1.7 percentage point increase in turnout in low risk areas, almost three times the average treatment effect in Table 1 (Column 9). For constituencies at the highest level of risk (*ex ante* flood risk = 5), however, there is no longer a statistically significant relationship between flood exposure and turnout. To illustrate the relationship visually Figure 4 shows the average marginal effects of a unit increase in flood exposure for different levels of *ex ante* flood risk from our preferred specification. We interpret these results as modest evidence that flood exposure had a greater impact where people were surprised by the flooding.

It is important, however, not to overstate the magnitude of the interaction effect. As Figure 4 makes clear the difference between the treatment effect from flood exposure at very high levels of risk vs. very low levels of risk is not statistically significant. To avoid assuming linearity in the interaction term, consider the regression in Panel B where we compare the slope of the coefficient on flood exposure in places below 1 on the risk scale with places above it. The slope shift is only statistically significant in one specification, but it is negative in all but one and not particularly close to zero once we control for levels of past turnout. As shown in Panel B (Columns 7–9) the marginal effect of flood exposure is always larger in low-risk areas, but is not statistically significantly so in our preferred specification ($t = 1.47$).

In Appendix C we provide survey evidence captured 5–17 months post-flood and 14 months pre-election that indicates a behavioral change among flood-affected individuals in so far as they seem to have invested more time and effort in acquiring political knowledge and become more supportive of aggressive political action.[21] Given that the survey data are cross-sectional,

[21] The survey results, in fact, generated the theoretical predictions in this paper. We thought the flood might influence support for aggressive political action/participation and

Table 5: Continuous and dichotomous interaction of exposure with flood risk.

	Controls			Controls and turnout trend			Controls and turnout levels		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Continuous Interaction									
% Pop. exposed	0.114	0.158	0.050	0.172	0.198	0.100	0.185	0.191	0.115
	(0.063)	(0.056)	(0.045)	(0.069)	(0.063)	(0.051)	(0.056)	(0.053)	(0.042)
Flood risk	−0.010	−0.014	−0.010	−0.009	−0.012	−0.008	0.001	−0.003	−0.001
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)
% Flooded × risk	−0.008	−0.005	0.007	−0.024	−0.015	−0.006	−0.029	−0.028	−0.020
	(0.017)	(0.018)	(0.011)	(0.022)	(0.023)	(0.015)	(0.015)	(0.016)	(0.011)
Marginal effects:									
Flood risk (25th pctile = .13)	0.113	0.157	0.051	0.169	0.196	0.099	0.181	0.188	0.112
	(0.061)	(0.054)	(0.044)	(0.067)	(0.061)	(0.049)	(0.055)	(0.051)	(0.040)
Flood risk (Median = .96)	0.107	0.153	0.056	0.149	0.184	0.094	0.157	0.165	0.096
	(0.049)	(0.042)	(0.037)	(0.052)	(0.045)	(0.038)	(0.044)	(0.040)	(0.033)
Flood risk (75th pctile = 2.22)	0.097	0.147	0.065	0.119	0.165	0.086	0.120	0.130	0.071
	(0.033)	(0.028)	(0.027)	(0.037)	(0.032)	(0.027)	(0.031)	(0.026)	(0.023)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.301	0.465	0.613	0.346	0.489	0.636	0.551	0.606	0.707
Observations	556	556	556	556	556	556	556	556	556
Clusters	109	109	109	109	109	109	109	109	109

(*Continued*)

Table 5: (*Continued*)

	Controls			Controls and turnout trend			Controls and turnout levels		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel B: Dichtomous Interaction with Flood Risk ≥ 1									
% Pop. exposed	0.153	0.149	0.063	0.192	0.177	0.095	0.202	0.184	0.114
	(0.067)	(0.066)	(0.053)	(0.066)	(0.065)	(0.051)	(0.055)	(0.058)	(0.046)
Flood risk ≥ 1	0.003	0.012	0.000	0.007	0.014	0.003	−0.008	0.002	0.000
	(0.013)	(0.010)	(0.009)	(0.014)	(0.011)	(0.009)	(0.012)	(0.010)	(0.009)
% Flooded $\times$ risk ≥ 1	−0.072	−0.005	0.004	−0.096	−0.018	−0.013	−0.107	−0.072	−0.061
	(0.063)	(0.064)	(0.047)	(0.065)	(0.063)	(0.046)	(0.053)	(0.056)	(0.045)
Effect differential by impact:									
Flood impact (Median = .07)	0.002	−0.012	−0.001	−0.000	−0.012	−0.002	0.015	0.002	0.004
	(0.013)	(0.010)	(0.008)	(0.014)	(0.011)	(0.009)	(0.011)	(0.009)	(0.008)
Flood impact (75th pctile = .21)	0.012	−0.011	−0.001	0.014	−0.010	0.000	0.030	0.013	0.013
	(0.017)	(0.015)	(0.012)	(0.016)	(0.015)	(0.011)	(0.013)	(0.012)	(0.010)
Flood impact (90th pctile = .42)	0.027	−0.010	−0.002	0.033	−0.006	0.003	0.052	0.028	0.025
	(0.027)	(0.026)	(0.020)	(0.026)	(0.025)	(0.018)	(0.021)	(0.021)	(0.017)
Province FE		X			X			X	
Division FE			X			X			X
R-Squared	0.303	0.466	0.613	0.347	0.489	0.636	0.553	0.606	0.707
Observations	556	556	556	556	556	556	556	556	556
Clusters	109	109	109	109	109	109	109	109	109

Notes: Unit of observation is a Provincial Assembly constituency. Models 4 through 6 control for previous turnout using a trend variable ($trend =$ turnout$_{08}$ − turnout$_{02}$). Models 7 through 9 control for previous turnout through 2002 and 2008 turnout level variables (turnout$_{02}$, turnout$_{08}$). All regressions include controls for *ex ante* UNEP flood risk, distance to major river, dummy for constituencies bordering a major river, std. dev. of the constituency's elevation, mean constituency elevation, and the percentage of the population affected by flooding in 2012. Marginal Effects in Panel A shows the effect on turnout at the indicated level of flood risk. Effect Differentials in Panel B show the difference between the effect of flood impact on high risk areas versus low risk areas (turnout$_{risk<1}$ − turnout$_{risk>1}$) at the indicated level of flood exposure (where the distribution is conditional on flood exposure > 0). Standard errors are clustered at the district level and reported in parentheses.

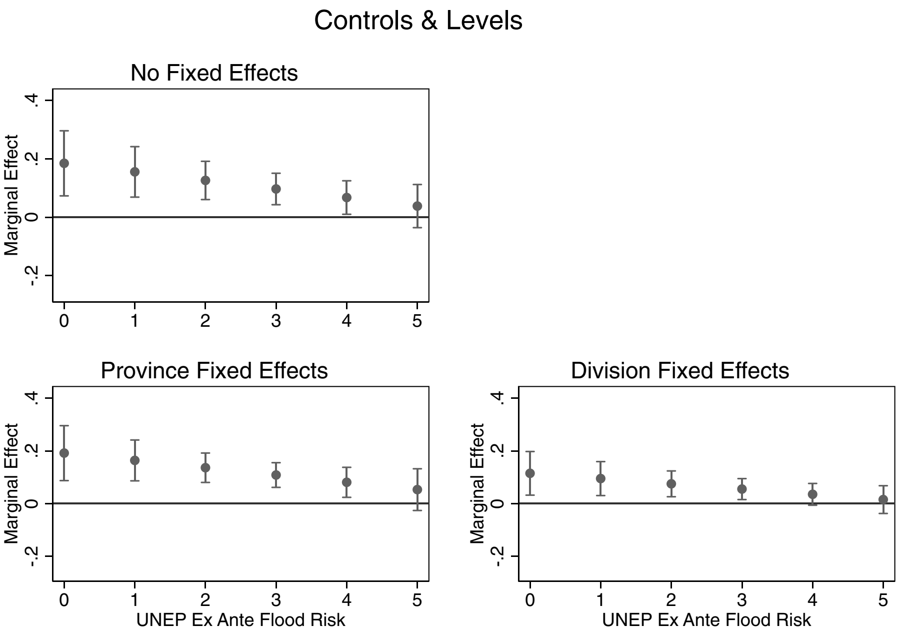

Figure 4: Average marginal effect of flood exposure by flood risk in the 2013 PA elections. Average marginal effects of a one unit change in the proportion of population exposed to the 2010–11 floods in a constituency for different *ex ante* flood risks (calculated from the UN Environmental Program (UNEP) and exposure measures). Flood exposure calucated using objective measures from 2010 Landscan population data along with UNOSAT flooded area data.

we are unable to make strong causal inferences. Nonetheless, we include information about the survey in the Appendix to better elucidate the inductive reasoning that generated the predictions in this paper.

Overall, our results suggest that turnout in the 2013 PA elections significantly increased across the flood gradient and did so more strongly in places that had a low *ex ante* flood risk than in areas with a higher flood risk. This heterogeneity together with the lack of consistent evidence of partisan response provides empirical evidence that is inconsistent with predictions from standard political accountability models, but is in line with our learning mechanism.

so built the vignette experiment described in Appendix C to test that hypothesis and fielded it in Spring 2012. Shapiro gave a talk on April 6, 2013, presenting results from that survey showing that those exposed to the flooding had more aggressive attitudes about demanding government services. During the talk several Pakistani scholars argued that if the results in the vignette experiment did capture aggressiveness about demanding government services then we should see increased turnout in the 2013 election. As the analysis above makes clear that appears to have been correct.

Robustness

We explore three alternative explanations for our findings to assess the robustness of the conditional correlation between flood exposure and turnout. First, we show that the result is not driven by differential response to flooding in urban areas. Second, we provide evidence that the effect is unlikely to be driven by compositional changes wherein people with a low propensity to vote left flood-affected areas and/or those with a high propensity to do so moved in. Third, we show that controlling for the distribution of food and shelter relief in the aftermath of the flood does not substantively change the results. This suggests that the increased political engagement in flood-affected PA constituencies is not an artefact of citizens rewarding aid spending.

Do the Results Reflect an Urban Effect?

One concern is that rapid changes in voting behavior that results from democratization are driving the result.[22] Voter participation tends to increase dramatically during democratization and the changes may be especially large in urban areas that had historically experienced low turnout. In Pakistan many of these urban areas are concentrated around the Indus River. Hence it is possible that these democratization factors are driving the correlation between flood exposure and turnout. While controlling for past turnout and trends would partially address this concern, a more direct test is to look for differences in the conditional correlation between flooding and turnout in urban areas vs. other areas.

To do so we use Landscan population data to classify constituencies as 'urban' if their population density is above the 75th percentile of the population density distribution, approximately 921 people per square kilometer.[23] Appendix Table B.2 shows that the conditional correlation between flooding and turnout is in fact weaker in urban areas. In the full sample (Columns 1–3), the conditional correlation between flooding and turnout is close to zero in urban areas but strongly positive everywhere else. Once the sample is restricted to constituencies near rivers (Columns 4–6) or just neighboring rivers (Columns 7–9), the effect in urban areas is statistically indistinguishable from that in other areas. Importantly, urban areas share common support with rural areas on flood exposure, so the estimate of the interaction term is valid. It is therefore extremely unlikely that our results are driven by the fact that

[22] We thank an anonymous reviewer for making this valuable point.

[23] For reference this is approximately the density of Tuscon, Arizona or Reno, Nevada according to the 2010 census. Using the median population density of 403 people per square kilometer, approximately two-thrid the population density of sprawling Atlanta, Georgia, does not substantially alter the results.

urban areas were more likely to be flooded and saw greater turnout increases due to the natural progress of democratization.

Is This Just a Compositional Effect?

An immediate concern with any analysis of the impact of a natural disaster which is not based on individual-level panel data is that we may simply be picking up a compositional effect. If people who moved out after the floods were systematically less likely to vote than those who stayed put (or moved in), then the changes we are attributing to the flood's impact on individual civic engagement could actually be an artifact of those migration decisions.

This possibility seems unlikely to drive our results for several reasons. First, there is no evidence in surveys designed to study migration that there were significant, permanent population shifts in Pakistan due to the 2010–11 floods, either to or from flood-affected districts (Mueller *et al.*, 2013). Less than 2% of those reporting their village was hit in the 2010 or 2011 floods in a nationally representative panel study were living in a different village than in 2001.[24] That would be inadequate to cause effects of the size we observe.

Second, the particulars of Pakistan's voting system also make it unlikely that compositional changes are driving the results. The major door-to-door voter registration effort by the Electoral Commission of Pakistan for the 2013 election occurred from August 22 to November 30, 2011 (mostly after the 2011 floods). Voters were registered at the address on their national identity card and anyone not at home during the door-to-door drive could register until March 22, 2013 at their local electoral commission office by providing a national identity card. Because changing the address on one's national identity card is a relatively cumbersome process (it requires visiting an office with either proof of property ownership or a certificate from a local government representative), many people choose to vote where they were registered rather than changing that address. This registration process means that if those who moved out were disproportionately inclined not to vote, then their registration would likely remain in flood-affected areas (there would be, after all, no reason for them to shift their registration if they do not plan to vote). This would introduce a downward bias, making our main estimates of the effects of the floods on turnout conservative.

We conduct three tests to assess whether compositional effects drive the results. First, we replicate Tables 1 and 2 using (valid votes/registered voters) as an alternative measure of turnout. As Appendix Tables B.3 and B.4 show all results remain substantially the same. This suggests that neither a sudden influx of highly competent voters (i.e., those more likely to cast valid votes) to flooded areas, nor a mass departure of incompetent ones (i.e., those less likely

[24] Private communication with the authors of Mueller *et al.* (2013).

to case valid votes) from such areas is driving the result. Second, we show that the results are unlikely to be driven by changing registration rates (i.e., out migration post-flood lowering the denominator in flooded areas). Appendix Table B.5 shows that registration is inconsistently correlated with flooding across different specifications and is positively correlated with flood exposure in our preferred specification (Column 9).

While we cannot rule out a compositional effect without better information on migration patterns, the aggregate migration figures and nature of the registration process make it unlikely. We provide suggestive evidence from our 2012 survey to generate a proxy measure for migration and include it in our core turnout regressions. We first calculate the number of respondents reported suffering from flood damage who lived in 2012 in places that were not affected by the 2010–11 floods. If we assume that all those reporting any damage who live in unaffected districts migrated because of the flood, then we estimate that 4.6% of the population in unaffected districts are migrants from the flood-affected regions and that a total of 2.05% of Pakistan's population migrated as a result of flood damage. This is surely an overestimate as many of those who report being affected but live in districts with no flooding either moved for other reasons, are referring to damage suffered by kin, or answered based on damage suffered from monsoon rains in the summer of 2010. Still, we can use our estimates of migration to benchmark the difference in electoral behavior attributable to the impact of the flood.

The simplest way to do so is to estimate the migration rates for the 61 districts in our survey (recall the sample was designed to be district representative) and include the estimates of the proportion of migrants in a district in our core regressions. If people who moved out were less likely to vote, then we should see a negative conditional correlation between the number of migrants in unaffected communities and our outcome variables. Panel A of Appendix Table B.6 shows that controlling for migration generally has little impact on the correlation of interest in the full sample (Columns 1–3) compared to the main results, but could account for roughly half of the flood exposure effect in places neighboring rivers (Columns 7–9). Instead of controlling for migration directly — since our measure of migration is restricted to a subset of constituencies and does not capture in-migration by people unaffected very well — we can also estimate our baseline regressions for the PA constituencies that we estimate did not receive any migrants using our imperfect definition (i.e., those in districts we surveyed that were either clearly hit by the floods or that had no one report flood exposure). As Panel B shows the core results remain substantially unchanged within that sub-sample. Hence, it seems very unlikely that we are simply capturing the impact of differential migration.

Does Increased Turnout Reflect a Reward for Relief Efforts?

The final concern is that the turnout effects merely reflect "turnout buying" arising from relief spending (Nichter, 2008). To measure relief spending we used district-level data on food and shelter disbursements provided by the National Disaster Management Authority. We then constructed a standardized additive index of total aid disbursement from eight categories of shelter relief and the standardized amount of food relief.[25] Note that our aid data are at the district level and may therefore mask intra-district variation in disbursements that are correlated with constituency-level flood exposure, so this is not as strong a test as one might like.[26]

We first examine how our baseline results in Table 2 change if we control directly for relief efforts at the district level. If relief effort is the driving factor underlying our results, we should expect the inclusion of a variable for total flood relief to drastically attenuate the coefficient of our flood treatment. We find little evidence of this. Appendix Table B.7 shows that controlling for total flood relief has little impact on the size of our coefficient estimates of interest. Controlling for aid spending does attenuate the coefficient on population exposed due to its correlation with aid distribution in the full sample (i.e., R-squared = .25 in a regression of total flood relief on population exposed without division fixed effects and .42 including division fixed effects), but the resulting attenuation is generally less than 10 percent of the effect size. It therefore seems unlikely that gratitude for preferential aid spending in the immediate aftermath of the floods is driving the results.

We also added total flood relief to our models of major party vote shares.[27] Again, we find little evidence that voters rewarded the national or provincial ruling party for what was generally considered to be an effective response (particularly compared to previous floods in Pakistan) or disproportionate flood relief. Our estimates of flood exposure remain almost identical in size and inconsistent across specifications. Moreover, the coefficient estimates of total flood relief have no consistent sign and are generally insignificant, providing little evidence for a patronage effect.

[25] The eight categories of shelter aid were: tents, tarpaulins, ropes, toolkits, blankets, kitchen kits, bedding, and plastic mats. The data record the count of each item distributed at the district level.

[26] Higher resolution aid data were collected during the recovery effort but unfortunately erased when the NDMA changed its website and computer systems in early 2013. Personal communication with NDMA officials, November 15, 2013.

[27] Results available from authors.

Conclusion

We have shown that in the case of the 2010–11 Pakistani floods — the largest floods in the last 20 years in Pakistan — a major natural disaster led to greater political engagement. In early-2012, 5–17 months after the most recent floods, citizens exposed to the disaster knew more about politics, reflecting a greater investment in acquiring political information. In May 2013, 14 months later, citizens in those same areas turned out to vote at substantially higher rates compared to otherwise-similar unaffected constituencies, exactly as one would have expected, given the survey results.[28]

Examining underlying mechanisms, three pieces of evidence point toward the previously described psychological and social changes in the aftermath of natural disasters (e.g., Bardo, 1978; Bolin and Stanford, 1998; Levine and Thompson, 2004; Rodriguez *et al.*, 2006; Toya and Skidmore, 2014; Vollhardt, 2009). First, the survey results are consistent with citizens becoming more politically engaged in hard-hit areas. Second, the effects described above were particularly strong in the subset of places that had a low *ex ante* risk of being flooded (i.e., those places that were genuinely surprised by the flood). Third, we found only modest evidence that these changes in electoral participation reflect citizens rewarding politicians for their relatively effective handling of the disaster. Instead, the data suggest to us that flood exposure can highlight the importance of a responsive government and community, which creates incentives to invest in political knowledge and to become more politically engaged.

Overall, this is good news for policymakers worried that natural disasters in weakly institutionalized countries undermine democratic institutions. Exposure to natural disasters that are well-handled might actually highlight the necessity of governmental services and foster citizens' political engagement. Future research should assess this possibility further in the following three ways. First, it is important to test more directly the underlying psychological and social mechanisms. Second, we need to assess whether the increase in political engagement we identified actually leads to policy changes, such as the provision of local goods and services across the flood boundary. Finally, an open question is how long these effects last. What we know now is that the floods had enduring political effects two years on, but evidence from work in Germany suggests we may expect effects even long after that (Bechtel and Hainmueller, 2011).

From a policy perspective, the increase in political engagement we observed in Pakistan most likely depended on a relatively effective government response, one that was far more effective than outsiders expected it would be. Policy-makers can do a great deal to enable such responses.[29] By reallocating modest

[28] And as our Pakistani colleagues did expect in April 2013, as noted in Section 5.

[29] Andrabi and Das (2010) show that international aid helped significantly in the wake of Pakistan's devastating 2005 earthquake, for example.

funds from their current investments in response, donors could support regular exercises in coordinating large-scale aid flows with emergency management authorities in disaster-prone areas. In doing so they would create the social and organizational ties that can enhance cooperation in the wake of a disaster.[30]

Our results also speak to three additional literatures. First, these results raise questions about the interpretation of a broad set of papers that use natural disasters as a source of variation in economic conditions that is plausibly exogenous to political factors (e.g., Brückner and Ciccone, 2011; Burke and Leigh, 2010; Chaney, 2013; Miguel *et al.*, 2004). The economic impact of disasters can obviously be highly contingent on government response. And even when that response effectively minimizes economic impacts, we can still observe large changes in citizens' political attitudes and behavior. Thus, the exclusion restriction in a number of recent papers on political liberalization and democratic transition is clearly violated in at least one important case and may be in others.

Second, we provide valuable evidence on the question of what drives governments from patron-client systems — which focus on providing targeted benefits to supporters at the cost of services with larger collective benefits — to programmatic systems focused on effective service provision. Most work on the subject has focused on elite bargaining and has left unexamined how changes in citizens' preferences impact elite incentives (e.g., Acemoglu and Robinson, 2012; Shefter, 1977). Yet, as Besley and Burgess (2002) show theoretically and empirically, more informed and politically active electorates create strong incentives for governments to deliver services.[31] The evidence from Pakistan, a country long considered a stronghold of patronage politics, suggests that exogenous events can create just such changes in the electorate.

Finally, our results are relevant to the emerging academic literature on the impact of natural disasters on conflict and to government decision makers planning disaster response. Scholars in this literature typically find a positive relationship between natural disasters and conflict (see e.g., Brancati, 2007; Ghimire and Ferreira, 2013; Miguel *et al.*, 2004), though there are exceptions (Berghold and Lujala, 2012). These findings worry many as climate change is predicted by most models to lead to a long-run increase in the incidence of severe weather-related disasters (Burke *et al.*, 2013). The evidence from Pakistan suggests that effective response to such disasters can mitigate their negative political consequences. In this case, the international community provided a great deal of post-disaster assistance which the state effectively coordinated. The net result was an increase in legal political engagement by citizens in flood-affected regions compared to non-affected regions. The results

[30]Establishing those ties is a key reason allied militaries regularly exercise together and there is no reason to think similar dynamics do not apply in the disaster response field.

[31]Pande (2011) provides a review of experimental evidence showing that providing voters with information improves electoral accountability.

thus provide micro-level evidence that aid in the wake of natural disasters can turn them into events which enhance democracy, a possibility consistent with the cross-national pattern identified in Ahlerup (2011), who finds that natural disasters are correlated with democratization in countries that are substantial aid recipients. Overall, our findings suggest enhanced investments in helping poor countries respond well to natural disasters could yield long-run political gains in addition to their obvious economic value.

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