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Understanding Climate-Security Risks: A Mechanism-based Approach

By Zafar Imran, PhD

Executive Summary

Whether climate change can stoke political violence and civil conflict is a critical and controversial question. Differences in methodological traditions (qualitative vs. quantitative) are often blamed for academic infighting over this question. This brief suggests that the real problem lies with an impoverished understanding of the process of climate change, particularly how social and ecological systems interact, and how changes in either propagate through the other and generate feedbacks. By presenting a dynamic understanding of the climate-conflict equation, this brief presents a mechanism-based analytical framework that can be used to study the complex phenomenon across diverse social settings. It illustrates the approach by tracing mechanisms through which climate change is fueling protests by farmers in Pakistan, and suggesting other potential applications.

In recent years, the "press and pulse of climate change"[1] has increased in frequency and severity around the world. Gradual change in long-term climate trends superimposed with extreme weather events have been deemed at least partially responsible for the social stresses leading up to violence in Darfur and Syria, a spate of farmer-suicides in India, internal and external displacement of vulnerable populations in Bangladesh, and human insecurity in many parts of West Africa, South and Central America. Climate change appears to be taking a toll on agriculture even in rich countries such as the United States, imposing social stresses on farming communities and contributing to political tensions.

Despite a broad consensus that climate change threatens human security, scholars have struggled to agree about whether and how climate change affects social and political instability. The differences are conceptual and analytical. Conceptually, there is no consensus over whether climate-induced scarcity will engender resource competition and ultimately conflict, or trigger the type of human ingenuity and cooperation that has sustained our species thus far. The two positions are sometimes called neo-Malthusian and Cornucopian views.

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[1] Harris et al., (2018). Biological responses to the press and pulse of climate trends and extreme events. *Nature Climate Change*, *8*(7), 579.

On the analytical front, the battle is about whether qualitative or quantitative methodology is most suited to studying the climate-conflict phenomenon in a systematic and scientific manner. Those in the quantitative camp look for generalizable macro-level statistical associations between climate variables and predictors of conflict. Qualitative scholars pursue a deeper, albeit context-specific, understanding of the phenomenon through case studies.

These academic debates have frustrated the defense community, who must deal with the security challenges of climate change,[2] and also the development and environmental communities who try to mitigate them. By perpetuating preexisting social inequities and creating new ones, climate change erodes development gains already made. It also jeopardizes the ongoing and future efforts aimed at fostering human security and sustainable development.

Climate scientists have tried to fill the knowledge gap by modelling general "pathways" that illustrate how various climate change scenarios may affect global society, demographics, and economics.[3] Yet, local factors, especially local perceptions of a climate stressor and subsequent coping responses, cannot be adequately represented in general models. Therefore, developing a deeper, more systematic understanding of how climate change interacts with social, political, and economic systems at local levels is of paramount importance.

This paper offers a blueprint for developing such an understanding by shifting the focus from "whether a link exists between climate change and conflict" to *how* climate change induces instability in a society. I argue that because the final outcome of the causal chain connecting the cause (climate change) with the effect (conflict/cooperation) varies from one society to the next, intermediate generalizable mechanisms can and must be identified to explain the variance. Identification of these intermediate robust "chunks of theory" will help trace the process of climate-society interaction at various stages. It will also facilitate development of targeted policy interventions throughout the process to mitigate or even preempt undesirable outcomes.

The next section presents conceptual constructs needed for reformulating the climate-security problem, and a rationale for a mechanism-based approach for analysis. The middle section applies the framework to Pakistan and shows how local-level climatic changes are interacting with the society's preexisting social, political, and economic processes to fuel an increasingly contentious protest movement among affected farmers. The final section suggests how the analytical approach can be generalized by applying it to structurally dissimilar cases around the world.

Towards a dynamic understanding of climate-society interaction

A common shortcoming in the climate-security literature is the assumption that the process of climate change, and its interaction with a society, unfold in the same manner across cases. In the neo-Malthusian formulation, vulnerable populations are assumed to resort to resource-capture

[2] Brosig et al. (2019). *Implications of climate change for the U.S. Army*, United States Army War College.; Brock et al. (2020). *The World Climate and Security Report 2020*, International Military Council on Climate and Security.
[3] Riahi et al., (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: An overview, *Global Environmental Change*, Volume 42, pp. 153-168.

and violence.[4] Similarly, in the Cornucopian formulation, vulnerable populations employ "efficient" and "appropriate" adaptation measures.[5]

Both of these assumptions are limiting. Human beings have always been adapting to environmental changes. Assuming that climate change will produce a direct shift of a society into conflict at the first signs of scarcity is overly simplistic. Similarly, the success or failure of adaptation measures will depend on a society's preexisting social structure and on information available to vulnerable populations about the climate stressor. Distortions caused by entitlements or inaccurate local perceptions can lead to unsuccessful or even maladaptive coping responses. A linear conception of the relationship between climate change and conflict also ignores the effects of globalization, especially how global commodity markets impact local food security. As international trade interweaves with local economies, the effects of climate change and (mal)adaptation can traverse the entire global economy. A society's political economy and food security can unravel due to climate events taking place elsewhere in the world.

An alternative approach

To take these complexities into account, I propose an alternative conceptualization of the relationship between climate change and security, based on three broad claims:

1: Climate change is a complex process that manifests in varied fashions within and across societies around the world. Assessing climate change using only a few variables (e.g. temperature and rainfall) fails to capture all it unleashes on vulnerable populations.

2: Social and ecological systems are tightly coupled. The slightest change in either will trigger adjustments in the other. In the case of climate change, these adjustments come in the form of coping responses from vulnerable populations.

3: Macro social phenomena such as social movements, rebellions, and civil conflict are not born at the macro level. Nor do they erupt overnight. Instead, they result when individual grievances and uncoordinated expressions of unrest coalesce into organized and sustained episodes of political contention and violence.

Climate change is a complex process. The earth's climate consists of different biophysical components interacting with each other to create an environment more or less conducive for social and ecological systems to survive. This complexity is cascaded in climate systems at regional and local levels. A society's hydrology and weather patterns, such as stream-flows, temperature, precipitation, humidity, cloud-cover-days, degree-days, wind patterns, and meteorological calendars, produce a unique combination of environmental conditions. Change in any one (or more) of these components will have system-wide ramifications.

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[4] Homer-Dixon, T. F. (1994). Environmental scarcities and violent conflict: evidence from cases. *International security*, 19(1), 5-40; Kahl, C. (2006). *States, scarcity, and civil strife in the developing world*, Princeton University Press.

[5] Mendelsohn, R. (2000). Efficient adaptation to climate change. *Climatic Change, 45*(3), 583-600; UNFCCC. (2007). *Climate change: Impacts vulnerabilities and adaptation in developing countries*, (p. 10).

A review of the sprawling climate change literature indicates some key considerations:

1. Climate change has many manifestations. Most of the quantitative climate-security literature relies on only four climate-related independent variables: precipitation, temperature, sea level, and natural disasters.[6] Yet, Savo et al. reviewed 10,660 observations from 2,230 different localities in 137 countries and reported that observed changes in climate and weather included unpredictable weather patterns, shifting meteorological calendars, highly variable snowfall and snowmelt trends, spatial and temporal changes in wind directions and intensity, increased severity of rainfalls, and many other variables.[7] Their finding is consistent with a growing realization among climate scientists that the term "global climate disruption" more accurately captures the breadth, magnitude, and intensity of instability caused by changes in the earth's temperature.[8]

2. Changes in the natural system are not uniform spatially or temporally. Despite the illusion of uniform changes in the earth's climate, owed in part to the consistent rising trend of the global temperature, climatic changes are not uniform at local levels. Like the global climate, local and regional climates are also complex systems, each with its own sets of intra-annual and intra-seasonal long-term trends that maintain social-ecological balance at local and regional levels.[9]

The effects of changes in long-term trends of a climate variable can also vary across societies. Shifts in precipitation patterns will have much more pronounced effects in a society where farmers rely primarily on rainfall than where they have access to surface or ground water. Similarly, a change in temperature will affect different crops (and economies) differently.

Additionally, a society may also consist of more than one agro-ecological zone—areas of land with "similar characteristics related to land suitability, potential production and environmental impact."[10] Generalizing the effects of climatic changes at the national level may mask spatial heterogeneity in both climate trends and their effects on local populations and economies.

Social and ecological systems interact through coping responses. The rich concept of social-ecological systems (SES) is most suited to explain the complexity involved in climate change and its interaction with society.[11]

[6] Theisen, O. M., Gleditsch, N. P., & Buhaug, H. (2017). Climate change and armed conflict: Reviewing the evidence. In M. Stohl, M. I. Lichbach, & P. N. Grabosky (Eds.), *States and peoples in conflict: Transformations of conflict studies* (pp. 113-129). New York: Routledge.
[7] Savo et al. (2016). Observations of climate change among subsistence-oriented communities around the world. *Nature Climate Change*, *6*(5), 462.
[8] Holdren, J. (2017). Why the Wafflers are Wrong: Addressing Climate Change is Urgent (and a Bargain). In *World Conference of Science Journalists*. San Francisco.
[9] Svenning, J. C., & Sandel, B. (2013). Disequilibrium vegetation dynamics under future climate change. *American Journal of Botany, 100*(7), 1266-1286.
[10] FAO. (1996). Agro-Ecological Zoning Guidelines. *FAO Soils Bulletin,* Vol. 73.
[11] Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419-422.

1. Natural and social systems are tightly coupled. Extreme weather events cause widespread destruction in a short amount of time, but most changes in climate and weather patterns unfold gradually, interacting with a society via coping responses employed at varying levels, which are not always efficient adaptations from either an individual or a collective perspective. Farmers may resort to drawing water from aquifers to make up for surface water shortage. They may also shift sowing and harvesting schedules; switch crops; intensify agricultural inputs such as pesticides, fertilizers, irrigation waters; or employ other individual-level coping responses.

The effects of climate change are not limited to the agriculture sector. Climatic changes in a river basin may create stresses on downstream populations that use water for other purposes. Distributional conflicts between using water for irrigation vs. power generation can create acute energy shortages, creating additional stresses in virtually every part of a society, from urban populations, to businesses, to manufacturing sector, etc.

Collective-level coping mechanisms are also at work. Faced with unpredictability and change in available natural resources, governments and other institutions will reassess their resource distribution priorities. Markets and businesses will respond both to the direct effects of climatic changes, and also to the impact of coping responses employed by vulnerable populations, state institutions, and international organizations. Painting a full picture of climate-induced instability must include how a society's adjustment efforts mediate stresses imposed by the changing environment.

Depending on how successful or dysfunctional they turn out to be, these adjustment efforts determine whether a society plunges into instability or becomes more resilient.

2. Adaptation under complexity: Uncertainty resolution, not optimization. The foundational assumption of Cornucopians and the climate adaptation framework is that vulnerable individuals and societies will act as self-interested, rational agents. They will employ "efficient private adaptation" that promotes efficiency, minimizes externality, and reduces overall costs imposed by climate change. Given the level of uncertainty climate change imposes on vulnerable populations, though, this assumption is unrealistic. Field reports from around the world note that unpredictability and complexity attributable to climate change are resulting in bounded-rational and inefficient coping responses.[12]

Scholars of information and cognitive sciences have long argued that the human mind lacks the computational resources needed to calculate the most optimal and efficient solutions in times of uncertainty. Instead, it responds to complexity by taking (coping) measures aimed only at the narrow, short-term goal of resolving uncertainty.[13] Such shortsighted adaptation measures may generate feedbacks that resonate through society.

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[12] Boonstra, W. J., & Hanh, T. T. H. (2015). Adaptation to climate change as social–ecological trap: a case study of fishing and aquaculture in the Tam Giang Lagoon, Vietnam. *Environment, Development and Sustainability,* 17(6), 1527-1544; Cinner, J. E. (2011). Social-ecological traps in reef fisheries. *Symposium on Social Theory and the Environment in the New World (dis)Order,* 21(3), 835-839.

[13] Steinbruner, J. D. (1974). *The cybernetic theory of decision: New dimensions of political analysis*: Princeton University Press; Mullainathan, S., & Shafir, E. (2013). *Scarcity: Why having too little means so much*: Macmillan.

3. Double exposure (to climate change and global trade). Since local societies are interwoven in the global fabric through international trade, the effects of climate change on one society can instigate social and political disruption elsewhere in the world. "Double exposure"—simultaneous exposure to climate change and international trade—imposes additional pressure on vulnerable societies.[14] For instance, droughts and wildfires in wheat-exporting countries (think China and Russia in 2008 and 2010, respectively) may contribute to widespread instability in wheat-importing countries (think Egypt in 2011).

Social stresses traceable to climate change fester and evolve over time. Complex, contentious events, such as social movements, rebellions, and civil conflicts rarely, if ever, spring up extemporaneously. Instead, non-violent expressions of unrest usually fester over time before transforming into violent contention. Interaction among aggrieved groups realigns them by mobilizing and demobilizing certain actors, building coalitions, recruiting new members, broadening identities, etc. Expressions of unrest also evolve depending on what opportunities political entrepreneurs foresee, and how the state responds as a social movement unfolds.

Similar evolutionary processes are at work in other collective manifestations of social stress, such as migration. As is true of civil conflict, the decision to migrate is not a spontaneous one. Identifying intermediate mechanisms is essential to understand the causal chain connecting the original stressor with the final outcome of vulnerable populations leaving behind their homes, jobs, and families to embark on a perilous journey.

These three processes—climate change, climate-society interaction, and the evolution of social movements traceable to climate change—do not always occur in a linear fashion or one at a time. Sudden and severe weather events, such as a flash flood or a heat wave, might destroy livelihoods overnight, catapulting a society into chaos before vulnerable populations have time to adjust. In other situations, the effects of a natural disaster may fester, and even multiply by interacting with a society's antecedent processes, long after a climate event has occurred.

A mechanism-based approach to explain complex climate-security risks

Using a mechanism-based approach instead of fishing for macro-level statistical associations between structural variables makes it possible to identify generalizable pieces of a causal chain in the three processes of climate change, climate-society interaction, and contentious politics. Mechanism-based explanations are not purely descriptive and anecdotal accounts of unique chains of events connecting a particular cause with an effect. Mechanisms are generalizable pieces of theory found in a range of different social settings. They operate according to the same logical principles and produce the same or similar effect across contexts.

This approach is based on two profound insights from sociological and political theories:

[14] Leichenko, R., & O'Brien, K. (2008). *Environmental change and globalization: Double exposures*: Oxford University Press.

1. Big structures and sequences of social phenomena seldom repeat themselves exactly, but result from varying combinations of generalizable mechanisms. Although, the causal chain connecting climate change with social and political instability in society A may not repeat itself exactly in society B, and vice-versa, some generalizable mechanisms, such as uncertainty minimization or tunnel vision, may be common to both. The outcome in each society will depend on which mechanisms are triggered, and in what sequence and combination they concatenate to complete the causal chain leading up to that outcome.

2. Macro-level social phenomena, such as social movements, civil conflict, and migration are not born at the macro level. Several variables, by interacting with micro- and meso-level causal mechanisms and processes, influence individual actors. Over time, individual-level grievances morph into collective expressions of unrest and contention that may turn violent.

Tracing the mechanisms through which climate change can lead to conflict provides a high-resolution understanding of the phenomenon. The analytical flexibility of the mechanism-based approach also resolves the paradox as to why climate change causes a particular outcome (conflict, cooperation, or migration) in one society but not in others.

Application to Pakistan

Being an agricultural country, Pakistan's socio-economic and political stability is tied to predictable weather patterns and sustained stream-flows of the Indus River and its tributaries. As climatic changes unfold in the Upper Indus Basin—the higher reaches of the Karakoram glaciers—downstream populations are feeling the effects of shrinkage in Indus stream-flows. How they are affected and how they respond, though, depends on their location, their entitlements, their perceptions, and other factors. Spatial and temporal changes in meteorological patterns are also disrupting agricultural production in the country's nine agro-ecological zones. The result is widespread unrest in Pakistan's agricultural community, especially among small- and medium-sized farmers, who lack the resources for successful adaptation. In recent years, this unrest has manifested in a farmers' movement, currently aimed at policy change, that has mobilized small farmers in all corners of the country.

Changes in climate trends. Most quantitative research on the climate-conflict relationship measures variables at the country/year level, but using higher-resolution data reveals important variations by location and date that disappear at the country/year level. Time-series analysis of long-term records of extreme weather events, Indus stream-flows, and meteorological variables in Pakistan reveals important general trends and significant details:

1. The frequency of extreme weather events, such as flash floods, heat waves, hailstorms, cold snaps, etc., has significantly increased in recent decades (Fig. 1). These events are not just unseasonal (temporal change), they are taking place in areas with almost no history of such events happening before (spatial change).

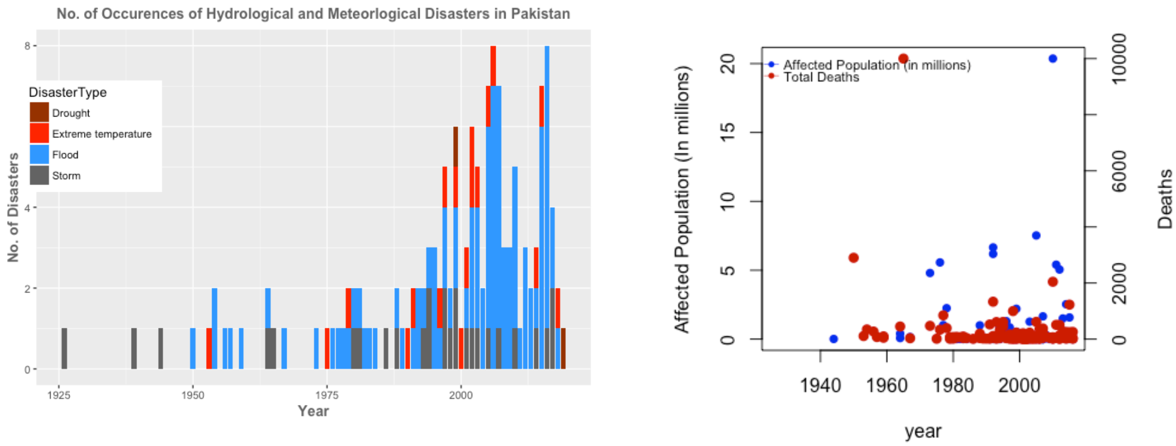

Fig. 1: Extreme weather events in Pakistan over the years
Data source: EMDAT

2. Long-term records of Pakistani meteorological variables (1950-2013) and water flow in the Indus River and its tributaries (1922-2011) show that changes in climate trends in the country are also spatial, with meteorological trends changing differently across regions, sometimes in ways that cancel each other out nation-wide. These records also show significant intra-annual change – revealing widespread variability and long-term change *within* a year, but little or no deviation of annual average values from long-term mean.

More specifically, Indus stream-flows show a downward trend during the peak summer months (Fig. 2) when demand for water is the highest for both irrigation and hydroelectric power generation. Due to preferential treatment of the agriculture sector, distributional conflict has produced an acute energy shortage, with power outages lasting up to twenty hours a day in most parts of the country. These outages inadvertently hurt farmers too, because they need electricity for accessing the underground water for irrigation.

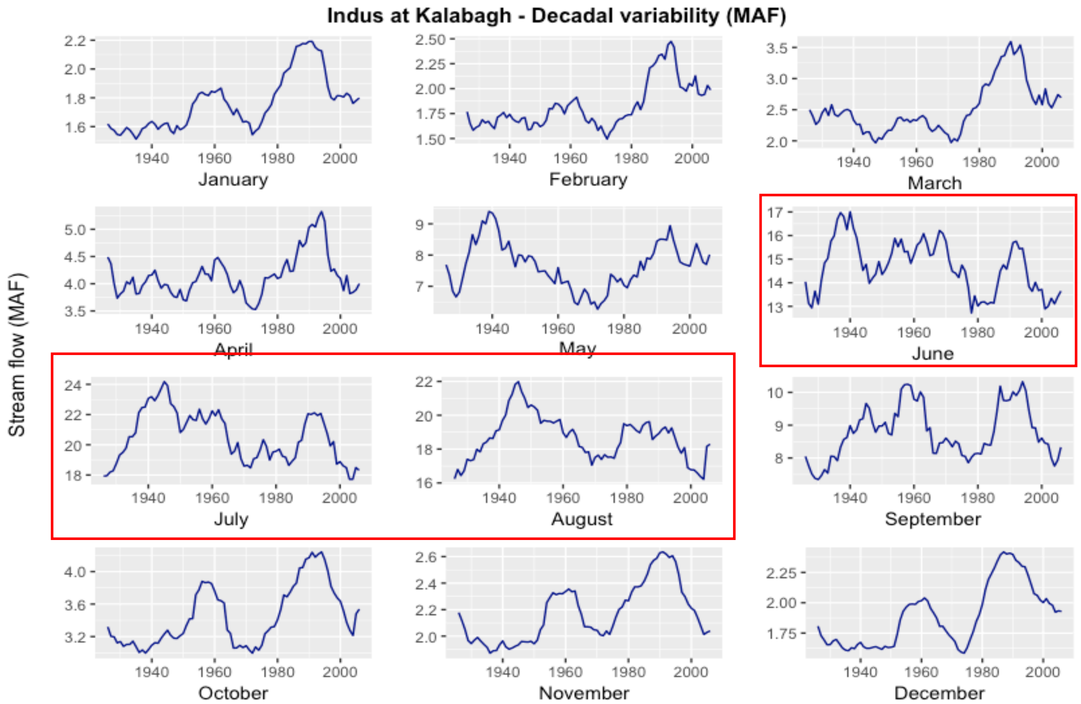

Fig. 2: Indus stream-flows at Kalabagh (1920-2011)
Data source: National Engineering Services of Pakistan (NESPAK)

Climate change is most visible in meteorological trends (Fig. A-2). Meteorological calendars have shifted by at least two months, with a warming trend in winter months throughout the country. Temperatures start to rise as early as February or March, and are often punctuated with unpredictable extreme weather events such as hailstorms and heatwaves. Fall and winter seasons have become significantly shorter, and the summer season has lengthened. The summer season in historically hot and dry regions of the country has become cooler and wetter, while the historically colder regions in the country's northern areas face significant warming in their climates.

Effect on agricultural system. The direct effects of climate change in Pakistan are readily discovered through interviews with farmers, even though they do not always show up in aggregate data on agricultural yields. They include crop failure due to water shortage, heatwaves, flash floods, unpredictable rainstorms, hailstorms, cold snaps, etc. Early onset of higher temperatures results in forced maturation and resultantly poor crop yield. Cold snaps, especially in the early phase of cultivation, stunt crops' growth. Cooler temperatures in previously hot and dry regions result in poor yield. Also, changes in diurnal temperatures provide suitable environment for pests to multiply rapidly. The combined effect has been frequent crop failures and/or the plummeting yields of most major and minor crops (Fig. 3 & A-3).

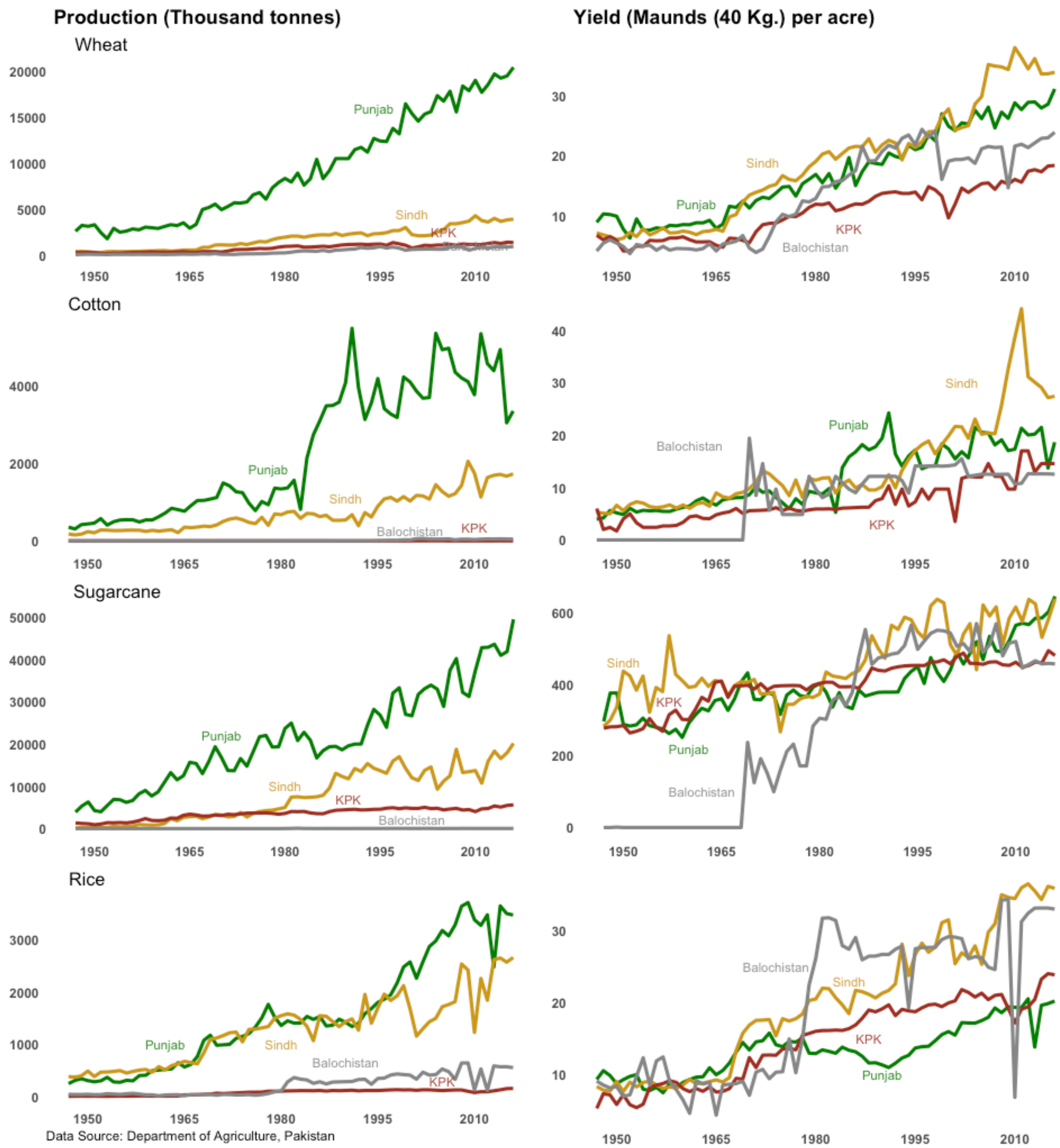

Fig. 3: Production and Yield of major crops
Data source: Department of Agriculture, Pakistan

Although acutely aware of changes in local weather patterns, Pakistan's farmers lack knowledge of long-term climate trends, so they often adopt shortsighted coping strategies. For example, instead of adopting conservation measures in recognition that water shortages will become more severe over time, farmers have resorted to groundwater overdraft, i.e. pumping the aquifer at a rate much higher than the rate of recharge. Not only is this practice unsustainable, it is also uneconomical. It makes the water table sink, which increases the energy needed to pump water. Farmers also intensify their use of fertilizers and pesticides as a way to increase crop yields when water is scarce. Yet, the increased cost of production has made Pakistani farmers uncompetitive. Running losses crop after crop, many small farmers are abandoning agriculture as a vocation.

Those farmers who manage to stay afloat tend to minimize climate-induced uncertainty by switching to other less risky, albeit less profitable, crops (Fig. A-4). As more struggling farmers imitate each other by switching to the same crop in a cultivation cycle, though, prices crash due to overproduction, and more farmers go bankrupt. In the past few years, the price of almost every major and minor crop grown in Pakistan has crashed at some point due to overproduction. Swaying like a pendulum between overproduction and shortage, local commodity markets have become highly unstable. This damages Pakistan's manufacturing sector, which was designed around the cheap and predictable supply of locally produced agricultural commodities. Thousands of manufacturing units have shut down or moved abroad due to power outages and the increased cost of production, leaving behind hundreds of thousands of unemployed factory-workers.

Apprehensive to pass the price increase to the general public out of fear of widespread political unrest, successive governments have unsuccessfully switched between protecting local farmers by subsidizing the ever-increasing cost of agricultural production and allowing the import of cheaper commodities. Both are difficult and unsustainable options for the state. Protecting local agriculture that has been rendered uncompetitive by climate change and suboptimal coping responses requires massive deficit spending in the form of farm subsidies, soft loans, subsidized agricultural inputs, etc. Alternatively, allowing the import of cheap agricultural commodities undercuts local farmers, and results in massive unemployment and social unrest.

Lastly, Pakistan's farmers are also vulnerable to the effects of other societies undergoing similar stresses in their respective agriculture systems (Fig. A-5). For example, during the global food crisis of 2010, the sudden increase in global grain prices resulted in most of Pakistan's grain being smuggled to countries where it could fetch a higher price. Domestic food shortages triggered riots in most cities in the country. Unrest also occurred in subsequent years for obverse reasons when Pakistan's farmers, unable to compete with low commodity prices in the international market, saw their fortunes plummet almost overnight.

Contentious politics

The result of these direct and indirect effects of climate change has been so destabilizing for farmers, especially the small- and medium-sized farmers in the southern parts of Punjab and Sindh provinces, that early signs of a social movement are observable. Although this social movement is currently aimed at policy change, farmers' protests are becoming more organized and violent.

The natural progression of farmers' unrest is manifesting in the form of their mobilization and organization as they struggle to maintain their livelihoods. Political violence data retrieved from the Armed Conflict Location and Event Database (ACLED) shows a rapidly rising trend of Pakistan's farmers organizing at the grassroots level and mobilizing for contentious collective action. In the last five years alone, farmers of Punjab and Sindh—two predominantly agricultural provinces of the country—have carried out over 700 protests, sit-ins, rallies, and marches across the country (Fig. 4 & A-6).

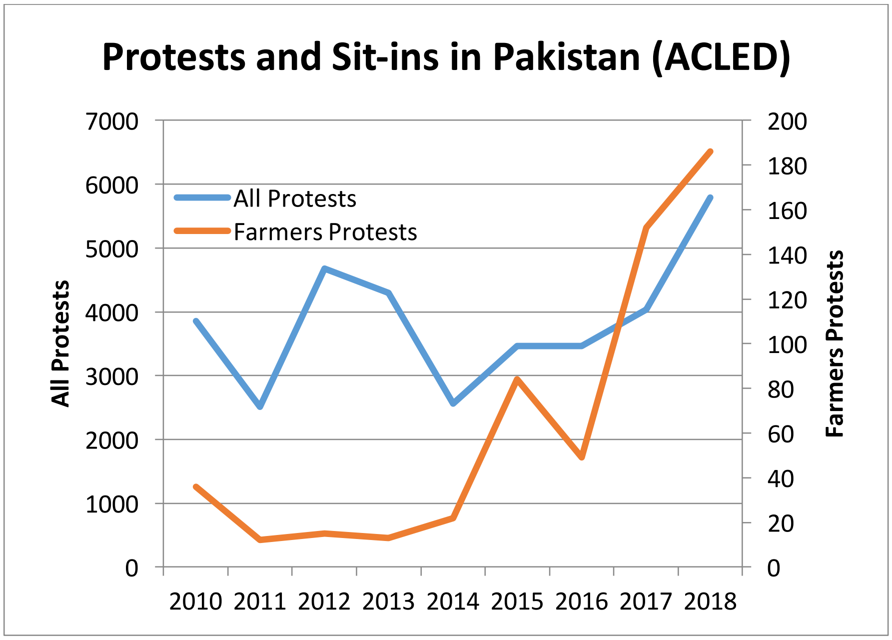

Fig. 4: Protests and sit-ins carried out by farmers in Pakistan
Data source: Armed Conflict Location and Event Database (ACLED)

The connection between the farmers' unrest and political contention is straightforward, if one traces the pathway(s) through which climatic changes are upending their livelihoods. In the past few years, so many crops have failed due to water shortage, pest attacks, or unseasonal weather events that farmers' protests have become a constant fixture in local and national news.

Expressions of unrest by struggling farmers have evolved too—from non-violent localized protests to increasingly violent and large processions, sit-ins, and even civil disobedience campaigns. Scores of farmers' representative organizations have sprung up throughout Pakistan. Farmers travel in large numbers from remote villages to big cities, and choke national highways, railways tracks, and important city squares.

In a very short time, and without any support from mainstream political parties or elites, ordinary farmers have carved out a separate space for themselves in the country's political landscape. This is of grave concern in a multi-ethnic nation-state where deep fault lines around identity and ethnicity crisscross the length and breadth of the country. These fault lines have deepened and widened due to climate change. Other social groups in Pakistan, such as small businesses and unemployed factory workers in cities, particularly in the textile industry that continues to suffer the most from energy shortage, may be undergoing their own evolution toward increasingly organized and contentious demonstrations of fear and frustration. If so, the government will have even more difficulty trying to respond in a way that does not fuel even more social unrest.

The way forward

The proposed framework offers a way to study *how* climate change can cause conflict by opening the black box and analyzing the inner workings of climate-society interaction. It provides a deeper understanding of the phenomenon at work in one location, and suggests mechanisms that could also be at work in other structurally similar societies as humans respond to uncertainty and complexity imposed by climate change. It directs researchers to ask what coping responses are being undertaken by farmers, herders, fishermen, etc., and how these responses are interacting with respective political economies at the local, national, and regional level? What is the "connective tissue" between individual grievances traceable to changes in the natural system and the decision-making calculus that culminates in social and political unrest including conflict or migration or both. It is only by finding answers to these questions that one can begin to look for an effective policy prescription before social stresses become too intractable to preempt or mitigate.

For example, in India*,* it is the intra-annual variability in rainfall trends that has destabilized the agriculture sector. Rainfall is the primary source of irrigation water in the country, and for centuries farmers have relied on its predictable schedule for their livelihoods. Too much rainfall in a single spell, and not enough for the rest of the crop-season translates into doom for poor farmers who often do not have resources to access ever-depleting groundwater. In the last thirty years, at least 59,000 farmers have committed suicide due to worsening financial conditions.[15]

A similar situation is brewing in Latin America, particularly countries in Central America, where climatic changes have led to successive crop failures in recent years, leaving some to suspect climate to be the cause of recent upticks in migration within and from the region.[16] Disentangling from the mix of confounding factors the role of environmental stresses would require tracing the climate change process as it unfolds in disparate agro-ecological zones in the region, and analyzing its interaction with respective societies.

Since this framework is not deterministic, it can be applied to study the effects of climate change even in structurally dissimilar cases. Climate change is destabilizing societies rich and poor alike. Its final outcome will vary from one society to the next depending on the nature of the stressor, how vulnerable populations respond to uncertainty imposed by climatic change, and how efficient or otherwise governments' decisions are in the face of direct and indirect environmental stresses.

Although the United States is much wealthier and more powerful than Pakistan, the situation is strikingly similar in key ways. Gradual climatic changes are taking place below the radar, interspersed with extreme weather events. Both destabilize livelihoods. According to the USDA, important metrics that influence plant growth, such as growing degree days, plant hardiness zones, and heat zones have already changed significantly and continue to do so.[17] Variability and change in intra-annual rainfall and temperature trends is increasingly catching farmers off guard.[18] Added to the mix are vagaries of double exposure to climate change and international

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[15] Safi, Michael, (2017). Suicides of nearly 60,000 Indian farmers linked to climate change, study claims, *The Guardian*, July 31, 2017.

[16] The migration problem is the coffee problem, *Washington Post*, June 11, 2019; Central American farmers head to the U.S., fleeing climate change, *The New York Times*, April 13, 2019.

[17] USDA Office of Sustainability and Climate (2018). Climate Change Pressures in the 21st Century. Retrieved from https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=96088b1c086a4b39b3a75d0fd97a4c40.

[18] House, Silas, (2020). Eastern Kentucky has been under water, but you probably didn't notice, *The Atlantic*; Lam, Linda (2020). Spring's record-late arrival in parts of the U.S. has a serious consequence, *The Weather Channel*.

trade,[19] which have made an already complex situation even more complicated for farmers. As farmers struggle to survive, grim stories of bankruptcies and even suicides have begun to pile up.[20] Societal fault lines are widening, and protest movements are forming. The Trump administration's response emphasizes measures that are popular with some vulnerable populations, like building a border wall to slow immigration and initiating trade wars. The likely result, though, will be higher consumer prices, more alienation, and increased deaths from despair. Without understanding how climate change is affecting Midwestern farmers, and how individual and collective coping strategies can be maladaptive, policy responses are bound to be inadequate or misguided.

Climate change is a global phenomenon that needs to be understood in local detail. Conducting more case studies is essential to understanding the full scope of the burdens climate change is imposing on societies around the world. The more pathways connecting climate effects and social outcomes that are identified, the richer the suite of mechanisms will be, and the more effective policies can be in mitigating or preempting the deleterious effects of climate change.

About the Author

Zafar Imran is a research associate at the Center for International and Security Studies at Maryland (CISSM), at the University of Maryland's School of Public Policy. He received his doctorate in policy studies from the School. This Policy Brief is derived from his doctoral dissertation, "Climate Change and Political Contention - A Mechanism-based Framework," for which Imran won both the Yamamoto-Scheffelin Dissertation Prize and the Caramello Distinguished Dissertation prize.

[19] De Moines Register (2016). Bumper crop tumbling corn, soybean prices; McFetridge, Scott (2019). Soy, corn farmers devastated by double punch: trade war and flooding, *LA Times*.
[20] Gowen, Annie (2019). 'I'm gonna lose everything', *Washington Post*; Eulfhorst, Ellen (2019). Faced with floods and suicides, U.S. readies for a warmer world, *Thomson Reuters Foundation News*; Wedell, Katie, Lucille Sherman, and Sky Chadde, (2020). Midwest farmers face a crisis. Hundreds are dying by suicide, *USA Today*.

Appendix A: Climate change, agricultural production, and social unrest in Pakistan

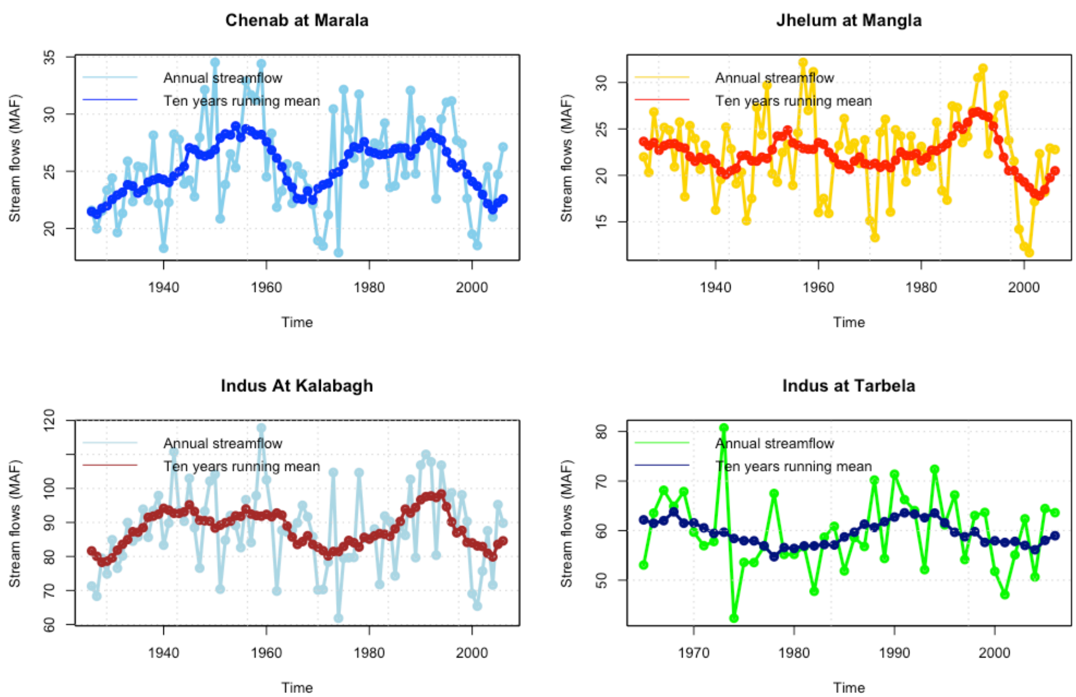

Fig. A-1: Annual historical stream-flows of Indus and its tributaries
Data source: National Engineering Services of Pakistan (NESPAK)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lahore	**5.58** (0.00)	**5.41** (0.00)	**4.30** (0.00)	**5.60** (0.00)	**4.33** (0.00)	1.18 (0.24)	0.92 (0.36)	**2.07** (0.04)	**3.60** (0.00)	**5.35** (0.00)	**11.62** (0.00)	**7.63** (0.00)
Bahawalpur	**1.728** (0.084)	0.138 (0.89)	0.057 (0.954)	0.529 (0.596)	**2.678** (0.007)	-1.111 (0.266)	0.488 (0.625)	**-2.783** (0.005)	-0.299 (0.764)	0.844 (0.398)	**1.935** (0.052)	**3.201** (0.001)
Hyderabad	0.71 (0.48)	0.36 (0.72)	0.84 (0.40)	0.08 (0.94)	-1.09 (0.28)	-1.61 (0.11)	**-3.16** (0.00)	**-2.61** (0.01)	0.15 (0.88)	0.75 (0.46)	1.62 (0.11)	**2.2** (0.03)

a) Mean Monthly Minimum Temperatures: Mann-Kendall Values

Station	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Lahore	-1.55 (0.12)	-0.53 (0.59)	0.23 (0.82)	0.40 (0.69)	0.12 (0.91)	**-5.04** (0.00)	**-2.77** (0.01)	**-1.79** (0.07)	**-2.52** (0.01)	**-2.31** (0.02)	0.69 (0.49)	0.18 (0.86)
Bahawalpur	**-2.95** (0.003)	-1.39 (0.16)	-0.42 (0.67)	0.87 (0.38)	**2.29** (0.02)	-1.80 (0.07)	-0.12 (0.90)	**-3.05** (0.00)	**-3.13** (0.00)	**-1.74** (0.08)	1.08 (0.28)	0.61 (0.54)
Hyderabad	**-1.94** (0.05)	-0.78 (0.44)	-0.04 (0.97)	0.32 (0.75)	-0.81 (0.42)	-0.70 (0.48)	-0.95 (0.34)	**-2.77** (0.01)	**-2.17** (0.03)	-1.10 (0.27)	0.45 (0.65)	-0.33 (0.74)

b) Mean Monthly Maximum Temperatures: Mann-Kendall Values

Station	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Lahore	**-1.65** (0.10)	0.93 (0.35)	1.06 (0.29)	0.69 (0.49)	**1.94** (0.05)	**2.09** (0.04)	**4.72** (0.00)	**4.11** (0.00)	**2.71** (0.01)	0.55 (0.58)	1.07 (0.28)	-0.07 (0.94)
Bahawalpur	0.90 (0.37)	**5.54** (0.00)	0.50 (0.62)	**3.83** (0.00)	1.00 (0.31)	**2.04** (0.04)	0.30 (0.76)	**1.85** (0.06)	1.28 (0.20)	0.26 (0.79)	0.67 (0.50)	0.50 (0.61)
Hyderabad	1.27 (0.20)	-0.19 (0.85)	-0.58 (0.56)	0.97 (0.33)	-0.53 (0.60)	-0.53 (0.60)	-1.34 (0.18)	0.19 (0.85)	0.13 (0.90)	0.17 (0.87)	0.08 (0.94)	-0.31 (0.76)

c) Total Monthly Rainfall: Mann-Kendall Values

Fig. A-2: Meteorological trends in three distinct agro-ecological zones in Pakistan (1950-2013)
Data source: Meteorological Department of Pakistan

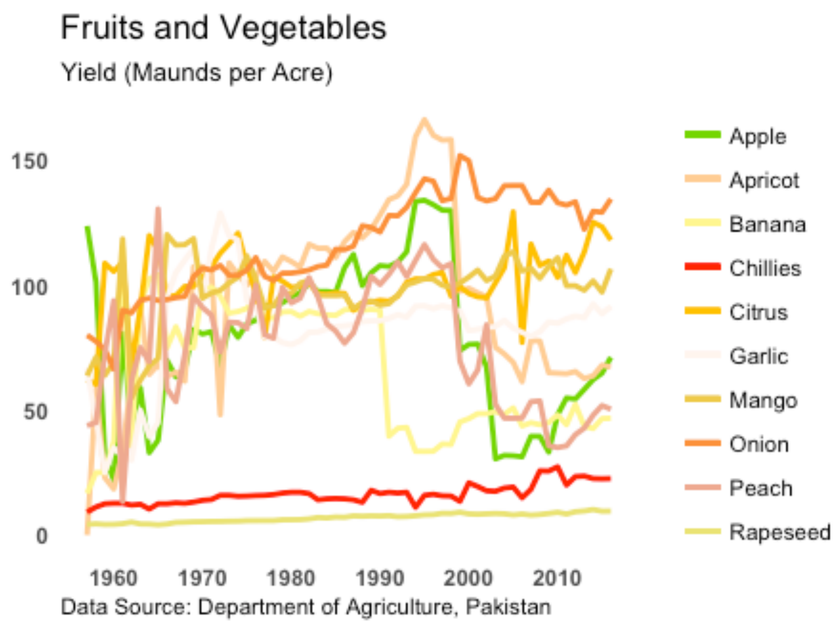

Fig. A-3: Yield of minor crops
Data source: Department of Agriculture, Pakistan

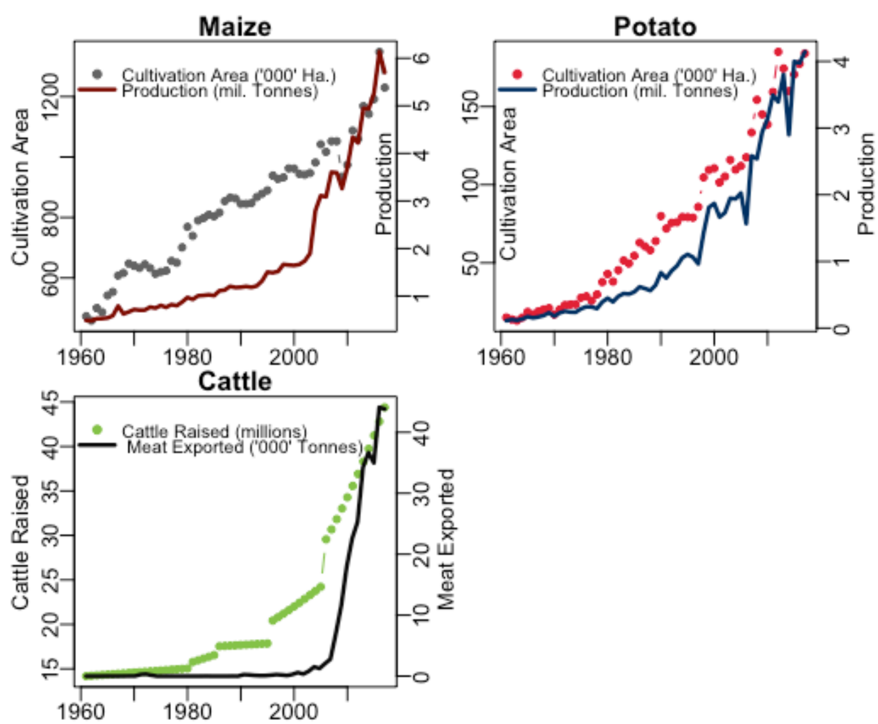

Fig. A-4: Crop production trends in Pakistan
Data source: FAO STAT

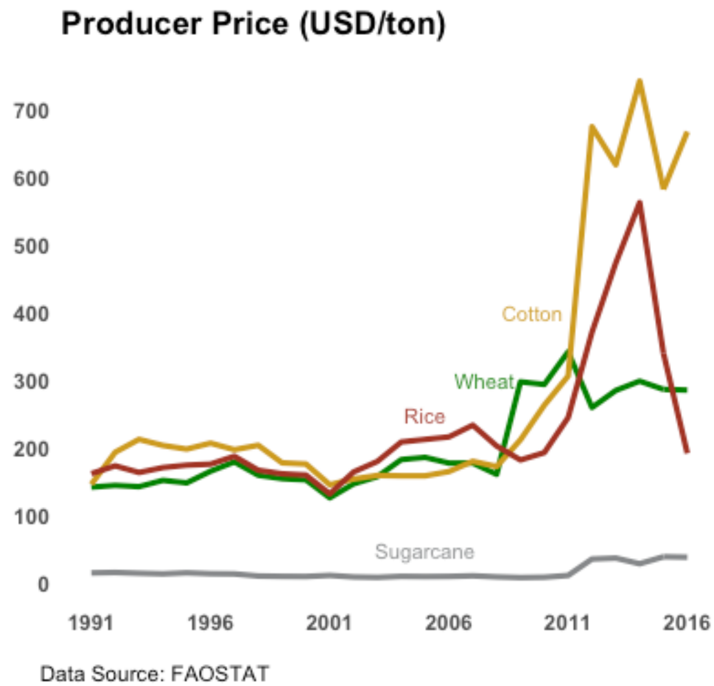

Fig. A-5: Producer Price for the four major crops
Data Source: FAO STAT

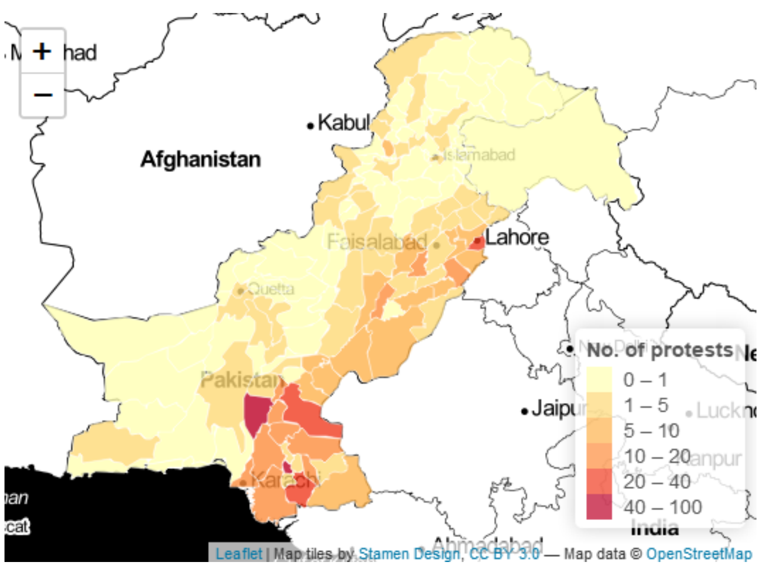

Fig. A-6: Farmers protests over the years
Data source: Armed Conflict Location and Event Database (ACLED)