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Rice or riots: On food production and conflict severity across India

Gerdis Wischnath [a, 1], Halvard Buhaug [a, b, *]

[a] Peace Research Institute Oslo, PRIO, PO Box 9229 Grønland, 0134 Oslo, Norway
[b] Norwegian University of Science and Technology, NTNU, 7491 Trondheim, Norway

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ABSTRACT

In large parts of the developing world agriculture remains a broad economic sector securing livelihoods for large parts of the population. In the discourse on security implications of climate change, effects on agricultural production and food insecurity are frequently claimed to be a plausible intermediate causal connection. Earlier research has linked economic shocks to conflict outbreak but loss of income from agriculture may also affect dynamics of fighting in ongoing conflicts. We identify three complementary processes through which loss of food production may escalate enduring conflicts: lowered opportunity costs of rebelling, increased opportunities for recruitment, and accentuated and more widespread social grievances. Using India as a test case, we investigate how year-on-year fluctuations in food production affect the severity of ongoing armed conflicts. The statistical analysis shows that harvest loss is robustly associated with increased levels of political violence. To the extent that future climate change will negatively affect local food production and economic activity, it appears that it also has the potential to fuel further fighting in areas that already are scenes of chronic conflict.

"If one compares maps of precipitation with those of violence, a disturbing pattern emerges: where drought advances, so do Maoists" (Parenti, 2011, 135).

Introduction

The recent wave of uprisings across the Arab world and beyond has accentuated claims that food insecurity constitutes an important driver of contemporary political violence (Johnstone & Mazo, 2011; Sternberg, 2012). Food shortage and escalating food prices may have multiple causes, including severe drought and resulting crop failure in major food-producing areas. Partly for this reason climate change is viewed with much concern, and diminishing food productivity in response to rising temperatures and increasingly erratic rainfall patterns is frequently cited as a significant threat to societal stability and peace (e.g., Adger et al., 2014; Stern, 2006; World Bank, 2010).

The academic debate on climate change and violent conflict is far from settled. Some claim that climatic events are robustly linked to civil conflict risk whereas others fail to find a systematic connection. Overall, most attempts to synthesize the literature conclude that scientific research to date provides mixed and inconclusive findings (e.g., Bernauer, Boehmelt, & Koubi, 2012; Meierding, 2013). Yet, this debate may be somewhat misplaced as it (1) employs a restricted understanding of 'climate' that is limited to extreme climatic events and yearly deviations from mean conditions (climate variability), and (2) is largely limited to considering climate as a possible trigger of political violence. While the global number of armed conflicts has dropped considerably in recent years (Themnér & Wallensteen, 2013), many active insurgencies have simmered for decades with no imminent prospect of resolution. Even if climate variability and extreme weather events are weakly and inconsistently related to general conflict risk, shifting environmental conditions and their immediate social impacts may affect the dynamics of ongoing fighting. Thus far, this issue has received scant scientific attention. The sole focus on climate variability (although important, it is only one aspect of future climate change) also devalues other effects of global warming (e.g., melting glaciers, instability of the monsoon system) that have the potential to have equally adverse effects on agricultural production and economic performance in the future.

A third limitation with extant research is the near exclusive focus on uncovering a direct, aggregate relationship between climatic events and conflict without considering plausible

* Corresponding author. Peace Research Institute Oslo, PRIO, PO Box 9229 Grønland, 0134 Oslo, Norway. Tel.: +47 22 54 77 00; fax: +47 22 54 77 01.
E-mail address: halvard@prio.org (H. Buhaug).
[1] Tel.: +47 22 54 77 00; fax: +47 22 54 77 01.

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mechanisms and conditions under which a climate-conflict link might materialize. This paper addresses these shortcomings. While precipitation is a good predictor of agricultural production in areas solely reliant on direct rain for farming, it is less good of an indicator in countries that use irrigation and canal systems to regulate water flows and/or depend on groundwater extraction or annual glacial runoff for water supply. In order to maximize generalizability and be more precise in testing the causal linkage, we move beyond using short-term changes in rainfall levels as indicators of economic performance. We focus directly on changes in agricultural food production and how they influence the severity of ongoing conflicts. Informed by the general civil war onset literature, we argue that loss of income from agriculture may affect conflict dynamics through three complementary processes: lowered opportunity costs of rebelling, increased opportunities for recruitment, and accentuated and more widespread social grievances. Absent proper compensation by the state (e.g., through relief aid, food price subsidies, redistribution schemes, crop insurance), these processes will motivate a larger pool of individuals to join and/or support an active opposition movement to redress their grievances, thus increasing the likelihood of violence escalation.

To test this general expectation, we conduct a quantitative analysis of political violence across India since 1980. India is a suitable microcosmos in this context as agriculture constitutes the largest and most important economic sector and the country has been the scene of a number of rural-based insurgencies over the last few decades. The main finding shows that times of low agricultural production are significantly associated with higher casualty figures in ongoing armed conflicts.

On conflict dynamics

What explains temporal dynamics of political violence is analytically distinct from research questions addressed in the bulk of the empirical civil war literature, namely issues relating to causes for the initial outbreak of conflict.[1] Even today, most quantitative work seeks to refine our understanding of how particular pre-war structural and social conditions explain conflict onset (see Blattman & Miguel, 2010 for a review). In contrast, after the surge of state consolidation conflicts in the early 1990s there have been very few *new* civil conflicts breaking out. Instead, inter-annual fluctuations in the frequency of armed conflicts today can to a large extent be explained by cyclical patterns of initiation and failure of ceasefires as well as stochastic processes that cause conflicts to satisfy the inclusion criteria of conventional conflict datasets only in some years (see Themnér & Wallensteen, 2013).

Most research to date that does move beyond onset analysis and investigates the severity of intrastate conflict applies a strictly comparative perspective, looking at aggregate characteristics to understand why conflict(s) in country *i* generated more casualties than conflict(s) in country *j*. For example, Lacina (2006) finds that democracy is associated with significantly fewer civil war deaths than other political systems; Heger & Salehyan (2007) link civil war severity inversely to the size of the ruling elite; whereas Lu & Thies (2011) report that civil wars tend to be more deadly in countries with larger economic inequalities. Shifting focus from host countries to characteristics of the actual conflicts, Lujala (2009) finds that petroleum production and drug cultivation in the conflict zone have opposite effects on battlefield severity whereas Eck (2009) shows that ethnically mobilized conflicts are much more likely to escalate to the level of civil war than are other conflicts (see also Costalli & Moro, 2012). These studies provide important insights into aggregate patterns of intrastate conflict but they are unable to inform us on drivers of temporal dynamics of violence within conflicts.

Partly due to coarse data, the question of what explains variations in casualties over time remains largely unaddressed. Common explanations of conflict outbreak, and indeed of aggregate conflict severity, refer to macroeconomic performance, political institutions, demographic and ethnic characteristics, and resource dependence. With the exception of economic performance and associated processes (e.g. unemployment rate; commodity prices), these factors are either static or change only slowly and are as such poor predictors of short-term variations in conflict intensity. In this paper we propose that changes in food production can exert a systematic and robust impact on conflict severity. Food insecurity and economic shocks are frequently promoted as driving factors in the climate-breads-conflict debate in Western media (Sneyd, Legwegoh, & Fraser, 2013), but they are still largely ignored by the civil conflict scholarship, which instead tends to focus on direct relationships between climatic patterns and violence. In the following sections we first outline central arguments from the environmental security literature linking climatic patterns to armed conflict and then discuss how food insecurity and sudden loss of agricultural income can be important drivers of conflict severity.

Environmental scarcity and conflict risk

Most quantitative work assessing correlations between environmental conditions and armed conflict is theoretically informed by environmental security thinking, which links scarcity of renewable resources to violent uprisings, be it triggered by natural disasters, climate variability and extremes, or environmentally induced migration (Homer-Dixon, 1999; Kahl, 2006). The forthright argument typically describes how climatic anomalies such as droughts, floods or changes in temperature affect state stability via their impact on macroeconomic performance, agricultural output, and livelihood security. Under certain (often tacitly assumed) conditions, this process may increase both opportunities for mobilization and personal incentives to use violence to redress grievances. Examples of studies that pursue this logic include Ciccone (2011), Hendrix & Glaser (2007), Koubi, Bernauer, Kalbhenn, & Spilker (2012), and Miguel, Satyanath, & Sergenti (2004) although the overall conclusions from this literature is mixed (Bernauer et al., 2012; Gleditsch, 2012; Meierding, 2013; Scheffran, Brzoska, Kominek, Link, & Schilling, 2012; Theisen, Gleditsch, & Buhaug, 2013).

Apart from the mostly inconclusive empirical evidence for a general climate-conflict association, a striking feature about the literature is its near complete lack of attention devoted to possible impacts of changing environmental conditions on the dynamics of conflicts: whether and to what extent impacts of climate extremes affect the severity of fighting. Yet, some idiosyncratic evidence suggests that climate change may "aggravate numerous existing conflicts" (Gupta & Dutta, 2009, 40) even if climatic conditions by themselves have little influence on the risk of new organized violence, so this should be subject to more systematic scrutiny.

Environmental stress and conflict severity

The dynamics of severity – how conflicts escalate and contract over time – are contingent on several factors. First, conflict severity depends on the actors' motivations and opportunities for sustained combat. As the sides recruit additional supporters, become better armed and organized, receive more support by the local population, and become increasingly committed to the cause, military battles are likely to become fiercer (Lacina, 2006; Weinstein, 2007). Conversely, conflicts tend to fade as popular support for the rebels wanes and the opportunity cost of protesting and fighting the government increases. Second, the course of conflict depends on the strength of the state and its involvement and reactions in the conflict. In many cases, regimes facing armed opposition groups seek to take advantage of shifting conditions – be it playing up local inter-communal cleavages during times of election (e.g., Kahl, 2006) or providing selective compensation in response to disaster events (see de Waal, 1991 for an account of how the Etiopian Derg regime unsuccessfully attempted to exploit the 1984 drought to quell the Tigrayan uprising).

Environmental stress can put people's lives and livelihoods at risk, especially those dependent on agricultural output for food and income security. Following water shortages, local farmers may experience severe loss of harvests or may have to discard the production of pulses and other crops or sell their livestock below normal marked prices. This does not only put subsistence farmers at risk but it also contributes to higher levels of unemployment during the cultivation periods, especially among seasonal workers and the landless poor. For example, both Paige (1975) and Scott (1976) describe how vulnerable peasants are a central driving force of rebellions and revolutions where economic hardship threatens the survival of agrarian livelihoods. If the state fails to respond in a satisfactory manner or public safety nets and insurance schemes are absent and people lack personal credit to cope with such shocks, individuals' incentives to join an ongoing insurgency against the government increase.

The general causal narrative outlined here rests on the assumption that the severity of fighting increases when the opposing groups grow numerically larger. Larger rebel groups imply more fighters who can die in combat and are generally perceived as a larger threat to the government, which may intensify its military presence in the contested areas as a response. The logic behind this reasoning is quite similar to conventional explanations of civil war onset, but it differs in how it prescribes mobilization. The initial forming of a political movement against the government requires entrepreneurial leaders, a number of committed participants, as well as monetary and material resources. Conflict outbreak thus is the outcome of a collective action by a coordinated pool of followers, 'first movers' or political entrepreneurs (Kalyvas & Kocher, 2007, 182) with strong motivations and a shared commitment to the cause at a certain point in time. In contrast, the decision to join an established and active opposition movement is an individual action, motivated by sudden changes in livelihood security or expected short-term benefits and pay-offs. Reasons for an individual to join a rebellion at a later stage are more likely to be found in the personal outlook on private or material benefits and security concerns than in the ideological conviction to fight for a common public good.

Our argument builds on three complementary theoretical accounts prescribing a connection between declines in agricultural output and severity of fighting. The first links agricultural decline and associated economic loss with changes in individual material gains of joining a rebellion relative to pursuing other economic activity; the second views conflict sensitivity to economic variability through the latter's impact on the state's capacity to offer credible compensation and the opposition elites' ability to recruit new supporters; whereas the third argument focuses on emotional reactions to adverse environmental conditions and inadequate state response. The following paragraphs expand on how each of these conceptually overlapping accounts may be associated with fluctuations in conflict severity.

(1) Individual Opportunity Cost

According to Collier & Hoeffler (2004; see also Ehrlich, 1973), the decision to take up arms against the government is based on individuals' rational calculations of expected benefits of fighting vis-à-vis normal economic activity. Although originally pitched within the context of conflict outbreak – explaining the timing of mobilization – the logic is in principle equally applicable to understanding recruitment and popular support during conflict. If opportunities and prospects of legal income activities diminish, participation in a rebellion becomes relatively more economically advantageous and might be seen as a way out of the misery. While potential costs and dangers of participating in a rebellion may make joining unattractive, the promised long- and short-term benefits – material or around ethnic, religious or ideological promises – may tip the balance in times of need (Weinstein, 2007).

In the absence of alternative modes of living, people living off the land are forced to pursue unconventional coping strategies when drought strikes or other environmental conditions severely impact agricultural production and income. In economic terms, the perspective of insecure revenue from agriculture can lower the opportunity cost of joining an ongoing conflict (as well as criminal behavior and looting more generally) such that violent action emerges as a tempting alternative source of income to sustain one's life and livelihood.

(2) Collective Opportunities for Mobilization

The second pathway takes an elite perspective by outlining how loss of state and household income inhibits state compensation and facilitates recruitment. Governments affected by a sudden economic downturn may be weakened in their ability to deal with insurgent activities, but more importantly, economic shocks make it more difficult to maintain expected levels of basic public services, provide adequate compensation for experienced material loss, and simultaneously secure sustained loyalty of central branches (Miguel et al., 2004). If state support fails in times of environmental hardship, grievances against the government become more prevalent and can intensify other discontent over employment, education, political exclusion, and economic and religious structures. This undermines political legitimacy and creates opportunities for political opponents and rebel leaders to raise people's awareness of their misery. For the landless poor and smallholders, common demands by insurgent groups such as self-determination, regional autonomy, or redistribution of political and material privileges can more easily be framed by entrepreneurial leaders as an attractive coping strategy worth endorsing in times of personal need and when one directly suffers from lack of support by the state.

The Naxalite movement in India is often used as an example in this regard (Parenti, 2011). One-third of the Indian states have been affected by Marxist violence since the country's independence in 1947. The Marxist rebels have primarily mobilized among farmers and other people in the countryside. They gained much popularity by providing basic services to the deprived and among the tribal population by expressing their substantial grievances. While the Naxalites are especially popular among the rural poor, for standing up for their demands and needs, a common claim is that they are "likely to attract more adherents as the consequences of environmental stress mount" (Paul, 2011, pp. 73–84). The Naxalites are also known for what has been referred to as 'famine raids' (Garg, 2008, pp. 25–38). During times of drought the rebels mobilize tribal groups and the poor to loot rice mills or the houses of vendors, rich landlords and government officials for food, supplies, paddy and clothes (Garg, 2008). In Andhra Pradesh, one of the Naxalite hotspots, the government's drawback on subsidies in the early 1990s has forced many farmers to take loans from the bank or local moneylenders (Parthasarathy & Shameem, 1998). As a consequence of recurring crop failure and the inability to repay debts, the number of suicides in the region skyrocketed and support for the Naxals rose (Parenti, 2011).

(3) Grievances

The third and complementary pathway centers on individual-level grievances towards the state. In the same manner as countries differ with respect to their latent conflict risk, the propensity for violent behavior is also likely to vary between social groups within a society. For example, peripheral rural ethnic or religious minorities are more often subject to active discrimination in political processes, they are more frequently repressed or denied their entitlements, and violence can turn into a tool of resistance when non-violent means of expression no longer works (Raleigh, 2010). If governmental help is scarce or unequally distributed, social cleavages are likely to become more pronounced. Minority groups that are actively denied political participation because of their ethnicity, religion, class or caste are also prone to being neglected or discriminated by government-sponsored relief aid. This does not only accentuate livelihood insecurity, it also amplifies inequalities between groups and shared grievances and frustrations towards the government (as well as resentment toward the privileged). Collective identities among marginalized groups facilitate a shared perception of injustice, which is important when mobilizing for rebellion (Gurr, 1970; Tilly, 1975, 483–555). One example where this logic appears to have played out forcefully is the growth of the Sendero Luminoso [Shining Path] movement in Peru and the subsequent escalation of violence:

> Rural peasants in the jungle and the highlands, as well as the indigenous people of southern Peru (the Quechua), were basically ignored as resources became scarce. Sendero Luminoso generated interest and support by pointing to the government's economic and political failures (Weinstein, 2007, 84).

The discussion of how livelihood activity, food security, and income affect opportunities and motivation for joining a rebellion can be summarized in the following general expectation:

H1. Conflict severity increases in times of low agricultural production.

An alternative approach

It is not given that environmental stress always, or as a general rule, leads to an intensification of violence. The following section outlines one reason for why sudden agricultural livelihood insecurity may reduce the severity of an ongoing conflict.

According to resource mobilization theory (e.g., Tilly, 1978), sustaining a rebellion depends critically on the support by the local population in terms of offering recruits, providing shelter, and ensuring ample supplies of food and funds. In times of climatic extremes and agricultural recession, household income from agriculture may diminish to the extent that the local population may be forced to choose between supporting the rebellion and sustaining their own livelihood. This would suggest that rebel organizations would keep a lower profile and generally avoid direct encounters with superior state forces until environmental and economic conditions are more conducive to renewed mobilization and fighting. Evidence of such a reverse dynamic is not hard to come by, and the following observation from contemporary Africa is illustrative:

> First, we find some evidence that rainfall correlates with civil war and insurgency, although conflict outbreak is more likely in wetter years. This may be due to tactical considerations: violent actors may be less likely to launch campaigns when there are severe water shortages, making it difficult to care for combatants in the field, and they will be more vulnerable when there is less foliage to provide cover (Hendrix & Salehyan, 2012, 45).

H2. Conflict severity decreases in times of low agricultural production.

Loss of income and increasing livelihood insecurity as a consequence of environmental changes are certainly not the only factors that might affect the level of fighting in armed conflict. Political elections are frequently associated with the outbreak of violence in divided societies (Collier & Vicente, 2012; Höglund, 2009) as they often contribute to escalating intergroup animosity, provide opportunities for rallies and rebel recruitment, and more generally raise the public's awareness of governance deficiencies and discrimination. Other plausible triggers of violence escalation include global financial crises and commodity price shocks, which can have severe national and local consequences (Berkmen, Gelos, Rennhack, & Walsh, 2012), as well as spillover effects from nearby social uprisings and armed conflicts (Gleditsch, 2007). In addition, the government obviously plays a crucial role in affecting conflict dynamics through how it decides to respond to imminent socioeconomic crises (e.g., economic shocks, increasing food insecurity) and opposition mobilization (Cunningham, Gleditsch, & Salehyan, 2009). The security impacts of such events are likely to extend beyond sparking the initial round of violence, although we consider these processes complementary to, rather than conditioning, the separate effect of local economic shocks related to failing food production.

On India

To test these general propositions, we study temporal fluctuations in food production and political violence across India. India is a near ideal case in this context, for two reasons. (1) The Indian subcontinent is home to some of the oldest, most persistent, and deadliest insurgencies in the world. In fact, India is the country with the highest number of ongoing intrastate conflicts over the last decades (Themnér & Wallensteen, 2013). As these conflicts involve mostly rural populations living off the land, worsening conditions under climate change have been promoted as a source of escalating violence (Paul, 2011; see also Vadlamannati, 2011). (2) India is the world's second largest food producer, agriculture constitutes the largest economic sector in most Indian states even today, and while there have been notable improvements in technology and irrigation over the past decades agricultural yield still is sensitive to precipitation patterns in main catchment areas and seasonal river flows. In India, 2/3 of the country's population depends on the stability of the monsoonal rains between June and August for subsistence agriculture (Paul, 2011). Due to the unequal spatial distribution of the monsoonal rains across the Indian subcontinent, direct rainfall is a poor indicator of agricultural production – in contrast to other conflict-prone regions, such as Sub-Saharan Africa, where food production is almost entirely dependent on local rainfall. Projecting monsoonal behavior under climate change scenarios includes considerable uncertainties and alternative simulations indicate both more intense rains (Kumar et al., 2006) and decreases in absolute rainfall from the summer monsoon (Lal, Cubash, Voss, & Waszkewitz, 1995). Additionally, rising temperatures plus more frequent and longer droughts will affect agricultural production via reduced river flows and its effects on water quantity in groundwater aquifers. While the direct temperature effect could lead to an increase in production of certain crops there is general agreement that the Indian agricultural production will be negatively affected by water-stress due to climate change (Dinar, Mendelsohn, & Songhi, 1998; Lal, Singh, Rathore, Srinivasan, & Saseendran, 1998).

The availability of cheap electricity in India allows for widespread pumping of groundwater, which leads to over-depletion of aquifers. Irrigation in India also depends on canal systems for water distribution and on glacial runoff from the Himalaya, which feeds some of the major rivers in the north of the country. River flows across state borders and water distribution between federal units is also a highly politicized process as states frequently quarrel and renegotiate allocated shares of water. The case of the waters in the Cauvery River is a good example in that regard. The river runs from the Indian State of Karnataka through Tamil Nadu where it enters the Bay of Bengal and forms the Cauvery Delta, a major farming area and 'rice basket' of Southern India. Decades of negotiations have not lead to equitable sharing of the resource and the dispute frequently runs high in anticipation of late or failed monsoonal rains when water in the reservoirs runs low (Swain, 1998).

The main food commodities in terms of quantity are rice and wheat. Since the year 2000, Indian agriculture has produced 90 million tons of rice and 76 million tons of wheat on average every year (statistics derived from the Indian Ministry of Agriculture). This represents an increase in output in excess of 50% since the 1980s although poor rural infrastructure (roads, irrigation and flood control, electricity, storage facilities), inefficient smallholder farming, and high rates of harvest spoilage have prevented a much steeper increase in productivity. The potential for sustained growth is substantial: Indian wheat production is only a third of France's per area unit and rice productivity is less than half of the average output in China. There are also huge differences between Indian states both in terms of total production and crop yield per hectare. Punjab is often labeled India's breadbasket with Haryana and Uttar Pradesh being other major wheat producers. Rice production is most extensive in the flood plains and delta areas, as found in e.g. West Bengal, Uttar Pradesh, and Chhattisgarh.

Adverse dips in agricultural productivity and soaring food prices lead to deficits in trade, income losses among the rural population, and increase food insecurity among the poor (Lal & Chauhan, 2009). India's massive Public Distribution System (PDS), which issues food below market prices to the population below the poverty line through a network of Fair Price Shops (FPS), is an important instrument to secure basic food availability. However, food grains supplied by the FPS are not enough to meet the consumption needs of the poor, are often of inferior quality, and fair distribution is challenged by corruption. While the program ensures availability of basic commodities (rice, wheat, edible oils), it only makes up about 11% of food grains consumption among the rural poor and does not compensate for reduced access to food due to income poverty (Dev & Sharma, 2010; Swaminathan, 2000).

Data and analytical framework

To capture regional diversity in conflict patterns as well as economic development and agriculture, we use a dataset of Indian states covering the time period 1980–2011. The Indian state system as we see it today came into effect in 1956 following the States Reorganization Act. The major reform of Indian boundaries separated between states along linguistic and ethnic lines. The Indian states have substantial governmental autonomy while the union territories are smaller areas governed by administrators, who have been nominated by the Indian President. Since 1956 there have been several minor changes in the state system, with larger states splitting and some union territories achieving statehood. The panel structure of our dataset includes all current 28 states and 7 union territories of the Indian subcontinent and it takes temporal changes in state borders into account.

The dependent variable in the main models is severity of state-based political violence, measured in logged number of people killed per state year. Three different conflict indicators from separate data providers are analyzed in order to maximize the breadth and rigidity of the analysis. The first dependent variable is constructed from the India Sub-National Problem Set (ISPS; Marshall, Sardesi, & Marshall, 2005), which is based on news reporting in *Keesing's Record of World Events*. ISPS collects a set of different parameters – timing, location, counts of participants, and casualties – on conflictive events between 1960 and 2004 and assigns them to different levels and types of violence. By aggregating those categories that refer to violence against the state[2] we constructed our own count measure of casualties in violent events that can be considered state-based conflicts, i.e. incompatibilities between the state and non-state actors that concern issues inherently linked to the state and/or national government.

The second conflict severity indicator is based on data from the South Asia Terrorism Portal (SATP), which collects annual counts of deadly incidents in states that are scenes of chronic conflict, with significant violence year on year. The database contains yearly estimates of violent activity in 18 states over differing time-periods, though most of these states are covered only from 1993.[3]

The third indicator is the number of battle deaths in armed intrastate conflicts from the Uppsala Conflict Data Program (UCDP) Battle-Related Deaths Dataset (UCDP, 2013). UCDP codes the reported number of people killed in combat for all conflict-years with more than 25 battle-related fatalities, 1989–2011. Since all Indian armed conflicts, except the Naxalite rebellion, are territorial or separatist conflicts, we simply assigned battle deaths[4] to the state that is listed as the main issue of incompatibility on a case by case basis. To not lose observations for the Maoist rebellion, which lacks locational information in the UCDP data, we replaced UCDP's estimates with fatality counts from SATP for the states that have seen continuous left-wing violence.

Fig. 1 shows the temporal coverage and trend in conflict severity for the three conflict indicators. Even though the trend lines correspond fairly well in overlapping years, it is clear that the different datasets capture somewhat different forms of political violence. The SATP casualty estimates are consistently higher than those of the other two variables, which suggest that this dataset relies on a broader set of sources and, possibly, applies less restrictive criteria for defining organized and politically relevant violence.

Just as political violence varies in intensity over time it also shows considerable spatial variation (Fig. 2). The states that have the highest rates of state-based violence are Jammu and Kashmir in

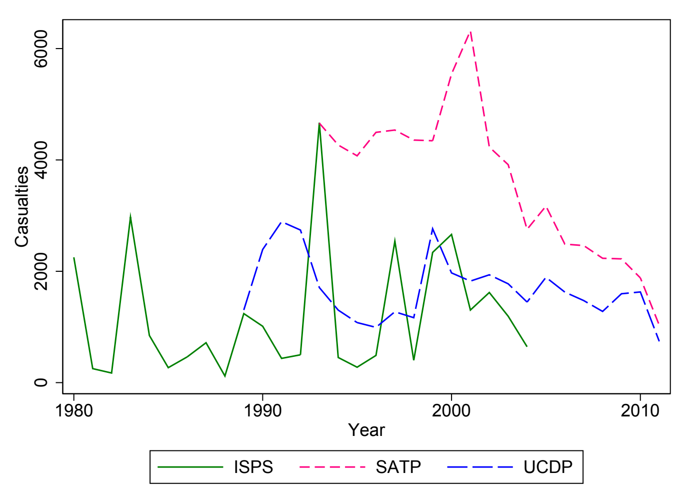

Fig. 1. Conflict severity in India, 1980–2011. ISPS – fatalities in state-based violence from the India Sub-National Problem Set, 1980–2004; SATP – fatalities in violent conflicts from the South Asia Terrorism Portal, 1993–2011; UCDP – battle deaths in intrastate armed conflict from the Uppsala Conflict Data Program, 1989–2011.

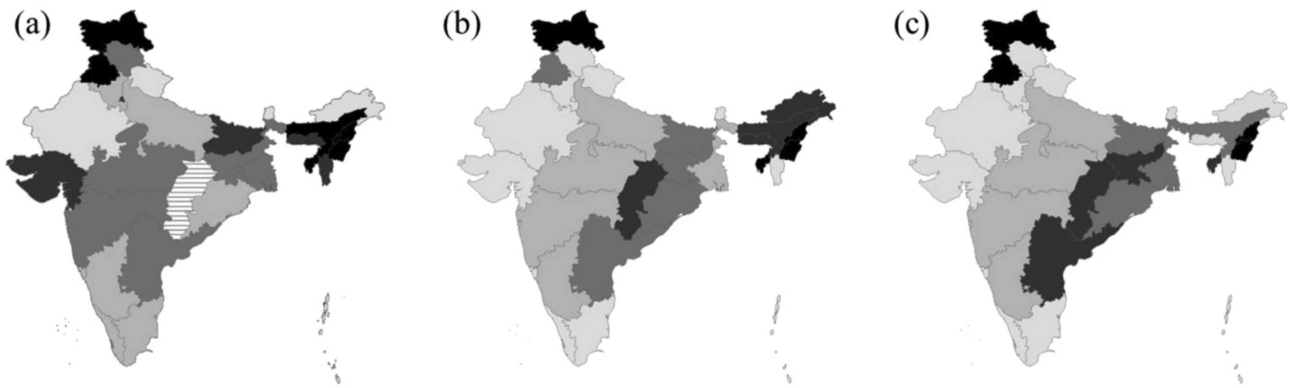

Fig. 2. Violence rates across India. The figure illustrates the severity of political violence for contemporary Indian states, expressed as reported fatalities as a share of the state's population size and categorized in quintiles. Panel (a) shows fatalities per capita in state-based violence from the India Sub-National Problem Set, 1980–2004; panel (b) shows fatalities per capita in violent conflicts from the South Asia Terrorism Portal, 1993–2011; panel (c) shows battle deaths per capita in intrastate conflict from the Uppsala Conflict Data Program, 1989–2011. Darker shades indicate higher rates of violence.

the northwest and Tripura, Assam, Nagaland, and Manipur in northeastern India, where several active secessionist insurgencies are located. In addition, Maoist violent activity, which is best captured by the SATP data, is clearly detectable along the "Red Corridor" in Chhattisgarh, Andhra Pradesh, and adjacent strongholds of the Naxalite movement in central India (Hoelscher, Miklian, & Vadlamannati, 2012).

The main independent variable for this study is an indicator of food production growth. In a first step, we use annual data on wheat and rice production obtained from the Indian Ministry of Agriculture to construct state-specific measures of wheat and rice production, 1980–2011. Based on these indicators, we identified the main agricultural commodity for each Indian state, and then calculated a simple interannual growth measure, operationalized as *Food growth* $=$ *(Agricultural production* $_{t}$ $-$ *Agricultural production* $_{t-1}$*)/Agricultural production* $_{t-1}$. States without significant rice or wheat production are excluded since these observations would be unable to shed light on how variations in food production affect conflict dynamics.[5]

Interannual growth is the preferred measure since we are interested in tracing short-term changes in opportunities and motivation for individuals to join an ongoing rebellion. Accordingly, a short-term negative growth should increase the latent pool of rebel recruits under the ceteris paribus assumption regardless of whether it constitutes a return to normal yields from an ample previous harvest or worsening of already adverse conditions during the previous year. This reasoning is decidedly distinct from the logic informing relevant research on civil conflict onset, in which absolute deprivation, or negative deviations from long-term mean trends, is considered the most conflict-prone context (Ciccone, 2011; Koubi et al., 2012). In sensitivity tests we replace food growth with economic growth as a possible driver of conflict severity.

All reported models are estimated using Ordinary Least Squares (OLS) regression with a limited number of controls; mean conflict severity (logged casualties) among contiguous Indian states (t−1) to handle possible spatial dependencies in the data (Beck, Gleditsch, & Beardsley, 2006); a time-lagged dependent variable (logged casualties t−1) to control for serial dependence (Beck, Katz, & Tucker, 1998); state fixed effects to control for unit heterogeneity, and a common time trend. The fixed effects approach ensures that all results reflect strictly temporal covariance, implying that the particulars of each state – such as suitability and mode of agriculture, average productivity growth rates, and other time-invariant traits – are accounted for by design. Since the conflict indicators have different temporal coverage and we apply different intensity thresholds for inclusion, the models presented below cover different subsets of the full sample, 1980–2011. Note that we find the linear OLS model preferable to a two-stage instrumental variable approach, which has been used in some earlier research (Koubi et al., 2012; Miguel et al., 2004). For reasons outlined above, rainfall is a poor instrument for food production among contemporary Indian states, and our quest concerns estimating security impacts of agricultural performance, regardless of what role the weather might play. See the section on robustness tests for discussion of alternative specifications.

Empirical results

The extent to which future global warming will affect precipitation patterns and annual run-off from glaciers and affect government-induced water sharing policies is interesting as it can have significant consequences for food production and income from agriculture. Even if technological innovation and development make the agricultural sector less vulnerable to direct climatic stress, it is the complexity of social and environmental processes that lead to actual or perceived water scarcity and food insecurity. Understanding how crop failure and food insecurity can have an independent effect on political violence is thus important in its own right, regardless of how future climate change may affect the conditions for sustained agricultural growth.

Table 1 presents the main results from the analysis of the relationship between conflict severity and food production growth. Model 1 is run on violence data from ISPS and covers all states with at least five years of reported fatalities; Model 2 uses casualty estimates from SATP and includes all state years with reported conflict in the sample period; and UCDP's estimates of battle-related deaths in intrastate armed conflicts are used in Model 3. Varying numbers of observations across model specifications are caused by differences in temporal and spatial coverage of the dependent variables and the sample inclusion criterion.

In line with Hypothesis 1, all three models indicate that food production growth lowers the intensity of organized violence. Only the lagged measure obtains a significant estimate at 5% level of uncertainty, however, which suggests that it takes some time from changing economic conditions in the countryside to translate into altered conflict behavior.

The temporal and spatial controls for autocorrelation and conflict diffusion reveal some interesting, and at first sight seemingly counterintuitive, patterns. Earlier civil war research has found a

Table 1
Food production growth and conflict severity.

	(1)	(2)	(3)
	ISPS fatalities 1982–2004	SATP fatalities 1993–2011	UCDP battle deaths 1990–2011
Food growth $_t$	−0.425 (0.271)	−0.109 (0.131)	−0.314 (0.350)
Food growth $_{t-1}$	−0.514** (0.255)	−0.473** (0.231)	−1.379** (0.414)
Time	0.004 (0.012)	−0.042** (0.010)	0.031* (0.018)
Neighbor severity $_{t-1}$	−0.203** (0.059)	−0.041 (0.029)	−0.359** (0.142)
Conflict severity $_{t-1}$	0.156** (0.059)	0.507** (0.065)	0.692** (0.063)
Constant	3.775** (0.830)	5.271** (0.769)	1.645 (1.029)
Observations	414	191	232
R-squared	0.324	0.889	0.736

Note: OLS with state fixed effects; robust standard errors in parentheses; $^{**}p < 0.05$, $^{*}p < 0.1$.

significant "bad neighborhood" effect, where a civil conflict in a neighboring country significantly increases the baseline risk of conflict due to negative economic externalities (Murdoch & Sandler, 2004), refugee flows (Salehyan & Gleditsch, 2006), and cultural ties between nationalist groups (Buhaug & Gleditsch, 2008). Our data suggest that, within India, the neighborhood effect of conflict is opposite. Evidently, states with severe violence nearby tend to have lower levels of violence than expected by chance, other factors held constant. We believe this discrepancy can be ascribed to inherent differences between onset and severity analysis; our models only include observations already suffering from armed conflict, in which the proposed trigger effect of nearby violence is largely foregone. Also, an inspection of the maps in Fig. 2 reveals several local hotspots of violence, surrounded by relatively peaceful states. For the estimated samples, the conflict indicators and their neighbor severity counterparts correlate in the range from $r = -0.15$ (ISPS) and $r = -0.37$ (SATP). The conflict history variable, however, replicates the very powerful temporal effect documented in cross-national civil war literature. Lastly, we find little consistency in the time trend across conflict types: Whereas the ISPS state-based fatalities show little indication of a linear (or parabolic) trend, the SATP and UCDP estimates suggest an underlying downward and upward trend over time, respectively.

The models differ considerably in the extent to which they explain the observed variation in conflict severity. Models 2 and 3 fit very well to the empirical data whereas Model 1 leaves much more of the variation unexplained. This difference is largely due to the different samples covered, and, to a lesser extent, because of different inclusion criterion being applied; Model 2, which obtains the highest estimated R^2, only includes state years with reported casualties whereas the other models also include non-violent years in all states that see the given form of conflict in at least five years in total. In robustness tests documented in the Supplementary Material, we evaluate the sensitivity of these results to changing the sample inclusion criterion.

Fig. 3 provides a visual interpretation of the regression results, illustrating how the estimated severity of political violence drops with increased levels of food production (last year) across all three conflict datasets. The plots were created by means of the Clarify expansion package to Stata (King, Tomz, & Wittenberg, 2001), holding spatial and temporal conflict lags at their minimum values. The absolute prediction values are less interesting in this context than the overall trend, or shape of the effect, although the difference in expected severity levels between a good and a bad harvest is notable. For example, violence from Maoist insurgent activities in Chhattisgarh is predicted to increase from 347 to 457 deaths if food production growth drops one-standard deviation below mean levels, other factors held constant. For other states and other conflict types the effect is less dramatic.

The negative estimates for food production growth on the severity of armed conflict correspond well with theoretical expectations and they also mirror earlier findings on the link between economic shocks and communal violence in India (Bohlken & Sergenti, 2010). Moreover, the consistency of the pattern across definitions of state-based conflict indicates that it is very unlikely to be found at random, although we need to consider an alternative explanation to the one proposed above before concluding on the direction of causality. Economic activity and violent conflict are prone to endogeneity, where past violence affects current economic behavior (Gates, Hegre, Nygård, & Strand, 2012) – possibly to a much greater extent than past economic growth rate affects the severity of current conflict. Accordingly, we estimated the conflict models in Table 1 with lead instead of lag food production. If violent conflict in India indeed has a powerful impact on agricultural production, we should find that next year's level of food production correlates negatively and significantly with current-year level of violence. In models shown in the Supplementary Material, we find that this is not the case; the effect of food production growth $(t+1)$ on conflict severity (t) is statistically indistinguishable from zero for all indicators of political violence. Likewise, the measures of log

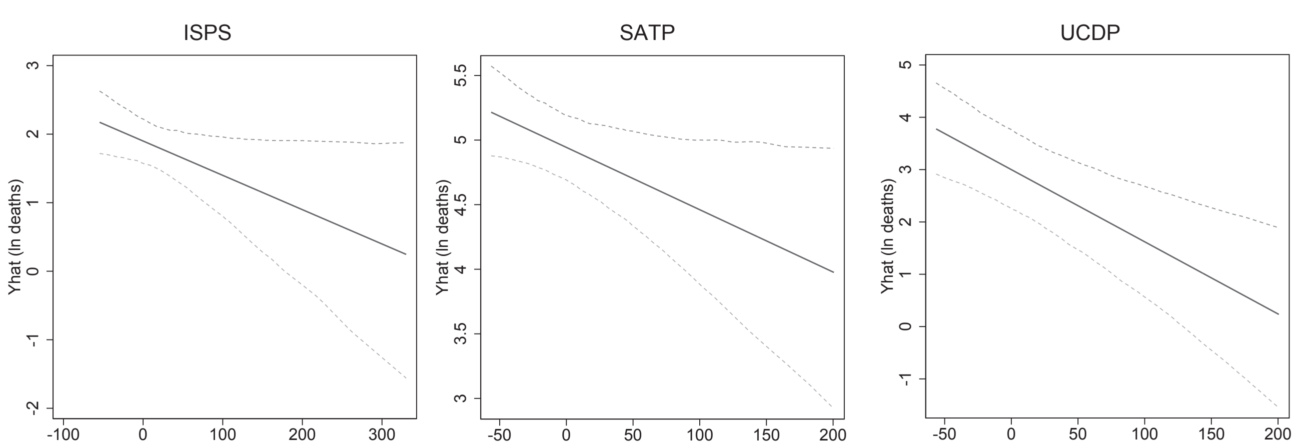

Fig. 3. Predicted conflict severity by food production. The vertical axis shows estimated log conflict casualties while the horizontal axis represents food production growth last year. Dotted lines denote 95% confidence interval round the mean effect. ISPS – fatalities in state-based violence from the India Sub-National Problem Set; SATP – fatalities in violent conflicts from the South Asia Terrorism Portal; UCDP – battle deaths in intrastate conflict from the Uppsala Conflict Data Program.

conflict fatalities are insignificant in models with food production as the dependent variable. We also considered an instrumental variable approach as an added test for endogeneity, using rainfall growth as an exogenous instrument for food production growth. However, averaged annual rainfall statistics exert a weak association with state-level food production in India, explaining only about 7% of the variation in food production in our data – around half of the reported effect of rainfall on economic growth in Sub-Saharan Africa, which is still considered "somewhat weak" (Miguel et al., 2004, 735). Hence, we are reluctant to interpret the weak and inconsistent results from this test as evidence that our finding reflects a reverse causal relationship. More plausibly, the estimated effect of food production growth on conflict severity is largely insensitive to averaged statistics on year-on-year fluctuations in local rainfall.

Since agriculture is the largest economic sector in most Indian states, we also inspected the direct effect of growth in state-level GDP on the severity of conflict. This additional test found a similar pattern for two of the three indicators of conflict although overall the results are somewhat less consistent than what we reported above. This was not entirely surprising since the agricultural sector makes up a modest part of the GDP even if it employs the largest share of the total workforce, and hence economic volatilities are affected by other factors besides variation in crop yields.

Next, we considered the sensitivity of the reported findings to changes in the sample size. In Models 1 and 3, we include all state years with valid data that saw at least five years of fatal unrest during the analysis period. This is a generous inclusion criterion as it permits considering a substantial number of state years that did not experience fatal unrest. Hence, we also estimated these models with a sample reduced to states with at least ten years of fatal conflict. This led to a slightly larger estimated effect of food production growth. Likewise, we expanded the sample to include states without significant agricultural production; the results do not change.

Other sensitivity tests included possible interaction effects. Although the fixed effects specification takes care of underlying, time-invariant differences in conflict propensity, it might also be that the social impact of a given agricultural shock depends on certain state-specific conditions. Several possible conditions were considered, such as state rural poverty and agricultural production per capita, without returning results that overturn the main conclusion presented here. Earlier research has tested for similar interactions with political marginalization (e.g., Theisen, Holtermann, & Buhaug, 2011/12; Wischnath & Buhaug, 2014), although the coarse nature of available group-level exclusion data combined with the democratic system of India imply that there would be very little subnational variation in such indicators in our context. All of these tests are documented in the Supplementary Material. Taken together, the results show that a reduction in crop yields has a significant and adverse impact on conflict dynamics.

Discussion

Overall, the analysis demonstrated that fluctuations in food production can have direct effects on the dynamics of organized political violence. Based on three distinct and complementary conflict datasets, we found that a loss of harvest is significantly associated with an increase in severity of fighting during the subsequent year. The effect is significant also in substantive terms, if less influential overall than conflict history or time-invariant and conflict-specific drivers of baseline violence intensity. With reference to the two proposed hypotheses, it is clear that the empirical material offers much more support for the conventional environmental scarcity-inspired expectation than the feasibility argument that predicts actors to invest in protest and rebellion during surplus times (see also Urdal, 2008).

So, is a poor harvest a good indication of escalating violence in India? Based on the results presented above, the answer is a qualified yes. Across all models, the parameter estimates for food production are negative, but the strength of the association depends on the indicator under consideration as well as the applied time lag, and the magnitude of the estimated effect also depends on underlying risk factors. To the extent that social impacts of future climate change or other socioeconomic developments will negatively affect Indian agricultural production, increased livelihood insecurity and escalation of violent conflicts constitute possible consequences. However, while a historical trend is seen between rural livelihood security and the severity of fighting, projections into the future should be conducted with care. India's impressive National Action Plan on Climate Change specifically aims at making the country's agricultural sector more resilient towards worsening environmental conditions. By introducing thermally resistant crops and alternative production patterns, improving water resource management by optimizing irrigation, investing in water storage and distribution systems, and boosting job creation for some of India's poorest communities, the government aims to reduce poverty and lower rural vulnerability towards climate change (FAO, 2011). The potential for efficiency improvements in the Indian agricultural sector is considerable, and very likely several times greater in magnitude than possible negative productivity impacts of climate change in the short to medium term (Godfray et al., 2010). Additionally, India is rapidly transforming from a rural to an urban society with vulnerabilities to climate change potentially shifting from the countryside to the (informal) urban and periurban settlements. Future efforts to unravel societal implications of climate change should emphasize urban insecurities that are created through environmentally induced migration, pressure on public resources (jobs, housings, health care, etc.), rising food prices, and amplified social inequalities.

To what extent can the reported link between failing food production and escalating violence be considered representative for a larger number of cases across the globe? This remains to be determined, although the fact that many agriculturally dependent societies, especially in Sub-Saharan Africa, are also hosts of durable violent conflicts makes such a general pattern plausible. Despite decades of consistent progress in curtailing hunger, the number of food insecure is yet again on the rise, so the potential for conflict escalation and political instability may also be increasing. Moreover, India could to some extent be considered a tough case since the state has initiated large-scale food subsidies and distribution systems to alleviate some of the social pressure imposed by widespread food insecurity and general poverty. Such 'safety nets' are critical measures to mitigate the negative effect of short-term threats to food availability, potentially helping to prevent escalation of violent conflict and contribute to long-term development. However, especially in areas where such instruments are underdeveloped, mismanaged or weak, food insecurity becomes both a contributing factor to conflict but also a consequence of widespread violence. Since the Indian population in principle should be somewhat less vulnerable to socioeconomic shocks due to governmental food subsidies and the Public Distribution System, an even stronger link between food insecurity and severity of fighting might be expected in states with more fragile market structures and weak political institutions. However, such speculations about security implications of food shortages in the future should be conducted carefully, as advances in international food assistance, aid, and provision of basic services in conflict zones may contribute to remedying adverse effects of failed agricultural production.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.polgeo.2014.07.004.

Endnotes

[1] We use the terms political violence, violent conflict, armed conflict, and civil war interchangeably throughout the article unless specified otherwise. By these terms, we imply violent fighting between organized groups (usually involving the state) that leads to the loss of human lives. In the statistical analysis below, the models differ with respect to the minimum severity threshold for inclusion.

[2] The conflict type (CTYPE) categories from the India Sub-National Problem Set that we aggregate are the following: 1 – General Warfare; 2 – Ethnic/Identity Warfare; 3 – Political/Economic Warfare; 11 – Pro-Government Terrorism Campaign (Repression); 12 – Anti-Government Terrorism Campaign; 21 – Armed Battle/Clash; 22 – Armed Attack; 23 – Organized Violent Riot/Demonstration; 24 – Spontaneous Violent Riot/Demonstration).

[3] In all, 18 states are included in SATP, though only ten states have data for ten years or more and most are recorded only from 1993 and onwards. The database is unclear on whether missing observations (and a small number of coded zeros) imply no relevant activity or truly missing information so we decided to only include state years with positive values on the terrorism count.

[4] The UCDP Battle-Related Deaths Dataset specifies low, high, and best estimates for each conflict year. We use the best estimate in our analysis.

[5] Our theoretical concern is how fluctuations in agricultural performance might affect fluctuations in conflict severity. A state with no significant food production thus is unable to shed light on the variation in the dependent variable. However, as a robustness test, we relaxed this inclusion criterion and replaced missing production growth statistics with zero. The main finding upholds.

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