Do Property Rights Mitigate Drought-Induced Conflict?

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Abstract

Changing climate is projected to increas variability in precipitation. In areas that depend on rain-fed water sources to grow crops or raise livestock, the resulting droughts and floods can have significant impact on livelihoods. Recent research has found links between drought and small-scale between-group conflict (Almer, Laurent-Lucchetti, and Oechslin 2017). However, it has not considered whether property rights institutions are a mechanism that affect whether or not conflict occurs during heavy drought or flood periods. In this paper we paper use a spatio-temporal disaggregated approach to examine the role of property rights institutions as a mechanism. Though not yet accounting for population density, it finds no significant impact of water availability on the prevalance of small-scale group conflict.

Introduction

In a water-scarce world, how likely is the thunderdome? Desert apocalypse makes excellent entertainment, but the dystopian response to water shortages does not necessarily bear out. Under Ostromian (1990) conditions where communities are cohesive or where contracts can reallocate water, communities may band together in mutual self-interest, but fail to take steps when resources seem plentiful. Yet if water supplies dwindle and the alternative to conflict becomes more costly, groups may resort to violence. There are at least three factors at play: the value of the resource, the distribution of the resource among groups, and the resilience

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and impartiality of institutions. Recently, researchers have used global climate datasets to conduct explicit spatial-temporal analysis of the likelihood of conflict, but results have been mixed.

In this paper we discuss conflict in the context of property rights and economic choice. We present a more general model of the relationship between conflict and resources, focusing on the role of property rights institutions and the value of the resource. We test our model empirically with a gridded global climate dataset combined with a measure of drought and incidences of conflict to evaluate the relationship betwene drought and conflict. Our work is novel in two ways. First, we extend the analysis beyond Africa, the region that previous papers using gridded spatial-temporal climate and drought data have focused on [Almer, Laurent-Lucchetti, and Oechslin (2017); HarariLaFerrara2017]. Regional differences in the relationship between drought and conflict offers important information as to the factors that underly the likelihood of conflict. Second, we examine historical scenarios where a sudden change in property rights institutions may offer insight into their role in migitating or enhancing the likelihood of conflict. If property rights are a mechanism through which changing resources levels affect conflict, then stronger property rights should reduce scarcity-induced conflict if it allows stakeholders to negotiate or mediate disputes over resources. On the other hand, if property rights are used to exclude a group in a way that is perceived as unfair, they could increase the likelihood of scarcity-induced conflict. This leads to the main hypothesis: the existence of legal property rights for a scarce resource alter the effect of scarcity-induced conflict.

Property rights institutions can have strong effects on the likelihood of conflict if they provide an avenue for enforcement of rights and mitigation of disputes between parties. Yet in some areas, resources, particularly water resources, are still open access. In the framework of Anderson and Hill (1975), in these "pre-frontier" – in the economic sense – regions, water is not valuable enough to define explicit rights. Yet paradoxically, water may be the source of conflict. In Butler and Gates (2012), increasing resources lead to increased conflict because returns to conflict are higher. But conflict may also be more likely as resources decrease and groups face a "fight for survival" (Lee 2009). In other words, the cost of *not* fighting increases.

While Klomp and Bulte (2013) fond no relationship between scarcity and conflict and Almer, Laurent-Lucchetti, and Oechslin (2017) and HarariLaFerrera2017 found a positive relationship between drought and rates of conflict, BurkHsiangMiguel2015 found in a meta-analysis that conflict occurs as a result of deviations from the mean, rather than levels of resources themselves.

Theory

Consider a model in which groups allocate an endowment of resources between production and 'fighting effort' to command a share of a resource. The resource is an input to production and is open-access, so the amount of resource available is dependent on the fighting effort of each group. Given an endowment ω_i, group i chooses e_i, the effort spent on resource protection, to maximize production, solving

$$\max \pi_i = F(l_i, R(e_i, e_{-i}, S)), \quad \text{s.t.} \quad e_i + l_i \leq \omega_i,$$

where l_i is labor allocated to production and $R(\cdot)$ is a resource function that depends on e_i, the group's fighting effort; e_{-i}, all other groups' fighting efforts; and S, the resource stock.

The best response function is

$$e_i(e_{-i}) = \arg\max_{e_i \geq 0} F(\omega_i - e_i, R(e_i, e_{-i}, S)).$$

Whether or not conflict occurs in response to water shocks depends on the dynamics of e_i and S. If $\frac{\partial e_i}{\partial S} < 0$, a decrease in water resources leads to increasing conflict. If on the other hand $\frac{\partial e_i}{\partial S} > 0$, an abundance of water would lead to more conflict.

Of course, e_i need not be actual violence, instead it may be interpreted as costs associated with protecting a right, which may include legal action or installing cameras where property rights institutions make those strategies viable. The optimal level of effort dedicated to protecting a resource is also dependent on property rights institutions, which may change the marginal value of protecting a right.

Butler and Gates (2012) present the above model in a form that includes a measure of property rights enforcement, where group i receives a share the resource based on their effort as a share of total effort by all groups. Property rights enforcement by the state or via community norms (Ostrom 1990) is given by η_i, where the subscript i indicates that enforcement can differ between groups if the institutions do not impartially enforce rights[3]. Thus π_i takes the form

$$\pi_i = \frac{e_i + \eta_i}{\sum_i (e_i + \eta_i)} \left[\sum_i (S_i - e_i) \right]$$

where S_i is the resource stock belonging to group i. The best response function for group i is

$$e_i(e_{-i}) = \sqrt{\left(\sum_{j \neq i} e_j + \eta_j \right) \left(\sum_i S_i + \eta_i \right) - \sum_{j \neq i} (e_j + \eta_j) - \eta_i}$$

If enforcement is impartial, then

$$e_i(e_{-i}) = \sqrt{(n\eta + e_{-i})\,(n\eta S) - n\eta e_{-i}}.$$

Since $\frac{\partial e_i}{\partial S}$ is positive, effort dedicated to protection of a resource increases as the stock increases. With respect to η, we have

[3]If enforcement is impartial, the model simplifies to that in Neary (1997)

$$\frac{\partial e_i}{\partial \eta} = \frac{1}{2}\left[\left(n\eta + e_{-i}\right)\left(n\eta S\right) - n\eta e_{-i}\right]^{-1/2}\left(nS(2n\eta + e_{-i}) - ne_{-i}\right).$$

Data

To estimate the level of drought, we use the Standardized Precipitation Evapotranspiration Index (SPEI) developed by Vicente-Serrano, Beguería, and López-Moreno (2010) and Beguería et al. (2013)[4]. The SPEI captures deviation from the long term trend at a 0.5 degree spatial resolution for every month and year from 1901 to 2015, and is available as one- to 48-month deviations. We follow Almer, Laurent-Lucchetti, and Oechslin (2017) in using the one-month deviations.

Records of conflict are from the Social Conflict Analysis Database (SCAD) developed by Salehyan et al. (2012)[5]. In addition to other information, each record contains the event type, start and end date, geo-coded location, and number of deaths. Here we focus on non-governmental conflicts, defined in the SCAD as violent or non-violent riots. Riots include forms of conflict between groups of people, or perpetrated by a group of people, that are not military or governmental groups. we create four measures of conflict for each spatial grid cell and month-year time point: (1) *Days of Conflict* measures the number of days during which a conflict occurred; (2) *Start of Conflict* measures whether or not a conflict began in that time period; *Conflict Occurred* measures whether or not a conflict occurred regardless of whether it started; and *Number of Conflicts* measures how many distinct conflict events occurred.

Additional geospatial variables are from the PRIO-GRID database developed by Tollefsen, Strand, and Buhaug (2012). These include travel time to nearest major city (Uchida and Nelson 2010), number of ethnic groups (Vogt et al. 2015), land with irrigation equipment, night lights detected (Elvidge et al. 2014), and percent land covered by urban area

[4]Specifically, we use the global SPEI database available from Beguería (2017) at http://spei.csic.es/database.html.

[5]Available at https://www.strausscenter.org/scad.html.

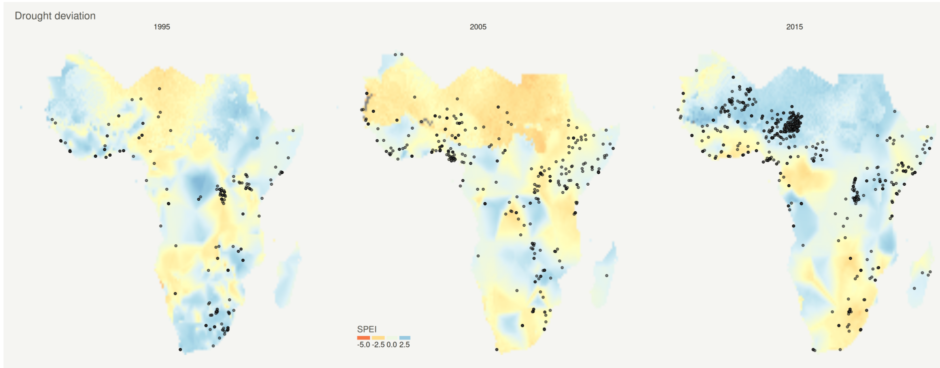

Figure 1: Map of Riots and Drought, 2013.

(Meiyappan and Jain 2012).

Two measures of water property rights are used to asses the extent of a country's water rights legal framework. The first is the Rights to Resources dataset developed by the World Resources Institute (2014). The data contain the responses to eleven questions on the legal status of property rights for water, mineral, and other resources. Of importance for this work are whether the state declares public ownership of the resource, whether property rights can be private, and whether traditional/cultural property rights are recognized. In each case a response of "Yes", "Yes, implied", or "Partial" is coded as a one, while other respones are coded as zero. The second is data from Alden Wily et al. (2017), which includes the year in which each country implemented its water law, allowing for the use of a water law in a fixed-effects model.

The resulting dataset includes 9,320 spatial grid points covering 45 countries in Africa over 312 time periods from January 1990 to December 2015. Of these, 6,872 grid points are in the 40 countries for which information on property rights is available. Not all spatial points contain information in all time points, so the resulting data include 2,137,427 spatio-temporal records of conflict, property rights, and drought level.

Table 1: Summary statistics for climate and riots.

Variable	Mean	Std. Dev.	Min.	Max.
Days with riots	0.01326	0.58471	0	187
Riot occurred	0.00073	0.02705	0	1
Riot onset	0.0007	0.02647	0	1
Number of riots	0.0008	0.03221	0	13
SPEI	-0.09688	0.98707	-8.01478	7.45265

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Table 2:

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max

Method

The central hypothesis of this paper is that water property rights reduce the likelihood of conflict that stems from a lack of water during drought. To test this, we first replicate the approach used by Almer, Laurent-Lucchetti, and Oechslin (2017) to check that drought affects the prevalence of conflict. If the hypothesis that water rights mitigate conflict, then water rights interacted with drought should produce a negative effect on conflict, but other property rights for resources that are not affect by drought (such as mineral rights) should not have any effect on conflict when interacted with drought.

We employ a fixed-effects model that takes the form:

$$y_{it} = \alpha + \beta_0 \Delta W_{it} + \beta_1 X_{it} \Delta W_{it} + V_c + \delta_i + \phi_t + \gamma_{rm} + \rho_{cy} + \varepsilon_{it},$$

where y_{it} is the conflict variable of interest, ΔW_{it} is the SPEI measure, X_{it} is a vector of possible mechanisms through which water scarcity or abundance may operate, V_c is country-level aspects that may change over time such as political stability, δ_i is spatial fixed-effects, ϕ_t is time fixed-effects, and γ_{rm} and ρ_{cy} are region-month and country-year fixed effects.

In the initial model, we let $\beta_1 = 0$ to test whether drought has a causal effect on conflict. This specification makes use of the entire spatio-temporal dataset.

Unfortunately our data on property rights is limited to a single year, so in the specification testing whether property rights mediate the effect of drought on conflict the model is cross-sectional for the year 2013. We test the robustness of the results of this cross-sectional analysis by assuming that property rights are unchanged for years on either side of 2013. If the results are similar, the cross-sectional approach is less likely to suffer from omitted variable bias.

An alternative specification limits the analysis to South Africa, which implemented a water usage rights policy in 1999.

Results

A fixed-effects regression of SPEI, SPEI^2, and Polity. Results are similar to those in Almer, Laurent-Lucchetti, and Oechslin (2017). Polity and non-linearity in SPEI do not have a significant effect.

Dummy variables for SPEI greater than one or two standard deviations are not significant. Combined with the non-significance of the squared term, this suggests that the relationship between spei and conflict onset is close to linear and in the negative direction, i.e. more drought leads to the onset of conflict.

Table 3: SPEI and start of conflict.

	Dependent variable:		
	Conflict Start		
	(1)	(2)	(3)
SPEI	-0.00006*	-0.00006*	-0.00006*
	(0.00003)	(0.00003)	(0.00003)
$SPEI^2$		-0.00003	-0.00003
		(0.00003)	(0.00003)
Polity			0.00008
			(0.00013)
Constant	0.00008	0.0001	0.00067
	(0.00072)	(0.00072)	(0.00085)
Observations	1,253,952	1,253,952	1,203,321
R-squared	0.044	0.044	0.044
Note:			$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 4: SPEI and start of conflict.

	Dependent variable:		
	Conflict Start		
	SPEI	(SPEI > 1 SD)	(SPEI > 2 SD)
Independent Variable	-0.00006*	-0.00002	-0.00019
	(0.00003)	(0.00007)	(0.00017)
Conflict Mean Response	0.99983***	0.99982	0.99983
	(0.00466)	(0.00466)	(0.00466)
Constant	0.00008	0.00007***	0.00007***
	(0.00072)	(0.00072)	(0.00072)
Observations	1,253,952	1,253,952	1,253,952
R-squared	0.044	0.044	0.044
Note:			$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 5: SPEI and start of conflict.

	Dependent variable:			
	Conflict Start			
	No Private Right	Private Right	No Public Right	Public Right
SPEI	-0.00005	-0.00012	0.0007	-0.00006*
	(0.00004)	(0.00008)	(0.00115)	(0.00003)
$SPEI^2$	-0.00003*	0	-0.0001	-0.00003
	(0.00003)	(0.00007)	(0.00088)	(0.00003)
Conflict Mean Response	0.99956	1.00119***	1.32498***	0.99982***
	(0.00514)	(0.01167)	(0.79933)	0.0047
Constant	0.00015	-0.00779***	0.03863***	0.0001***
	(0.00072)	(0.0028)	(0.00706)	(0.00072)
Observations	1,038,840	191,100	1,248	1,228,692
R-squared	0.044	0.045	0.052	0.044
Note:				*p<0.1; **p<0.05; ***p<0.01

Discussion

The main point to consider is that in earlier research (Almer, Laurent-Lucchetti, and Oechslin 2017) effects were found only if considering locations with greater than median population. Since riots cannot occur in areas without people in them, including population density should create a better identification. This is the next step.

Here we use one-month deviations from long run spei to measure drought, but it may be that one-month deviations are too short-lived to drive groups to conflict. An improvement would be to test whether longer period deviations have a larger effect. (Note: Almer et al. only use the one-month deviations.)

The measure of property rights used here only indicates whether they exist in law. In countries without strong central governments and the institutional infrastructure to enforce property rights, the effect would be minimal. An alternative source of property rights data is the International Property Rights Index (IPRI), which is produced every year from 2007 onward, and provides more detailed data on property rights. However, the IPRI data does not break out rights by resource type.

To summarize, no effect of drought on riots was found, but this may be due to limitations of the current analysis, in particular including a large number of grid points that do not have people living in them.

Next Steps

There are several aspects that need further expansion. Data from Latin America has been included, but not yet analyzed. An important question is how to dilineate regions. If the strength of property rights institutions affect conflict, they should be included in the fixed effects of the model, to the extent that they are truly fixed. It may be better to focus on regression discontinuity design scenarios like that in South Africa, in which a property rights institutional change can be evaluated. This question of how best to isolate the role of property rights is the major issue of this paper going forth.

References

Alden Wily, Liz, Fabrice Dubertret, Peter Veit, Katie Reytar, and Nicholas Tagliarino. 2017. "Water Rights on Community Lands: Landmark's Findings from 100 Countries." *Land* 6 (4): 77. https://doi.org/10.3390/land6040077.

Almer, Christian, Jérémy Laurent-Lucchetti, and Manuel Oechslin. 2017. "Water Scarcity and Rioting: Disaggregated Evidence from Sub-Saharan Africa." *Journal of Environmental Economics and Management* 86: 193–209. https://doi.org/10.1016/j.jeem.2017.06.002.

Anderson, Terry L, and Peter J Hill. 1975. "The Evolution of Property Rights: A Study of the American West." *The Journal of Law and Economics* 18 (1): 163–79.

Beguería, Santiago. 2017. "SPEIbase: Version 2.5.1." https://doi.org/10.5281/zenodo.834462.

Beguería, Santiago, Sergio M. Vicente-Serrano, Fergus Reig, and Borja Latorre. 2013. "Standardized Precipitation Evapotranspiration Index (Spei) Revisited: Parameter Fitting, Evapotranspiration Models, Tools, Datasets and Drought Monitoring." *International Journal of Climatology* 34 (10): 3001–23. https://doi.org/10.1002/joc.3887.

Butler, Christopher K, and Scott Gates. 2012. "African Range Wars: Climate, Conflict, and Property Rights." *Journal of Peace Research* 49 (1): 23–34. https://doi.org/10.1177/0022343311426166.

Elvidge, Christopher D, Feng-Chi Hsu, Kimberly E Baugh, and Tilottama Ghosh. 2014. "National Trends in Satellite-Observed Lighting." *Global Urban Monitoring and Assessment Through Earth Observation* 23: 97–118.

Klomp, Jeroen, and Erwin Bulte. 2013. "Climate Change, Weather Shocks, and Violent Conflict: A Critical Look at the Evidence." *Agricultural Economics* 44 (s1): 63–78. https://doi.org/10.1111/agec.12051.

Lee, James R. 2009. *Climate Change and Armed Conflict: Hot and Cold Wars*. Routledge.

Meiyappan, Prasanth, and Atul K. Jain. 2012. "Three Distinct Global Estimates of Historical Land-Cover Change and Land-Use Conversions for over 200 Years." *Frontiers of Earth Science* 6 (2): 122–39. https://doi.org/10.1007/s11707-012-0314-2.

Neary, Hugh m. 1997. "Equilibrium Structure in an Economic Model of Conflict." *Economic Inquiry* 35 (3): 480–94. https://doi.org/10.1111/j.1465-7295.1997.tb02026.x.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge university press.

Salehyan, Idean, Cullen S. Hendrix, Jesse Hamner, Christina Case, Christopher Linebarger, Emily Stull, and Jennifer Williams. 2012. "Social Conflict in Africa: A New Database." *International Interactions* 38 (4): 503–11. https://doi.org/10.1080/03050629.2012.697426.

Tollefsen, Andreas Forø, Håvard Strand, and Halvard Buhaug. 2012. "Prio-Grid: A Unified Spatial Data Structure." *Journal of Peace Research* 49 (2): 363–74. https://doi.org/10.1177/0022343311431287.

Uchida, Hirotsugu, and Andrew Nelson. 2010. *Agglomeration Index: Towards a New Measure of Urban Concentration*. 2010, 29. Working paper//World Institute for Development Economics Research.

Vicente-Serrano, Sergio M., Santiago Beguería, and Juan I. López-Moreno. 2010. "A Multiscalar Drought Index Sensitive to Global Warming: The Standardized Precipitation Evapotranspiration Index." *Journal of Climate* 23 (7): 1696–1718. https://doi.org/10.1175/2009jcli2909.1.

Vogt, Manuel, Nils-Christian Bormann, Seraina Rüegger, Lars-Erik Cederman, Philipp Hunziker, and Luc Girardin. 2015. "Integrating Data on Ethnicity, Geography, and Conflict." *Journal of Conflict Resolution* 59 (7): 1327–42. https://doi.org/10.1177/0022002715591215.

World Resources Institute. 2014. "Rights to Resources: The Status of Local Natural Resource Rights in National Laws in Sub-Saharan Africa." Washington, DC: World Resources Institute. http://datasets.wri.org/dataset/rights-to-resources-map.