journal of peace RESEARCH

© 2006 Journal of Peace Research,
vol. 43, no. 5, 2006, pp. 507–522
Sage Publications (London, Thousand Oaks, CA
and New Delhi) http://jpr.sagepub.com
DOI 10.1177/0022343306066627

The Geographic Spread of Militarized Disputes*

ALEX BRAITHWAITE

Department of Political Science, Colorado State University

A thriving literature investigates the claim that geographic processes cause military conflict to cluster and diffuse. With the recent update of the Militarized Interstate Dispute (MID) data and the collection of geographic locations to accompany these data, it is now possible to offer a location-based examination of the geographic spread of conflict. Consideration of the literature that identifies a role for physical geography in conflict processes leads to the derivation of hypotheses in which territory and resources are expected to provide incentives for states to seek to increase territorial acquisitions, while impassable terrain is expected to act as a barrier to such spread. These hypotheses are tested using ordinary least squares (OLS) estimation – regressing the spread of individual MIDs in the years 1993–2001 upon a range of location- and dispute-specific variables. These regressions demonstrate that the spread of individual disputes is a function of the issue over which they are fought, the presence of vital resources in the host country, the prevailing terrain of that country, and the relevant conflict history of the participants. It is argued that knowledge of the precipitants of the spread of individual conflicts is of great benefit to policymakers seeking to mitigate the detrimental impact of conflict upon the societies in which it occurs, as well as to those deploying peacekeeping troops to conflict zones.

Introduction

Why do some international conflicts spread across large territorial expanses while others remain confined to a small geographic area? This question is motivated by an interest in assessing the assertion that 'once conflict begins, there is some tendency for it to spread out from the "infected" spot' (Alcock, 1972: 64). Investigation of the processes leading to the spread of conflicts enables us to recognize their impact upon the societies within which they occur. While the literature addressing the expansion and escalation of conflict informs our understanding of state attributes and issues of dispute that motivate the use and escalation of force, the present study additionally focuses upon the localized geographic and political conditions that determine the extent of the presence of conflict within societies.

This study offers a competitive test of potential explanations of the process of geographic spread. A number of characteristics of the dispute at its outset are assessed as causes of spread. These include measures of the geographic nature of its location, its participants' attributes, and the issue over which it is fought. Ordinary least squares (OLS) regression leads to the conclusion that territorial disputes in mountainous and resource-rich countries are more likely to experience substantial geographic spread than other disputes. There is, additionally, marginal evidence to suggest that conflicts fought

* I am grateful to Håvard Hegre and five anonymous reviewers for their extremely useful comments and suggestions on earlier drafts of this article. Any remaining errors are my responsibility. Please direct correspondence to abraithwaite@gmail.com. The data used in this article can be found at http://www.prio.no/jpr/datasets.

between states that share a 'vital'[1] border are significantly less likely to spread geographically. These results are discussed in the context of their policy relevance, with particular attention paid to the value this knowledge adds to our ability to manage future conflicts of this ilk. Moreover, these factors are shown to continue to play an important role even when we control for a range of 'ex post' factors.

The Geographic 'Spread' of International Conflict

From a conceptual perspective, geographic spread refers to the extent of territory affected by the hostilities of individual conflicts. As such, it differs from a number of similar concepts, including 'expansion', 'fatalities', and 'duration'. Starr & Siverson's (1991) identification of contiguity and alliances as determinants of the expansion of international war is motivated by the analogy between war and disease. Thus, conflict evolves only when it becomes a multilateral affair. My focus on geographic spread is not reliant upon the expansion of participation in order for the diffusion of hostilities to be observed. Indeed, 263 of the 296 disputes in my data are bilateral affairs for their entire duration. Of the remaining 33, 15 become multilateral and 18 begin as multilateral.

Geographic spread is also quite distinct from measures of the 'severity' of conflict. That is to say that while measures of fatalities (e.g. Sarkees, Wayman & Singer, 2003; Lacina & Gleditsch, 2005) reflect the human cost of conflict, spread measures the impact conflict has upon territories and societies, even when it does not incur human casualties. Indeed, only 42 of the 296 MIDs experienced any battle-related fatalities. It seems unreasonable, however, to assume that the remaining 252 conflicts do not have a 'significant' impact upon society simply because they do not incur a human death-toll. Therefore, I argue that geographic spread provides an alternative means by which to assess a conflict's impact on territory and society both with and without fatalities.

Finally, geographic spread is an alternative characteristic of conflict that parallels its 'duration'. Bennett & Stam (1996) sought to predict the duration of wars on the basis of conditions and characteristics of the conflict on day one. Similarly, I focus upon identifying cues that help predict variance in the impact of individual conflicts on the basis of their initial motivations, hostilities, and locations. Here, however, I offer an indicator of the particular locations at which hostilities are located. A long-running conflict could, for example, be rampant and consume large areas (e.g. World War II) or be intractable and entrenched, resulting in minimal spread (e.g. the Vietnam War).

The Geography of International Conflict

Diehl (1991) identifies geography as both a *cause* and a *context* of conflict. The former identifies territory, resources, and contiguity as precipitant issues in the outbreak and escalation of international conflicts (e.g. Bremer, 1992; Vasquez, 1993). The latter theme identifies the geographic proximity of two states as a context that shapes the occurrence of conflict between those states (e.g. Boulding, 1962; Zipf, 1965). These notions are reflected by Most & Starr's (1989) *opportunity* and *willingness* framework.

Studies by Kirby & Ward (1987), Anselin & O'Loughlin (1990, 1992), and O'Loughlin & Anselin (1991, 1992) address the global and regional distribution of conflicts. Their works stress the importance of specifying

[1] Starr (2002) defines borders as being 'vital' if they are both easily accessed and salient to their governments – contain valuable resources, significant populations, and/or administrative centers.

analytical models that account for spatial dependence between observations to improve upon the traditional approach of simply assuming independence between observations. Recent studies by Gleditsch (2002), Ward & Gleditsch (2002), and Braithwaite (2005) develop notions of clustering and diffusion at the regional and local levels of interaction, demonstrating that fine-grained consideration of geographic processes is warranted. Each of these studies concludes that conflicts are spatially dependent and that conflict locations cluster spatially, forming 'hot spots'. My interest in *space* differs from those listed above in that it pertains to the precise geographic spread (or size) of militarized disputes, which enables us to develop a clearer picture of their evolution as well as their impact upon their host territories.

Buhaug & Gates's (2002) study of civil conflict offers the only precedent for an endeavor such as mine. While there is reason to suspect that the processes determining the spread of inter- and intrastate conflicts vary, their study offers some insights into the variables that might be associated with the process of spread. They demonstrate that the *scope* – synonymous with spread – of a civil war is a product of its duration and its proximity to valuable natural resources.

The physical geography–conflict nexus additionally pertains to the impact conflicts have within the territories and societies upon which they take place. The literature on conflict and democratization, for example, commonly notes the impact that international conflict has upon expediting and mitigating the process toward democratization (Gleditsch, 2002; Gleditsch & Ward, 2000; and Enterline, 1998). The conclusion of this line of work tends toward identifying conflict as a precipitating factor in regime change but not necessarily as a cause of democratization.

Second, an increasing number of studies build upon the work of Russett, Ghobarah & Huth (2003), which illustrates the long-term impact that conflict has upon indices of social welfare. Similar conclusions about the longevity of the impact of conflict upon indicators of public health (see e.g. Davis, Iqbal & Zorn, 2003) and refugee flows (see e.g. Davenport, Moore & Poe, 2003) suggest that the conflict processes literature has made great strides toward understanding the impact of conflict upon society. This endeavor is aided by examination of conflict's geographic spread, which enables observation of a direct link between conflict locations and the effects of these events upon public health and humanitarian matters.

Specifying a Model of the Spread of Conflict

Geography shapes the course of political actions. Mahan (1890) and Mackinder (1904), for example, debate the relative value of 'territorial' and 'naval' power, while recent work by political geographers (e.g. Le Billon, 2001) highlights the influence of geographical factors (including natural resources) upon political behaviors. This study identifies a range of geopolitical explanations for why some conflicts spread from their original point of onset while others remain geographically confined, focusing, in particular, upon characteristics of disputes at their outset. Specifically, expectations associate the issue over which the dispute is being fought and geographical characteristics of the onset locality with the tendency for the dispute to spread geographically. These factors are isolated because they provide an incentive for state acquisition of additional territory and/or they act as barriers to or transmitters of hostilities.

The very characteristics of the dispute itself are central to identifying factors that affect the geographic spread of individual conflicts. Diverging from traditional realist approaches in which it is assumed that the

seeds of conflict are ever-present (see e.g. Morgenthau's [1967] discussion of power and international relations), a great deal of contemporary scholarship suggests that conflict necessarily rests upon the existence of specific issues of contention. Geller & Singer (1998), for example, conclude their summary of the scientific study of international conflict by arguing that while the probability of conflict between states is affected by the various attributes of the potential combatants, the conflict's occurrence requires an issue over which states choose to compete. One issue area commonly identified by the extant literature as being associated with both conflict onset and escalation is that of territory (e.g. Vasquez, 1993; Hensel, 1996; Vasquez & Henehan, 2001).

The traditional explanation for territorial conflicts rests upon the observation that territory is a zero-sum resource and that conflict over it is, therefore, more intractable than non-territorial conflict. It follows that states motivated by territorial concerns are more likely to compete to acquire new territory so as to maximize their relative balance of power vis-à-vis their counterpart. That is to say that the value associated with the possession of territory adds incentives to any strategy that causes states to pursue additional acquisitions. This logic results in the first testable proposition:

H1: Disputes characterized by a territorial issue are more geographically spread out than are conflicts motivated by non-territorial issues.

A second aspect of the incentives underlying conflict relates to the local presence or absence of valuable natural resources. Recent work by Le Billon (2001), Buhaug & Lujala (2005), and Lujala, Gleditsch & Gilmore (2005) provides crucial data on valuable, lootable resources, as well as hypotheses regarding their influence upon conflict. In the study of civil conflict, it is argued that valuable resources fund ongoing rebellion activities. While it is unlikely that these resources are desired by states to fuel their ongoing conflicts, it is fair to assume that such valuable resources provide an incentive for territorial acquisition. This logic motivates the ongoing data-collection efforts of the Issue Correlates of War (ICOW) project. Hensel (2001), for example, argues that knowledge of territorial (and other resource-based) claims improves our understanding of the motivations behind international uses of force. Various US uses of force in the Middle East to protect oil reserves (e.g. in Kuwait), Arab–Israeli conflicts over increasingly depleted water resources, and the ongoing internationalized civil conflicts in Central Africa (a gem-rich region of the world) are examples of conflicts in which natural resources appear to play a central motivating role. Accordingly, if states wish to maximize their acquisition of such resources, it follows that conflicts are likely to expand geographically when occurring in states that are rich in these endowments. I argue, therefore, that

H2: Disputes located in countries with endowments of valuable natural resources are more spread out than disputes in other countries.

In their study of civil conflict, Buhaug & Gates (2002) argue that impassable terrain provides an aid to rebel groups in their actions against government forces. In particular, they argue that rough terrain – both forested and mountainous landscapes – provides safe haven for rebels, allowing them to expand their efforts while evading government detection. In international conflicts, however, it is not so clear that this logic applies. Given that both parties are reliant upon conventional forces, it is not so apparent that one side should benefit from variations in the prevailing local geography. Rather, I argue that passable terrain facilitates the spread of conflict zones, as both sides' conventional forces are more easily able

to conduct their campaigns. Accordingly, impassable terrain acts as a barrier to the spread of hostilities. For example, US forces in Desert Storm made dramatic territorial gains with relative ease across the flat desert conditions of Kuwait and Iraq, whereas the same nation's forces had previously struggled in the heavy forest conditions of Vietnam. Therefore, I hypothesize that

H3: Disputes located in areas characterized by passable terrain are more spread out than disputes that occur in areas of impassable terrain.

The potential spread of a particular conflict is presumably also constrained by the geographic size of the countries upon whose territory it is being fought. Larger states provide greater potential arenas for combat. If the bilateral originators of the conflict possess large territorial endowments, the potential arenas of conflict are themselves greater, and, thus, the potential for the conflict to spread is surely greater also. Thus, I contend that

H4: Disputes between geographically large states are more spread out than conflicts between states with smaller territorial endowments.

Recent work examining variance in the length and salience of shared borders between contiguous states enables us to offer a more fine-tuned examination of the relationship between potential interaction and conflict (Furlong & Gleditsch, 2003; Starr, 2002; Starr & Thomas, 2005). Following the logic of the 'opportunity–willingness' framework (Most & Starr, 1989), states that share communicable and more salient borders have more opportunities and a greater willingness to fight one another, as they are likely to view conflict over the border as a great threat to their territorial sovereignty. Developing this argument with respect to the potential impact of borders upon the geographic spread of conflict, it is logical to argue that a communicable border facilitates the spread of hostilities across territory. Moreover, states are, presumably, more compelled to devote resources to defend salient borders that are home to significant population and administrative centers. Thus,

H5: Disputes between states are more spread out if they share a vital border.

Building a Model of the Geographic Spread of Disputes

The unit of analysis for the testing of these hypotheses is the MID. Data are drawn from 296 MIDs that consisted of at least a single show or use of force[2] and took place between 1993 and 2001 (Ghosn, Palmer & Bremer, 2004). The specific selection of MIDs is in line with most recent work on conflict escalation, which identifies them as a stepping stone from peace to war (e.g. Bremer & Cusack, 1996; Reed, 2000; Vasquez & Henehan, 2001). Moreover, MIDs are more prevalent in the international system than international wars and have a broader distribution across the states and regions of the world. Moreover, the recent MID 3.0 data-collection project includes a variety of variables summarizing the characteristics of the individual incidents of which each MID is comprised – thereby enabling fine-tuned assessment of the correlates of their geographic spread. As Table I states, there is a mean of just over 6 individual incidents per MID, but a range from 1 to 372.

Dependent Variable

My choice of dependent variables follows that of Buhaug & Gates (2002), insofar as I operationalize the geographic spread of MIDs as a circular area measured in km^2, the

[2] In my analysis, I do not include MIDs that consisted solely of a 'threat' to use force, because there is no inherent geographic location at which threats are made. As such, it is not possible to identify a location, let alone the 'spread' of these MIDs. Eight MIDs were excluded from the analysis on the basis of this decision.

Table I. Descriptive Statistics for Variables

Variable	*N*	*Mean*	*Standard deviation*	*Min.*	*Max.*
Spread (logged)	296	6.93	3.62	3.83	16.30
Territory	296	0.40	0.49	0.00	1.00
Resources	296	0.37	0.48	0.00	1.00
Mountain	296	29.44	27.06	0.00	95.71
Forest	296	29.25	29.26	0.00	90.86
Ocean	296	0.18	0.38	0.00	1.00
Vital border	296	0.68	0.53	0.00	2.00
Size of states (logged)	296	14.39	1.67	10.34	17.86
Peace years	296	7.02	15.93	0.00	159.00
Number of incidents	296	6.38	24.63	1.00	372.00
Duration (logged)	296	3.01	2.20	0.00	8.07
Hostility level	296	1.65	0.58	1.00	3.00

radius of which is defined by the distance from the MID's geometric mean (center) location to the furthest outlying incident.[3] Figure 1a depicts my conceptual operationalization of the geographic spread of MIDs. In this instance, the thick black circle represents the total area characterizing the spread of the individual dispute.

Location data used to calculate this spread variable are taken from my recent collection of geographic data to accompany the MID dataset (see Braithwaite, 2005, for full details of the coding protocol and descriptive statistics). For the years 1993 to 2001, this dataset includes geographic location data (x and y coordinates) for each individual MID incident. The 296 MIDs analyzed in this study are mapped in Figure 2.

Independent Variables

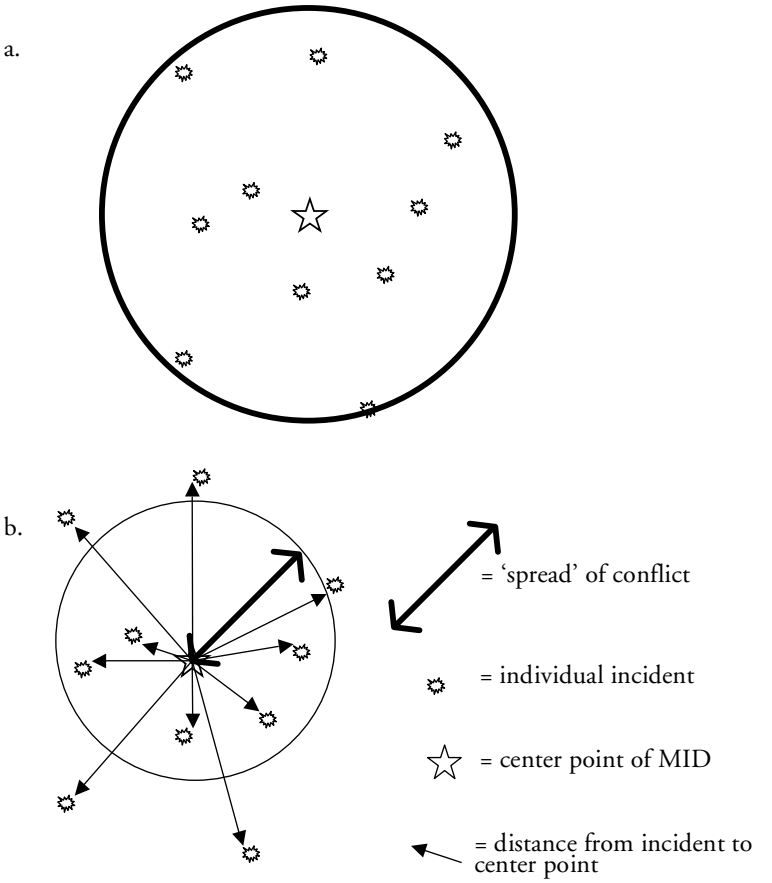
Details of the descriptive statistics for each of the variables included in this study are listed in Table I. Their conceptualization, operationalization, and measurement are listed in Appendix A.

In order to gauge the importance of the issue under dispute upon its spread, I include a binary variable, *territory*, for which 1 indicates that at least one of the parties in the dispute prioritizes a territorial matter. Therefore, 0 aggregates all non-territorial issues, including 'policy', 'regime', and 'other' categories. This information is taken from Ghosn, Palmer & Bremer (2004). Of 296 MIDs, 118 are identified as being motivated by a territorial issue.

Details about natural resource endowments are drawn from Buhaug & Lujala (2005). A binary variable, *host resources*, is included to measure the presence (1) or absence (0) of natural resources within the host country. Resources are present if the country has an endowment of oil, gems, or illicit drugs and absent if none of these resources are located within the state. Of 296

[3] This measure could be affected by the presence of far-outlying observations. Therefore, I additionally employ a measure of compactness as a control. The equation used to calculate this alternative value is also listed in Appendix A. Intuitively, this measure represents the mean deviation of distance between individual incidents and the MID center point. This is the two-dimensional, spatial equivalent of the more familiar standard deviation. As such, it can be considered a measure of the 'compactness' of observations around the center location of the individual MIDs (Grubesic & Murray, 2005). The advantage of employing a mean distance in this manner is that it is not significantly biased by the presence of distant outlying incidents – the impact of outliers is controlled for by the presence of the number of observations in the denominator of the statistic. This alternative measure is illustrated in Figure 1b. Here, the double-headed black arrow represents the standard deviation distance that is calculated to capture the spread of the dispute.

Figure 1. Illustrating the Spread of Conflict



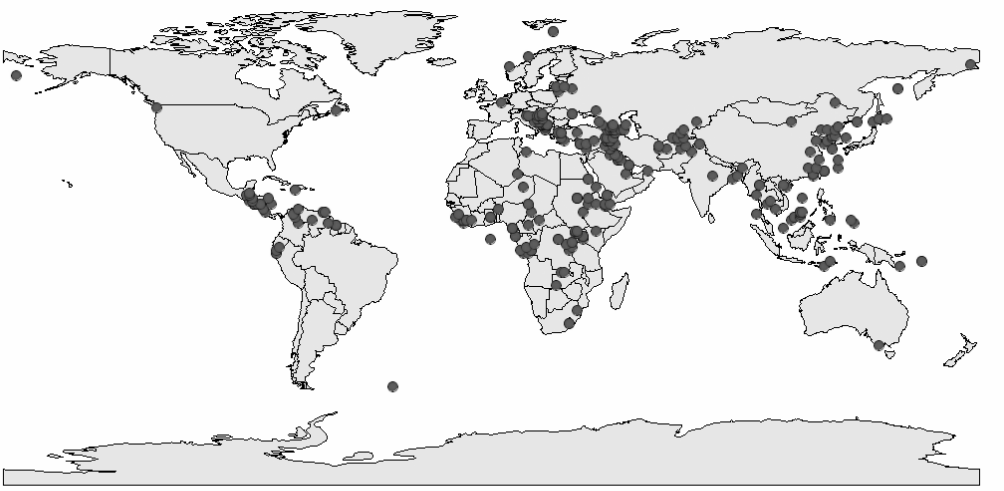
MIDs, 109 are fought on the territory of states that are considered as having a resource endowment.

Three measures of the predominant terrain at the location of each dispute are included in this analysis. *Mountain*[4] measures the proportion of the territory of the host state of the initial incident of the dispute that is defined as being mountainous according to the 'Mountain Watch' project (UNEP, 2002). This measure ranges from 0 (completely flat, e.g. Iraq) to 100 (completely mountainous – Tajikistan is considered 95.7% mountainous). In line with the logic of Hypothesis 3, spread ought to be shown to be negatively associated with location in mountainous areas.

Second, *forest* measures the proportion of the territory of the host state of the initial incident that is defined as being covered by forests according to the Food and Agriculture Organization (FAO) of the UN (FAO,

[4] Alternative operationalizations for both the *mountain* and *forest* variables focus upon the immediate location of the initial incident of which the MID is comprised. The Mountain Watch and FAO data also come in GIS-compatible Raster formats that enable one to identify the presence or absence of mountains and/or forest cover in the immediate vicinity of the MID onset. This variable is excluded from this analysis because it plays a lesser role in accounting for spread than does the national-level summary variable. Moreover, the national-level summary variable speaks to the area of potential spread insofar as it provides details away from the immediate location of the dispute.

Figure 2. Locations of MIDs, 1993–2001



1999). This measure ranges from 0 (absolutely no forest cover, e.g. Saudi Arabia) to 100 (completely covered in forest – Guyana is considered 90.8% forested). In line with the logic of Hypothesis 3, spread ought to be shown to be negatively associated with location in heavily forested areas.

Third, *ocean* is a binary variable indicating whether or not the initial incident of the dispute is located at sea – that is, disputes over fishing rights and naval operations within broader conflicts (US operations in the Gulf). The initial incidents of 53 out of 296 MIDs took place at sea. In line with the logic of Hypothesis 3, spread ought to be shown to be negatively associated with location at sea.

Two additional explanatory variables employed in this initial analysis are specific to the participants in the conflict. First, I hypothesized that MIDs fought between contiguous states that share a 'vital' political boundary are more likely to spread geographically than MIDs between states that do not share such a boundary. To test this hypothesis, I employ new GIS data on the nature of international boundaries (Starr, 2002; Starr & Thomas, 2005).[5] This dataset codes two indicators that describe the ease of interaction across the border (representing the opportunity for conflict) and its importance to the state (representing the state's willingness to fight). I employ a variable, *vital border*, adapted from that in Starr (2002), which combines these indices. This variable ranges from 0 (incommunicable borders that are not salient) to 2 (borders that provide easy interaction and are salient). A positive coefficient for this variable would support the notion that more vital borders increase the likelihood of conflicts spreading geographically.[6]

A second geographically sensitive, participant-specific variable, *size of states*, measures the joint size of the territories of the two states in the dyad. This variable is logged to

[5] Starr's (2002) collection of this GIS dataset was made possible by a University of South Carolina Research & Productive Scholarship Award (#13570-E120), which in turn was instrumental in securing a National Science Foundation grant (SBR-9731056) to continue the project.

[6] I also employed a binary measure of contiguity and a variable measuring the length of the border between the two states; however, neither variable improved the model's ability to account for the spread of MIDs.

control for the skewed nature of its distribution. Larger joint areas are expected to be shown to precipitate greater geographic spread.

Finally, I include a control variable measuring the conflict history of the originating combatants in the dispute. Following Beck, Katz & Tucker (1997), this variable, *peace years*, measures the number of years, prior to the present MID, since the same two states experienced a MID. This history is counted back to 1816, such that the variable ranges from 0 (the dyad experienced a MID in the previous year) to 159 (the dyad has never experienced a MID in the time period covered in this study).

Research Design

The strength of OLS regression is that it generates 'BLUE' (best, linear, unbiased, and efficient) parameter estimators and an intuitive test of hypotheses (Kennedy, 1998). The weakness of this method, however, results directly from its increased intuitiveness: it is an oversimplification of the underlying relationship because it forces linearity. In particular, OLS does not operate with zero as its baseline figure and can, subsequently, generate negative predictions that are nonsensical. Thus, its employment upon data that are inherently non-negative is suboptimal. I do feel, however, that because my data are non-integer counts and the individual disputes themselves are my units of analysis, the value of clear alternatives is drastically reduced. Thus, I specify OLS regressions in order to test the five hypotheses listed above.[7]

Results

Results of this first stage of analysis are detailed in Table II.[8] This model shows, in line with Hypothesis 1, that disputes fought over territorial issues are significantly more likely to spread than non-territorial disputes. This finding is indicated by the presence of a statistically significant and positive coefficient

Table II. OLS Regression of Dispute Dispersion upon Physical Geographic Factors

	Model 1	
Variable	*Coeff.*	*Z-score*
Territory	1.624*	3.83
Resources	0.984*	2.22
Mountain	0.026*	3.55
Forest	–0.012	–1.78
Ocean	–0.601	–1.07
Vital border	–0.809*	–2.03
Size of states	0.136	1.21
Peace years	–0.040*	–3.93
Constant	4.496*	2.69
N	296	
R-squared	0.15	

Robust standard errors. * $p < 0.05$.

[7] Two simple means are employed to assess the threat of multicollinearity between variables in my models. First, the highest partial cross-correlation between any pair of covariates in my models is –.26 (between *vital border* and *size of states*). Second, Variance Inflation Factor (VIF) tests on each variable do not appear to be indicative of multicollinearity, in that no single VIF value exceeds 1.51 (see Kennedy, 1998 for a discussion of this testing procedure). To diagnose heteroskedasticity, I first examined graphical representations of the residuals of my regressions to assess the face validity of the assumption of constant variance in the error term. Second, I ran White's general heteroskedasticity test, examining the null hypothesis that there is constant variance in the error terms of the model. White's test returned clear indications of heteroskedasticity in my model specification; thus, the results that I present below reflect re-run regressions introducing robust standard errors. I additionally ran each model using a Tobit regression technique that enables me to specify a censored dependent variable with a lower limit of 0. The employment of the Tobit model does not alter the substantive conclusions drawn from my analyses, suggesting that the heteroskedasticity does not have a significant impact on the conclusions drawn from this model.

[8] A number of additional, participant-specific control variables were also included in a version of this first stage of analysis to account for alternative hypotheses. In particular, I controlled for the ratio of capabilities, the presence of joint democracy, and the presence of a formal alliance. None of these variables, however, offers any additional power in explaining the spread of conflict, nor does their inclusion/exclusion alter the substantive interpretation of the remaining variables. They are, therefore, omitted from the reported analysis.

associated with the *territory* variable. Moreover, the model demonstrates that disputes occurring in resource-rich host states are significantly more likely to experience spread than disputes that occur in states that are not richly endowed in natural resources. These two findings offer credible support for the notion that physical geography adds incentives to the acquisition of additional territorial gains by states involved in disputes – resulting in the geographic spread of the dispute.

The third hypothesis being tested – that MIDs located in areas of impassable terrain are less likely to spread geographically – receives mixed, somewhat confounding support. The *mountain* variable returns a statistically significant but positive coefficient, suggesting that disputes that occur in states with greater proportions of mountainous terrain are, in fact, more likely to become geographically spread out than disputes in states with relatively flat, passable terrain. In contrast, the model returns coefficients in the expected direction for both the *forest* and *ocean* variables, but neither quite achieves statistical significance. These mixed findings suggest that while the physical geography of the host location plays a significant role in determining the eventual spread of the dispute, it is not necessarily the case that apparently 'impassable' terrain lives up to its name – rather, it appears as though this hypothesized barrier may actually be associated with the geographic spread of the dispute.

Disputes occurring between states that share a 'vital' border are actually less likely to spread geographically than disputes that occur between states with either a less vital border or no border at all. Rather than signaling an increased willingness to expand campaigns in defense of such borders (as hypothesized), this suggests that states may, in fact, invest their energies and resources in managing disputes with countries with whom they share a vital border – thereby avoiding the elevated costs that are presumably the result of disputes in such areas.

The final physical geography variable, *joint size*, returns a positive coefficient, in line with Hypothesis 5, but it does not achieve statistical significance. That is to say that we can not conclude that disputes that occur between states with jointly large territorial endowments do not experience greater spread than disputes between smaller states.

Finally, the model demonstrates that traditional rivals appear to experience more geographically spread out disputes than states with no recent history of conflict. This finding is confirmed by a significant, negative coefficient on the *peace years* variable – the longer the period of time since the dyad experienced a dispute, the less the eventual spread of the current dispute. This suggests that rivals, rather intuitively, are less capable of managing their disputes.

These findings return considerable support for the notion that the resources inherent in physical geography incentivize the spread of disputes, while the nature of local terrain acts to facilitate their spread. The performance of the model as a whole, however, leaves a little to be desired – an R^2 of 14.5 indicates that the model accounts for just under 15% of the variation in its eventual spread. Perhaps greater explanatory power comes with the inclusion of ex post measures of the dispute – measures that help to characterize the dispute's evolution.

Using Ex Post Information to Account for Spread

The addition of ex post information of the dispute's evolution poses two important problems. First, the inclusion of information that is not available until the conclusion of the dispute detracts somewhat from this study's policy relevance. Second, doing so replaces apparent omitted variable bias

(indicated by the low R^2) with potential issues of endogeneity. With these concerns noted, I do feel, however, that it is valuable to at least explore the relationship between a range of ex post characteristics of the dispute and the extent of its eventual geographic spread.

Three ex post characteristics of the dispute itself are included in the second stage of analysis as determinants of a dispute's geographic spread. Each of these variables represents a characteristic that raises the potential for endogeneity bias at the later stage of analysis. One might, for example, claim that geographic spread itself leads to the extended duration of the MID, its evolution to higher levels of hostility, or a proliferation in the number of incidents of which the MID is comprised. I argue here, however, that the logic against endogeneity is sufficiently compelling to warrant examination. If a dispute lasts longer, becomes more hostile, or consists of a greater number of incidents, it is plausible that it will, consequently, become more geographically spread out. The reverse seems implausible because spread is, conceptually, a consequence rather than a cause.

I argue, therefore, that as hostilities in a conflict intensify (e.g. from a show of force to a use of force), combatants are increasingly employing strategies designed to maximize their territorial gains – assumed to be key to attaining a victorious outcome to the conflict. Second, passing time increases the possibilities for new geographic areas to be targeted and for territorial gains to be realized. Finally, as new cases of conflict emerge, the possibility for the consumption of new locations increases. These expectations lead to the following hypotheses:

H6a: Disputes that escalate to higher levels of hostility become more geographically spread.

H6b: The longer the duration of the dispute, the greater its geographic spread.

H6c: The greater the number of incidents that comprise the dispute, the greater its geographic spread.

For the purpose of testing, three ex post measures of the evolution of disputes are included alongside the physical geography variables in the first model. *Hostility level* is an ordinal variable that indicates the highest hostility level experienced in the aggregate MID. This variable is recorded from the original operationalization (Ghosn, Palmer & Bremer, 2004), such that a 0 value (the omitted category) indicates that a 'threat to use force' was the most hostile action taken by either side. A 1 indicates that a 'show of force' was the most hostile action taken by either side; a 2 indicates that a 'use of force' occurred; and a 3 indicates that the MID escalated to war. I also include a measure of the *duration* of the MID. Originally measured in days, this variable is logged because it previously ranged from a handful of days to over ten years.[9] *Number of incidents* is a simple count of the number of individual incidents of which the MID is comprised.[10]

The results of this second stage of analysis are detailed in Table III. The value of adding these three additional variables is quite large – the R^2 has increased from some 15% to 50%. This suggests that the ex post model accounts for fully half of the variation in the geographic spread of disputes in the post-Cold War era. Moreover, this model demonstrates that the coefficients for each of the new variables are in the direction hypothesized. Only two of the three – duration and hostility level – are, however, statistically significant. That is to say that long-lasting disputes and disputes involving greater levels of hostility (on the show-use-war spectrum) become more geographically spread out than

[9] The introduction of the logged term does not alter the results reported below.

[10] The value of this variable includes only those incidents for which I have a recorded geographic location.

Table III. OLS Regression of Dispute Dispersion upon Physical Geographic and 'Post-Hoc' Factors

	Model 1	
Variable	*Coeff.*	*Z-score*
Number of incidents	0.015	1.00
Duration	0.924*	12.80
Hostility level	0.732*	2.83
Territory	0.963*	2.98
Resources	0.435	1.31
Mountain	0.012	1.91
Forest	–0.011*	–2.00
Ocean	–0.290	–0.71
Vital border	–0.491	–1.58
Size of states	0.242*	2.62
Peace years	–0.180	–1.94
Constant	–0.708	–0.49
N	296	
R-squared	0.50	

Robust standard errors. * $p < 0.05$.

short disputes or those involving low levels of hostilities. Clearly, statistical value is added by including ex post information about the disputes.

What impact does this model alteration have upon the original conclusions drawn from the first round of analysis? Disputes fought over territorial issues are still found to experience greater geographic spread. In this instance, however, the variable measuring the presence of natural resources in the host country loses statistical significance – once we account for the eventual evolution of the dispute, it appears as though resources (oil, gems, and drugs) no longer act to incentivize the acquisition of new territories.

If anything, the addition of these ex post measures acts to strengthen the role of variables capturing the extent to which local terrain is passable. First, the *mountain* variable loses significance (though this is marginal). Second, disputes occurring in states with greater levels of forest cover are shown to be less likely to spread geographically – in line with Hypothesis 3. The *ocean* variable remains insignificant in this model. Finally, we can see that this new model uncovers a statistically significant role for the *size of states* in the process of spread. In line with Hypothesis 4, it appears as though disputes occurring in states with larger territorial endowments are more likely to become more geographically spread out.

Conclusions and Implications

I opened this study by asking why some conflicts become geographically spread out while others remain confined within small geographic spaces. Having operationalized the geographic spread of militarized disputes via observation of the precise location of their component incidents, I have demonstrated that the answer lies in the characteristics of the dispute itself and the nature of the physical geography of surrounding areas. In particular, I find that MIDs with long durations, high levels of hostilities, underlying territorial issues, and those located in mountainous but not forested areas become more geographically spread out than those that do not share these characteristics. I have additionally demonstrated that MIDs between states with jointly large territories and recent histories of conflict tend to be more geographically spread out than those between states without such attributes.

The logistical implications of these findings are intriguing. As a measure of the geographic size of conflict, this notion of spread can also be considered a proxy for the area consumed by conflict and, thus, as a measure of the potential destructiveness of disputes in regard to the territories upon which and societies within which they occur. It is feasible to consider, therefore, that these data and findings could be incorporated into studies that prioritize assessment of the impact of conflict upon the wider society. One could, for example,

conceive of geographic spread as an explanatory variable in models of forced migration, refugee flows, and the diffusion of public health crises – each of which might be expected to be more severe in the presence of increasingly spread-out hostilities.

Moreover, knowledge of the characteristics that foretell whether or not a dispute will expand to consume a greater geographic area is valuable to parties interested in forging conflict management plans to mitigate the costs of conflict. In particular, Model 1 demonstrates that information that is publicly available at the outset of the dispute helps us to predict its eventual spread. This information could enhance the efficacy of deployments of conflict management resources and peacekeeping troops to conflict zones.

As always, a number of additional endeavors could help to improve the validity of the results herein and their value to scholars and policymakers alike. First, greater energy could be committed to understanding how states select the locations for their initial employments of force. The first stage of analysis in this study was based on the notion that we can predict the likely spread of a dispute on the basis of characteristics of the dispute on day one. It is conceivable that we can go even further back and investigate potential spread as a correlate of the process of initial target selection. Second, the map in Figure 2 suggests that the population of conflict locations clusters geographically. This assertion – supported statistically elsewhere (Braithwaite, 2005) – encourages one to think about modeling the process of spread via means of geographically weighted regression (GWR). The advantages of such an approach would be to directly explore the presence of spatial non-stationarity in the global regression model. Third, the present model could be fused with a study of the escalation and de-escalation of disputes. By paying attention to the incident-to-incident changes in the spread of individual disputes, it may be possible to identify a spatial–temporal model of the process of conflict escalation.

Appendix A. Variable Concepts, Operationalizations, and Measurements

Variable name	*Concept*	*Data Source*	*Measurement*
Spread	Spread of incident locations within the MID	Self-assembled, using Levine's (2002) *Crimestat 2.0*	Circle defined by radius (distance from geometric mean center of MID to furthest outlying individual incident) in km^2
Compactness	Spread of incident locations within the MID	Self-assembled, using Levine's (2002) *Crimestat 2.0*	Standard Deviational Distance: $\sqrt{\frac{\Sigma\left(x_i-\bar{x}\right)^2}{N}+\frac{\Sigma\left(y_i-\bar{y}\right)^2}{N}}$
Number of incidents	Number of incidents in the MID	Braithwaite (2005)	The number of incidents (for which I have geographic location data) that comprise the individual MID
Duration (logged)	Temporal duration of the MID (logged)	Ghosn, Palmer & Bremer (2004)	The logged mean of the minimum duration and maximum duration variables in the MID 3.0 dataset
Hostility level	Highest hostility level experienced during the MID	Ghosn, Palmer & Bremer (2004)	The maximum value recorded within the MID on the Dispute Hostility Level variable from the MID 3.0 dataset
Territory	At least one participant in the MID considers territory to be the primary issue of the conflict	Ghosn, Palmer & Bremer (2004)	Recorded as 1 if the MID 3.0 dataset notes that at least one party to the dispute prioritizes a territorial issue; 0 otherwise
Resources	The host state has a valuable resource endowment	Buhaug & Lujala (2005)	Recorded as 1 if the dispute occurs on the territory of a state with an endowment in oil, gems, or illicit drugs; 0 otherwise
Mountain	Extent of mountainous terrain in the host state	UNEP (2002)	% of host state's territory that is considered mountainous
Forest	Extent of forest-covered terrain in the host state	FAO (1999)	% of host state's territory that is considered under cover of forest
Ocean	Location of initial incident is at sea	Braithwaite (2005)	Binary variable: 1 = initial incident located at sea; 0 = initial incident located on land
Vital border	The 'vitalness' of a shared border	Starr (2002)	Ranges from 0 to 2 with higher values indicating more 'vital' border
Size of states (logged)	The joint size of the territories of the two states (logged)	ESRI (1992)	The natural log of the combined size of the territories of the two states (in 1000s of km^2)
Peace years	The length of time since the two states previously experienced a MID	Bennett & Stam (2000)	The number of years since the dyad experienced a MID prior to the present onset

References

Alcock, Norman Z., 1972. *The War Disease*. New York: CPRI.

Anselin, Luc & John O'Loughlin, 1990. 'Spatial Econometric Analysis of International Conflict', in Manas Chatterji & R. E. Kuenne, eds, *Dynamics and Conflict in Regional Structural Change*. New York: New York University Press (325–345).

Anselin, Luc & John O'Loughlin, 1992. 'Geography of International Conflict and Cooperation: Spatial Dependence and Regional Context in Africa', in Michael D. Ward, ed., *The New Geopolitics*. Philadelphia, PA: Gordon and Breach (39–75).

Beck, Nathaniel; Jonathan Katz & Richard Tucker, 1997. 'Taking Time Seriously: Time-Series–Cross-Section Analysis with a Binary Dependent Variable', *American Journal of Political Science* 42(4): 1260–1288.

Bennett, D. Scott & Allan C. Stam III, 1996. 'The Duration of Interstate Wars, 1816–1985', *American Political Science Review* 90(3): 239–257.

Bennett, D. Scott & Allan C. Stam III, 2000. '*EUGene*: A Conceptual Manual', *International Interactions* 26(2): 179–204 (http://eugenesoftware.org).

Boulding, Kenneth A., 1962. *Conflict and Defense: A General Theory*. New York: Harper.

Braithwaite, Alex, 2005. 'Location, Location, Location . . . Identifying Conflict Hot Spots', *International Interactions* 31(4): 251–272.

Bremer, Stuart, 1992. 'Dangerous Dyads: Conditions Affecting the Likelihood of Interstate War, 1816–1965', *Journal of Conflict Resolution* 36(2): 309–341.

Bremer, Stuart & Thomas Cusack, 1996. *The Process of War*: *Advancing the Scientific Study of War.* Amsterdam: Gordon and Breach.

Buhaug, Halvard & Scott Gates, 2002. 'The Geography of Civil War', *Journal of Peace Research* 39(4): 417–433.

Buhaug, Halvard & Päivi Lujala, 2005. Accounting for Scale: Measuring Geography in Quantitative Studies of Civil War', *Political Geography* 24(4): 399–418.

Davenport, Christian; Will H. Moore & Steven C. Poe, 2003. 'Sometimes You Just Have To Leave: Threat and Refugee Movements, 1964–1989', *International Interactions* 29(1): 27–55.

Davis, David R.; Zaryab Iqbal & Christopher Zorn, 2003. 'Conflict and Public Health: Modeling Spatial Effects', paper prepared for presentation at the Workshop on 'Geography, Conflict, and Cooperation', Joint Sessions of Workshops, ECPR, Edinburgh, 28 March–3 April.

Diehl, Paul F., 1991. 'Geography and War: A Review and Assessment of the Empirical Literature', *International Interactions* 17(1): 11–27.

Enterline, Andrew J., 1998. 'Regime Changes, Geographic Neighborhoods, and Interstate Conflict, 1816–1992', *Journal of Conflict Resolution* 42(4): 804–829.

ESRI, 1992. 'ARC/INFO Digital Chart of the World' (http://www.esri.com).

FAO, 1999. 'Global Forest Cover Map', *FAO Working Paper* 19 (http://www.fao.org/forestry/foris/webview/forestry2/index.jsp?siteId=101&sitetreeId=1191&langId=1&geoId=0).

Furlong, Kathryn & Nils Petter Gleditsch, 2003. 'The Boundary Dataset', *Conflict Management and Peace Science* 20(1): 93–117.

Geller, Daniel & J. David Singer, 1998. *Nations at War: A Scientific Study of International Conflict*. Cambridge: Cambridge University Press.

Ghosn, Faten; Glenn H. Palmer & Stuart A. Bremer, 2004. 'The Militarized Interstate Dispute Data Sets, Version 3.0 Procedures, Coding Rules, and Description', *Conflict Management and Peace Science* 21(2): 133–154.

Gleditsch, Kristian Skrede, 2002. *All International Politics Is Local: The Diffusion of Conflict, Integration, and Democratization.* Ann Arbor, MI: University of Michigan Press.

Gleditsch, Kristian Skrede & Michael D. Ward, 2000. 'Peace and War in Time and Space: The Role of Democratization', *International Studies Quarterly* 44(1): 1–29.

Grubesic, Tony & Alan T. Murray, 2005. 'Detecting Hot Spots Using Cluster Analysis and GIS', working paper, Ohio State University (http://www.ojp.usdoj.gov/nij/maps/dallas2001/Grubesic.doc).

Hensel, Paul R., 1996. 'Charting a Course to Conflict: Territorial Issues and Interstate Conflict, 1816–1990', *Conflict Management and Peace Science* 15(1): 43–74.

Hensel, Paul R., 2001. 'Contentious Issues and World Politics: The Management of Territorial Claims in the Americas, 1816–1992', *International Studies Quarterly* 45(1): 81–109.

Kennedy, Peter, 1998. *A Guide to Econometrics*. Oxford: Blackwell.

Kirby, Andrew & Michael D. Ward, 1987. 'The Spatial Analysis of Peace and War', *Comparative Political Studies* 20(3): 293–313.

Lacina, Bethany & Nils Petter Gleditsch, 2005. 'Monitoring Trends in Global Combat: A New Dataset of Battledeaths', *European Journal of Population* 21(2–3): 145–166.

Le Billon, Philippe, 2001. 'The Political Ecology of War: Natural Resources and Armed Conflict', *Political Geography* 20(5): 561–584.

Levine, Ned, 2002. *CrimeStat II: A Spatial Statistics Program for the Analysis of Crime Incident Locations (version 2.0)*. Houston, TX: Ned Levine & Associates/Washington, DC: National Institute of Justice.

Lujala, Päivi; Nils Petter Gleditsch & Elisabeth Gilmore, 2005. 'A Diamond Curse? Civil War and Lootable Resource', *Journal of Conflict Resolution* 49(4): 538–562.

Mackinder, Harold J., 1904. 'The Geopolitical Pivot of History', *Geographical Journal* 23(4): 421–437.

Mahan, Alfred T., 1890. *The Influence of Sea Power upon History, 1660–1783*. New York: Hill and Wang.

Morgenthau, Hans J., 1967. *Politics Among Nations: The Struggle for Power and Peace,* 4th edn. New York: Alfred Knopf.

Most, Benjamin & Harvey Starr, 1989. *Inquiry, Logic and International Politics*. Columbia, SC: University of South Carolina Press.

O'Loughlin, John & Luc Anselin, 1991. 'Bringing Geography Back to the Study of International Relations: Spatial Dependence and Regional Context in Africa, 1966–1978', *International Interactions* 17(1): 29–61.

O'Loughlin, John & Luc Anselin, 1992. 'Geography of International Conflict and Cooperation: Theory and Methods', in Michael D. Ward, ed., *The New Geopolitics*. Philadelphia, PA: Gordon and Breach (11–38).

Reed, William, 2000. 'A Unified Statistical Model of Conflict Onset and Escalation', *American Journal of Political Science* 44(1): 84–93.

Russett, Bruce; Hazem Ghobarah & Paul K. Huth, 2003. 'Civil Wars Kill and Maim People – Long After the Shooting Stops', *American Political Science Review* 97(1): 189–202.

Sarkees, Meredith; Frank Wayman & J. David Singer, 2003. 'Inter-State, Intra-State, and Extra-State Wars: A Comprehensive Look at Their Distribution over Time, 1816–1997', *International Studies Quarterly* 47(1): 49–70.

Starr, Harvey, 2002. 'Opportunity, Willingness, and Geographic Information Systems (GIS): Reconceptualizing Borders in International Relations', *Political Geography* 21(3): 243–261.

Starr, Harvey & Randolph Siverson, 1991. *The Diffusion of War: A Study of Opportunity and Willingness*. Ann Arbor, MI: University of Michigan Press.

Starr, Harvey & G. Dale Thomas, 2005. 'The Nature of Borders and International Conflict: Revisiting Hypotheses on Territory', *International Studies Quarterly* 49(1): 123–139.

UNEP, 2002. *Mountain Watch*. Cambridge: UNEP World Conservation Monitoring Centre.

Vasquez, John, 1993. *The War Puzzle*. Cambridge: Cambridge University Press.

Vasquez, John & Marie T. Henehan, 2001. 'Territorial Disputes and the Probability of War, 1819–1992', *Journal of Peace Research* 38(1): 123–138.

Ward, Michael & Kristian Skrede Gleditsch, 2002. 'Location, Location, Location: An MCMC Approach to Modeling the Spatial Context of War and Peace', *Political Analysis* 10(2): 244–260.

Zipf, George K., 1965. *Human Behavior and the Principle of Least Effort*. New York: Hafner.

ALEX BRAITHWAITE, b. 1978, PhD (Pennsylvania State University, 2006); Assistant Professor of political science, Colorado State University (2006–); research interests: conflict processes, spatial analysis, and global patterns of terrorism.