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Environmental influences on pastoral conflict in the Horn of Africa☆

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Abstract

This paper seeks to discern the influence of environmental variability on pastoral conflict in the Horn of Africa. While the literature on environmental factors in civil wars is rich in empirical research and explanatory power, the dearth of data is an obstacle to the study of other important forms of violence such as pastoral conflict. If environmental factors are associated with pastoral conflict then what are they, and can they be used as early warning indicators to prevent its escalation or mitigate its effects? These questions are increasingly important given the expected impact of climate change on pastoral societies worldwide. To help answer these questions we draw on data collected by field monitors with the Inter-Governmental Authority on Development's (IGAD) Conflict Early Warning and Response Network (CEWARN) and environmental data for the same region. Field monitors collect incident and situation reports from more than two dozen areas of reporting along the borders of Ethiopia, Kenya and Uganda collectively known at the Karamoja Cluster. We compare these conflict data with three environmental

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indicators: precipitation, vegetation and forage. Preliminary statistical analyses of the data suggest that aggravating behavior, along with a reduction in peace initiatives and reciprocal exchanges, is associated with an escalation in pastoral conflict, particularly when coupled with an increase in vegetation that may provide cover for organized raids. We therefore recommend that conflict early warning systems integrate both response options and salient environmental indicators into their analyses to better deal with the complexity of the relationships between pastoral conflict and the environment in an era of climate change.

Keywords: Pastoral conflict; Environment; Climate change; Early warning

Introduction

While the literature on environmental factors in civil wars has produced a plethora of early warning indicators and models that seek to anticipate the onset of intra-state conflict (Collier & Hoeffler, 2004; Fearon & Laitin, 2003; Sambanis, 2004), comparable models in the pastoral conflict literature are generally not as empirically well founded (Baxter, 1993; Bollig, 1993, 1994; Hendrickson, Mearns, & Armon, 1996; Ocan, 1994). To be sure, the causal links alleged in the latter have not been tested to the same level of rigor and sophistication as those models that cast light on the causal pathways between resources and civil wars. However, the civil war data fail to capture important types of organized violence such as pastoral conflict (Miguel, Satyanath, & Sergenti, 2004), and qualitative studies on pastoral conflict, however convincing, do not compensate for the lack of statistical evidence on this form of conflict (Adano & Witsenburg, 2004).

Markakis (1997), Mkutu (2002) and Kahl (1998) suggest that resource scarcity can lead to violent pastoral conflict *à la* Homer-Dixon (1999). These and other studies, however, often lack empirical support of said trends and thus they remain largely descriptive with weak empirical foundations (Adano & Witsenburg, 2004). Levy and Meier (2004) suggest that the lack of institutionalized early warning systems to collect sub-national events data on conflict inhibits an understanding of the possible role of environment influences in them. A rare exception, they argue, is the Inter-Governmental Authority on Development's (IGAD) Conflict Early Warning and Response Network (CEWARN) in the Horn of Africa. CEWARN field monitors collect incident and regular situation reports in the Karamoja Cluster.

A pastoral system represents a complex form of natural resource management, which Pratt, Le Gall, and de Haan (1997) define as the direct interaction between the ecosystem, the social system and the geopolitical system. This interaction occurs at multiple geographical and temporal scales with the interplay between endogenous and exogenous factors adding complexity to the dynamics that is punctuated by violent conflict.

In this study, we compare field data on behavioral indicators from the CEWARN project with three geo-referenced environmental indicators: precipitation, vegetation and forage from the Climate Prediction Center (CPC) and the Livestock Early Warning System (LEWS). Is the relative scarcity in one or more of these resources associated with a higher frequency and intensity of pastoral conflict, as the literature would have us believe? We seek to identify whether environmental indicators might serve as possible harbingers of pastoral conflict for the purposes of early warning and early response. For example, can environmental indicators that gauge resource scarcity serve as indicators for early warning on pastoral conflict?

We first review the pastoral conflict literature and then the literature on resource scarcity to formulate a basis for testing the assumed link between environmental constraints and the escalation of pastoral conflict. We then describe briefly the CEWARN project before outlining the methods and data used in the present study. Finally, we discuss our empirical findings within the context of the larger literature on resources and conflict and provide tentative recommendations to improve our understanding of the relationships between the environment and pastoral conflict.

Pastoral conflict

Pastoral households are thought to number close to 200 million with an estimated billion heads of livestock worldwide. Pastoral systems alone use a quarter of the world's land area and provide 10% of global meat production (FAO, 2001). Indeed, pastoralists in the Horn of Africa are found in all seven countries (Djibouti, Eritrea, Ethiopia, Kenya, Sudan, Somalia and Uganda) that are members of the Inter-Governmental Authority on Development (IGAD), the Horn's regional inter-governmental organization. Livestock production is an important source of revenue and wealth for IGAD countries with global demand for meat expected to double before 2050 (FAO, 2001; Mwaura & Schmeidl, 2002). However, nomadic pastoralism, "as a traditional system, is currently under pressure, induced primarily by modern development and related social changes" (Mwaura & Schmeidl, 2002: 39). These dynamics, coupled with climatic and environmental pressures, have created tensions and violence in the Horn (Baxter, 1993, 2001; USAID, 2002).

Krätli and Swift (1999) argue that a certain level of violent conflict is endemic to many pastoral areas. Hendrickson et al. (1996: 189) concur, citing that "local-level conflicts over natural resources, of which livestock raiding is one specific form, are endemic in Africa's pastoral and agro-pastoral systems." However, pastoral groups distinguish between the theft and raid of livestock. The former generally comprises individuals acting on their own without permission from elders. Raiding, on the other hand, is considered a "very different and far more legitimate activity. It is not considered theft but is described as taking by force" (USAID, 2002: 2). Raiding is associated with pastoral traditions, and provides a right of passage for young men. Cattle give status and are used as dowry in marriage. To this end, raiding was traditionally based on established norms and principles. For example, elders from the attacking group would often notify their enemy of the approaching raid. Of course, pastoral groups sometimes war against each other for different reasons, and feuds are not uncommon both within and across pastoral lines (USAID, 2002: 28).

These days, cattle raiding and theft are thought to be the result of more complex cross-scale dynamics. Hendrickson et al. (1996: 186) argue that raiding has been transformed "from a quasi-cultural practice with important livelihood-enhancing functions, into a more predatory activity," which "occurs on a very large scale, is extremely violent and is sponsored by actors from outside the pastoral sector with criminal motives." It is then clear that resource scarcity is not the sole or even the most important driver of pastoral conflict. Clearly, pastoral conflict is driven by a host of factors and "the effect of climate on pastoralism cannot be validly considered in isolation but should be examined within a socioeconomic framework" (Le Houerou, 1985). In seeking to identify the causes of environmental conflicts, "political ecologists follow a mode of explanation that evaluates the influence of variables acting at a number of scales, each nested within another, with local decisions influenced by regional policies, which are in turn directed by global politics and economics" (Robbins, 2005: 11).

Mwaura and Schmeidl (2002: 45) argue that conflict in the Horn of Africa ‘‘inevitably tends to have political dimensions and implications by virtue of the fact that the groups are organized and/or because the state is involved either in trying to handle conflict or in becoming the arena for such conflict.’’ On the Kenyan side of the Karamoja Cluster, for example, Moi’s corrupt government deliberately fueled Kenya’s pastoral rivalries to fool the West in believing that democratic reforms and a multi-party system would result in civil war (Kahl, 1998). The Kenyan government’s neglect or uneven responses to exacerbating pastoral fighting is an indicator of vested interests and should be considered a causal factor in pastoral conflict (Keen, 2000).

According to Krätli and Swift (1999), raids have also been used to generate funds for electoral campaigns. Indeed, ‘‘the occurrence of predatory raiding at the local level often resonates with political events at the national level, especially the heightened inter-ethnic competition which regularly accompanies national elections in Kenya’’ (Hendrickson et al., 1996: 193). Politicians may also improve their reputation and political standing by initiating raids (Amisi, 1997; Robbins, 2005: 203; Umar, 1997; USAID, 2002: 5). Often, the personal pursuits by local officials for wealth and financial security create a negative chain of events that increase tension with pastoral groups. ‘‘Because raiding continues to be seen as something ‘primitive’ that pastoralists do, it provides a convenient front behind which substantial political realignments unfavorable to pastoral interests are taking place’’ (Hendrickson et al., 1996: 193).

The commercialization of cattle rustling, which is increasingly linked to foreign markets and the proliferation of small arms, also provides added incentives to engage in raiding (Hendrickson et al., 1996: 191).[1] Young men from pastoral groups are hired and armed by powerful, wealthy individuals, including livestock traders, arms dealers and others to carry out raids on their behalf. Commercial raiding provides a mean to achieve economic independence and social recognition (Nori, Switzer, & Crawford, 2005: 16). Indeed, Mwaura and Schmeidl (2002: 40) point to the emerging phenomena of ‘‘livestock warlord rivalry […], most notably in the Kenya, Sudan, and Uganda border area (particularly in the Pokot and Turkana communities).’’ These warlords have also acquired more sophisticated weapons [as bandits] than those of government security forces (Adano & Witsenburg, 2005: 720).

The stolen cattle are occasionally herded into trucks and then transported or driven on foot. One popular destination is the port cities where the cattle can be sold and exported abroad (FAO, 2001). In either case, they are marketed very rapidly and the profit is used to purchase more weapons in order to steal even more cattle. The increase in demand for automatic weapons, in fact, is matched by an increase in supply of livestock as payment for the weapons (Krätli & Swift, 1999: 13). Indeed, the proliferation of weapons has become an increasingly important income generating activity for some pastoral groups (USAID, 2002: 3). Mwaura and Schmeidl (2002: 40) argue that the wide availability of arms has ‘‘altered the cultural foundations of many communities—erosion of traditional conflict-resolution mechanisms in the face of arms-bearing youth being one of the most significant examples.’’

The availability of small arms has also produced new forms of conflict such as banditry and robberies have also increased noticeably (Odhiambo, 2004: 28). According to Krätli and Swift (1999: 22), small-scale banditry and even fights between individuals, which in a town would

[1] Krätli and Swift (1999: 8) argue that commercial raids should not be interpreted as a separate category in which ‘‘external’’ interests interfere with pastoral economy. They suggest that these raids are better understood as a wider integration of pastoralists within a market economy.

fall under the category of small-scale criminality, can lead to clan raids and escalate into a full-scale ethnic war. This has led a local area expert to conclude that ''commercial raiding is a more important factor contributing to violence than ecological pressure'' (USAID, 2002: 52).

At the same time, pastoral groups admittedly inhabit a mercurial ecological system, whose potential influence on pastoral interactions can hardly be ignored. A relief map of the Karamoja Cluster immediately reveals that the ''international boundary between Uganda and Kenya quite closely follows the natural division between the drier plains to the east (Turkana District) and the wetter higher elevation areas to the west'' (USAID, 2002: 24). Long-term environmental degradation and climate change exacerbate or even alter these divisions (FAO, 2001). Indeed, the consequences of climate and environmental change in Africa mean that ''inter-annual variability of rainfall has been increasing and the chances of drought occurring in parts of the Greater Horn of Africa have doubled from one in six years to one in three years.''[2]

The increasingly frequent and more severe droughts in arid and semi-arid lands provoke migrations, which places additional stress on already stressed social and political systems (IPCC, 2001; Suhrke, 1996). Mwaura and Schmeidl (2002: 38) recall that in the last decade, ''several years of poor rains and the onset of drought affected an estimated 16 million people [in the Horn of Africa], resulting in an increased number of what are now referred to as ecological refugees.'' Suhrke (1996: 123) expects that the impact of such refugees will ''mostly be felt locally, often in near-impoverished or also-affected areas, since persons displaced by flood or famine typically lack the resources to move long distances.''[3] Such changes in pastoral ecosystems have an immediate influence on the fluid relationships between pastoral groups. In fact, Krätli and Swift (1999: 26) assert that, ''all conflicts are ultimately over resources, due to their scarcity in pastoral areas.'' While conflict is prevalent in virtually all pastoralist regions, the situation in the Karamoja Cluster—which is the focus of this study—stands out in terms of its persistence and severity (Odhiambo, 2004).

A degree of mobility is thus enforced on pastoral communities which require access to water sources and productive patches of land for forage (Galvin, Thornton, Boone, & Sunderland, 2004). Hendrickson et al. (1996: 193) note that pastoralists in south Turkana have ''traditionally moved 10-15 times per year in search of patchy rainfall zones and pockets of high-potential rangelands for their livestock.'' These Turkana occasionally cross into southern Ethiopia in search of water and pasture (USAID, 2002: 17–18). The Inter-governmental Panel on Climate Change's (IPCC) 2001 Report suggests that average changes in resource distribution may affect migration and thus increase the risks of tension and conflict. Indeed, competition for grazing land and water was identified as the single most important structural cause of conflict by pastoralists in the Cluster in a recent field study (USAID, 2002).

The vulnerability brought about by environmental stress may very well alter the competition–cooperation calculus between pastoral groups vying for access to scarce resources. However, do pastoralists affected by drought generally turn to raiding as a coping mechanism? According to Hendrickson et al. (1996: 191), ''raiding serves to rebuild herds after livestock have been killed by drought or seized in raids and its incident is thus often tied to climatic conditions and the prevailing state of the 'tribal peace'.'' Krätli and Swift (1999: 31) draw on the results of a field study of the Turkana group in northeastern Kenya in addressing this question.

[2] Livestock Early Warning System (LEWS); Web site http://cnrit.tamu.edu/lews/description.html.

[3] There are close to 90,000 Turkana refugees living along the border (McCabe, 2004).

Of the possible customary strategies employed to restock cattle, the Turkana rank raiding is the third most attractive option. The second is bride wealth and the first, inheritance.

In sum, pastoral groups face three structural challenges: (1) to exploit resources that vary across space and time, (2) to account for the risk of climatic extremes or related production loss (Nori et al., 2005), and (3) the wider equally complex national level conflict with state authorities (Umar, 1997). In the section that follows, we review the resource conflict literature.

Resource scarcity and conflict

Barnett (2001: 7) suggests that environmental change will primarily affect smaller conflicts and that future research should "focus on areas where renewable resources are particularly sensitive to climate change" such as semi-arid ecological systems. To this end, "econometricians have moved steadily from models of nations, and even multinational systems, towards lower levels of spatial desegregation" (Ballas, Rossiter, Thomas, Clarke, & Dorling, 2005: 27). The focus on pastoral conflict as the dependent variable is therefore salient if we seek to discern the local influence of resource variability on interactions between pastoralists—dubbed the "climate change canaries" according to a recently commissioned report, which suggests that pastoralists in the Horn of Africa are likely to be the first people wiped out by climate change (Christian Aid, 2006: 3). "At an intuitive level, it is reasonably obvious that in some cases certain kinds of environmental stresses might somewhat exacerbate the risk of armed conflict" (Wirth, 1998: 328). The salient questions, however, are which types of cases, what kinds of stresses and how probable the risks? While some qualitative studies have addressed these questions in depth, the imprecise nature of the general discourse on pastoral conflict has equally vague conclusions.

We therefore pose a very specific question based on our interest in conflict early warning: do environmental resource constraints have an effect on pastoral conflict? We do not deny that local and global political economies play an important role in driving the environmental degradation and resource scarcity that persistently plague pastoral communities (Robbins, 2005). Indeed, CEWARN has recently begun collecting structural data at the sub-national level in an effort to contextualize its events' data analyses. Bond and Meier's (2005) "Lesson Three" advocates precisely this kind of integration of structural and behavioral data in early warning systems.

In considering various causes of pastoral conflict, we should certainly not confine ourselves to any single or simple research agenda or theory, but the causes we do consider should at least "be concrete events specific to concrete situations" (Vayda & Walters, 1999: 171). In this respect, a conflict early warning approach to environmental conflicts may usefully be characterized as "event ecology." This characterization does not prejudge the importance of political factors but is still duly attentive to any and all kinds of them whenever they are seen in the course of research to be interesting and relevant to explaining particular environmental or environment-related events.

Event ecology is particularly well suited for conflict early warning given that the latter often uses events-driven methodologies and events-data analysis. This approach differs from earlier studies on scarcity and conflict which have been "using methods and developing theories consisting of plausible, generalizable causal mechanisms and not simple specific predictions as well as on diagnostic frameworks of potential intervention points rather than on ostensibly universal and precise policy change packages" (Khagram & Ali, 2006: 401).

Moreover, political ecologists tend to follow "explanations 'upwards' from produced environments, through producers, and on to increasing scales of interaction (typically the community, the state, and the global economy), a conceptual hierarchy of power and causal force is imposed on political ecological problems that is empirically unfounded, and perhaps politically undesirable" (Robbins, 2005: 210). This presents another conceptually sound reason why an integrated ecology- and conflict-events methodology for the study of environmental conflicts makes sense.

Our hypothesis is therefore grounded on the influence of resource scarcity as defined in the research carried out by the Peace and Conflict Studies Program at the University of Toronto and the American Academy of Arts and Science (AAAS), among others. That is, the depletion and/or degradation of natural resources increases the probability of violence between competing groups (Homer-Dixon, 1994, 1999). The Toronto—AAAS project analyzed three types of scarcity creating processes based on 16 regional and country case studies: supply-induced, demand-induced, and structural scarcity (Khagram & Ali, 2006). Supply-induced scarcity is generated through processes of depletion and/or degradation of natural resources. Demand-induced scarcity is driven by the increased consumption generated largely by growth in income and population. Structural scarcity involves the unequal distribution of natural resources across social groups (Homer-Dixon, 1994, 1999).

The empirical research identified two key causal mechanisms "resource capture" and "ecological marginalization." The former relates to predation while the latter "involves the long-term migration of people, often to ecologically vulnerable areas, which might not have otherwise been suitable for habitation, as a result of unequal resource access and population growth in their home regions." (Khagram & Ali, 2006: 397) That being said, environmental reasons alone are insufficient to explain why people move (Barnett, 2001; Nordås & Gleditsch, 2005; Suhrke, 1996). Turner (2004: 877) specifies that resources need to be "of sufficient density and persistence to elicit competitive behavior—behavior that has costs and risks." This begs the question: how much density and persistence, and under what circumstances?

In this context, rainfall, vegetation and forage (RVF) availability—while not *absolutely* dense and persistent in the sense that Turner (2004) describes—may nevertheless be sufficient to prompt migration and influence competitive behavior between pastoral groups. Applying this proposition to pastoral conflict, we expect that environmental variability drives pastoral migration and competition over dwindling resources critical to livelihoods, which in turn may lead to the use of violence to secure these resources. The literature on pastoral conflict reviewed above suggests that the *relative* density and persistence in renewable resources may in part explain the onset of competition and subsequent insecurity in the Horn of Africa. In particular, scarcity in RVF due to climate and environmental change may exacerbate pastoral conflict.

The level and scope of analysis

A recent study empirically demonstrates that country statistics are poor approximations of conflict zones: "The essence of the problem is that proxies for geography are generated at the wrong level of measurement: the nation state" (Buhaug & Lujala, 2005: 404). Scale matters and statistical analyses show that "certain findings are indeed dependent upon the scale of measurement" (399). In fact, the authors demonstrate that the scale of measurement not only influences standard errors and confidence intervals, "but even the substantive impact of some regressors in multiple regression equations" (413). To be sure, aggregate figures such as GDP and casualty counts "only make sense if we can assume that the conflict area constitutes a representative sample of the conflict-ridden country on all explanatory factors, and in cases in which the conflict spans the entire country. However, such an assumption is rarely valid'' (404).

Buhaug and Lujala (2005) therefore recommend using first-order administrative units (e.g., counties or provinces) as the focal point of data generation and analysis. ''Subject to data availability, such a research design facilitates more precise testing of several prevailing theories on causes of civil war…'' (413). The authors also present an alternative strategy that defines a geometric unit, like a 100 km × 100 km grid, as the basis for measurement, and assign values for conflict and the explanatory variables to each cell in the grid. However, as they recognize, ''the grid approach is less intuitive than the administrative level, and policy implications will necessarily be less apparent'' (414).

The use of such grids was not feasible with the present study. We had to use a fixed administrative level, which though sub-national in scale, is burdened with uneven sizes among the units. Clearly, this approach does not optimally frame the environmental influences and the behaviors of the pastoral groups. Indeed, we acknowledge that pastoral conflict may be manifest precisely in the complex process of interactions within and between sectors, spatial and temporal scales, and human–environment systems (Eakin & Luers, 2006: 381). Our approach in using data aggregated to an administrative level therefore is pragmatic, constrained by logistical considerations of access to conflict data that are sensitive in raw form in that they include identifying information of reporters, victims and perpetrators alike.

We have aggregated the field data to roughly the first administrative level. In Uganda, Nakapiripirit District and Pokot County were merged into a unit called NAK. Moroto District stands alone as MOR, while the Dodoth and Labwor areas are aggregated to a unit called KOT. Kapchorwa District is called KAP. The approximate equivalent administrative level in Kenya corresponds to the Province level, where we used the data collected in the Rift Valley Province or RVP. Five Kenyan reporting areas—Turkana North, Central, South, and Trans-Nzoia and West Pokot—constitute the Rift Valley Province. In Ethiopia, the Kibish and Nebremus reporting areas are included under the SNN (Southern Nations and Nationalities) unit but the Buboa reporting area has been excluded because the reporting there began only recently. In sum, we draw upon field data from six locations labeled as follows—Ethiopia: SNN, Kenya: RVP, and Uganda: KAP, KOT, MOR & NAK. Fig. 1 depicts the Areas of Reporting (AORs) corresponding to reporting locations of the field reporters represented in this study.

Data

The CEWARN events data

Since July 2003, CEWARN[4] field monitors from 12 (the number has more than doubled over the years) reporting locations along the borders of Ethiopia, Kenya and Uganda have been submitting incident reports (documenting episodes of armed clashes, organized raids, protest demonstrations and banditry), and regular (weekly) situation reports on indicators, both positive and negative, of pastoral conflict behavior within the Karamoja Cluster.

[4] The authors are indebted to CEWARN for providing the field data used in this study. CEWARN Unit staff members and Country Coordinators were extremely helpful in interpreting the results. However, responsibility for any errors or omissions remains ours alone.

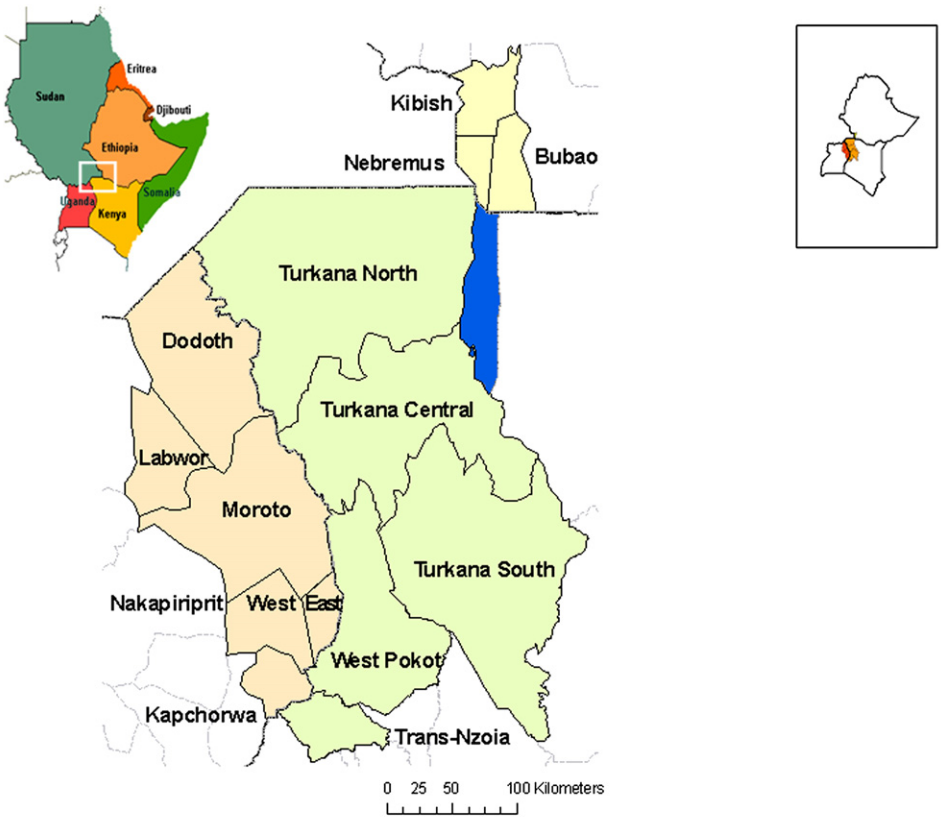

Fig. 1. CEWARN areas of operation.

Field monitors are responsible for providing CEWARN with timely and consistent information on indicators of pastoral conflict behavior as observed from the field.[5] The monitors complete standardized situation reports on a weekly basis. From these situation reports we derive the conflict and cooperation data used in the present study. In addition to these regular situation reports, episodic reports of selected incidents are also submitted, and from which the outcome measures for this study were derived, specifically, human deaths, livestock losses and the incidence of organized raids.

The Incident Report, or IncRep, represents episodic data and serves to document violent events that result from, or are related to, pastoral conflict. IncReps document armed clashes, organized raids, protest demonstrations, and other crime such as assaults and banditry. Each incident that is documented by CEWARN's field monitors includes information on "*who did what to who, where, when and how*." In addition, IncReps document the immediate outcomes of the incidents such as injuries, deaths and destruction. Each IncRep also includes a narrative of the event to provide contextual background information.

[5] The Field Monitors are supported by Country Coordinators as well as the CEWARN Unit staff. Quality control is done as the reports are submitted with suspect data triggering a call to the field monitor to discuss or follow up as needed. To date, no formal reliability study has been conducted on these field data.

The second type of CEWARN report is a Situation Report, or SitRep; these reports are submitted on a regular (weekly) basis, independent of the incidence of conflict. This questionnaire monitors how pastoral livelihoods change over time by identifying situations that render the likelihood of violent pastoral behavior less or more probable. To this end, SitReps monitor precursors to pastoral conflicts and also mitigating factors that may reduce the likelihood of escalation. When an incident is documented, it can be linked with preceding SitReps to identify those situational changes that may have led to the incident. These changes can then be monitored to help prevent or mitigate future incidents.

The SitRep draws on 51 questions identified by local area experts as the most important precursor and mitigating indicators of pastoral conflict. These are grouped into seven clusters that address: (1) communal relations, (2) civil society activities, (3) economic activity, (4) governance and media, (5) natural resources, (6) safety and security, and (7) social services. The indicators listed under each cluster include a set of questions utilizing a five-point Likert scale.

The indicators are categorized by their polarity (positive or peaceful, and negative or conflictual) arrayed into an index and presented as eight "scores"; four of these scores, or aggregate indicators, represent negative polarity situations or conflict while the other four represent positive polarity situations or cooperation. We focus our attention here on three of the four conflict scores. These include (1) aggravating behavior, (2) provocative behavior and (3) environmental pressure. The armed conflict cluster is omitted here due to its rare (virtually non-) occurrence in the region.

Aggravating behavior documents types of behaviors that are expected to exacerbate tensions among pastoral communities. These include (a) pastoral migration, (b) harmful pastoral policies, and (c) availability of small arms. *Provocative behavior* appears frequently in the CEWARN data. Local area experts have identified (a) the unusual movement of all male groups, (b) pre-raid blessings and (c) traditional forecasting which we have labeled as provocative behavior. *Environmental pressure* documents the following situations: (a) natural disasters, (b) land competition, (c) more livestock in secure areas, (d) grazing areas abandoned and (e) livestock disease. Table 1 includes descriptive statistics of the CEWARN conflict data.

Parallel to these indicators of conflict situations, CEWARN also tracks cooperation in the region. Specifically, four clusters of positive polarity variables are included: alliances, exchanges, mitigation and initiatives. These categories should be self-explanatory, and further information on their specific indicators is available upon request from the authors.

Table 2 includes descriptive statistics of the CEWARN cooperation data.

The CEWARN project is a relatively new initiative, which means that the available data span less than four years at the time of writing. The first few months of reporting in 2003 were used

Table 1
Summary data for conflict indicator scores (range = 0–100)

Country–AOR	Aggravators		Pressure		Provocations	
	Mean	SD	Mean	SD	Mean	SD
ETH–SNN	30.1	6.2	48.8	9.8	43.6	11.9
KEN–RVP	29.7	4.6	36.3	7.2	21.1	8.1
UGA–KAP	25.7	4.2	64.5	4.4	8.5	3.9
UGA–KOT	19.1	5.8	26.8	7.2	16.9	10.7
UGA–MOR	26.8	9.6	44.9	11.5	23.3	14.8
UGA–NAK	25.4	5.2	31.4	10.4	9.5	5.4
Overall	26.1	7.1	42.1	15.2	20.5	15.2

Table 2
Summary data for peace indicator scores (range = 0–100)

Country–AOR	Alliances		Exchanges		Mitigation		Initiatives	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ETH–SNN	32.9	14.6	36.7	11.0	52.1	6.1	25.5	10.3
KEN–RVP	13.5	8.1	25.9	7.7	57.0	10.3	58.4	13.2
UGA–KAP	3.6	7.8	17.5	13.7	41.5	9.0	51.0	6.7
UGA–KOT	10.1	9.5	20.8	11.3	65.7	7.9	47.9	15.4
UGA–MOR	22.6	13.0	36.2	13.5	86.5	2.4	80.2	4.0
UGA–NAK	12.7	16.2	23.1	8.7	47.6	17.0	48.1	15.8
Overall	15.9	15.1	26.7	13.3	58.4	17.6	51.8	19.9

for refining the information collection process and standardizing the reporting procedures. We therefore focus our analysis here on the 24 months from January 2004 through December 2005, which include well over fifteen hundred Situation Reports and a thousand Incident Reports.

Ideally, longer time-series data are required to draw statistically significant conclusions regarding longer-term, i.e., more than one seasonal cycle. This limitation may in part constrain our conclusions. In addition, the narratives included in the IncReps and SitReps supplement the quantitative indicators with annotations, clarifications and even possible explanations. This means that inflections in conflict trends might perhaps be explained in the accompanying narratives. Unfortunately, we had only restricted access to the narratives in the reports.

A second set of CEWARN data was derived from the incident reports. We used three outcome measures of the incidents for this study: the number of human deaths, the number of livestock losses and the incidence of organized raids. We suggest the first two measures characterize the intensity or severity of the incidents while the number of raids captures their incidence. Across all three variables, the figures for each area of reporting were simply summed over the time period under study. Table 3 includes descriptive statistics of the CEWARN outcomes or dependent variables data.

The environmental data

This study's rainfall data for the Karamoja Cluster draw on NOAA's Climate Prediction Center and in particular version two of the African Rainfall Estimation Algorithm.[6] Hendrix and Glaser (2007) find that both long-term trends in climatic variance and short-term climatic variance in Africa have a significant impact on the likelihood of conflict onset. Their analysis of marginal effects also suggests that, "inter-annual variability matters more than the specter of changes in overall means and climate, which took place over long periods of time" (2). We therefore focus our analysis on inter-annual variability and use NOAA's precipitation data set to produce baselines for precipitation that are geographically comparable to the Admin 1 time-series produced with the CEWARN data.

In other words, we aggregate precipitation estimates for all of CEWARN's AORs to the Admin 1 level. This enables us to compare precipitation data and conflict data for the same geographical area. In terms of temporal scale, the precipitation data are measured in dekads,

[6] The authors thank Dr. Stefano Disperati for generously sharing his rainfall and vegetation data.

Table 3
Dependent variables summary data

Country−AOR	Human deaths			Livestock losses			Organized raids		
	Sum	Mean	SD	Sum	Mean	SD	Sum	Mean	SD
ETH−SNN	486	20.3	20.2	35,238	1468.3	2241.9	102	4.3	3.6
KEN−RVP	553	23.0	26.9	27,594	1149.8	1508.4	282	11.8	10.9
UGA−KAP	177	7.4	7.9	1818	75.8	127.9	135	5.6	4.4
UGA−KOT	1215	50.6	80.5	62,904	2621.0	4885.8	306	12.8	9.9
UGA−MOR	789	32.9	37.1	45,447	1893.6	3732.4	489	20.4	25.1
UGA−NAK	822	34.3	57.3	36,189	1507.9	1737.0	342	14.3	8.7
Overall	4042	28.1	46.5	209,190	1452.7	2887.6	1656	11.5	13.5

that is, in 10-day periods. There are approximately three dekads per one-month period. We took the average of three dekads to produce a monthly estimate of precipitation per district for 2004−2006.

We use the common Normalized Vegetation Index (NDVI). This ‘‘Vegetation Index’’ quantifies the concentration of green leaf vegetation around the globe. Lower values signify barren areas while higher values indicate temperate and tropical rainforests. For these data, we draw again on NOAA and in particular the Advanced Very High Resolution Radiometer (AVHRR). We produce NDVI trends for each Admin 1 location in the Karamoja Cluster and aggregate the dekads to the one-month period.

Precipitation influences the availability of forage, or fodder for livestock. But this is an indirect measure. The availability of forage, and thus pasture for grazing, depends on several other factors such as land-use and type of plant species and soil. We therefore complement the precipitation data with forage estimates for the Horn of Africa produced by the Livestock Early Warning System (LEWS). LEWS monitors nine zones in the IGAD region.[7]

‘‘For each geo-referenced monitoring point, a multiple species rangeland plant growth model (PHYGROW) is parameterized with data (soils, plants and grazers). The model is then run with current satellite weather data to determine standing crop of the forage available (kg/ha) to grazing animals. The model output is compiled for each dekad (10-day intervals, like rainfall data) and processed to produce forage maps for the IGAD region and for each individual zone. To develop surface maps, the model output (forage kg/ha) data is coupled with the Normalized Difference Vegetation Index (NDVI). ‘Ground truthing’ to verify accuracy of maps is carried out by zonal monitors.’’[8]

Using the LEWS GIS forage data for 2004 and 2005, we calculated the average amount of forage available per month per AOR. To do so, we calculated the average of 75 geo-referenced forage data points that spatially cover the Ethiopian areas of reporting, 1235 for Kenya and 556 data points for the areas of reporting in Uganda. This gives us the average amount of forage in kilograms available per hectare per AOR, which we then aggregate to the Admin 1 level by country. Filtering and organizing the GIS forage data in a tabular format enables us to compare forage baselines with rainfall, vegetation and conflict trends. Table 4 includes descriptive statistics of the environmental data used in this study.

[7] The authors are grateful to Dr. Robert Kaitho and the director of LEWS, Dr. Jerry Stuth for their assistance. For further information on the LEWS data, please see: http://cnrit.tamu.edu/maps.

[8] Livestock Early Warning System (LEWS); website http://cnrit.tamu.edu/lews/description.html.

Table 4
Summary data for environmental variables

Country–AOR	Rainfall (mm)			Vegetation (nvdi)			Forage (kg/ha)		
	Sum	Mean	SD	Sum	Mean	SD	Sum	Mean	SD
ETH–SNN	286	11.9	11.3	1488	62.0	14.4	27,065	1127.7	238.2
KEN–RVP	284	11.8	10.8	1930	80.4	13.6	20,324	846.8	116.4
UGA–KAP	594	24.7	13.8	3472	144.7	14.0	38,072	1586.3	245.2
UGA–KOT	390	16.2	14.3	2876	119.8	33.6	28,119	1171.6	229.7
UGA–MOR	341	14.2	13.3	2727	113.6	29.3	32,152	1339.7	298.7
UGA–NAK	526	21.9	15.6	3207	133.6	33.7	34,893	1453.9	211.2
Overall	2420	16.8	14.0	15,699	109.0	38.0	180,625	1254.3	330.3

Methodology

We employ least squares regression models in order to better understand the temporal[9] relationships between reported behaviors reflected in the situation reports, environmental factors and outcomes in the Karamoja cluster. We examined 10 independent variables (X_1 to X_{10}), 7 behavioral (peace and conflict) and 3 environmental and 3 dependent variables (Y_1 to Y_3).

Peace Indicator Scores, derived from CEWARN SitReps:

$X_1 = \text{Alliances}$
$X_2 = \text{Exchanges}$
$X_3 = \text{Mitigation}$
$X_4 = \text{Initiatives}$

Conflict Indicator Scores, derived from CEWARN SitReps:

$X_5 = \text{Aggravators}$
$X_6 = \text{Pressure}$
$X_7 = \text{Provocation}$

Environmental Measures, calculated from NOAA & LEWS data:

$X_8 = \text{Rainfall}$
$X_9 = \text{Vegetation}$
$X_{10} = \text{Forage}$

[9] It would clearly have been preferable to also include a spatial regression analysis. However, given that our access to the data were limited to the Admin 1 level, the *N* for a spatial analysis would have been just six, which is simply inadequate. We have discussed this limitation with the CEWARN Unit and are hopeful that future analyses of these data will be able to include identifications of the specific areas of reporting that will support such spatial analyses. Indeed, the question is not so much whether there is geospatial as well as temporal influences in the data, as this seems quite obvious given the (raiding) behaviors under examination; rather the question for future analyses is to what extent will spatial analyses help us to identify specific influences that are amenable to intervention so that these conflicts can be prevented or at least mitigated.

Dependent Variables, derived from CEWARN IncReps:

Y_1 = Human Deaths
Y_2 = Livestock Losses
Y_3 = Organized Raids

A total of 144 cases were included in our analysis. For each of the six AORs, we took the respective monthly mean values for the period of January 2004 through December 2005 [6 AORs × 24 months = 144 cases]. All of the data were measured at the interval and ratio levels.[10]

An implicit assumption of the regression equation is that the relationship between the expected value of Y and each X_i is linear and the effects of the independent variables are additive. A review of the scatter plots suggests that the 10 independent variables are reasonably linear in their relationships to the dependent variables. Another consideration related to the explanatory variables is the potential problem of multicollinearity. While three pairs of independent variables have relatively high correlations,[11] we did, nevertheless, find statistically significant results. We have elected to err on the conservative side rather than drop variables that we consider to be theoretically relevant. While overlap exists, we believe that the each of the 10 explanatory variables affect the outcome variables for different and distinctive reasons.

We used the Durbin–Watson statistic (d) to test for autocorrelation for all models. Two models, raids lagged and raids not lagged, fell short of the range needed to reject the null hypothesis,[12] although the d for the lagged raids really falls in the "grey zone."

We conducted visual inspections of the plots of regression residuals for all models in which we plotted the residuals of each model against all independent variables. Considering that our sample is relatively large ($n > 100$), we would expect to see an envelope pattern if the homoscedasticity assumption is met. This was the case with each plot. Given the apparent lack of heteroscedasticity in all of our models and borderline autocorrelation in the lagged dependent variable raid, we proceeded to evaluate the OLS models, including with and without lags. Since it is reasonable to believe that some degree of lag is present between our independent variables and the outcomes, we limit our discussion here to include only those where a one-month lag was imposed. After examining the outliers on the dependent variables, we noted that a few of the values were unacceptably large (>±3 sigma). These cases were dropped from the analysis.[13] In total, we ran 9 models: 1 for each of the 3 dependent variables with all 10 independent variables; 1 for each of the 3 dependent variables with only the 7 "behavioral" variables; and 1 for each of the 3 dependent variables with only the 3 environmental variables.

Results

The models where the dependent variable is human deaths were all found to be statistically insignificant ($p < 0.05$). Likewise, the models where the dependent variable is livestock losses

[10] The scores from the SitReps may be considered to be quasi-interval.

[11] The three pairs include: provocations–alliances, initiatives–mitigation, and forage–vegetation.

[12] Raids lagged ($d = 1.51$), raids not lagged ($d = 1.46$), losses lagged ($d = 2.07$), losses not lagged ($d = 1.98$), deaths lagged ($d = 1.91$), and deaths not lagged ($d = 1.86$).

[13] Three cases were omitted for deaths, 4 cases for losses and 3 for raids, (with some overlap) for a total of 8 excluded cases of the 144 total data points. Thus the final N was 136 for all runs. No significant differences were found when we excluded only the three, four or three outliers on individual model runs.

were all found to be statistically insignificant ($p < 0.05$). However, we found the models where the dependent variable is the incidence of organized raids to be significant at the $p < 0.05$ level. The results of these three organized raids models are presented below.

Discussion

Only the incidence of organized raids is statistically significant as a dependent variable. We had hoped that the death and loss variables might contribute a measure of intensity of the raids beyond their incidence. However, at least with the version of data used in this study, this triangulation is not possible. We suspect measurement error in the human death and livestock loss estimates is to blame. Table 3, for example, shows that all six of the standard deviations on livestock losses and five of the six for human deaths are greater than their respective means. In addition, an inspection of the raw data on these variables reveals wild fluctuations and improbable estimates. CEWARN has begun a quality control program to identify these potential errors immediately after their submission rather than in batches sometimes months subsequent to the incidents.

Still, none of the three significant models using incidence is particularly robust. The highest R^2 that appears in Model 3 is just 0.18 and, as expected, the overall explanatory power decreases as the number of variables decreases. The adjusted R^2 values also decreases as the number of explanatory variables decreases suggesting that the models are additive. Although measurement cannot be ruled out as a factor dampening the explanatory power, it is more likely that other variables not accounted for here need to be considered. The most important of these we think is to be found in the varying structural contexts among the AORs. With the exception of the environmental variables, structural attributes of the AORs are not accounted for in the present study with its focus on observed behaviors. Again, CEWARN is aware of the need to formally incorporate structural variables into its ongoing analyses. Toward this end, CEWARN in early 2007 began to develop a protocol to collect relevant structural data at the AOR level.

Nevertheless, five variables are statistically significant in the current study, two at $p < 0.05$ level and three $p < 0.01$. As would be expected of ‘‘peace indicators,’’ reciprocal exchanges and peace initiatives are both negatively related to the incidence of raids. More interestingly, mitigation, another of the ‘‘peace indicators,’’ presents a positive relationship with the raids. We think this may simply reveal that attempts to mitigate hostile situations associated with raids often take place during or shortly after the raiding activity. Thus the joint reporting of raiding activity and efforts to mitigate the situation are to be expected, with more intense raiding activity leading to more intense efforts to mitigate in the wake of the conflict.

Among the ‘‘conflict indicators,’’ aggravating behavior was positively associated with the incidence of raids at a statistically significant level. This is understandable, but it also begs the question why the other two ‘‘conflict indicators’’ were not significant, at least in the all-inclusive variable model—Table 5—(but it is significant in the behavioral variables only model—Table 6). We think that perhaps the explicit provocations as conveyed in the current SitRep questions may be somewhat ambiguous. With respect to the SitRep questions on pressures, these were originally included as a proxy for a more systematic inclusion of direct environmental measures. Now that CEWARN is including the direct measures, it is likely that these indirect measures are no longer useful. Actually, in a recent workshop to discuss the present results, CEWARN embarked on an effort to review all of the SitRep questions, refining them for improved precision with respect to the phenomena that they are intended to capture, and to minimize their ambiguity. A renewed emphasis on regular training for the field reporters is also underway, which should improve the quality of future data.

Table 5
Regression summary for the dependent variable raids (using all IVs; $N = 136$)

	St. Err.		St. Err.		$t(136)$	p-level
	β	of β	B	of B		
Intercept			−1.489	5.085	−0.293	0.770
Alliance	0.130	0.107	0.075	0.062	1.216	0.226
Exchange	−0.250	0.101	−0.167	0.067	−2.489	0.014*
Mitigation	0.414	0.144	0.211	0.073	2.883	0.005**
Initiation	−0.261	0.146	−0.120	0.067	−1.786	0.077
Aggrevate	0.317	0.110	0.396	0.138	2.874	0.005**
Pressure	−0.125	0.095	−0.072	0.054	−1.317	0.190
Provocate	−0.214	0.133	−0.125	0.078	−1.608	0.110
Rainfall	−0.015	0.091	−0.010	0.060	−0.165	0.869
Vegetation	0.358	0.115	0.083	0.027	3.112	0.002**
Forage	−0.159	0.103	−0.004	0.003	−1.544	0.125

*$p < 0.05$, **$p < 0.01$.
$R = 0.431$, $R^2 = 0.186$, Adjusted $R^2 = 0.120$.
$F(10,124) = 2.831$, $p < 0.003$, Standard Error of estimate: 8.304.

The environmental variable vegetation also presented a positive relationship with the incidence of raids, and there appears to be a cyclical influence of bi-modal seasons Table 7. Recall that we are using a one-month lag in all of the equations presented. This direct environmental measure then suggests that the raiding behavior is strategically planned and tied to opportunities presented by the environment. Indeed, Turner (2004: 877) argues that the ‘‘high spatiotemporal variability of productive resources leads to a situation in which there is little spatial fixity in the competition over land’’ which means that ‘‘conflicts are less likely to be ‘in-the-moment’ struggles over a particular resource patch and more likely to resemble strategic contests to maintain resource access over the longer-term.’’ In the case of pastoral conflict, these strategic interests must in part be tied to tactics aligned with the environment. High vegetation represents high grass and dense bush cover which makes it easier to track and ambush cattle with minimal risk of being caught. Herders interviewed during related field research explain that, ‘‘raiders like to attack during wet years because of high grass, strong animals, dense bush to hide in and the availability of surface water, which makes it easier to trek with the animals…’’ (Adano & Witsenberg, 2005: 723).

Table 6
Regression summary for the dependent variable raids (behavioral IVs only; $N = 136$)

	St. Err.		St. Err.		$t(136)$	p-level
	β	of β	B	of B		
Intercept				3.341	4.012	0.833
Alliance	0.108	0.108	0.062	0.062	0.996	0.321
Exchange	−0.226	0.101	−0.151	0.067	−2.248	0.026*
Mitigation	0.349	0.144	0.178	0.073	2.423	0.017*
Initiation	−0.132	0.144	−0.061	0.066	−0.919	0.36
Aggrevate	0.259	0.111	0.324	0.139	2.323	0.022*
Pressure	−0.121	0.093	−0.069	0.053	−1.296	0.197
Provocate	−0.276	0.132	−0.161	0.077	−2.087	0.039*

*$p < 0.05$, **$p < 0.01$.
$R = 0.346$, $R^2 = 0.120$, Adjusted $R^2 = 0.071$.
$F(7,127) = 2.47$, $p < 0.021$, Standard Error of estimate: 8.53.

Table 7
Regression summary for the dependent variable raids (environmental IVs only; $N = 136$)

	St. Err.		St. Err.		$t(136)$	p-level
	β	of β	B	of B		
Intercept			7.314	3.033	2.412	0.017*
Rainfall	−0.037	0.091	−0.024	0.059	−0.407	0.685
Vegetation	0.289	0.101	0.067	0.024	2.847	0.005**
Forage	−0.134	0.099	−0.004	0.003	−1.36	0.176

$*p < 0.05$, $**p < 0.01$.
$R = 0.243$, $R^2 = 0.059$, Adjusted $R^2 = 0.038$.
$F(3,131) = 2.74$, $p < 0.046$, Standard Error of estimate: 8.685.

The variability in vegetation may at times coincide with cultural practices as well. "Anthropological studies have shown that raids often take place as revenge for previous attacks. However, revenge activities are not supposed to coincide with religious ceremonies, which take place in certain periods corresponding to the lunar cycle, irrespective of rainfall. On the other hand, a slight increase in violence is said to take place after age-set ceremonies, during which groups of warriors are initiated or ritual leaders installed" (Adano & Witsenberg, 2005: 731).

We are still left with two questions: first, why is there no statistically significant relationship between rainfall as a proxy for surface water and ensuing conflict due to competition over a necessary but scarce resource? Second, why does forage present similar non-statistically significant results?

One answer for the precipitation question may be that it is too indirect a measure. The availability of surface water is a function of rainfall as well as numerous influences such as ground cover, topography and land use. Since we have not controlled for any of these variables in this study, it should not be surprising that rainfall as a proxy variable is not adequate. We were aware of this limitation going into this research and therefore sought to use surface water data. Regrettably, no data set was readily available for us to use.

The forage measure that we used is a measure calculated from a model and as such it theoretically includes many related influences. However, specification and measurement error as well as the way in which we had to transform the forage unit and level of analysis to the AORs may very well have contributed to this measure's lack of statistical significance.

Additional answers may be found in regional practices. "Pastoralists usually plan their raids and attacks carefully in an effort to achieve surprise, and they use traditional methods of surveillance of the other group's territory to identify targets" (USAID, 2002: 54). It may be that rainfall and forage are important elements in this planning, but that they may serve to increase or decrease the incidence of raids, depending upon the local circumstances. For example, "if there would be fights and people would try to steal each other's animals, there would not be a place where to water them. Tracking with stolen cattle during droughts is virtually impossible." (Adano & Witsenburg, 2003: 15).

Conclusion and policy recommendations

Using field data from the Karamoja cluster, we have shown that at least one environmental variable (vegetation) is positively associated with the incidence of organized raids at a statistically significant level. Two behavioral indicators, aggravating actions and mitigation efforts, are also positively associated with raids, while reciprocal exchanges and peace initiatives are associated negatively. In other words, organized raids are more likely when aggravating behavior and vegetation are high (and these may be accompanied by mitigation efforts) and reciprocal exchanges and peace initiatives are low.

Our assessment of the behavioral data leads us to believe that refinements in the situation report questions, integration of structural attribute indicators, improvements in quality control, and more regular training are likely to increase the explanatory power of CEWARN's early warning efforts. The quality of the field data, however, is not the only obstacle to understanding the relationships between behavior, the environment and conflict. Synchronizing the CEWARN, the temporal and spatial units of analysis with that of the environmental data was a major task in this study. The aggregations and transformations we employed may have introduced error for which we cannot account. Future studies of the CEWARN data would benefit from a lower level of analysis, ideally focused on the individual reporters' AORs. Indeed, we agree with Restrepo, Spagat, and Vargas (2006: 105), "when there are no underlying time series, we find it difficult to place great confidence in aggregate numbers."

How do these conclusions relate to the larger literature on the environment and conflict? And what appropriate policy recommendations may be drawn? Environmental factors do appear to influence pastoral conflict if only in the influence and constraints they pose to those making the tactical decisions to engage in raids. Turner (2004: 877), however, suggests that resources need to be "of sufficient density and persistence to elicit competitive behavior—behavior that has costs and risks." Thus, with indirect measures such as rainfall and forage the longer lags and complex influences may obscure the relationship between environment and pastoral conflict. In this study, we have shown that resource predation and looting may be important in sustaining raiding behavior given the association between vegetation and raids. More generally, these results may contribute to the resource scarcity versus abundance debate.

An issue deserving of more attention centers on the entry points for conflict prevention. Khagram and Ali (2006: 399) suggest that "preventative factors such as social learning, monitoring systems, anticorruption initiatives, or dense social networks" need to be considered. Clearly, a broad inclusion of political, economic, social, cultural and institutional variables is needed, especially as they are related to possible response mechanisms. Field monitoring of the dynamics and implications of disarmament, demobilization and reintegration (DDR) programs may be especially useful as they can have a pervasive impact throughout a region.

Finally, this study suggests that the CEWARN Unit may benefit from the inclusion of environment indicators into their regular field reporting to improve the Unit's ability to carry out reliable early warning analysis. This integrated approach may become even more pressing given the expected impact climate change will have on pastoral societies worldwide. Thus we also recommend a closer institutional collaboration between CEWARN and IGAD's Climate Prediction and Assessment Center (ICPAC) as well as the Livestock Early Warning System (LEWS). We also recommend that this collaboration should not be limited to early warning only, but also include early response. We believe that integrating conflict and disaster warning systems for early response reflects a wider recognition that complex emergencies are only going to become more complex with the impact of climate change. This approach may therefore be the logical next step for scholars and practitioners in the field.

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