Networking Disaster and Conflict Early Warning Systems For Environmental Security[1]

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[2] http://fletcher.tufts.edu/phd/students/Meier.html

Introduction

Can Disaster and Conflict Early Warning (D/CEW) systems be networked to untangle the multiple but interdependent crises that characterize complex emergencies, particularly in response to climate change? In other words, can high quality and continuous information gathering identify the ecological ingredients of complex crises before they are exploited for perverse political purposes by exacerbating environmental *in*security? And if so, can early warning methodologies based on events-data analysis provide the common platform for networking D/CEW? The purpose of this paper is to explore these questions from the perspective of a scholar-practitioner engaged in the development of field-based conflict reduction systems. The Conflict Early Warning and Response Network (CEWARN) in the Horn of Africa serves as the primary case study. The paper is structured as follows: the first section considers the confluence of climate change and complex emergencies. The next section presents CEWARN as an operational methodology being adapted to network D/CEW. The final section outlines how networked warning systems can remain effective in response to climate change.

Climate Crises

The occurrence of "natural" disasters amid complex political crises is increasingly widespread: over 140 natural disasters have occurred alongside complex political crises in the past five years alone (UN 2006). "The dramatic increase in major disasters witnessed in the last 50 years [also] provides worrying evidence of this trend, [and] if climate change produces more flooding, heat waves, droughts and storms, this pace may accelerate" (UN 2004: 27; Sachs 2006; Bättig *et al*. 2007). In fact, average worldwide losses from natural disasters have been increasing exponentially since 1960 (Cutter and Emrich 2005; Munich Re 2005; Helbing, Ammoser and Kühnert 2006). To make matters worse, where conflicts already exist, "the threat of climate change is likely to exacerbate, rather than ameliorate matters because of uncertainty about the amount of future resources that it engenders" (IPCC 2001, Working Group II: 225; Barnett 2001; Brauch

2002). At the same time, political crises and armed conflicts indirectly exacerbate the impact of natural disasters by exhausting coping mechanisms and response capacities (Walker 2006; O'Brien, O'Keefe, Rose and Wisner 2006; Pelling and Dill 2006; Brauch 2002; deSoysa 2002; Homer-Dixon 1999). Indeed, human-driven "environmental degradation has enhanced the destructive potential of natural disasters and in some cases hastened their occurrence" (UN 2004: 27). In this rush of feedback loops, "the catastrophic risks are magnified by the fact that some of the risks are positively correlated" (Posner 2004: 89), which implies that "regional climate change, as with other causes of environmental degradation, could make armed conflict more likely" (Purvis and Busby 2004: 68).

There is no single crisis in the Sudan—there are multiple crises cascading into a complex series of emergencies (Meier 2007; Noji 2005). While the complicity of the Sudanese government is indisputable, "analysts close to the conflict and with access to data on actual behavior have pointed out that these characterizations can be misleading" (Kuznar and Sedlmeyer 2005: 5). The genesis of the crises in the Sudan is fundamentally ecological in nature and driven by long-term climate change (Elasha 2006; Sachs 2006; Baechler 1998; Suliman 1996, 1997). Conflict "reductionist" models tend to reduce protracted conflicts to ethnic and religious causes. These, however, may represent symptoms rather than underlying root causes and therefore limit the efficacy of a military response. In fact, "the relevance of military state-centered forces in addressing or 'solving' non-state-centered issues is questionable" (Liotta 2004: 51).

In the early 1980s, the low-lying plains used by pastoral nomads were disproportionately hit during one of the worst droughts in over half a century, scorching Darfur and wiping out entire livestock holdings. Increasing poverty, famine, desertification and land degradation followed the drought and nomads coped by migrating to better pastures (Elasha 2006). They sought water and forage in the Jebel Marra region of Darfur, which "intensified conflict between peasants and nomads, [and] given the irreversible effect of drought on declining environmental productivity, the conflicts continued" (Kuznar and Sedlmeyer 2005: 6). The Khartoum government has taken advantage of these ecological

crises, effectively using the impact of climate change as continuation of war and politics by other means (Meier 2007). As in other complex emergencies, if crises are not produced deliberately, then they are often allowed to progress. The Sudanese government is directly responsible for exterminating some 150,000 people (and counting). At the same time, however, these premeditated atrocities coupled with the ongoing ecological crises has displaced millions and killed another 250,000 civilians. The leading causes of death were health-related but the crime was committed in Khartoum (c.f. Meier and Hernes 2007). In effect, the Sudanese government has exploited the impact of climate change by using it as a force multiplier to carry out the execution of 400,000 civilians. Recognizing both the political and ecological elements of complex emergencies is imperative, particularly given the expected impact of climate change.

Future crises of pestilence, war, famine and death conflated by climate change are likely to see "more people on the move, internally and across borders, as they seek livelihoods away from stressed areas" (Walker 2006: 2; O'Brian *et al.* 2006; Sachs 2006). During the last decade, for example, an estimated 188 million people per year worldwide were affected by natural disasters, more than 6 times the 31 million annually affected by armed conflict (Purvis and Busby 2004).[3] The International Panel on Climate Change (IPCC) warns that "migration of populations affected by extreme events or average changes in the distribution of resources might increase the risks of political instabilities and conflicts" (IPCC 2001, Working Group II: 85; Liotta 2004). At present, an estimated 25 million people per year are fleeing temporarily from weather-related disasters and global warming is projected to increase this number at least eight-fold to some 200 million before 2050 (Brauch 2002; Myers 2002).[4] Ethnic compositions usually in flux may solidify around local resource- and identity-based conflicts as a result.[5] The most recent drought and famine in the Horn of Africa is unfortunately yet another data point on this

[3] Disasters alone cost some US$ 738 billion between 1995-2004 (Reid 2006, 2167).

[4] Projected sea level rise is no less of a concern with 44% of the world's population living within 150 kilometers of a coast (Berger *et al*. 2006).

[5] The activation or use of coping mechanisms should be understood as an early warning indicator. Indeed, competition over scarce resources will exacerbate when vulnerable communities are forced to shift from coping mechanisms to non-reversible survival strategies (see Walker 1992).

grim scatter plot since it had an immediate impact on the fluid relationships between pastoral groups. To be sure, "the ethnic composition of countries can be altered [or sharpened] by migration. This is one of the most widely cited conflict-generating effects of climate change in the literature" (Nordås and Gleditsch 2005: 18).

In summary, contemporary crises in the Horn are increasingly plagued by cascading ecological and social stresses (Elasha 2006; Sachs 2006; Bättig *et al*. 2007). The number of environmental refugees is growing, creating further feedback effects on existing complex emergencies (Suhrke 1996; Brauch 2002; Myers 2002). At the same time, in many if not most cases, complex emergencies are the result of conscious decisions or intentional indecisions by those holding the reigns of power, i.e., political crises (Edkins 2002; Keene 2004). There is little doubt that climate change will spawn new ecological crises across Africa (Bättig *et al*. 2007) but these needn't become complex political emergencies unless perilously managed—perhaps deliberately so—by outdated strategies of war and diplomacy (Sachs 2006; O'Brien *et al.* 2006). Put differently, "if all you have is a hammer, then every problem begins to look like a nail" (Liotta 2004: 64).[6]

Clearly then, "study[ing] the linkages between human insecurity and conflict and between humanitarian crises and conflict is vital," yet these linkages "have not been as widely studied as the political and military factors that lie behind [them]" (Lacina and Gleditsch 2005: 149-150). More effective cross-disciplinary research is desperately needed to bridge the archipelago of disaster studies (Hewitt 1983). To be sure, partitioning the general study of disasters from other fields, and partitioning specialties within disaster studies from other specialties, "creates a patchwork of isolated approaches rather than what we need: a coherent, comprehensive, and connected view."[7]

These isolated approaches explain why the disaster management and conflict prevention communities hardly collaborate. Indeed, they opine that disaster and conflict early

[6] This view was expressed by Prince Bernhard von Bülow (German Chancellor form 1900 to 1909), who in 1914 declared: "In the struggle between nationalities, one nation is the hammer, the other the anvil, one is the victor, the other the vanquished."

[7] Email exchange with Dr. Ilan Kelman, January 18, 2007.

warning systems "are logically different" (Schmeidl and Jenkins 1999: 474) even though "both types of disasters have commonly led to massive internal and external displacements of people" (Ryan 1992: 166), and many disasters, "whether man-made or natural, are interlinked, and disaster-prone regions, countries or groups are vulnerable to any kind of disasters" (Kuroda 1992: 217). In other words, "despite the different origins of disasters, they share many common elements" (Helbing, Ammoser and Kühnert 2006: 332).[8] Moreover, there are obvious functional parallels in risk assessments, monitoring and warning, dissemination and communication, response capability and impact evaluation (Meier 2006). These analogous functions have real operational consequences for implementing organizations and stakeholders (Brauch and Oswald 2006).

Still, the two communities are not engaged in either joint dialogue or scientific research. This is ironic given repeated concerns that disaster early warning (DEW) systems are too narrowly focused on meteorological and agricultural information at the expense of socio-political indicators (Maxwell and Watkins 2003; UN 2006; Dynes 1998), while conflict early warning (CEW) systems are being urged to integrate environmental change indicators into their analyses (Meier 2006; Brauch and Oswald 2006). These converging trends clearly demonstrate that disaster and conflict early warning share the same functional logic: early detection and early response. The section that follows outlines how centralized approaches to conflict early warning can be networked with early warning systems for natural disasters.

[8] "These disasters have at least one thing in common. That is the inability of the organization involved to effectively synthesize and share the information from separate "precursor" incidents with the relevant people across the organization so that appropriate action could be taken to reduce the risk of disaster" (Cooke and Rohleder 2006: 214).

Networking CEWARN

Established in 2003, the Inter-Governmental Authority on Development's (IGAD) Conflict Early Warning and Response Network (CEWARN) in the Horn of Africa uses events-data[9] analysis to monitor and anticipate pastoral conflict.[10] In 2005, the author initiated CEWARN's collaboration with IGAD's Climate Prediction and Assessment Center (ICPAC) in order to network D/CEW systems. The focus on pastoral conflict and climate change in the Horn's cross border regions is salient since similar ingredients were present in the Sudan some 20 years ago (Meier 2006d). Indeed, "is it merely a coincidence that many of today's major conflicts are fought in pastoral regions—places such as Somalia, Afghanistan, Sudan and Palestine?" (Nori, Switzer and Crawford. 2005: 3).

Pastoral conflict is considered inherent to many pastoral ecosystems (Krati and Swift 1999). [11] Indeed, "local-level conflicts over natural resources, of which livestock raiding is one specific form, are endemic in Africa's pastoral and agro-pastoral systems" (Hendrickson, Mearns and Armon *et al.* 1996: 189). Cattle raiding is increasingly predatory as pastoral groups are well armed with AK-47s—the result of the Cold War and political machinations between neighboring states vying for both local and regional influence. To be sure, armed conflict in the Horn "inevitably tends to have political

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[9] The salience of using events as data or inputs for early warning analysis stems from the fact that descriptive information on its own is of limited value. An events-data approach complements qualitative description with prescriptive analysis, which forms the basis for early response. An events-data or structured approach to early warning is therefore critical and a distinction must be made "between random information flows and information which could be organized so as to constitute early warnings. Infrequent newspaper reports of disasters, social upheavals, mass killings or even astrological predictions may be the raw material for early warning reporting; but only when data is systematized, classified, and organized for retrieval and analysis would it constitute the rudiments of an early warning system" (Rupesinghe 1988, 218). To be sure, "the 'quality' of information augments as it becomes more structured, more organized and hence more manageable" (Mubareka *et al*. 2005: 237).

[10] See www.cewarn.org.

[11] A recent field study found that competition for grazing land and water was identified as the single most important structural cause of conflict by pastoralists in the cross border region between Ethiopia, Kenya and Uganda called the Karamoja Cluster (USAID 2002).

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" (Mwaura and Schmeidl 2002: 45). The proliferation of small arms has also encouraged the commercialization of cattle raiding, which is increasingly linked to foreign markets (Hendrickson *et al.* 1996; FAO 2001).

At the same time, pastoral groups inhabit a mercurial ecological system, which can hardly be ignored as having a potential influence on pastoral conflict and beyond (Krätli and Swift 1999). A relief map of the region immediately reveals that the "international boundary between Kenya and Uganda quite closely follows the natural division between the drier plains to the east and the wetter higher elevation areas to the west" (Halderman et al. 2002: 24).[12] Long-term environmental degradation and climate change is expected to further exacerbate or even alter these divisions (IPCC 2001, Working Group II). To be sure, "climate change could reduce water availability in the semi-arid savannah ecosystems of tropical Africa [where] conflict already occurs between herdsmen and farmers in this region" (IPCC, 2001, Working Group II: 394). In the last decade, for example, "several years of poor rains and the onset of drought affected an estimated 16 million people [in the Horn], resulting in an increased number of what are now referred to as ecological refugees" (Mwaura and Schmeidl 2002: 38).

The impact of climate change 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" (Suhrke 1996: 123). Scholars have therefore urged that future research on environmental conflicts focus on local areas "where renewable resources are particularly sensitive to climate change" (Barnett 2001: 7), and areas with high population growth, urbanization and where local competition over dwindling resources may lead to tensions that might escalate across borders and threaten the

[12] Pastoral conflict in Kenya and Uganda alone has claimed at least 3,094 deaths and displaced a further 206,830 people over the past decade (Adan and Pkalya 2005: 39).

security of one or more states (O'Brien *et al.* 2006; Liotta 2004; Posner 2004).[13] Little wonder then that pastoralists have been 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.[14]

In 2002, Swisspeace and Virtual Research Associates (VRA) were invited by IGAD to develop and operationalize an appropriate methodology for CEWARN.[15] The two non-governmental organizations (NGOs) had previously collaborated on the development of Swisspeace's FAST early warning system, which IGAD had taken an interest in. FAST is a field-based early warning system that uses Local Information Networks and the Integrated Data Event Analysis (IDEA) framework—originally developed by VRA to automatically code events reported in global newswires (Bond *et al.* 2003; Krummenacher 2006; Krummenacher and Schmeidl 2001).[16] FAST's Local Information Networks comprise local employees who track and report relevant information in accordance with the specific set of indicators dictated by the IDEA framework. FAST's reports are primarily geared towards international development organizations. Given CEWARN's specific focus on pastoral conflict, the IDEA generic framework used by FAST to monitor armed conflict was considered sub-optimal. To be sure, "preventive action requires a degree of specificity which usually does not flow from global [or macro] indicators" (Ryan 1992: 170). VRA therefore proposed and developed a customized approach that went beyond FAST's basic event-logging methodology (Bond and Meier 2005, 2006). Today, CEWARN field monitors use fully customized surveys to report from more than twenty locations along the borders of Ethiopia, Kenya, Somalia

[13] The Economist. "The Horn of Africa: Path to Ruin." August 10, 2006. Of course, population growth also plays a role in making resources scarcer although like climate change, the intervening variable is government policy.

[14] Christian Aid (2006). "Life on the Edge of Climate Change: The Plight of Pastoralists in Northern Africa." Available on-line at: www.christian-aid.org.uk/indepth/0611climatechange2/kenya_climatechange.pdf.

[15] Disclaimer: The author was formerly a consultant to Swisspeace, VRA and IGAD between 2003-2006.

[16] See www.swisspeace.org/FAST

and Uganda—collectively known as the Karamoja and Somali Clusters.[17] Unlike FAST, CEWARN integrates two types of complementary, standardized and structured surveys: Incident Reports and Situation Reports (Meier 2006).

Incident Reports or "IncReps" are surveys used to document specific incidents of pastoral conflict that CEWARN seeks to prevent. Local area experts from Ethiopia, Kenya and Uganda identified these incidents during a series of indicator workshops.[18] IncReps are used to record "*who did what to who, where, when* and *how*," when these incidents occur. IncReps also document the consequences of individual incidents.[19] In addition, each report includes measures for quality control and a short textual description or narrative of the incident, which provides the context for subsequent interpretation (Schmeidl and Jenkins 1999).

Like FAST's event-logging approach, Incident Reports are completed episodically, that is, when incidents occur. However, "everyone knowns at least since David Hume that we have no reason to believe that the association of events provides a basis for inferring the presence of a causal relation" (Waltz 2000: 9). Furthermore, since the purpose of conventional early warning is to anticipate these incidents before they occur in the first place, this retroactive approach misses the point. Early warning analysis must move beyond the singular, backward-looking event-logging approach to context-based, forward-looking methodologies that monitor precursors to peace and conflict (Bond and Meier 2006; Schmeidl and Jenkins 1998). Furthermore, this approach has been known to underreport cooperation events, which are particularly important for early response.[20]

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[17] 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 (Oxfam 2004).

[18] The incidents monitored by CEWARN include: armed clashes, organized raids, protest demonstrations and banditry.

[19] These include injuries, gender-violence, casualties, livestock losses and infrastructure damage amongst others.

[20] See JRC Evaluation of VRA Event Data-based Tool for Conflict Early Warning.

This explains why CEWARN uses Situation Reports or "SitReps". The purpose of SitReps is to monitor situational processes that render the likelihood of those incidents both more *and* less likely. In other words, SitReps use a weighted Likert scale[21] to monitor both precursors and mitigating processes associated with pastoral conflict incidents. Relevant situational processes were identified and "unpacked" into discrete events by local area experts with extensive knowledge of pastoral livelihoods.[22] In other words, precursors and mitigating factors were translated into physically observable indicators.

It is important to note that SitReps monitor a wide range of events. These include events associated with communal relations, civil society activities, economic activity, governance and media, natural resource use and disasters, safety and security, and social services. Like IncReps, each Situation Report includes contextual descriptions of evolving situations. Unlike IncReps, they are completed on an episodic basis, currently weekly; thus ensuring that processes are monitored systematically.

By complementing these two types of surveys, CEWARN can empirically verify which precursors of pastoral conflict (documented in SitReps) are most closely correlated with subsequent pastoral conflict incidents (tracked in IncReps). Furthermore, by monitoring precursors of conflict (and not just outcomes), CEWARN may be in position to respond to an increasing frequency of precursor events *before* these translate into irreversible incidents—such as the body counts documented in IncReps. In other words, developing SitRep baselines of precursor events is tantamount to monitoring social vulnerability and needs, while baselines of mitigating factors quantify changes in social resilience which focuses on "what is already in place: resources and adaptive capacities" (O'Brien *et al.* 2006: 71; Manyena 2006).

[21] More specifically, CEWARN uses a five-point scale that ranges from Strongly Disagree to Strongly Agree via Don't Know.

[22] A number of experts had PhDs and one was formerly a pastoralist in the Karamoja Cluster.

This approach may then provide an advanced warning of impending incidents directly relevant to pastoral conflict, thus rendering systematic conflict prevention more than a hypothetical possibility (Meier 2006). In addition, by monitoring mitigating processes, CEWARN can identify the "causes of resilience" or local knowledge and coping mechanisms employed by indigenous stakeholders when confronted with stressful situations produced by conflict and/or environmental change (Walker 1992). Indeed, "the ability of local institutions to survive and emerge from emergencies should not be underestimated" (Maxwell and Watkins 2003: 80; Barrs 2006). Information on the drivers of resilience is invaluable since recognized trends in coping mechanisms can serve to guide and inform early response and capacity building with respect to livelihoods (Walker 1992; Kuroda 1992; Reid 2006; UN 2006; Meier and Zambiras 2006). The section that follows outlines how conflict systems networked with disaster systems can be adapted to inform prevention and mitigation strategies in response to climate change.

Adapting Early Warning to Climate Change

Taking a multi-hazard approach by monitoring both events and the situations that lead to them is a critical component of a robust early warning and response system, particularly within the context of climate change (Meier 2007; Reid 2006; Maxwell and Watkins 2003). This is because "disasters triggered by environmental phenomena do not cause political change, rather they act as catalysts that put into motion potentially provocative social *processes* at multiple social levels" (Pelling and Dill 2006: 4; Cardona 2004). In other words, natural disasters are uncertain both in their occurrence and magnitude. "It is helpful to distinguish between them, whether the goal is prediction or mitigation. Society can work to mitigate either dimension of loss—either reducing the likelihood of a disaster or reducing a disaster's likely effect" (Berger, Kousky and Zeckhauser 2006: 9). Put differently, there is a subtle but fundamental difference between disasters [processes] and hazards [events], a distinction that Jean-Jacques Rousseau first articulated some two

hundred years ago after Portugal was shaken by an earthquake in 1755.[23] In a letter to Voltaire one year later, Rousseau notes that, "nature had not built [process] the houses which collapsed and suggested that Lisbon's high population density [process] contributed to the toll" (Kelman 2007).

In other words, natural events are hazards and exogenous while disasters are the result of endogenous social processes (Oliver-Smith 1986; Glantz 1994; Hewitt 1995; Cardona 2004; Sornette 2006; Chladná, Moltchanova and Obersteiner 2006).[24] As Rousseau added in his note to Voltaire, "an earthquake occurring in wilderness would not be important to society" (Kelman 2007). That is, a hazard need not turn to disaster since the latter is strictly a product of social processes (O'Keefe *et al.* 1976; Lewis 1988; Kelman 2007).[25] And so, while disasters were traditionally perceived as "sudden and short lived events, there is now a tendency to look upon disasters in African countries in particular, as continuous processes of gradual deterioration and growing vulnerability," which has important "implications on the way the response to disasters ought to be made" (cited in Rupesinghe 1988: 219). But before we turn to the issue of response, what does the important distinction between events and processes mean for early warning?

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[23] This event triggered earthquake research in Europe and also served as the focus for various publications, ranging from Kant's essays about the causes of earthquakes to Voltaire's *Poème sur le désastre de Lisbonne* (Jentsch, Kantz and Albeverio 2006).

[24] This endogeneity argument holds for society as a whole, but not necessarily for specific communities, countries, or regions. All disasters result from social processes, but many disasters result from social processes external to the community, which experiences the disaster.

[25] Natural disaster research is a product of the Cold War when US government institutions provided research funds to study the reactions of people to possible air raids. Disasters were believed to elicit human reactions comparable to air raids, which led to a conceptual understanding of disasters as being events exogenous to society. "Bombs fitted easily with the notion of an external agent, while people harmed by floods, hurricanes, or earthquakes bore an extraordinary resemblance to victims of air raids" (Gilbert 1998: 12). This understanding of disasters was challenged in a paper entitled "Taking the 'naturalness' out of natural disasters" which identified human behavior, not changes in nature, as causing the observed increase in disasters (O'Keefe *et al*. 1976).

In *The Poverty of Historicism* (1944), the German Philosopher Karl Popper distinguishes between two kinds of predictions: "We may predict (*a*) the coming of a typhoon [event], a prediction which may be of the greatest practical value because it may enable people to take shelter in time; but we may also predict (*b*) that if a certain shelter is to stand up to a typhoon, it must be constructed [process] in a certain way […]" (38). A typhoon, like an earthquake, is certainly a hazard, but it need not lead to disaster if shelters are appropriately built since this process culminates in minimizing social vulnerability.[26]

In contemporary disaster research, "it is generally accepted among environmental geographers that there is no such thing as a natural disaster. In every phase and aspect of a disaster—causes, vulnerability, preparedness, results and response, and reconstruction—the contours of disaster and the difference between who lives and who dies is to a greater or lesser extent a social calculus" (cited in Kelman 2007; Reid 2006). In other words, the term "natural disaster" is an oxymoron (Reid 2006) and "phrases such as a 'disaster hit the city,' 'tornadoes kill and destroy,' or a 'catastrophe is known by its works' are, in the last resort, animistic thinking" (Dombrowsky 1998: 21).

The vulnerability or resilience of a given system is no longer solely the outcome of future events since vulnerability is the complex product of past political, economic and social processes (O'Keefe *et al.* 1976; O'Brien *et al.* 2006). When hazards such as landslides interface with social systems the risk of disasters may increase. "The role of vulnerability as a causal factor in disaster losses tends to be less well understood, however. The idea that disasters can be managed by identifying and managing specific risk factors is only recently becoming widely recognized" (Dilley et al. 2005: 19; Lewis 1999). This explains why past "discussions with regard to early warning systems have emanated from a concern with the early prediction and reporting of events [instead of processes] which could lead to social disasters" (Rupesinghe 1988: 224).

Consider an hourglass or sand clock as an illustration of vulnerability-as-causality. Grains of sand sifting through the narrowest point of the hourglass represent individual events or

natural hazards.[27] Over time a sand pile starts to form, which represents the evolution of society or the connectedness of a social network. Occasionally, a grain of sand falls on the pile and an avalanche or disaster follows.[28] Why does the avalanche occur? One might ascribe the cause of the avalanche to one grain of sand, i.e., a single event. On the other hand, a systems approach to vulnerability analysis would associate the avalanche with the pile's increasing slope and to the connectedness (or population density)[29] of the grains constituting the pile since these factors render the structure increasingly vulnerable to falling grains.[30] Left on its own, the sand pile's stability, or the social network, becomes increasingly critical or vulnerable.[31] From this perspective, "all disasters are slow onset when realistically and locally related to conditions of susceptibility" (Lewis 1988: 4). A hazard event might be rapid-onset, but the disaster, requiring much more than a hazard, is a long-term process, not a one-off event. We must therefore "reduce as much as we can the force of the underlying tectonic stresses in order to lower the risk of synchronous failure—that is, of catastrophic collapse that cascades across boundaries between technological, social and ecological systems" (Homer-Dixon 2006).[32]

Recall Rousseau's comment on population density as a contributing cause of the earthquake disaster and Popper's remark that adequate shelter or resilience could offset the impact of typhoons.[33] The sand pile at the bottom of the hourglass is constrained by

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[27] This analogy was developed by the author in the seminars he teaches on "Disaster and Conflict Early Warning". Syllabi are available at: http://fletcher.tufts.edu/phd/students/Meier.html

[28] Note that this analogy is more than simply conceptual; the distribution of avalanches in sand piles with respect to frequency and magnitude follows a power law, i.e., frequency and magnitude are inversely proportional. The distribution of fatalities resulting from natural disasters and armed conflict also follows a power law (see Meier *et al*. 2006).

[29] Increasing connectedness can reduce degrees of freedom in disaster response. In other words, the required complexity or flexibility for effective disaster response is reduced.

[30] This analogy also holds for armed conflict (Meier 2006c; Buchanan 2002).

[31] This is an ordinary process in complex systems called self-organized criticality.

[32] Of course, "we have to do other things too, and advance planning for breakdown is undoubtedly the most important" (Homer-Dixon 2006: 291).

[33] Population density also a significant impact on the risk of armed conflict. Indeed, "conflict events tend to have frequencies in proportion to the size of the population in a given location" (Hegre and Raleigh 2006: 26).

the glass's circumference. While abstract, this image mimics the growth of densely populated cities that become increasingly vulnerable to hazards, either natural or technological (Reid 2006; OECD 2003). In fact, much of the increase in damages from natural disasters over the past five decades has occurred because of urbanization (Cutter and Emrich 2005). As for the future, "truly cataclysmic demographic changes will occur in the Lagos–Cairo–Karachi–Jakarta arc, where there will be astounding shifts in the global landscape that hinge on the 'flocking' of populations to urban centers," which will dramatically increase social vulnerability (Liotta 2004: 53). Unlike the clock's lifeless grains of sand, however, human beings can minimize their vulnerability to exogenous shocks through disaster preparedness, mitigation and adaptation. In doing so, individuals can "flatten" the structure of the sand pile into a less hierarchical system and thereby shift or diffuse the risk of an avalanche.[34] In conflict prevention terms, this means structural prevention, which typically focuses on local livelihoods and local capacity building (Noble 2005; Meier 2004; Hamburg 2002; Ryan 1992; Galtung 1980).

Clearly, early warning should seek to monitor both the falling grains *and* the vulnerability of the sand pile to determine the risk and magnitude of an avalanche.[35] In more formalistic language, a dual approach is important because it is not always clear *a priori* whether a disaster is due to a strong exogenous, to the internal dynamics of the system or a combination of both (Sornette 2006). As the disaster management community has learned, in "support[ing] good decision-making, the issue is not one of being able to predict the unpredictable. Rather, the fundamental question is that, given that we cannot have reliable predictions of future outcomes, how can we prevent excessive hazard levels today and in the future in a cost-effective manner? (Chadná, Motchanova and Obersteiner

[34] The author realizes that social and physical systems are not closed, as the hourglass analogy would suggest. In addition, within the context of climate change, avalanches in the sand pile have a feedback effect on the frequency and magnitude of the falling sand. In other words, human-induced climate change "emphasizes the *mutuality* of hazard and vulnerability to disaster due to complex interactions between nature and society" (Hilhorst 200: 53).

[35] Recent studies have combined social networks analysis and event-data to determine the robustness or resilience of social networks over time. See in particular Meier and Leicht 2006; Maoz 2006; Stoll and Subramania 2006; Antal *et al*. 2005; Widmer and Troeger 2004.

2006: 296). To this end, one definition of risk in the disaster literature is the product of hazard, exposure[36] and vulnerability (some divide this product by resilience which is a function of knowledge and capacity):

Risk = (Hazard x Exposure x Vulnerability) / Resilience

This explains why a simple event- or hazard-logging approach to D/CEW is sub-optimal.[37] D/CEW systems should systematically focus on both events *and* processes in order to calculate and forecast both the risk of a typhoon and the resilience of a shelter. This requires cross-disciplinary collaboration between "geologists, seismologists, meteorologists and other scientists who can monitor and predict hazards, while social scientists are brought in to explain people's behavior in response to risk and disaster and to develop early warning mechanisms and disaster preparedness schemes" (Hillhorst 2004: 52; Mayena 2006). In other words, close cross-disciplinary collaboration between the D/CEW communities from both the Global North and South is critical, as is the participation of local stakeholders absolutely essential.

Using a data-driven approach to humanitarian reporting means that the information collected is amenable to statistical and geospatial analyses. Indeed, the data collected using Incident and Situation Reports can be used in baseline or time-series analysis to identify trends and anticipate subtle changes in vulnerability that may lead to complex emergencies crises. Such changes or inflections in baselines may signify a deviation from the "norm" which may indicate the need for early response. To be sure, "understanding structural causes [processes] and recognizing the events and actions that lead to conflict should highlight potential moments and fields for intervention (van de Goor and Verstegen 1999: 4).

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[36] This parameter is particularly salient in face of climate change since exposure times are increasing while recovery times between disasters are being reduced (Walker 2006; Maxwell and Watkins 2003).

[37] Earthquake physicists do not only document where and when earthquakes take place, they focus predominantly on the composition of fault structures (Stein 2005).

Baseline analysis is thus "the fundamental building block of a rational information system" since "proper baseline data make it possible to identify the most critical information types for early warning […]" (Maxwell and Watkins 2003: 76, 87; Church and Rogers 2006). Moreover, baselines analysis permits the testing of counterfactuals, which is "an essential tool because the concrete event is too complex to subsume under causal generalizations or theoretical laws" (Griffin 1993: 1101).[38] At the same time, textual descriptions or narratives included in the Incident and Situation Reports provide the necessary context to interpret and comprehend change. "Events, then, are our points of access to structuring and narratives are how we describe, reconstitute and comprehend events" (Griffin 1993: 1098). The bottom line is that the use of both Incident and Situation Reports produces more reliable baselines.

If event-data analysis is to be used as a platform to network D/CEW (Meier 2004), then ecological causes of conflict need to "be concrete events specific to concrete situations" (Vayda and Walters 1999: 171). In this respect, "if the object of explanation is truly to be environmental change," the methodology used to network early warning within the context of climate change might be characterized as an event-focused approach to ecological study, or "event ecology" (Lees and Bates 1984: 78). This method focuses first and foremost on "the environmental events or changes that we want to explain and then work[s] backward in time and outward in space so as to enable us to construct the chains of causes and effects leading to these events or change" (Vayda and Walters 1999: 169).

[38] Indeed, what is lacking in early warning is the equivalent of "tornado warnings that announce tornadoes but also that do not announce low pressure areas that do not turn into tornadoes. Such distinctions do not prevail in meteorology or in politics as yet" (Zartman 2005: 5).

Conclusion

Event ecology is compatible with an events-data approach to CEW since the latter already uses data-driven analysis as a framework for reporting and analysis. An integrated events-data approach to disasters, conflicts and climate change may therefore provide an appropriate platform upon which to network D/CEW. However, given the importance of monitoring processes, this platform must not be limited to event-logging as in the FAST context but should instead adopt the Incident and Situation Reporting methodology developed by CEWARN.[39] Furthermore, relevant ecological processes relevant to violent conflict should be identified in collaboration with local stakeholders and the scientists at ICPAC. These can then be networked into CEWARN's SitReps as discrete observations that serve as precursors or mitigating factors to pastoral conflict. In other words, contrary to widespread recommendations that DEW should focus more on social and political indicators (UN 2006; Maxwell and Watkins 2003; Dynes 1998), the author maintains that D/CEW systems should maintain their individual comparative advantages and simply collaborate by "trading" structured event-data in real-time.

With this in mind, the author recently led a pilot study to empirically demonstrate the added value that closer collaboration between the D/CEW communities can offer.[40] Given pressing concerns over the implications of climate change for pastoral conflict in the Horn of Africa, the author drew on geo-referenced "event ecology data" from the Livestock Early Warning System (LEWS), the Malaria Early Warning System (MEWS) and IGAD's Climate Prediction and Assessment Center (ICPAC) to create baselines for forage, rainfall and vegetation availability respectively. By using geographic information system (GIS), these baselines or time-series were comparable to CEWARN's conflict baselines in both time and space.

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[39] Some early warning systems still "tend to be geared to informing pure emergency responses, as though the information required were for one-off events with clear beginnings and ends" (Maxwell and Watkins 2003: 73).

[40] For a detailed cross-disciplinary analysis of early response form a complex systems perspective, see Meier (2007). "New Strategies for Early Response: Insights from Complexity Science." Paper presented at the International Studies Association.

The preliminary findings, based on several multivariate regressions, suggest that the availability of vegetation is directly proportional to the social triggers of pastoral conflict with a two-to-three month lag. In other words, the correlation between high vegetation and high conflict triggers appears to be statistically significant at the 95% confidence level, which may at first seem counterintuitive (Meier *et al.* 2007). One of the advantages of networking disaster and conflict early warning systems is that results can be interpreted across disciplines. Upon further cross-disciplinary research, the key to explaining the results lay in raiding tactics. Indeed, as grasses grow tall, pastoralists seeking to raid cattle gain cover and therefore the element of surprise. Given that ICPAC provides high-resolution vegetation forecasts several months in advance, systematically integrating this ecological indicator (and others) into CEWARN's analysis is long overdue.

In conclusion, this study suggests that conflict early warning systems may benefit from mainstreaming selected environment indicators into their regular reporting to improve the their ability to carry out reliable early warning analysis in a timely manner. This integrated approach may become even more pressing given the expected impact climate change will have on pastoral societies worldwide. Thus we recommend a closer institutional collaboration between conflict and disaster early warning systems. We also recommend that this collaboration not be limited to early warning only, but also include early response. [41] We believe that networking 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.

[41] For a detailed cross-disciplinary analysis of early response form a complex systems perspective, see Meier (2007). "New Strategies for Early Response: A Complex Systems Perspective." Paper presented at the International Studies Association.

References available upon request.

Biographical Note

Patrick Meier is a Henry Luce Fellow and PhD Associate at The Fletcher School of Law and Diplomacy based at Tufts University. He is a recipient of the distinguished Robert E. Stewart Award for most outstanding graduate student at The Fletcher School in 2006. His academic and professional interests focus on the application of complexity science to social systems analysis, particularly in terms of risk, resilience, vulnerability and adaptation to systemic change and extreme events. His doctoral research therefore centers on the study and design of early warning/response systems that seek to anticipate, mitigate or prevent the impact of unscheduled change on social systems. This research applies complexity science as an analytical framework to explain why and when these systems fail. Mr. Meier is especially interested in the interdependence and synchronicity of cascading change—armed conflicts, natural disasters, pandemics, climate change—and evolving complex emergencies. To this end, Mr. Meier teaches seminars on "Preventing Catastrophes: Disaster and Conflict Early Warning/Response" and on "Managing Complex Systems: From Dynamic Networks to Tipping Points" to both graduate students and UN professionals. He has published widely on the subject of early warning and has presented his cross-disciplinary research at dozens of respected conferences worldwide.

As a professional consultant, Mr. Meier has worked on numerous conflict prevention and early warning projects with multiple offices and agencies of United Nations (UN), including the UN Secretariat, OCHA, UNDP, UNICEF, UNEP and the UN Millennium Secretariat. His work on early warning also includes projects with the International Crisis Group (ICG), International Alert (IA) and the Swiss Peace Foundation—establishing the latter's UN-liaison Office in New York where he served as interim director for the FAST International Early Warning Project. In addition, Mr. Meier has regularly consulted on the joint OSCE-NATO-UNDP regional early warning project for environmental security in Central Asia. He played an instrumental role in establishing West Africa's regional early warning system for the Economic Community of West African States (ECOWAS) and significantly scaled-up the Horn of Africa's Conflict Early Warning and Response Network. Most recently, he was solicited to develop the methodology for the regional early warning system being developed by the Economic Community of Central African States, and was also solicited by the UN Office of the Deputy Secretary General to evaluate the UN's capacity for early warning, which formed part of the external contribution to the Secretary-General's Report on the Prevention of Armed Violence. In addition, he is offering his expertise pro-bono to the Harvard Humanitarian Initiative (HHI) crisis-mapping project.

Mr. Meier is currently a Research Associate with the Peace Research Institute, Oslo (PRIO), where he works closely with Norway's former Secretary of State and Deputy Foreign Minister on a health and conflict project for the Norwegian Ministry of Foreign Affairs. He is a Fellow with the Conflict Prevention Program at Columbia University's Center for International Conflict Resolution (CICR) and a Research Assistant with the Conflict Analysis Resource Center based in Bogotá, Colombia. He is a

recent graduate of the Santa Fe Institute's (SFI) program on complex system and the New England Complex Systems Institute (NECSI). Previous academic studies include an MA in International Affairs and Conflict Prevention from Columbia University's School of International and Public Affairs (SIPA) and a BA (Hons) in Political Science, Economics and Philosophy from the University of York, England and California at Berkeley. He is the co-founder of both the American Council on Africa (ACA) and Partners for Conflict Reduction (PCR). Mr. Meier was born in Cote d'Ivoire, raised in Kenya and holds dual nationality from Switzerland and France. He is fluent in English and French, proficient in German and has studied Arabic in Morocco and Tunisia.

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