A region-specific prognostic model of post-earthquake international attention

Daniel P. Eriksson
Coventry University
Centre for Disaster Management
daniel@erikssonco.net

ABSTRACT

This project evaluates the feasibility of a prognostic model for international attention following earthquakes. The degree of international attention is defined as the number of situation reports issued by the United Nations. Ordinal regression is applied to a set of 58 case study events that occurred in Central Asia between 1992 and 2005. The context of the model is promising. Patterns were identified among the misclassified events. The patterns can prove helpful in understanding the irregular behavior of the international community and to improve future models by identifying subjects, such as bilateral relations and willingness to request external aid, for which additional indicators are needed.

Keywords

Earthquakes, Response, Attention, Prediction, Alert, Central Asia, Decision support

INTRODUCTION

There are signs that the community of earthquake alert users is not supplied with optimal decision support (Lamontagne, 2005). Though important, increased usability (Norman, 1998:188) requires more than improved user interfaces. Eriksson (2005) indicated that data on potential quantitative loss, though relevant, do not provide a complete picture of the resulting international needs. If quantified needs can be predicted (Shakhramanian, Larionov, Nigmetov, and Sutschev, 2000:156), what prevents the prediction of the resulting international response? By analyzing the past behavior of the international community, this study aims to evaluate the feasibility of a model for the categorical prediction of the magnitude of the international response following an earthquake. This is a novel approach in a domain where the majority of alert systems focuses on quantitative prognoses of impact (Alexander 2000; Wyss, 2004; Aleskerov, Say, Toker, Akin, and Altay, 2005) or need. Earlier research in the qualitative direction includes De Groeve and Ehrlich (2002) who initiated the development of a diagnostic loss assessment tool.

Definitions

Earthquake event

'Earthquake event' is a subjective term, but is defined here as a set of shocks that could lead to damage or casualties and would be perceived by almost any observer to be a single, disastrous event. In the eyes of the international relief community, an earthquake event involves a single series of shocks that is followed by an appeal for relief made by the host country. Pragmatically for the international relief community, a new earthquake event emerges if an "aftershock" from a previous earthquake event causes sufficient damage to give rise to additional needs for international response in terms of either content or quantity, and thus a new relief appeal.

International attention

In this account, the term 'international attention' sums up all the channels through which, and forms in which, the international community may express its solidarity with a developing country in the aftermath of an earthquake. This includes the frequency and extent of foreign media coverage, the volume of international aid received, and the sum of financial donations from foreign sources.

Purpose

The main purpose of this study is to investigate the feasibility of predicting the level of international attention following an earthquake. The secondary purpose is to probe the suitability of using situation reports (sitreps) issued by the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA) as a proxy indicator of the level of international attention devoted to earthquake events. The study is not designed to be normative. Instead, it aims to be descriptive by modeling the past behavior of the international community.

RESEARCH DESIGN

The study area chosen is Central Asia, as the countries of this region suffer perennially from earthquake disasters and are frequently the subject of international relief appeals. The data set consists of 58 case-study events that occurred between 1992 and 2005 in Afghanistan, China[1], Iran, Pakistan, Kazakhstan, Kyrgyzstan, Tajikistan, or Turkmenistan. These events were identified by querying the National Earthquake Information Center (NEIC) database managed by the US Geological Survey. The data on the impact and international response were mainly collected using content analysis of documents published on the UN-OCHA ReliefWeb website (www.reliefweb.org). The post-event data were gathered from both ReliefWeb and the Emergency Disasters Database (EM-DAT) compiled at the Catholic University of Louvain in Belgium by the Centre for Research on the Epidemiology of Disasters.

Variable Selection

Dependent Variable (DV)

Direct data on the level of international attention were collected. This included quantitative measures of donated assets extracted from sitreps as well as frequency analysis of printed media reporting in relation to the events. However, it became clear that the reported loss, needs, and response data only sporadically included a unit. This limited the quantitative analysis. Units were often not provided by the reporting sources and when used they were commonly non-standard, e.g. 'plane-loads' of goods or 'enough food for one village'. The frequency of media reporting was deemed incomplete for the pre-Internet events not consistently recorded by media analysis tools like the European Media Monitor (Best, van der Goot, Blackler, Garcia, Horby, Steinberger, and Pouliquen, 2005). Nevertheless, as shown in Figure 1, the data indicated that high magnitude international responses tend to increase the number of sitreps issued by UN-OCHA. Consequently, this study used the number of UN-OCHA sitreps issued on an event as a proxy indicator of the level of international attention devoted to it.

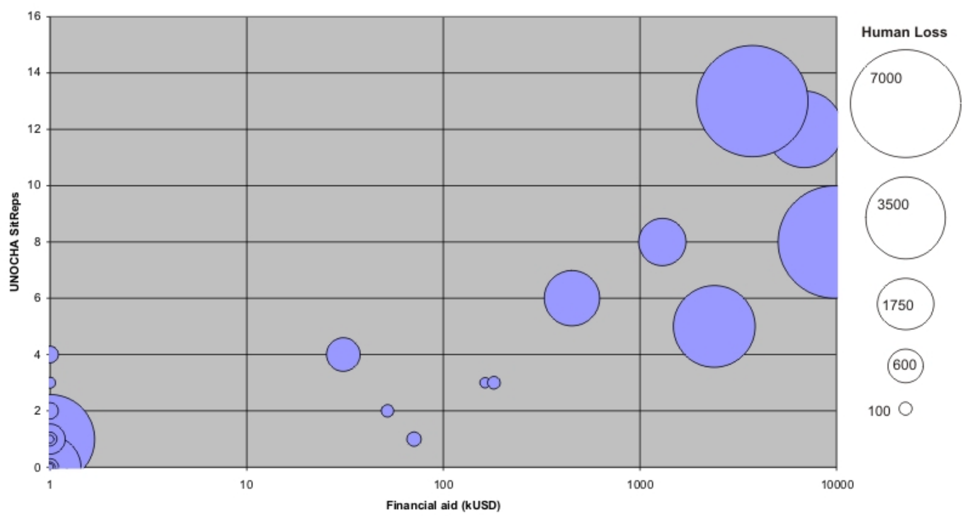

Figure 1 The relation between the number of sitreps, foreign financial aid, and total human loss

[1] Only the western autonomous provinces of Xinjang Uygur and Xizang/Tibet.

Independent Variables (IV)

It is tempting to approach the problem of IV selection as a series of sequential cause-and-effect relationships; i.e., losses cause needs which in turn lead to a response. At first, this approach seemed feasible. For instance, Wyss (2004) demonstrated the feasibility of real-time fatality estimation using an ordinal categorical approach involving proxy indicators of building quality. The subsequent step would be to estimate needs using data on losses. Shakhramanian *et al.* (2000:156) were in line with the prevailing paradigm when they used human loss figures as the basis for calculating need. Arguably, the loss of human lives may constitute an adequate basis for calculating needs in domestic emergencies where levels of resilience are known. However, the international need constitutes the difference between overall needs and the sum of domestic and regional resiliencies. Without the ability to predict international needs, the sequential approach to response prediction outlined above is difficult or impossible to apply.

The alternative is to circumvent the prediction of needs and proceed from the prediction of losses directly to that of responses. Olsen, Carstensen, and Hoyen (2003) claimed that the main factors affecting the size of an international response to a typical disaster are global politics, the presence on the ground of the international relief community at the time the disaster strikes, and the level of mass-media coverage. Given that the indicators of mass-media coverage of a disaster cannot be collected in advance of the event, emphasis must be placed on selecting indicators for global politics and the presence of the international community. Under the assumption that donor countries are more willing to support countries with democratic values, the World Press Freedom Index (WPFI) (see Table 1) can be used as a proxy indicator of positive global political relations.

Variable	Description
Magnitude	The magnitude of the main shock as stored in the NEIC database.
Depth	The hypocentral depth of the main shock as stored in the NEIC database.[2]
LocalTime	The local time of day of the main shock.
50kmPop	Population within 50 km from the epicentre calculated using the 2003 Oakridge National Laboratory Landscan (ORNL)[3] population raster.
GNA	A composite indicator of need developed by Billing and Siber (2003) ranking countries between 1 and 3 based on an average of the Human Development Index (HDI), the Human Poverty Index (HPI), natural disaster prevalence[4], conflict prevalence[5], internally displaced persons[6], child malnutrition[7], and child mortality.
UGrowth	National Urban Growth 2000-2005 as estimated by UN HABITAT.
WPFI	A qualitative country-level indicator developed by Reporters Without Borders[8] ranking countries on an open-ended scale with open countries scoring closer to zero.

Table 1 Selected IVs

Direct data on the presence of the international community is available for recent years (Durch, 2004), particularly after UN-OCHA started to monitor International NGO (INGO) operations through its Humanitarian Information Centres (HIC) located in different countries. However, as the direct data are not complete, a proxy indicator is required that offers complete coverage. An analysis by Darcy and Hofmann (2003) supports the assumption that the INGO community tends to concentrate its efforts on what it considers to be the countries most vulnerable to disaster. A composite indicator of need, such as the Global humanitarian Needs Assessment (GNA) score (see Table 1), can thus be applied as a proxy indicator of INGO presence. The inclusion of urban growth was inspired by the work of Gutiérrez, Taucer, De Groeve, Al-Khudhairy, and Zaldivar (2005), who found a correlation between earthquake vulnerability and the degree of urban sprawl.

[2] The value 33km is a default indicating a probable shallow focus, but are treated as an unknown
[3] www.ornl.gov/landscan/ accessed February, 2006
[4] Based on the EM-DAT
[5] Based on material from the Heidelberg Institute on International Conflict (HIIK)
[6] Based on UNHCR data
[7] Children <5 years, as reported by UNICEF
[8] See Reporter Without Borders website: http://www.rsf.org/

In the model, *Magnitude* and *Depth* represent the seismic character of the earthquake; *50kmPop*, *LocalTime*, and *UGrowth* represent vulnerability; *GNA* represents both resilience and INGO presence, and *WPFI* represents the state of the global political relationships of the affected country. With the exception of WPFI, the IVs are thus traditional indicators of loss. The difference is the DV that they are calibrated against. As for the accuracy of the indicators of seismic character, a fixed isoseismal radius does not give an accurate representation of the population affected by earthquakes (Hewitt, 1997:220). An intensity raster would provide a more realistic representation. It is likely that a future model would benefit from using loss estimations from a preceding model, like that presented by Wyss (2004), as an input that could replace the indicators of seismic character and seismic vulnerability. Additional concerns about accuracy stem from the variables that are static in time, even though the events are dispersed between 1992 and 2005. This is the case for the 2005 GNA, the 2004 WPFI, and the 2003 Landscan (50kmPop).

Categorisation

To absorb some of the inaccuracies in the data mentioned above, the variables are organized into meaningful categories. The arrangement of the DV into three ordinal levels (see Table 2) facilitates user-friendly cognitive mapping (Norman, 1998) similar to that carried out by De Groeve and Ehrlich (2002). Ordinal regression produces a model that classifies cases in ordinal categories, with each case being given a probability of belonging to each of the ordinal categories. Ordinal regression is hence well suited for our purpose. However, for the regression to be powerful there have to be events in every possible combination of categories, i.e. in every cell. As more categories are used, the number of cells that need to be populated multiplies. Because the population of events is relatively small, the number of cells must be limited. This also limits one's ability to use the continuous versions of variables, which would create even more cells than their categorized versions manage to use.

Role	Categorised Variable	Proxy Indication	Continuous Variable	Cate-gories	Category cut points
DV	AttCat	International attention	Sitreps	3	Low (<2 reports), Intermediate, and High (>4 reports)
IV	MagCat	Hazard intensity	Magnitude	3	Low (<5), Intermediate, and High (>6)
	Shallow		Depth	2	Depths less then 40 km are categorised as Shallow.
	PopCat	Vulnerability	50kmPop	3	Low (<50’000 persons), Intermediate, and High (>150’000 persons)
	Vulnerable		GNA	2	GNA>=2 are categorised as Vulnerable.
	HighGrowth		*UGrowth*	*2*	*Nations with growth rate above 4% are categorised as high.*
	Night		*LocalTime.*	*2*	*Time after 21:00 and before 07:00 is categorised as Night.*
	Open	*Political relations*	*WPFI*	*2*	*Nations scoring below 50 are categorised as open.*

Table 2 Categorised variables[9]

The variables are organized on the basis of theoretical and empirical knowledge of the subject. Empirically, the exact time is not as important as knowledge of whether the local population was awake or asleep (Alexander, 2000). As for *Depth,* the human loss is virtually zero for the ten events with depths that exceeded 40 km. Similarly, the total financial aid does not exceed USD 200,000 for each event that generated fewer than five sitreps. Admittedly, it is not true that earthquakes with depths exceeding 40 km are harmless, nor is it impossible for an event with fewer than five sitreps to receive more than USD 200,000 in aid. Nevertheless, the case studies and the analytical method both reaffirm the value and appropriateness of this classification.

[9] Excluded variables in italics

The Suitability of Variables

When analyzing the classified variables shown in Table 2 using cross-tabulation, some variables stand out as adding little or nothing to the predictive power of the model. The distribution of *Night* and *HighGrowth* over *AttCat* is equable. Consequently, it was appropriate to exclude both variables. Ordinal regression is sensitive to correlations among the IVs. Among these, significant correlation only exists between *WPFI* and *GNA*, and the power of the statistical analysis is improved by omitting one of these. As it is somewhat less subjective, GNA was chosen as the indicator for both vulnerability and political relations.

ANALYSIS

The prognostic model was developed by applying ordinal logistic regression[10]. Though half of the cells proved to be empty, the model developed using the cauchit link-model produced usable results. The cauchit link-model was chosen for its suitability in classifying extreme events. With a significance level close to zero, the developed prognostic model outperforms the intercept model. The model probabilities and event classification are listed in the appendix to this paper.

DISCUSSION

In total, the model misclassified twelve events out of 58. The most serious errors were the high-attention events in Iran, which were classified as intermediate-attention events. The misclassifications depended on the country to which they pertain. Events in Iran were predicted to receive less attention than observed values showed, and, in contrast, events in China were predicted to receive more attention than they actually did. It is safe to assume that additional intangible country-level variables are required in order to achieve increased accuracy and a broader geographical applicability. The composite GNA and WPFI do not provide a suitable indication of the political factors that affect the level of international attention. In situations in which the macroscopic vulnerability variables are adequate, they may still be of insufficient resolution to provide input that benefits the model. Moreover, the misclassifications in China are likely to be a result of insufficient resolution combined with the lack of an indicator of the government's inclination to request foreign aid.

The omissions and commissions in the intermediate attention category can all be attributed to the way in which input variables are categorized. Because the use of continuous variables restricts the analytical method, the best way to improve the predictive capacity of the model is to increase the population of events.

Though the frequency of sitreps does identify events that catch the interest of the international community, it is doubtful whether it accurately reflects international need. Several events with seemingly high levels of international need (i.e. events with great human loss in areas of low resilience), were observed to receive intermediate or low levels of attention. One cause could be that the aid is different in type or quantity and that the number of sitreps is reduced as a consequence of a reduced need to coordinate aid and relief. This could also be a sign of the "forgotten crises" syndrome identified by Holm (2002).

CONCLUSION

Despite some misclassifications, the context of the model is promising. Consequently, it is feasible to predict the level of international attention given to disasters in Central Asia. The misclassified cases are thought-provoking in that, in addition to highlighting the weaknesses of the model, they also expose cases in which the international community has acted irregularly and point to subjects which have no proxy indicators. Though there may be potential problems of lack of objectivity, the quantity of sitreps issued provides a useful proxy indicator of the level of interest manifested by the international community when an event occurs.

Future Research

A more detailed analysis of the abnormal cases could be used to identify indicators that represent some of the political aspects of international response. Using improved, spatial models of earthquake intensity or more precise loss estimations as inputs, future research could usefully focus on estimating needs and responses. Emphasis on these phases would allow the research to take a normative stance by attempting to analyze the appropriateness of

[10] SPSS version 12, standard location model

international responses. The role of mass media coverage could also be studied, as could the use of bilateral trade data, which both form useful indicators in the field of international relations.

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APPENDIX

Table 3 Model output

		AttCat[11]	
ISOA3	**Sitreps**	**Observed**	**Expected**
IRN	14	3	2
AFG	13	3	3
AFG	12	3	3
AFG	8	3	3
IRN	8	3	2
IRN	6	3	2
IRN	5	3	2
AFG	4	2	2
AFG	4	2	1
IRN	3	2	2
IRN	3	2	2
PAK	3	2	2
AFG	3	2	1
PAK	3	2	1
IRN	2	2	2
IRN	2	2	2
IRN	2	2	2
KGZ	2	2	1
PAK	2	2	1
CHN	1	1	3
CHN	1	1	3
IRN	1	1	2
AFG	1	1	1
AFG	1	1	1
AFG	1	1	1
IRN	1	1	1
IRN	1	1	1
IRN	1	1	1
IRN	1	1	1
IRN	1	1	1

		AttCat[11]	
ISOA3	**Sitreps**	**Observed**	**Expected**
IRN	1	1	1
PAK	1	1	1
TJK	1	1	1
TKM	1	1	1
CHN	0	1	3
PAK	0	1	2
AFG	0	1	1
AFG	0	1	1
AFG	0	1	1
AFG	0	1	1
CHN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
IRN	0	1	1
KAZ	0	1	1
TJK	0	1	1
TJK	0	1	1

[11]
1 = Low attention,
2 = Intermediate attention,
3 = High attention

Table 4 Model probabilities

MagCat	Shallow	PopCat	Vulnerable		AttCat (Probability %) Low	Intermed.	High
Low	No	Intermediate	No	*Observed*	*100*	*0*	*0*
				Expected	96	1	3
		High	Yes	*Observed*	*100*	*0*	*0*
				Expected	94	2	4
	Yes	Low	No	*Observed*	*100*	*0*	*0*
				Expected	91	4	5
			Yes	*Observed*	*100*	*0*	*0*
				Expected	83	10	7
		Intermediate	No	*Observed*	*100*	*0*	*0*
				Expected	94	2	4
		High	No	*Observed*	*86*	*14*	*0*
				Expected	90	5	5
Intermediate	No	Low	Yes	*Observed*	*100*	*0*	*0*
				Expected	93	3	4
		High	Yes	*Observed*	*100*	*0*	*0*
				Expected	92	4	5
	Yes	Low	Yes	*Observed*	*50*	*50*	*0*
				Expected	61	30	9
		Intermediate	No	*Observed*	*86*	*14*	*0*
				Expected	92	4	4
		High	No	*Observed*	*100*	*0*	*0*
				Expected	84	10	6
			Yes	*Observed*	*50*	*50*	*0*
				Expected	48	42	10
High	No	Low	Yes	*Observed*	*0*	*100*	*0*
				Expected	39	50	11
		Intermediate	No	*Observed*	*100*	*0*	*0*
				Expected	90	5	5
			Yes	*Observed*	*100*	*0*	*0*
				Expected	77	16	7
	Yes	Low	No	*Observed*	*50*	*50*	*0*
				Expected	13	58	29
		Intermediate	No	*Observed*	*25*	*50*	*25*
				Expected	28	59	13
		High	No	*Observed*	*0*	*50*	*50*
				Expected	11	49	40
			Yes	*Observed*	*50*	*0*	*50*
				Expected	6	12	82