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Survivor Needs or Logistical Convenience? –

*Factors shaping decisions to deliver relief to
earthquake-affected communities, Pakistan 2005-06*



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Cover page photo: Map in the United Nations Joint Logistics Center (UNJLC) offices in Muzaffarabad, Pakistan, November 2005, by Brody Dittmore.

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Summary

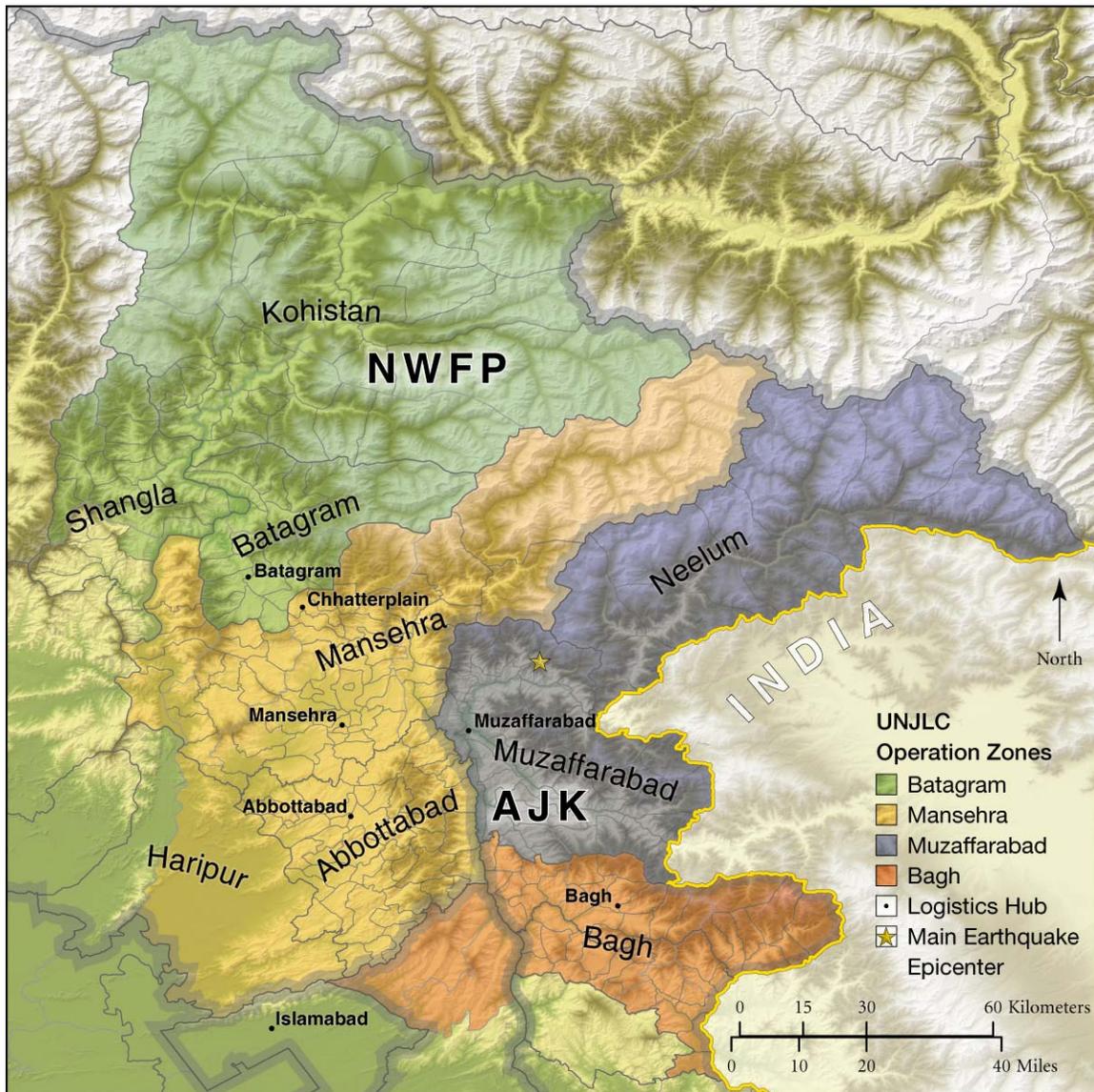
The 7.6 Richter scale earthquake that struck large swathes of northern Pakistan and Indian Kashmir on 8 October 2005 killed at least 73,000 persons (ActionAid International 2006) and made many more homeless (Tulloch 2006). It provoked a major internationally coordinated response that focused on ensuring the survival of an affected population of 3.5 million persons, over 100,000 of them in camps and many others in high-altitude settlements. The early months of the response became famously known as “*Operation Winter Race*”.

In Pakistan, national and international agencies distributed vast quantities of relief and reconstruction material during the period October 2005 through June 2006. Both road and air transport were used aggressively. Yet transport capacity was one of the major constraints on the speedy and sufficient delivery of relief, others being in funding, needs assessment and procurement.

Despite coordination mechanisms that the national government put in place (Khan 2006a), several networks of agencies operated with a measure of autonomy in needs assessments, procurement, distribution and reporting. As a result, comprehensive relief statistics are not available. However, the in-country deliveries indicate that approximately 90 distribution agencies asked the United Nations Joint Logistics Center (UNJLC) to coordinate the movements of their cargo. These are documented in time-stamped and geo-referenced manner, making this part of the response an ideal object for the study of relief dynamics in space and time.

We explore the factors associated with decisions to ship and with the amounts actually shipped to 87 affected Union Councils over 200 days for three major types of commodities – food, shelter, and construction material. Our statistical models simultaneously fathom out the needs-related and logistical considerations that the dispatchers had to balance. We use Heckman-type regression models

Figure 1: Overview map



(Sigelman and Zeng 1999) to use the information available from over 17,000 area-by-date observations, supplementing the UNJLC movement database with covariates from external sources.

Our research question is whether the decision makers, in the presence of severe logistical constraints, discounted survivor needs as effective criteria for relief allocation. We test the null hypothesis that needs-related indicators had no effect on cargo movements.

Our major finding is that survivor needs did in fact orient cargo movement decisions, but that nuances were very important:

Decisions to ship were fashioned by factors that varied starkly between commodity types. UNJLC focused helicopter transport on the critical needs for food and shelter whereas construction materials were more responsive to open roads. Food, much more than the other commodities, preferentially went to areas with small, scattered populations. This is explained by the fact that larger towns were being looked after by others such as the Pakistani Army and the World Food Program.

Across commodity types, delivery decisions were more strongly determined by terrain than by population size and the degree of destruction. This is explained in part by the association of hill settlements with pre-disaster poverty and the ensuing greater vulnerability, which the humanitarian community took into account. Terrain type as a decision factor was reinforced by the number and diversity of relief agencies, which made comparable needs assessments difficult. The so-called “Quake Jumpers”, assessment teams flown to mountain ridges and thence boldly descending to surviving hamlets and villages, also resulted in more deliveries made to remote and isolated communities in need.

Overall, the Pakistan response pattern suggests a balanced application of needs-based and logistical concerns by UNJLC and its affiliated relief agencies. “Operation Winter Race” effectively helped to avoid mass casualties from cold and starvation. Strong logistics played its vital part.

Yet, the relative weakness of the population and damage effects on cargo movement decisions raises an unpleasant possibility for the humanitarian community at large. The current endeavors to sharpen humanitarian logistics with imports from corporate-military supply chain management may be focusing on a secondary efficiency frontier (Özdamar, Ekinci et al. 2004: ; Beamon and Kotleba 2006) while we are lagging behind in the art of

speedy, reliable and valid needs assessments and their coherent translation into actual deliveries.



Figure 2: Improved tent village on mountainside, Jhelum Valley, November 2005

Photo: B. Dittmore

In keeping with Thomas' observation that logistics databases are rich "*data repositories of data that can be analyzed to provide post-event learning*" (Thomas 2003: 4), the aim of this study is to demonstrate the potential of humanitarian data management for a deeper understanding of issues that recur across a variety of disaster response situations. Analyzed together

with other data bodies, the UNJLC Pakistan cargo movement database offers an excellent opportunity for this purpose.

Preface by the Director, VVAF / iMMAP

This study is the result of a productive partnership that links our organization, VVAF/iMMAP, with the United Nations Joint Logistics Center (UNJLC).

Through such partnerships, UNJLC has been able to secure reliable support of critical skills and services in times of emergencies. VVAF's iMMAP specializes in the operational application of cutting edge information management, survey, analysis and geographic information system (GIS) technologies and services. iMMAP has directly supported UNJLC with technical personnel deployments to Pakistan, the Democratic Republic of Congo, southern Sudan, and the Horn of Africa Regional Office as well as with 11 specialists during the Indian Ocean Tsunami response in Indonesia, Sri Lanka, Thailand and the Maldives. These services provide a core component of UNJLC's successful missions.

Most recently, UNJLC asked for VVAF support in Lebanon in 2006 based on the Standby Partnership Agreement between WFP and VVAF, but also on a long running collaboration between the two organizations directly.

We often receive confirmation that our contributions were effective in enhancing critical skills and capacities in the disaster response theater. For example, the 2005 United Nations report "Information and Communications Technology for Peace" stated that the NGO with the most experience in the ICT sector is VVAF, *"whose iMMAP project – while only a small part of VVAF's work – has been instrumental in supporting both Mine Action initiatives and the HICs operated by OCHA. VVAF's iMMAP also provided direct support to OCHA Afghanistan and Iraq through seconded personnel in the co-located OCHA Humanitarian Information Centers. NGOs offer a different perspective and a different approach to GIS in the field, one that can complement that of international organizations, and it seems certain that these actors will expand their activities in coming years."*

While we are posed to do so, rare are the opportunities, for us as well as for others, to review past experience in an in-depth manner and in a disciplined lessons-learned perspective. While our experts help to marshal coherent, vast data bodies easily accessible to those working in the immediate response, usually very little gets done to unlock the wealth of fascinating associations and structures hidden in them.

This study is an exception, taking advantage of a systematically built database on the logistics aspects of the Pakistan earthquake response. It uses database management, GIS and statistical processes to link relief shipments with factors specific of this disaster as well as with data on the affected local society. As in other settings, VVAF/iMMAP personnel, while not creating the data themselves, have managed to link and interpret it in novel ways. These, I hope, will strike the reader as creative and leading to unexpected insights. In particular, this is a contribution to the growing research into humanitarian logistics, an arena that calls for circumspect combinations of modern supply chain management methods with interventions appropriate to disaster-stricken poor-country environments.

This study is one in a series that VVAF/iMMAP has been producing under the title “*Navigating Post-Conflict Environments*”. Together, they document important advances in several aspects of humanitarian information management. I wholeheartedly commend this latest addition to the reader's attention.

William E. Barron
Director

Washington DC, 30 October 2006

List of acronyms

AJK	Azad Jammu Kashmir (Pakistan Administered Kashmir)
CMCC	Cargo Movement Coordination Cell
DART	USAID Disaster Assistance Response Team
DEM	Digital elevation model
DFID	UK Department for International Development
EDP	Extended Delivery Point
FASS	Forward Area Support Site
FDP	Final Delivery Point
GIS	Geographic Information System
HIC	Humanitarian Information Center
IASC	United Nations Inter-Agency Standing Committee
IOM	International Organization for Migration
LSS	Logistics Support System
MMI	Modified Mercalli Index
MT	Metric ton
NATO	North Atlantic Treaty Organization
NGO	Non-governmental organization
NWFP	North West Frontier Province
POE	Port-Of-Entry
SIC	Strategic Information Cell
UC	Union Council (a local-government entity)
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHAS	United Nations Humanitarian Air Service
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNJLC	United Nations Joint Logistics Center
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
USGS	US Geological Survey
WFP	United Nations World Food Program

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Roman Rudel, Sabrina Migani and Elisabetta Masini, University of Lugano, invited one of us (Benini) to attend the Summer School and provided not only excellent hospitality, but also a forum to present key findings to a larger audience of practitioners and researchers.

Other individuals from outside the Lugano Summer School too were helpful, particularly in the process of revising earlier versions. Tim Connolly, former Chief of Party, UNJLC Pakistan, responded to several of our questions. Ann Marie O'Donoghue, who had served both with GOAL Ireland and with UNJLC, as well as Ben Wielgosz and Glyn Saunders, formerly with UNJLC, provided detailed comment, photos and/or interviews. Ted Paterson, Geneva International Centre for Humanitarian Demining, Quentin Wodon, The World Bank, John Harrald and Firoz Verjee, George Washington University, Max Stephenson, Virginia Tech Institute Blacksburg, as well as Bettina Buehler, Caritas Switzerland provided important comment. Thomas Kneib, University of Munich, explained aspects of the Heckman selection model and reviewed Bayesian estimation commands. Najeeb Ahmed Khan, Himalayan Holidays Pakistan, provided material on a needs assessment mission undertaken with the help of his mountain guides.

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Disclaimer

The Vietnam Veterans of America Foundation (VVAF) as well as any other persons or organizations named in this article are not responsible for the views expressed by the authors. Neither those organizations nor the authors are responsible for the accuracy of international borders displayed in maps or implied in the data.

Introduction

At 08:50 am on 8 October 2005, a 7.6 Richter scale earthquake struck large swathes of northern Pakistan and Indian Kashmir. Centered on the small town of Patika, in Pakistan's Azad Jammu Kashmir (AJK) province, seismic waves traveled along steep river valleys, up and down the alluvial soils of connecting watersheds. Final reports indicate the earthquake killed at least 73,000 persons (ActionAid International 2006) and made 3.3 million people homeless (ERRA and IASC 2006: v). It provoked a major internationally coordinated response that focused on ensuring the survival of an affected population of 3.5 million persons, over 100,000 of them would become temporary residents in camps or tent-villages, while many others would remain in high-altitude settlements with difficult transportation links. The early months of the response became famously known as the "Winter Race," as Himalayan snows were expected to begin affecting earthquake survivors as early as mid-November.

Within two weeks of the earthquake, international first responders began requesting additional resources and funding as the complexity of the situation in terms of diverse needs, access to survivors, proximity to armed conflict, responder diversity and an impending second disaster from winter became apparent. Both national and international organizations were becoming active in the relief effort and donations from across the globe were beginning to be received by Pakistan, but bottlenecks in coordination, impending relief constraints, and the difficulty of winter operations were fast approaching. In an effort to create greater efficiency in relief logistics, the United Nations' Inter-Agency Standing Committee requested the activation of the United Nations Joint Logistics Centre, and then increased the UNJLC's funding by 490% within 19 days of the earthquake.

Thus, logistical capacity came to be seen as the critical constraint that needed to be released in order to avoid a second disaster - large-scale excess mortality from exposure to cold and from starvation. International procurement, particularly of such items as winterized tents, was a close second in the list of concerns that preoccupied the relief community, but even assuming supplies were highly elastic, delivering the life-saving relief (and later reconstruction material) to the survivors was the paramount challenge.

"Operation Winter Race" and the subsequent transition from relief provision to reconstruction support, therefore, offer fascinating case material to study the status and relative importance of logistics vis-à-vis other factors that determine humanitarian outcomes. Such a study is attractive for two reasons. First, humanitarian logistics is undergoing a second wave of professionalization¹, with conceptual imports from military-corporate supply chain management, after a first wave that consisted of

¹ Russell (2005) retraces the historical development in recent decades, emphasizing networked community building, further improvements in communications, and the development of appropriate software for the current decade. Tufingki (2006) develops a conceptual framework that builds a bridge between disaster sociology and modern logistics science. Saunders (2006), who worked in UNJLC Pakistan, pointed out that humanitarian logistics has more in common with the just-in-case philosophy of the military than with the just-in-time imperatives of the commercial sector.

improved global warehousing, human resources, and transport and telecommunications policies. Second, as one of the proponents of this professionalization observed, “*since the logistics department is usually involved in every stage of a relief effort, it is a rich repository of data that can be analyzed to provide post-event learning*” (Thomas 2003: 4).

This study takes advantage of both factors. The Pakistan earthquake response attracted professional logisticians, including those who wrote the “*Last Mile Concept*” plan (UNJLC Pakistan 2005) to ensure relief would get all the way to survivors. UNJLC Pakistan is also the place where one of us (Dittemore) worked, from late October 2005 to end of March 2006, in GIS and in the facilitation of the cargo movement database that provides the data for the statistical models that we use here.

Together with a winter that turned out milder than many had feared, the massive logistics clout that the national and international responders mobilized averted the second disaster. Although the “*Last Mile Concept*” plan was not implemented in its original outlines (see below), shelter and food provision objectives were met to the point where consensus rules that massive deaths did not occur². In fact, many displaced people returned to their devastated villages early in winter in order to start rebuilding their homes. The logistics had been effective.

The research question

Such a sweeping statement hides the fact that the relief outcomes were the result of uncounted decisions, many of them taken against difficult trade-offs in the allocation of scarce relief goods and logistics resources. It is fair, if not particularly illuminating, to assume that decisions to deliver relief over the “*last mile*” were determined by cognitive models of the task environment, notably survivor needs, stocks, transport capacities, security conditions in the Kashmir conflict region, and winter climates.

But it is also fair to speculate that humanitarian agencies, very much like other types of service agencies, seek an internal equilibrium of activities, by scale and by scope, that will allow them to regenerate capacity even if client needs sometimes have to be deferred or transformed. For example, the Pakistan earthquake response assembled an impressive fleet of helicopters used to carry goods to over 200 delivery points. The servicing and safety imperatives, but also the donor management and media visibility implications, of this capability were a core concern of the coordination structures.

Some researchers have radicalized this perspective to the point of assuming that the needs of the affected populations are pushed back in the decision matrix by factors that go far beyond capacity maintenance. For example, in his “*Bureaucratizing the Good Samaritan*”, Waters (2001) details how client categorizations used by humanitarian agencies admit certain groups of people into relief and protection programs while other groups whose needs are equally pressing on commonsense grounds are excluded from

² The positive overall evaluation should not overlook the fact that some shortages remained chronic. Wielgosz (2006a) estimates that perhaps 30 percent of displaced people were in winterized accommodation, mostly in tents supplied bilaterally by the Chinese, and credits the success of the operation in large part to the good fortune of a mild winter.

these benefits. Exclusionary policies and mandates go hand in hand with massive failure at contingency planning; most anticipatory moves produce false negatives (worsening situation not foreseen) or false positives (response capacity built in excess). Much of this is due to the fact that needs on the ground and donor response are out of sync, producing an alternation of funding gluts and bottlenecks. Funding is driven strongly by media attention cycles. The factors that distract from the needs of the affected groups have been highlighted by others as a dysfunction of the international humanitarian community at large, above and beyond the local disaster theaters in which their perverse effects are felt (Smillie and Minear 2004).

The radical critique is not necessary in order to identify the balance between needs-related and logistical factors in the determination of relief deliveries. But it is useful as a *Devil's Advocate hypothesis* that leads to a keener, testable research question. Did the build-up and operation of massive logistical machinery obliterate a discerning response to survivor needs, or did it enhance and sharpen needs considerations? The Devil's Null Hypothesis, in a manner of speaking, simply is that the effects of needs-related variables on the probabilities and amounts of relief deliveries were zero.

The conclusion may seem forgone since "Operation Winter Race" was successful. Yet, while our analysis of cargo movement data will indeed confirm sensitivity to needs, it will also demonstrate that the needs indicators informing decisions were not always those most commonly expected.

The article proceeds as follows. We eclectically echo some voices representing the new wave of professionalization, inspired by supply chain management, of humanitarian logistics. The degree to which this pervaded the relief community in Pakistan is not the subject here, except to mention that the identity of our data provider, the UNJLC, is built around the strengthening of the logistics function in the humanitarian orchestra (Kaatrud, Samii et al. 2003).

Next, we provide a summary overview of the "families" (major sub-network) of responder organizations present in the theater, with a reference to the Humanitarian Information Center (HIC) created on the pattern of other such centers in previous disasters (Sida and Szpak 2004: ; Currión 2006: ; UN-HIC Pakistan 2006). We outline the logistics set-up and several information management instruments used within it. Then, mechanisms for producing needs assessments are described, including an ingenious innovation known as "Quake Jumpers". In response to assessed needs, relief commodities were shipped and distributed; the basic mechanisms for doing so are summarized. Summary statistics of goods delivered under coordination by the UNJLC are given before we detail the statistical model relating shipments and destinations to needs and logistical variables of interest.

The statistically less inclined reader may skip the model description and directly proceed to the findings. We interpret these against other observations of the Pakistan earthquake response and conclude with brief sections on humanitarian information management as well as on theory and methodology.

The importance of logistics

Forced Migration Review devoted its September 2003 issue to humanitarian logistics. In the opening piece, written by the director of the Fritz Institute (Thomas 2003), two functional attributes are emphasized that recur in many permutations in the literature – anticipation and speed:

- *“Logistics serves as a bridge between disaster preparedness and response through the establishment of effective procurement procedures, supplier relationships, prepositioned stock and knowledge of local transport conditions.*
- *The speed of response for major humanitarian programmes involving health, food, shelter, water and sanitation interventions is dependent on the ability of logisticians to procure, transport and receive supplies at the site of a humanitarian relief effort” (ibid., 4).*

Several academic centers and NGOs – among others, the a.m. Fritz Institute, the Interdisciplinary Program in Humanitarian Relief at the University of Washington, Cranfield University’s Defence College of Management and Technology, the Vietnam Veterans of American Foundation’s Information Management and Mine Action Programs - have been focusing on enhancing the toolboxes and critical reflection of humanitarian logistics and related information management functions. While some bring tools from mainstream logistics science for incorporation into humanitarian action (Özdamar, Ekinci et al. 2004: ; Beamon and Kotleba 2006), others emphasize the special conditions under which the humanitarian community mounts a disaster response. Pettit and Beresford (2005: 314), for example, citing work on famine relief, list four reasons why *“relief logistics is abnormal:*

- *it usually takes place in less developed regions with inadequate infrastructure;*
- *the consumer is not the customer of the carrier;*
- *logistics modelling for such events must combine both military and civilian aspects; and*
- *distribution networks must be established quickly in politically difficult situations.*

The provision of humanitarian aid and the complex logistics systems that enable the aid to be delivered are often more complex than simply providing disaster relief. Tasks might include refugee protection and restoring civil order, as well as securing humanitarian aid” [our bullets].

Regardless of the particular emphases of the authors, there is a common assumption that logistics places severe constraints on the effectiveness (lives saved) and efficiency (lives saved per dollar spent) of humanitarian action. From here it is not far to hope that additional investments in logistics might produce the highest efficiency gains among relief spending alternatives. But it is also well known that the humanitarian organizational field to which logistics prescriptions may be applied is a very heterogeneous and fractured one, sometimes even without a recognizable decision center (Benini 1999). This should caution us against ambitious efficiency gains from logistical enhancements alone. Logistics may, however, help to release other constraints that are

not commonly considered of its own domain, as we shall learn from the aggressive use of logistics assets for the needs assessment function in our case here.

The Pakistan earthquake response

Responder networks and coordination

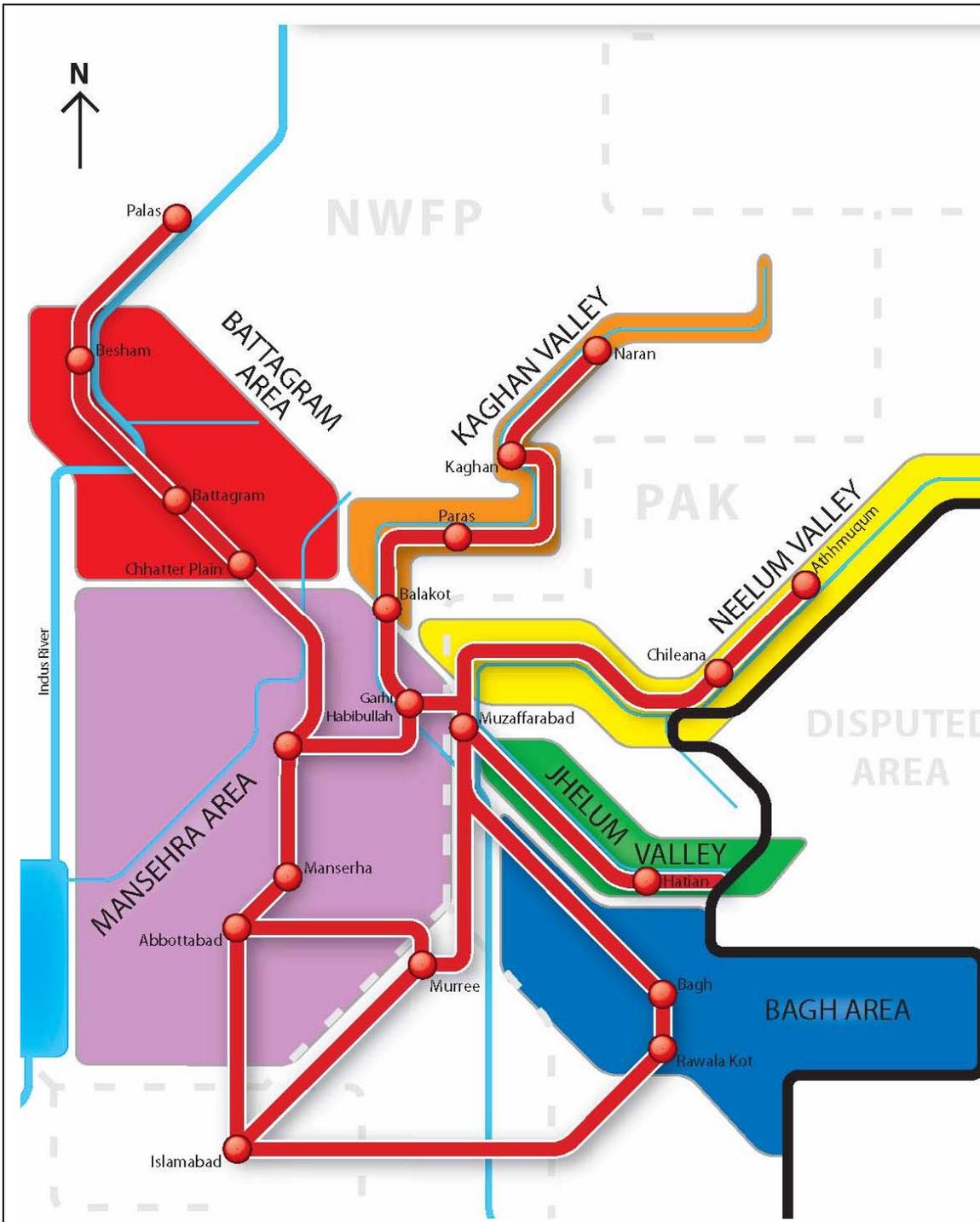
As in other disaster theaters attracting a massive international response, several families (dense sub-networks) of relief and reconstruction providers were operating (Stephenson 2005). The most important ones somewhat distinct from each other were the government and armed forces organizations of the host country, United Nations agencies, Red Cross/Red Crescent Movement components, as well as a host of national and international NGOs. Many among the NGO category formed a family in the sense of coordinating their relief goods movements through UNJLC. Foreign donor and military units added further to the taxonomy of actor types.

United Nations organizations responding to the disaster included: United Nations Children's Fund (UNICEF), United Nations High Commissioner for Refugees (UNHCR), World Food Program (WFP), United Nations Development Program (UNDP), International Organization for Migration (IOM), United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Disaster Assessment and Coordination team (UNDAC), and the World Bank. Pakistani efforts were being coordinated at the federal level by the Federal Relief Commission, while a multitude of non-governmental organizations involved in the relief effort, including *jihadi* groups operating in Kashmir (Bamforth 2006). Additionally, foreign governments were contributing aid and personnel, including foreign military units and governmental development agencies, such as the United States Navy, German Air Force, United States Agency for International Development (USAID), and the UK Department for International Development (DFID)-funded personnel.

The sum of the situation at the time was quite literally a jumble of resources, operating with minimal coordination. The need for coordination grew compelling, leading to the creation of a Humanitarian Information Center (HIC) in Pakistan (see Sida and Szpak 2004: for an analysis of some such centers). The need of unifying bodies such as the HIC and the Joint Logistics Centre increased their role.

Throughout the relief operation the functions of the HIC and UNJLC were intrinsically intertwined. In a brief sense, the UNJLC can be looked at as the logistics information arm of the HIC. The HIC was mandated as a repository of information from organizations involved in the relief effort, to analyze, improve, and create more encompassing data sources, and then to disseminate said data to the relief community, thereby expanding cohesion and coordination. UNJLC was one of the organizations contributing data to the HIC, and at times collaborating with the HIC in the acquisition, analysis and distribution of information. In truth, much of this collaboration resulted in confusion within the relief community, often blending the UNJLC into a unit within the HIC.

Figure 3: "Pakistan Metro Map" (segment)



In a responder community with rapid personnel turnover, briefing new arrivals effectively and graphically proved to be a necessity. This topological map, nicknamed "Pakistan Metro Map", was used widely in UNJLC Pakistan and beyond. It facilitates the reader's quick notion of the major hubs, road connections and mountain valleys. - Created by B. Dittmore.

Two months into the operation, steps were taken to relieve and improve any coordination issues surrounding the HIC's relationship with other organizations. The result was the creation of the Strategic Information Cell (SIC), a small number of HIC and non-HIC staff who regularly worked in the HIC office (UNOCHA 2006). While the implementation of the SIC was not fully embraced by all organizations invited, the efforts of collaboration that were set in motion in October were perpetuated for a longer duration.

It was the continued collaboration between organizations that was one of the difficulties of the operation. Seen from the UNJLC perspective, organizations seemed to go through phases of collaboration and isolation. A summary indication is provided by the response to the UN Emergency Relief Coordinator's request that all relief agencies share with the UNJLC data on stocks, pipelines and distributions; *"only approximately 55% of humanitarian actors provided the requested information or part thereof"* (UNJLC Pakistan 2006a: 6). Similarly, data on road conditions was volunteered in erratic fashion, obliging UNJLC to engage in road reconnaissance through its own logistics and GIS officers sent to the field (ibid.: 8).

Logistical setup

Using information available at the time, UNJLC was tasked with developing a logistics plan for the operation. During October and November this was done.

During November, in response to a recognized need for the humanitarian community to develop a proactive logistics strategy in preparation for the expected harsh winter, UNJLC developed a logistics plan promoting the Forward Area Support Site (FASS). This plan was a balance of the necessity to stockpile and distribute relief commodities within existing communities at risk of being cut off from transportation networks, and to make use of logistical air assets in a cost-effective manner.

At the time, the relief community was employing various hub-and-spoke methods of distribution. This was not uniform across organizations, and a hub consolidation had yet to occur. The method consisted of distribution in this sequence: Port-Of-Entry (POE) > Hub > Extended Delivery Point (EDP) > Final Delivery Point (FDP). There was no clear line of responsibility between EDPs and FDPs, thus some FDPs could be supplied by multiple EDPs. The method of transportation was heavily based on air assets, with deliveries to the FDP being made from the POE, Hub, and EDPs.

Table 1: Most commonly used hubs in the Pakistan relief community

Code	Town	Comment
ABB	Abbotabad	Main hub for helicopter ops, fuel farm; loosely linked to Mansehra
BAG	Bagh	Hub; personnel base
BAT	Battagram	Logistics hub; personnel base; linked to Chatterplain
CAT	Chatterplain	More operational, more storage than Battagram
MAN	Mansehra	Relief community more based here, loosely partnered with Abbotabad
MUZ	Muzaffarabad	Large hub; personnel base
ISB	Islamabad	Main port-of-entry; non-field operations center; linked to Rawalpindi's Islamabad International Airport and Chaqlawa Airforce Base

The FASS concept differed by creating streamlined method of distribution, responsibility, and increased efficiency of air assets. The distribution was to be a strict POE > Hub > EDP > FASS > FDP. Each tier of the hierarchy was to stockpile enough supplies to accommodate their representative communities for 22 days. Maintenance of supplies to the Hub, EDPs, and FASSs were to strongly rely on delivery by ground, and helicopter usage primarily allocated to distribution from a FASS to its corresponding FDPs, or in the case of inaccessibility by road.

The FASS concept propagated by the UNJLC plan did not mature into an accepted logistics practice. Instead, an effective system of POE > Hub > EDP > FDP was utilized, within the UN organs and many of its implementing partners. Others, however, did continue to utilize their own hubs and systems (such as the British NGO Merlin, which used Ghari Habibulah as opposed to Muzaffarabad).

Within the logistics setup, UNJLC continued to operate in the role of an advisor. In Islamabad and the field, UNJLC staff worked with other organizations to facilitate the movement of their relief cargo to destinations in the affected area. It was only in the UNJLC Cargo Movement Coordination Cell (CMCC) that some influence over logistics was possible. The CMCC was tasked with assuring access to transportation assets by the greater relief community, prioritizing shipments, and maintaining the ability of a flow of non-food item cargo to the affected area.

“At the height of its operation in mid-December, UNJLC had 23 international staff and 22 national staff employed in Pakistan” (UNJLC Pakistan 2006a: 2). At no time did it control transportation assets. However, through the CMCC, in exchange for the ability to monitor cargo movements, relief organizations gained access to air transport using helicopters tasked by the United Nations Humanitarian Air Service (UNHAS), and free trucking via IOM and *Atlas Logistique*, a French logistics NGO. UNJLC also provided expertise in the expedition of cargo via customs, packing instructions, maps, access to intra-agency warehousing, and road condition reports.

Information management

UNJLC, similar to the HIC, had a direct mandate to collaborate with other entities, and in fact could not exist without doing so. It proved itself well adept at coordinating with organizations from the UN, Pakistani government, national NGOs, international organizations, and foreign governments. In working with these various bodies, UNJLC developed three primary information systems which were used to collect and distribute data to the greater relief community.

At the end of October and early November, the UNJLC Cargo Movement Database was created. Its main purpose was to facilitate the cargo movement requests submitted by agencies to the CMCC and the tracking of commodities. The Cell and the relief community collaborated intensely in order to streamline and prioritize cargo movements. Due to the fact that the information system was used only for cargo movements overseen by UNJLC, it does not contain data pertaining to cargo moved by an agency using vehicles outside of UNHAS helicopters or IOM and Atlas trucks (e.g., Pakistan Army helicopters or WFP trucks).

In December UNJLC began utilizing the Logistics Support System (LSS), an inventory control database developed by several UN agencies, notably the Pan American Health Organization (UNJLC 2006). UNJLC actively sought records from the relief community of non-food items in the logistics pipeline, in warehouses, and that had been distributed. This system was operating through March 2006, and information pre-December 2005 was backfilled from data archives. One fault to this information system was its inability to attribute locations to NFI at anytime during the logistics process (LSS was designed to be used for the inventory of a single warehouse).

The third information system developed by UNJLC was a geographic information system (GIS), beginning in early October. This was integral to the tracking and representation of road infrastructure and conditions, helicopter landing zones, and locations of settlements. It was also capable of utilizing information exported from the two previous information systems with a varying degree of reformatting.

The first and last of these three information systems existed within the logistics operations of the relief effort, the second existed alongside of it. The cargo movement database was integral to the realistic delivery of relief items and the analysis of the cargo movements. The LSS was a collection of monthly relief indicators collected at the end of the month. The GIS and its products were used in situational assessments, planning, locating delivery destinations, archiving data, and analyzing data from a multitude of sources.

Assessments

Assessments of the field situation were performed for a variety of purposes and using different, sometimes novel and creative methods. This study is concerned only with field logistics and needs assessments (and not, for example, with security assessments); for, in theory at least, they should be primary sources for the data used in our statistical models.

In practice, these two activities were often combined although subsequently the results may have been collated through information streams that at some point were separated organizationally. Relief providers conducted their own assessments for internal and external use, and at times the United Nations Office for Project Services (UNOPS) was contracted by single and multiple organizations to assess situations throughout the area.

Gaps remained. On the logistics side, we already noted that the information flow from field agencies back to UNJLC was so erratic that the latter had to commit some of its own resources to road reconnaissance.

Logistics assessments

Logistics assessments were a mixture of dedicated activities (e.g., road trips to check out landslides) and desktop analyses of agency reports and meeting notes. They were shared and discussed during the Logistics Cluster meetings. In these meetings organizations were able to coordinate their efforts with one another, and thereby adjust their strategies if needed, but the meetings were not well attended by the logistics community as a whole.

Similar working meetings were conducted in the logistics hubs. Attendance was variable. For example, in February and March, attendance at the Muzaffarabad logistics cluster meetings were limited to roughly six organizations, which was a fraction of those operating out of Muzaffarabad.

Several factors discouraged field information exchange and meeting attendance. They ranged from the usual lament – staff turnover; the UNJLC was not able to staff each of the major hubs with a logistics officer continuously – to the hushed “*non-dit*”. The adoption of a logistics database that did not suit responder information needs (see page 21) violated the reciprocity norm; NGOs felt they were asked to contribute but would not get much of value in exchange (Varga 2006). On a purely speculative note, one may surmise that large helicopter capacity as well as direct contracting with road transporters lessened the need for them to engage in continuous close logistics coordination.

Needs assessments

Concerning needs assessments, the host of initiatives and formats fielded in this relief action defies exhaustive description. We mention a few as well as some issues that others noted before we call out a particularly creative one.

Rapid Village Assessments (RVA) were conducted in cooperation with the HIC during October and November. However, due to factors of political, design, technical, and temporal nature, these assessments were unsuccessful and were not disseminated by the HIC. Primarily, these completed RVA were not geographically or organizationally representative (Palmero 2005). Another flaw of the RVA, as criticized by British NATO intelligence officers during mid-January, was that the UN was unable to give their RVA format to NATO (after NATO’s request), which would have allowed for a far greater number of assessments to be integrated into the RVA.

During October, the US Military worked with the USAID-DART to catalog assessments gathered during relief flights. This information was made available to UNJLC in incomplete parts during late October. These assessments included damage to infrastructure, community needs, and locations of spontaneous camps.

One of the more complete assessment attempts was made by the Research and Information System for Earthquakes – Pakistan (RISEPAK), an initiative started by economists at Lahore and Harvard universities as well as the World Bank (RISEPAK 2005: ; Banerjee 2006) It was never fully embraced by the UN community. Their assessments which included variables expanded over time, included pre-earthquake demographics, relief deliveries information (typically non-UN), and damage caused by the earthquakes.

In place of the RVA, the HIC began developing the Integrated Monitoring Matrix. Its first version was distributed on December 19, 2005, after developing variables of significance to the cluster. This product was perpetuated until April 4, 2006. However, to the end, the HIC remained incapable of compiling the assessments, and we were unable to obtain documentation as to what exactly the significant variables were (as already noted in a UN evaluation in February; see IASC 2006: 10).

While needs assessments were being conducted, the chief of party for the UNJLC recalls that he was *“not sure there was a great deal of connection between the dozens of assessment missions and the allocation of actual resources. Most of the assessments were done as part of the flash appeal process, in order to scope the problem for the donors”* (Connolly 2006b). Their value for operational decisions must have been very uneven and sketchy. We were not able to obtain damage or needs assessments for the 87 Union Council areas to which the UNJLC coordinated relief and reconstruction material deliveries. The low degree of information integration – as evident in the needs assessment dynamics, but also in the co-existence within the UNJLC of two logistical databases - depressed the quality of the common operational picture.

Table 2: Sample assessment document, segment

Settlement	Latitude	Longitude	Description	Altitude
Mira Kalsi	342244.43N	0734254.23E	District: Muzaffarabad / Village: Nauseri / Pop: 2000 / No road access. Accessible from Muzaffarabad either by helicopter or walk only. The villagers have designated and marked areas for helicopter landing in Mira Kalsi and Bandi Pukrat. There is an Army helipad in Nauseri	
Panjkot Village	342121.41N	0734309.44E	District: Muzaffarabad (Neelam Valley) / Village: Panjkot / No road access. Pop: 17229. Accessible from either Muzaffarabad either by helicopter or walk only. The villagers have designated and marked area for helicopter landing	1304

Assessment information as 25 October 2005 (Enney 2005)

The obstacles to effective needs assessments typify to a small number of well-known categories. Some are political-institutional, such as when UN agencies are reluctant to share data with foreign armed forces units, given the ongoing regional conflict dimension in the disaster theater. Others are of the cognitive-organizational order. For lack of accepted protocols, and in the face of unusual challenges of the “Winter Race”, assessment formats proliferated; Currión (2006: 18) collected seven different assessment forms and stopped counting their local variants on top. A third area concerns human resources. The same author found that in most responder agencies information management skills were poor, and few had brought any monitoring and evaluation specialists.

The “Quake Jumpers”

Starting in November, UNJLC provided coordination and logistic support to “Operation Winter Race”. Initially a joint operation of IOM and IFRC, it involved inserting small teams by helicopter into remote areas. Teams assessed the non-food needs of beneficiaries and called in the necessary supplies by air. In December, UNJLC midwived the joining of those teams with local mountain guides that the WFP had hired for food assessments and distribution jobs in arduous terrain (UNJLC Pakistan 2006a: 9-10).

Referred to as “Quake Jumpers”, these composite teams were flown to isolated, mountainous communities, ideally of populations near 2,000, and which had severely impacted road access. The teams would secure landing sites for future helicopter cargo movements, assess the immediate needs of the community, and provide emergency assistance ranging from plastic sheeting for shelter, biscuits and first aid. While their activities were primarily focused on landing site assessments during November and December, the Quake Jumpers progressed into more of a needs assessment role and were active into March 2006.

In February, UNOPS began contracting out similar services to the UN community, using Hunza mountain guides to assess isolated areas on a number of variables. These two-person teams accessed high-elevation, rural communities by walking, driving, or coordinating with preexisting helicopter movements. From there, they would conduct assessments of the surrounding communities, and then proceed to move down to the valley floor by foot. Along the way, they would continue to assess community needs, as well as logistical needs such as roads and landing sites. These assessments would continue until the team reached the UN base camps, often more than 40 kilometers away, reporting in to their UNOPS field posts each night via cellular or satellite phone. Assessment missions typically lasted 5-7 days, but some involved walking for up to 16 days. The courage and endurance of these “Remote, Reconnaissance and Response teams (RRR)” drew accolades from as high as the presidency of Pakistan (Musharraf 2006).

For similar purposes, NGOs such as Caritas Switzerland hired the services of tourism firms, whose teams of high-altitude guides and porters carried winterized tents to mountain villages, counted survivors and returned to them with more goods (Khan 2006b). In similar terrain, the Pakistani army carried relief in numerous mule trains, but

we do not know to what extent it shared needs assessment information with the humanitarian community.

Figure 4: From jeep to mountain porter - Assessment and delivery combined



A party of mountain guides and porters, hired by an NGO from a tourism firm, at their road head drop-off point, as they set out to carry a small number of tents to villages uphill. They will survey these villages for survivors and return with estimates of tents needed in the area. The photo, courtesy Najeeb Ahmed Khan, Himalayan Holidays Pakistan, was taken before major snowfalls. Later, the UN would take teams to mountain ridges by helicopter and have them radio in daily reports; these teams became the famous “Quake Jumpers”.

The “Quake Jumpers” represent a creative innovation *during* disaster response, improvised in a mixture of inter-organizational midwifery (UNJLC suggested food and non-food needs assessment missions be combined), use for such assessments of assets primarily devoted to relief delivery (helicopters), as well as a good combination of national experts (high-altitude mountain guides) and expatriates (some of Canadian guides had worked in Afghanistan). This successful experiment reinforces observations reported from other large disaster responses that such unpredictable factors as local improvisation and creativity are key to the success of coordination and collaboration (Harrald 2006). The Quake Jumpers also provide an example of how strong logistics empowers the assessment function, rather than just passively waiting for assessment results to come in.

Deliveries coordinated by the UNJLC

Between October 28, 2005, when it created the first movement request in its cargo movement database, and May 18, 2006, date of the last record entry in the version we received, the UNJLC coordinated the movement of over 33,000 tons of relief and reconstruction commodities. Three quarters of it went by air. This proportion is indicative

not only of the large air transport assets that it could call upon; it also reflects the non-inclusion in the database of most of the goods carried by the Pakistani armed forces as well as under dedicated WFP trucking contracts (Connolly 2006a). These – statistically speaking – unobserved deliveries were correlated with factors of interest. Notably, the Pakistani armed forces made most of their food deliveries to larger towns and valley-floor communities, leaving goods for mountain communities to be delivered by others, preferably by the UNHAS controlled helicopters. This, we already want to point out, will bias parts of our model estimates.

Table 3: UNJLC-coordinated deliveries (in MT), by commodity group and transport mode

Commodity group	Road	Air	Total	Percent
Food, kitchen supplies and water	843	18,377	19,220	58%
Shelter and clothing	1,835	1,744	3,579	11%
Construction material and tools	4,550	3,772	8,322	25%
Health care supplies	263	122	385	1%
Education supplies	161	24	185	1%
Assorted relief goods	457	554	1,011	3%
Mission support	147	132	278	1%
Unknown	173	195	368	1%
Total	8,429	24,920	33,350³	100%

The UNJLC received 1,525 cargo movement requests, which it spread out over 2,768 actual movements. The composition by commodity type was recorded only for the requests, not for the actual shipments. The a.m. table therefore is an estimate, as far as composition goes, assuming that the goods actually moved were in the same proportions as stated in the requests (more on this below).

The goods were moved from 32 origins to 219 destinations, most of which were helicopter landing sites. The 219 destinations were located within the territories of 87 Union Councils – local government units – in nine districts in two provinces. In most cases, they were distributed to beneficiaries from within the enclosing Union Council population, with an unknown, assumedly very small fraction delivered for onward shipment. It is on these 87 receiving Union Councils, their populations, damage and geographic attributes that we chiefly base our needs vs. logistical factor model.

A model of influence factors

Decisions to move relief commodities

We consider the question on the basis of what information the UNJLC decided to deliver commodities to a given Union Council on a given date or not. Simultaneously, if the

³ Our figures, calculated from the database, slightly differ from those presented in the UNJLC end-of-mission report: “In seven months of operation, the CMCC coordinated the movement of 33,466 MT of humanitarian cargo. As detailed below, 75% of cargo coordinated by the CMCC was moved by UNHAS; 25% was moved by surface transport” (UNJLC Pakistan 2006a: 3). These include a small number of movements occurring in the weeks after the date on which our version of the database was closed.

decision to deliver to Council X on date Y was positive, commodity type, amount, and transport mode had to be decided. Estimation concerns oblige us to simplify this dual question somewhat. We estimate separate models for each of the three commodity groups passed through the system:

- Food, kitchen supplies and water
- Shelter and clothing
- Construction material and tools

regardless of the fact that they competed for transport resources. Moreover, instead of modeling the choice of mode jointly with the other outcomes of interest, we use two mode-related variables – total helicopter capacity on the date, and road access for the Union Council and date in point – on the explanatory side. We do so on the grounds that, although we do not observe WFP dedicated truck and Pakistani armed forces deliveries, open roads and more helicopters tasked by UNHAS will increase the probability as well as the expected amount of some commodity shipped to Council X area on date Y.

The following sections detail the statistical model used and the adjustments made to special circumstances. Readers interested in the findings only are advised to skip to page 33.

Joint effects on the decision to ship and on quantity shipped

We estimate effects on the decision to deliver as well as on the amount delivered if the decision was positive by means of Heckman-type regression models. As far as we know, such models have been used in disaster relief studies only once. Morris and Wodon (2003), using household-level data from Honduras, investigated who received relief after Hurricane Mitch, and how much. We prefer Heckman models to the equally often discussed Tobit models for the reasons elaborated by Sigelman and Zeng (1999): We are faced with a true decision situation in which the effects on the selection and on the amounts may differ widely for the same factor.

This is patent for the effects of helicopter fuel economy. Deliveries of given quantities to higher elevations or to farther destinations force lower payloads and therefore require more flights. The Heckman selection models afford this analytic flexibility. Moreover, the Tobit model assumes that the underlying dependent in principle may take negative values (although they are not observed); this does not make sense in our context. The disaster response does not extract contributions from local communities that are less needy or more difficult to reach. There is no “negative relief”.

The Heckman selection model is a two-equation model in which the outcome of interest y_j is assumed to be in a regression relationship

$$y_j = \mathbf{x}_j \boldsymbol{\beta} + u_{1j} \quad (1) \text{ (the regression equation).}$$

The outcome is observed, however, only if some condition

$$w_j^* = z_j\gamma + u_{2j} > 0 \quad (2) \text{ (the selection equation)}$$

is met. w_j^* itself is unobserved. w_j^* , in our context, may be understood as the “propensity to send relief to Union Council area j ”. It depends on observed factors z_{ij} , such as the observed needs of the area.

The error terms are drawn from $u_1 \sim N(0, \sigma)$, $u_2 \sim N(0, 1)$, and are correlated $\text{corr}(u_1, u_2) = \rho$. Model estimators are described variously (Sigelman and Zeng 1999: 177; Stata Corporation 2003).

A note of caution is in order. The Heckman model is more sensitive to the correctness of the model than ordinary regression and to the availability of variables that affect the chances of selection (“relief delivery took place”), but not the outcome (“weight of relief commodities delivered”). We address this concern in several ways:

Regarding the correctness of the model,

- Assuming that there are unobserved properties of the receiving Union Councils that influence selection and amounts, we specify in the estimation that observations are not necessarily independent *within* Council areas⁴. In STATA, this cluster option implies that the Huber-White estimator of the variance is used in place of conventional minimum likelihood. This is known also as robust estimation.
- We assume in the alternative hypothesis that survivor needs have a significant and positive effect on decisions to ship and on amounts of relief shipped, and in the null that these effects are zero. However, in the absence of detailed needs assessments data, we use three proxy indicators. Their validity is discussed in a sidebar.
- As mentioned, it was known that larger settlements, particularly valley-floor cities, received food relief chiefly from providers other than those coordinating through UNJLC. We conduct an influence analysis excluding the two outlier Union Councils with populations larger than 100,000 (the cities of Abbotabad and Muzaffarabad). Except for the population effect on delivery *size*, most of the highly significant effects proved robust.

As for the identifying variables to go into the selection part, we take advantage of the fact that uninterrupted runs of deliveries would often stretch over up to ten days. We attribute these long runs to the presence of requestor-agency teams on the ground, who had to be supported to finish their work in the given Union Council before they could move on to jobs in other areas. This mobility limit results from the nature of the warehousing and distribution work, not from needs or commodity transport capacity. Thus we use the

⁴ Our data violates the second assumption of this model, that observations are independent *between* clusters. Clearly, on any given day, requests from different Union Councils may have competed for the same transport resources. We mitigate this deficiency by including two variables for transport capacity.

observation that a movement request to the given Council, for *any* of the three major commodity types, had been open on the *previous* day or not, as the identifying covariate for the *selection*, but not the quantity, parts of the Heckman models.

Table 4: Correlations between identifying variable and selection, resp. outcomes

Commodity type	Had open movement request previous day x	
	Cargo movement (phi) (n= 17,313)	Quantity if movement (Pearson)
Food and water	0.36	0.15 (n=846)
Shelter and clothing	0.16	-0.09 (n=450)
Construction mat. & tools	0.19	0.07 (n=431)

The observation units are Union Council-days – in more generic terms: combinations of areas and dates. The cargo movement database is spotty for the initial weeks. We exclude movements made prior to December 1st, 2005. The remaining observation period spans 199 days (until 18 May 2006). Out of 87 destination Council areas x 199 days = 17,313 Union Council-days, relatively few saw deliveries: 844 for food, water and cooking utensils; 444 for clothing and shelter; 430 for construction material.

Separately for major commodity groups

The amounts delivered were measured by weight, as the common observation metric. Specific weights are vastly different between commodity groups (e.g., food vs. construction rebar), but within each group may be relatively homogenous. The weight metric is justified also by the fuel vs. payload dilemma in helicopter deliveries. Since our models are separated by major commodity group, we believe that the implications of the weight metric for model validity are minor⁵. But it would be dishonest to deny entirely that a problem exists, in our models as well as in the real world. The uneasy coexistence, within the cargo movement database, of consistently recorded shipment weights with haphazard notes of item counts, itself testifies to an ongoing commensuration problem (Espeland and Stevens 1998) in logistics information management. This is true also of the reporting by the larger responder community. The Red Cross / Red Crescent family, for example, while keeping track of cargo tonnage, emphasized relief packages distributed to families as its favored unit in its public reporting (Heigh 2006).

We now turn to the explanatory variables.

Needs and logistics factors

Detailed, comparable and complete assessment information is absent. In its lieu, we estimate the intensity of survivor needs as the combined effect of population size, a geo-physical damage proxy, and pre-existing poverty. Poverty is proxied for by

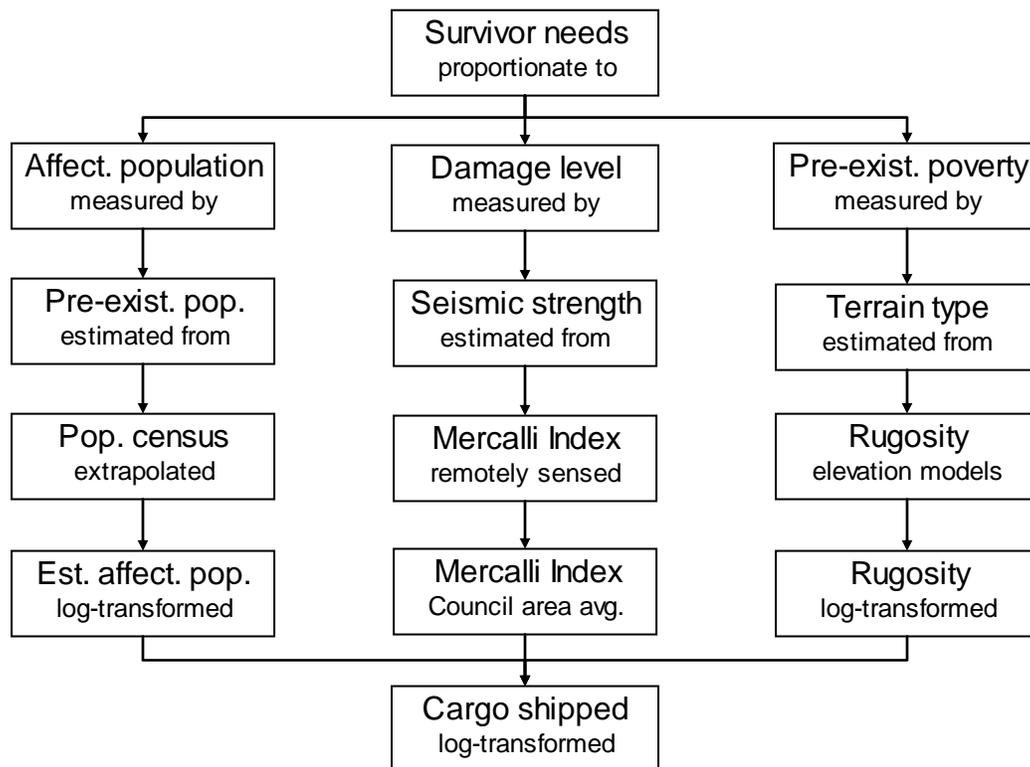
⁵ In other words, we assume a high correlation between weight (observed) and the utility for the survivors of the items (the composition of which remains unobserved) shipped *within* each commodity group.

“mountainness”, aka rugosity, on the assumption that mountain village and dispersed-homestead communities were poorer than valley-floor communities (AJK Provincial Government 2003) “Rugosity” is a bloodless technical concept; a hill farmer from Muzaffarabad District formulated it in a succinct, yet poetic way: “*This is ‘sky-land’ (asmani-mulk). Nothing is produced from this land*” (ibd.: 73). We use the Modified Mercalli Index, in its area-weighted mean for each Union Council, as the damage proxy.

Sidebar: The measurement of needs by proxy indicators

With complete and consistent needs assessments unavailable, this study depends on proxy indicators for the measurement of survivor needs. These needs, we postulate, were proportionate to size of the affected population and to their vulnerability. Vulnerability in turn was proportionate to local damage levels and to pre-existing poverty. For each of these concepts, we use one proxy indicator (regrettably, more were not available at the time of the study). The relationships between concepts and corresponding proxies are problematic and require comment. First, however, the conceptual translation from needs to relief commodity deliveries is attempted in this diagram:

Figure 5: Operationalizing needs measurements



The logarithmic transforms are justified on two grounds. First, the quantities shipped to Council area i on day j have an extremely skewed distribution; the normality requirement of the dependent in the Heckman regression model forces their log-transforms to go into the estimation. Second, because large population, extensive physical damage and high poverty levels must work together

to produce extreme needs, log-transforms of metrical co-variables capture their combined operation in creating the survivor needs.

Reservations regarding the validity of this model include:

- Population: The estimates of affected Union Council populations do not consider population displacements, particularly encamped groups who lost their homes. However, the number of people displaced by the earthquake was around 200,000, out of a total affected population of 3.5 million, thus a small minority even at its peak.
- Damage levels, ideally, would be expressed as an index of housing stock destruction because chances for people and domestic animals to survive the winter depended on the condition of their habitat. We did not have specific enough data to calibrate our proxy, the Modified Mercalli Index, to such a variable. An adequate functional form for the MMI thus is not known. However, a monotonic relationship is plausible.
- Pre-existing poverty: We will show that relief delivery decisions were in fact influenced by terrain type. Yet, only a segment of the humanitarian community explicitly connected the hill and mountain communities with poverty. The UNJLC logistics plan of 10 November 2005, also known as the *“Last Mile Concept”* (UNJLC Pakistan 2005), assumed that most affected people would not come down from their mountain homes. It was concerned with terrain as the factor that would make these “remote and isolated” communities inaccessible after snowfall. It did not mention poverty. Others, however, did. Oxfam (2006) demanded that the relief action *“must do more than return people to the dire poverty many suffered before the disaster- what is needed is ‘reconstruction-plus’ ”*.

While believe that these limitations on the validity of our proxy measurements are minor, it goes without saying that a direct measurement of needs would be much preferable. To our knowledge, a developed theory of proxy indicators in humanitarian needs assessment does not exist although Darcy and Hoffmann (2003: 64) seem to imply it: *“Where reasons of access or security do not allow consistent assessment [..], an agreed range of proxy indicators should be assessed.”* Economists have theorized the use of proxies in social control agencies, notably the conditioning of searches on the personal characteristics of search candidates, also known as “police profiling” (Manski Forthcoming). To the extent that humanitarian agencies exercise social control functions, one could start building from there.

We turn to the discussion of the logistics-related variables.

Rugosity, one of our needs indicators, of course, has logistical consequences too. Helicopters flying winding trajectories around hills and mountains use more fuel and carry smaller payloads. Landslides occur in hilly terrain, cutting roads and forcing use of scarce helicopter assets. To distinguish the logistics effect from the needs effect, we include the Union’s base elevation, the elevation of its lowest point. The rationale is that elevation goes hand in hand with higher fuel consumption, but not necessarily with higher poverty, given rugosity. Alluvial plains also in somewhat higher altitudes should have higher unit productivity than steep, eroded mountain slopes.

Other logistics variables may have greater face-value validity although their measurement or calculation for model purposes is not straightforward. Definitions are given in the appendix. Distance from the concerned operational hub is an intuitive effort variable. Total helicopter capacity on the given day is expected to improve the chances of a

delivery and, using multiple sorties, the quantities. Open roads are a precondition to deliveries by truck; since road reports were not produced every day, conditions had to be backfilled for unobserved periods. This results in some truck deliveries observed during days when roads to the Union Council area are considered shut.

The dichotomous variable indicating whether there had been an open movement request to any destination in the Union Council and for any type of commodity on the previous day, or not, was mentioned earlier. Its function is to provide an identifying variable for the selection part of the Heckman model. Its substantive interpretation is less important for our purposes; the strong positive effects express a preference to close open requests soonest in order for teams on the ground to move to other places where they were needed. This is the only lagged variable used in the model.

Again, in order to express the joint action of these conditions, covariates - distance from hubs and helicopter capacity - were put to their logarithms. For base elevation, this would not make sense, for lack of a uniform baseline in the hub and road context.

The following table lists the explanatory variables used in the Heckman models. To repeat, all of them are entered into both the selection and quantity parts of the model, with the exception of “*Had open movement request previous day*”, which is used in the selection part only. Measurement definitions and descriptive statistics are given in the appendix.

Table 5: Needs- and logistics-related explanatory variables

Variable	Measured as	In selection and / or amount equations	Transformed to logarithm
Needs-related:			
Population	Count; extrapolated to 2005	Both	Yes
Modified Mercalli Index	Index number, area-weighted	Both	No
Rugosity	3D-surface/base plane area (dimensionless)	Both	Yes
Logistics-related:			
Had open movement request previous day	Yes or no	Selection only	No
Base elevation	Meters above sea level	Both	No
Distance from supply hub	Kilometers to Union Council centroid	Both	Yes
Helicopter capacity	Metric tons per day, smoothed	Both	Yes
Road to Union Council area open	Yes or no	Both	No

Findings

Our models, as has been stated, simultaneously consider the effects of needs-related and logistical variables on the decisions to ship as well as on the amounts shipped when such a decision is taken. We expect that the effects on these two parts – move/don't move to Union Council X on this date vs. moving how much – may differ, depending on commodity type and on preferred transport mode and possibly on other considerations. For example, construction material and tool deliveries, given their higher specific weight, were preferably done by truck; it is no surprise that they responded more strongly to road access than food and shelter commodity shipments did. Open roads would trigger deliveries to more Council areas, but they would not significantly increase the size of individual shipments compared to days and places that could be reached by air only.

Our focus is on the comparison of needs vs. logistics drivers. Specifically, we test the “*Devil's Advocate*” hypothesis – see above, page 15 – that deliveries were not driven by survivor needs. Statistically, this implies that we cannot reject that the effects of population size, damage levels, and rugosity are positive and different from zero.

We find that needs-related effects persist side by side with the effects of logistics. Among the needs indicators, terrain as a proxy for poverty is important in the context of decision-making under great uncertainty. Among logistical factors, helicopter capacity had a particularly significant effect on delivery decisions. We devote a brief section to each of these aspects before summarizing the effects in terms of uncertainty reduction.

First, however, the reader will simply want to know how relief deliveries evolved over time. The sequencing of different relief goods is meaningful for the needs orientation of the total response; different relief goods fill needs of different urgency.

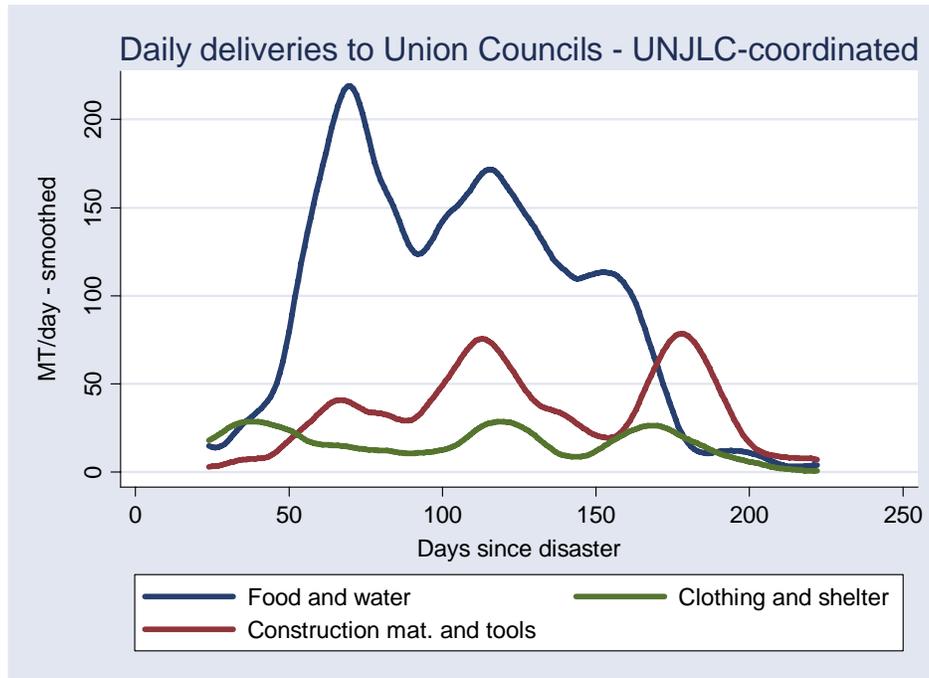
Sequence of delivery peaks

Needs and logistics drivers were very different across commodity types. This is not surprising; distinct response patterns developed according to the urgency of the needs, with clothing and shelter materials as well as food being more urgent needs than construction materials and tools. However, stark differences exist also between the food and shelter delivery patterns. As part of “Operation Winter Race”, clothing and shelter material deliveries had their first peak in mid-November while the build-up to the first food delivery peak was still ongoing. The deliveries of shelter material and clothing dropped through the second half of November and December, in response to lags in procuring winterized tents and to efforts on the part of WFP to accelerate food deliveries, particularly high-energy biscuits. The latter caused serious tension between WFP and NGOs, which resented WFP's influence on helicopter bookings (Varga 2006). This interpretation is disputed; others have stressed that WFP helped make good use of helicopters during times when NGOs, because of procurement delays, had little to transport (O'Donoghue 2006).

In early January, deliveries were ramped up again in all three commodity groups. In February, food deliveries started to drop precipitously. Clothing/shelter materials and construction materials saw another delivery peak in late winter. At this time, many camp

residents were heading back to their destroyed villages. By early May, all the three streams had been reduced to a trickle. UNJLC started winding down services in mid-April and closed the Cargo Movement Coordination Cell on May 31, 2006.

Figure 6: Deliveries over time of daily volumes shipped, by commodity groups
UNJLC-coordinated movements only



The overall pattern conforms to the assumption of a strong needs orientation although the actual deliveries were marked by, not one, but several peaks in each commodity group, due chiefly to logistics and weather factors. Also, they were the result of continuous negotiations over priorities, in which the UNJLC played the role of “honest broker”, and of the slow and incomplete needs assessment process.

Terrain as proxy indicator for needs

Apart from reflecting urgency assumptions – survivors must be helped to resist the harsh winter climate before they can make good use of construction materials to rebuild their homes -, the delivery patterns were produced also by considerations that operated for the entire duration of the relief action. For example, clothing and shelter material deliveries were clearly informed by needs gauged on population size. Councils with larger populations tended to receive more and larger deliveries. By contrast, food deliveries favored smaller Council populations. This tallies with the observation that larger communities received food relief chiefly from the Pakistani authorities and through dedicated WFP trucking contracts and thus were less in need of deliveries from the UNJLC system. All that goes to confirm a broad needs orientation, but is less unusual and fascinating than the next finding:

The needs indicator that very strongly influenced food delivery decisions was terrain type. Populations living in dispersed settlements on rugged mountains and hills attracted more numerous food deliveries. While this factor has an obvious logistical importance, “rugosity” in this context is shorthand for extreme poverty. By biasing airlifts towards these dispersed hill populations, the decision makers acknowledged their greater vulnerability. The UNJLC strategy was to “frontload” these communities, by moving “*the entire winter’s food basket into the higher elevations*” (Connolly 2006a) as early as possible.

The rugosity effect is strongest for food deliveries, but is significant for the other two commodity groups as well. There is a dampening effect on the *amount* of construction material delivered; this may reflect payload reduction when transporting heavy construction material in hilly terrain.

The more interesting question, however, is why terrain type, as one of the needs proxies, should inform delivery decisions more strongly than the size of population or the degree of earthquake damage did. While our data cannot answer the question directly, part of the answer comes from the logic of assessments. These were spotty as far as knowledge went of how many people had survived and where they had moved. Also the housing stock damage data was incomplete. It was not until December 19, more than two months after the earthquake, that the HIC came out with its first integrated needs matrix.

When we emphasize the importance of terrain as a proxy needs indicator, we need to address a legitimate objection: Cargo movement decisions were influenced also by information on displaced persons, particularly encamped populations. Because of these movements, actual Union Council populations differed from the pre-war population figures that the WFP extrapolated from the 1998 census, and which are the ones available to this study. This discrepancy may have attenuated our estimates of the population size effects.

Nevertheless, the rugosity effects are so prominent across commodity types that one must assume a substitution effect in the assessments. Terrain was easily observable. In fact, it was known from imported terrain maps. In addition, the precarious livelihoods of the hill populations and their greater vulnerability post-disaster were known. The preference for rugged Union Council areas can therefore, in part, be understood as a response to the greater uncertainty of knowing population size and damage levels.

Helicopter capacity and teams on the ground

On the logistics side, the two factors with the strongest influence are precedent and helicopter capacity. A Union Council was more likely to receive a shipment on a given date if it was the object of at least one open movement request on the previous day. This may seem trivial since the execution of requests was often delayed, sometimes by cancellations during several consecutive days. However, the probability of a shipment was higher if a request remained open, regardless of whether the request was for the type of commodity in point or for other commodities. Movement requests tended to be honored no matter for which commodity it was initially filed. Requesting NGOs had

teams on the ground; and until the request was entertained or definitively declined, they could not be moved to other Union Councils. This agrees with the numerous observed long runs of deliveries over subsequent days in a given Council area.

While the influence of open requests is more formal-administrative, total helicopter capacity in the system is an eminently informative one. It acted most strongly on food deliveries, but was still surprisingly strong also in determining construction material deliveries. These were the only ones responding strongly to road openings, given the preference to carry them by truck.

On some of the other logistics factors, effects differ across commodity types. As if to reinforce the preference for mountainous Union Councils, food deliveries are biased not only to more rugged areas, but also to those with a higher base elevation. Deliveries are biased towards Councils closer to operational hubs, but the bias to close-by Unions is statistically significant for clothing and shelter material deliveries only. The negative effects are expected. Once needs are controlled for (by the accident of geography, the Union Councils farthest from their supply hubs have the highest rugosity values), the deterrent effect of distance appears natural.

Survivors' needs and agencies' uncertainty

In sum, the dynamics of the relief deliveries was most closely determined by the hierarchy of needs met with different relief goods and by a small number of factors common to all commodity types. These factors included a time-invariant one on the needs side and two highly variable ones on the logistics side. On the needs side, the terrain type (which did not change over time, except for the landslides) provided stronger guidance than population and damage levels. These latter two were subject to greater variability over time, apace with IDP movements and with assessment dynamics, and therefore may have appeared less reliable in the eyes of decision makers. On the logistics side, the changing helicopter capacity and request status outdid the time-invariant base elevation and distance factors.

One may suspect, but cannot conclusively demonstrate with our data, that measurement properties ultimately accounted for the influence pattern. Logistical factors such as distances, stocks, and fleet capacity were known with greater certainty than needs; they were more easily updatable than needs assessments, which required more effort to gather and interpret. If this is correct, then the decision criteria essentially were patterned on organizational strategies to reduce uncertainty. This would be in line with established tenets of organizational sociology (Heimer 1985) and transaction economics (Barzel 1982) as well as with observations of humanitarian action in other contexts (Benini 1997: ; Roberts and Hofmann 2004: for proxy measures). These studies concur that formal organizations orient their task environment perceptions towards stimuli that produce a favorable balance between certainty and transaction costs.

Table 6: Results of three relief delivery models, by major commodity groups

	Food, cooking utensils		water, Excl. UC		Clothing and shelter		Construction material and tools	
	All Union Council areas	> 100,000 pop.	All Union Council areas	> 100,000 pop.	All Union Council areas	> 100,000 pop.	All Union Council areas	> 100,000 pop.
DELIVERY SIZE								
Needs-related:								
Population - 2005 est. - ln(x)	-0.465***	-0.542*	0.271*	-0.185	0.390***	0.461*		
Modified Mercalli Index (area-weighted mean)	-0.004	-0.001	-0.115	-0.160*	-0.100*	-0.089		
Rugosity (3D-surface/base plane area - ln(x))	-0.370	-0.331	0.371	-1.332	-3.214*	-2.867*		
Logistics-related:								
Base elevation (meters)	0.000	0.000	0.000	0.001	0.000	0.000		
Distance from supply hub (km - ln(x))	-0.125	-0.100	-0.359**	-0.369***	-0.015	-0.007		
Helicopter capacity - MT per day - smoothed - ln(x+1))	0.163	0.160	-0.085	-0.142	0.050	0.086		
Road to Union Council area open	0.005	0.000	-0.008	-0.115	0.089	0.101		
Constant	13.794***	14.411***	6.706**	12.253***	7.049**	5.902		
DELIVERY OCCURRENCE								
Needs-related:								
Population - 2005 est. - ln(x)	0.119	0.089	0.307***	0.450***	0.293***	0.661***		
Modified Mercalli Index (area-weighted mean)	0.069	0.064	0.066*	0.054	0.081*	0.081*		
Rugosity (3D-surface/base plane area - ln(x))	5.277***	5.037***	2.551***	2.266**	2.753**	3.087**		
Logistics-related:								
Had open movement request previous day	1.133***	1.165***	0.725***	0.750***	0.821***	0.843***		
Base elevation (meters)	0.001***	0.001***	0.000	0.000	0.000	0.000		
Distance from supply hub (km - ln(x))	-0.049	-0.055	-0.147*	-0.193**	-0.023	-0.082		
Helicopter capacity - MT per day - smoothed - ln(x+1))	0.305***	0.304***	0.144***	0.133**	0.190***	0.192***		
Road to Union Council area open	-0.060	-0.082	0.085	0.021	0.306***	0.286***		
Constant	-7.180***	-6.792***	-6.464***	-7.502***	-7.430***	10.881***		

Legend: * p<.1; ** p<.05; *** p<.01

(Table continued)

	Food, water,		Clothing and shelter		Construction material and tools	
	cooking utensils	Excl. UC	All Union	Excl. UC	All Union	Excl. UC
	>	100,000	>	100,000	>	100,000
	pop.	pop.	pop.	pop.	pop.	pop.
STATISTICS						
Union Council days observed (UC * 199 days)	17,313	16,915	17,313	16,915	17,313	16,915
without deliveries (censored obs)	16,469	16,088	16,869	16,515	16,883	16,508
Union Councils (clusters)	87	85	87	85	87	85
Log pseudolikelihood	-3880.4	-3784.3	-2553.3	-2353.0	-2405.8	-2279.4
Wald chi2(7)	17.595	10.504	17.363	17.322	39.693	19.328
Prob > chi2	0.014	0.162	0.015	0.015	<0.001	0.007
Rho	-0.243	-0.230	0.296	0.259	-0.282	-0.264
rho = 0 chi2	7.015	6.570	3.632	2.384	2.471	1.952
Prob > chi2	0.008	0.010	0.057	0.123	0.116	0.162

Discussion

Needs vs. logistical convenience

The model results demonstrate a consistent needs orientation of the decision making in the UNJLC-coordinated cargo movements to Union Council destinations. Logistical factors, by professional orientation and technical necessity, were strong, but they did not dislodge the expressed concern for the needs of the survivors. Without using advanced formal methods, the overall impression from the effects pattern is that needs-related and logistical factors exercised a fairly balanced influence on cargo movement decisions.

This may appear trivial, but it is worth noting that a similar pattern was found in another type of humanitarian action that we investigated with statistical methods. In a post-mortem of mine and unexploded ordnance clearance in Kosovo (Benini, Conley et al. 2002), it was found that (ultimately needs-oriented) policy factors and local logistical considerations determined the sequence of clearance operations with roughly equal strength. Clearance agencies had strong incentives to stay employed in a particular region, regardless of clearance priorities, but they were made to respect these through a central policy and monitoring mechanism.

Coordination structures such as the cluster approach⁶ and the HIC-based “Strategic Information Cell” may have had similar policy-enforcing effects on the UNJLC system, preserving a strong needs orientation. This should be regarded as an achievement, rather than taken for granted as some natural behavior of a group of well-intentioned logisticians. If, as Waters (op.cit.) suggests, humanitarian organizations follow bureaucratic rationalities, then we should expect them to place operative considerations above client needs. To the extent that such organizations exert social control of the behavior of affected populations (by conditioning benefits on desired behavior such as relocation or submission to the rationing process), the default assumption should be that needs orientations in practice and over time are weak.

Our analysis suggests the contrary. The UNJLC-coordinated relief delivery system preserved a strong needs orientation. However, one of the fascinating model results concerns how needs were measured. The levels of earthquake damage, as far as our proxy measure captures them, barely influenced shipment decisions. Population size did, in a pattern that is consistent with known specialization among responder families, i.e. the fact that Pakistani authorities and WFP distributed significant yet unobserved (in the UNJLC database) quantities of food to larger, mostly valley-floor communities.

The truly astounding effects, however, are those of terrain type. The association between mountain communities and the number of observed delivery days is strong. Terrain, in this context, however, proxies for poverty. The mountain communities had been poorer than their alluvial plain counterparts already prior to the disaster. Although our arcane

⁶ For background on, and an appraisal of the performance in Pakistan of, the UN cluster approach, see Action Aid International (2006) and IASC (2006).

Sidebar: Needs-related factors in space and time

We measure needs through proxy indicators. These vary in space – from Union Council to Union Council -, but not in time. For each Council area, the values of population, Modified Mercalli Index, and of rugosity are fixed for the entire observation period. The effects of these factors on shipment decisions, as estimated in the statistical models, are the same from beginning to end.

This is unsatisfactory. It implies that humanitarian agencies and their coordinating bodies such as UNJLC's CMCC did not learn over time; rather, they kept giving each decision factor the same weight during the entire response period.

We have used a different statistical method – semi-parametric Bayesian regression – to explore the varying importance over time of the three proxy indicators. On the opposite page, results are visualized in the effect graphs twinned to each of the underlying maps. The maps represent the time-fixed measurements across space (for better visual effect, population is mapped as density whereas the models hold needs to be proportionate to population size).

The line graphs represent the relative influence of a particular indicator over time, given its measured value in a Union. More formally, they are time-variant coefficients on standardized variables and as such are comparable. The shown coefficients are those for the food, water and cooking utensils delivery model. Line segments in dark hues represent periods during which the indicator had a significant effect; during times marked by lighter hues, the coefficient was not significantly different from zero. The values on the y-axis show the relative strength of the effects. The graphs for the clothing and shelter, resp. the construction materials models are similar in shape and do not warrant special presentation for this purpose.

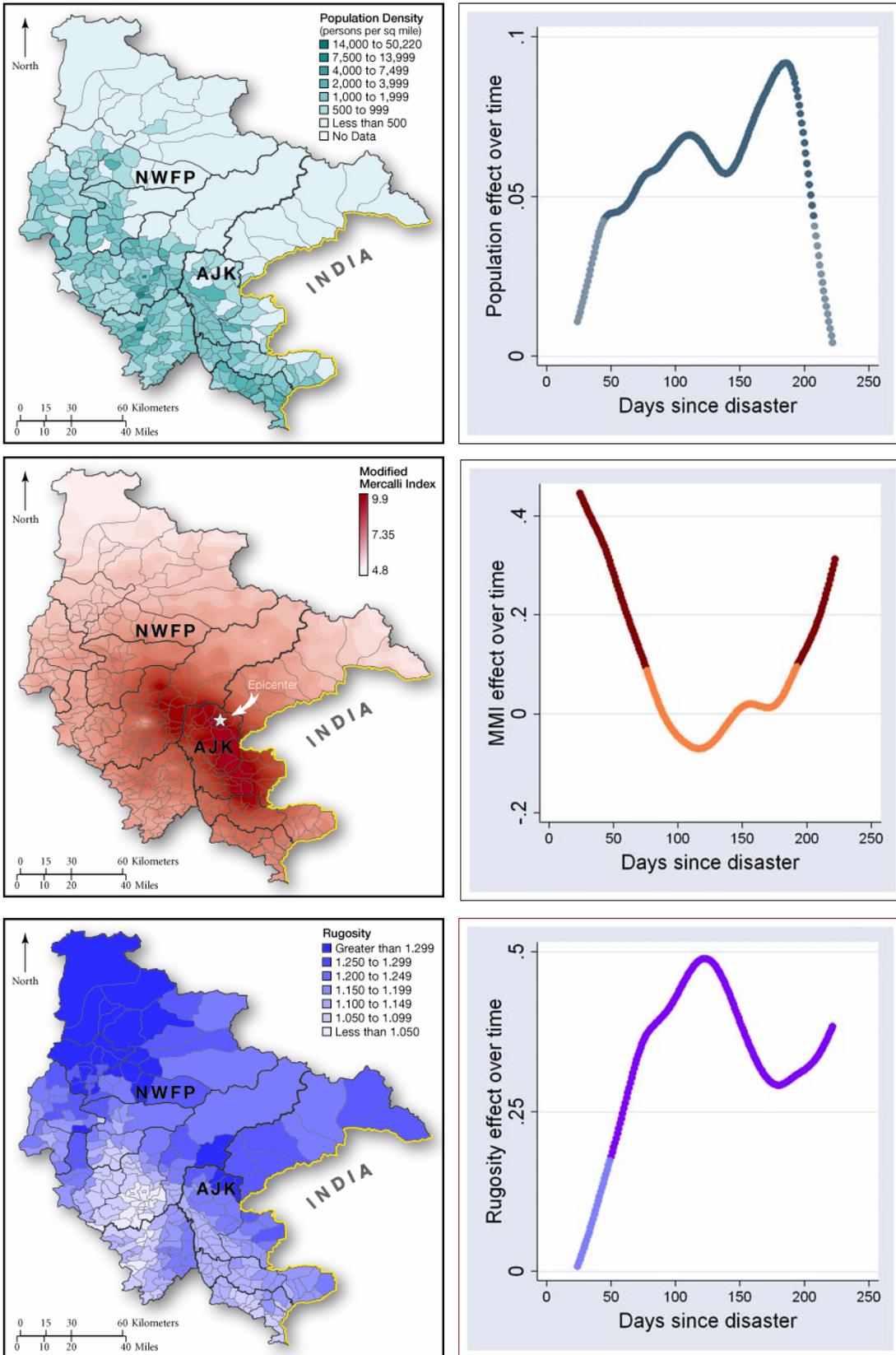
The patterns make sense, particularly for the first 180 days or so after the disaster. Initially, agencies flocked to Unions close to the epicenter of the quake; its location was public knowledge from day one while many areas farther away remained inaccessible or unexplored for some time. With everyone gearing up for the Winter Race to the hill settlements, the influence of rugosity shot up. Similarly, with better assessments, population size grew more influential, but its effect always remained four or five times smaller than that of the terrain type.

Moreover, the weight of population on food delivery decisions was sharply reversed in March 2006. Damage levels resumed strong influence, and rugosity halted the decline of its effect. Why? In March, the Pakistani authorities dissolved the formal camps for displaced persons, dispatching them to the roadheads to their destroyed villages. The government reorganized its relief administration and invited the UN and NGOs to channel their resources through the newly reformed reconstruction agency. Although the disagreement did not flare to the open, many relief NGOs hastened to dispose of their relief stocks, either through transfers to local development NGOs, or through accelerated distributions to returnees and their home communities. They were guided also by a UN mapping of underserved areas (UNJLC Pakistan 2006b: ; Wielgosz 2006b).

This analysis demonstrates the varying use of time of decision criteria in disaster response. It has an exploratory value and is less cogent than the parametric Heckman selection models. This is so for two reasons. First, with current Bayesian estimation software, we are able to estimate effect curves for the selection part of the Heckman model only – in other words, effects on the decision to ship, but not yet those on the amounts shipped once a positive decision is taken.

Second, and more importantly, there is, to our knowledge, no formalized theory of learning in humanitarian agencies although qualitative and typological approaches abound, with plenty of learning curve metaphors (Wright 2003). While we do not add any new theory, our quantitative data shows that organizational learning did take place through the Pakistan needs assessments.

Figure 7: Population, damage level, rugosity effects in space and time



measurement, using the GIS-derived “rugosity”, may not inspire confidence in the minds of some readers, we believe that the actual behavior of the UNJLC family expressed a concern for social equity in the face of disaster, captured through the association between the habitats of very poor people and cargo movement frequencies.

Logistics and humanitarian information management

This association pattern – insignificant effects of damage levels, strongly significant ones of the terrain type – has another connotation. It is a response also to a very fractured organizational field and to the concomitant absence of a common operational picture. The HIC was not in a position to organize a sufficiently universal and timely needs assessment process and later was not capable of compiling what assessments it had received. Information management discrepancies weakening the operational picture existed also within the UNJLC and between it and some of its close partners. The WFP, for example, did not entertain requests to share data on its dedicated trucking activities. The introduction of a second relief goods database to UNJLC Pakistan - LSS (UNJLC 2006) – paid homage to United Nations interagency politics more than to the needs of the decision makers in the theater, disregarding criticisms of its inadequacy that had simmered since the tsunami response (Messick 2006).

“Operation Winter Race” will be remembered also for its “Quake Jumpers”, an innovative arrangement using logistics assets to boost field assessments. Yet, overall, the assessment function remained weak, hampered, as it was, by the daunting terrain and weather, opportunistic participation of NGOs, multiple formats, unwillingness of donors to fund more HIC and UNJLC staff, and by volatile commitments to information sharing. This weakness has been found elsewhere (Sida and Szpak 2004: for Iraq, Afghanistan and Liberia; Benini, Barron et al. 2005: for Iraq).

Its causes are deeper than the short-term motivations of information managers. Logistics attains relatively high levels of certainty from proven technologies; many of these are built around dependable man-machine interactions. By contrast, needs assessments are open to double-contingency processes from the elemental constellation of persons asking other persons questions. In the disaster response rush, assessment networks negotiate issues of representativeness, validity and reliability at the same time.

The ensuing limitations were highlighted in the Pakistan theater by the inability to accommodate national science assets through the RISEPAK initiative. While its volunteers brought to the table precious knowledge of the affected communities, their role in the assessment process could not be effectively negotiated under the time pressure and within the organizational formats that were governing the core decision-making structures (Banerjee 2006).

All that goes to suggest that the deficiencies of the needs assessments and of other humanitarian information functions (those creating the “common operational picture”) may pose a more severe efficiency limit on disaster response than narrowly defined logistics does. The Overseas Development Institute devoted a lengthy study to the state of

“Needs Assessment and Decision-Making in the Humanitarian Sector” (Darcy and Hofmann 2003); the authors use the analogy with medical diagnostics:

“Consider the options available to a physician in the nineteenth century. He knows relatively little about the system (the body) he is dealing with; is able to observe only a limited range of symptoms; and has a limited range of potential remedies. The international humanitarian system is arguably in an analogous position with regard to the problems it seeks to tackle. On the other hand, it could be argued that the more appropriate comparison is with the modern-day doctor or paramedic attending the victim of a road accident. S/he will indeed be (rightly) concerned with a limited range of symptoms and of short-term remedies – the overriding concern being with keeping the patient alive and stable. What is needed here is not a comprehensive medical assessment” (ibid.: 10).

Using the same imagery for logistics, we have well equipped ambulances, and we know how to drive them. It is the quick and correct reading of the patient’s symptoms that is confounding the first-aiders. Of course, no one doubts that humanitarian logistics has scope for improved efficiency. Much of this may indeed be achieved by exploiting military-corporate supply chain management techniques⁷.

However, what should be supplied, and to whom, is far less straightforward than under market conditions. The fact that, as Pettit and Beresford (2005: op.cit.) noted for emergency relief logistics, “*the consumer is not the customer of the carrier*”, first of all creates a moral hazard. Distinctly from the moral hazards of insurance systems, it is agencies, not the final beneficiaries in the relief chain, who wield most power of abuse. Better humanitarian information management can reduce the moral hazard. It seems desirable that the second wave of professionalization in humanitarian logistics proceed in a wide perspective and without presumptions as to where the greatest efficiency gains will be made. The circumstances under which “Operation Winter Race” was successful recommend such a posture.

Theoretical and methodological contribution

This study first and foremost speaks to decision-making in humanitarian action. Compared to generic decision research, disaster sociology and to studies of poverty alleviation in regions that frequently are host also to humanitarian actions, theoretical developments in this subject are relatively young and are not easily ordered in recognizable schools of thought. Recurrent coordination issues in major international response have sustained a stream of studies that borrow, in very differing degrees, from theories of bureaucracy, social networks and multi-actor coordination. Much of this literature is either historical or practice-oriented and prescriptive. For example, the search term “humanitarian coordination” on Google yields close to 60,000 returns. The

⁷ TNT, a worldwide logistics firm, is supporting WFP in a private-public partnership. Oelrich (2006) described how network analysis applied to the Southern Sudan transportation map led to monthly savings to the tune of US\$ 300,000 after a one-time investment of \$ 1 million.

companion “Google Scholar” produces only 200 from the chiefly peer-reviewed journal literature that it references.

In a more theoretical perspective, this study provides a test of the hypothesis that bureaucratic rationality distracts humanitarian responders from survivor needs, prompting them to allocate relief on other operative criteria. Using a particular statistical model, we were able to demonstrate that the cargo movement decision process, recorded for a segment of the Pakistan earthquake relief, maintained a significant orientation towards the needs of survivors. However, measurement of these needs had to rely on proxy indicators, for lack of a complete, consistent and coherent needs assessment process. In such a situation, the decision makers used readily available information substitutes, together with certain operative assumptions, to structure their preferences. Notably, type of terrain became an important consideration in relief deliveries, the (correct) assumption being that residents in mountain and hill settlements had been poorer already before the disaster and thus were more vulnerable post-disaster. The demonstration of information proxies places our study closer to mainstream theories of transaction costs and formal organizations. Using Bayesian methods to explore how the influence of decision criteria changed over time, we were able to document organizational learning in the responder community, in the build-up as well as in the wind-down phase.

Our major contribution may be methodological, not theoretical. By integrating, on a GIS platform, various additional data bodies with the logistics database in point, we opened the relief data to empirical investigation within an econometric framework. The sources of the data used in explanatory variables are as diverse as the Pakistan population census, the US Geological Survey, and the responder community themselves. The integration of very differently referenced data involves the choice of a new referent – in this case, low-level local government areas -, spatial manipulation as well as treatment of missing values. It follows in the path of similar GIS-mediated humanitarian data management exercises that VVAF/iMMAP pioneered within the Global Landmine Survey (Benini, Conley et al. 2002: ; Benini, Conley et al. 2003).

On the practical side, we believe that our concern with information proxies in the measurement of needs can be elevated from a necessity to a virtue. Humanitarian logistics is as much about anticipation as it is about response. Particularly in societies dubbed as “failing states”, the humanitarian community will be faced with emergencies assessed in ways much more fragmentary and precarious than in the relatively orderly Pakistan earthquake theater. However, a judicious use of information available prior to acute disasters, from geospatial databases and small-area poverty estimates, and their evaluation and synthesis as timely proxy indicators can be promoted as part of larger disaster mitigation efforts.

Appendices

Data sources and definitions

Relief commodities and reconstruction material shipments

The UNJLC Cargo Movement Database contained 3,426 records of commodity movements scheduled between 28 October 2005 and 18 May 2006, with request ID, date, origin, destination, requestor agency, mode (road / air), canceled or not, and weight moved. The composition of shipments by commodity type was recorded only for the request, not for the actual shipment. A request could be executed through one or several movements, each reflected in a separate record. 2,767 records are for completed movements; the others were canceled.

We grouped the 25 commodity types used in the database into eight broad categories and calculated the weight of goods requested for each category.

Table 7: Recoding of commodity types

Broad commodity groups	Original commodity types
Assorted Relief Goods	Assorted Relief Goods
Construction Material and Tools	Construction Material Iron Sheeting Tools
Education	School Supplies
Food	Food Kitchen Supplies Water
Health Care	Hygiene Supplies Medical Supplies Medicine
Mission Support	Fuel Fuel Storage Mission Support
Shelter and Clothing	Blankets Clothes Mats Other Shelter Materials Plastic Sheeting Sleeping Bags Storage Sweaters Tarpaulin Tents
Unknown	Unknown

We then calculated the weight of goods actually moved by category, in proportion to the weight fractions in the movement request. This was non-trivial for a minority (15 percent)

of the completed movements only; for, 2,357 out of the 2,767 completed movements each responded to a request made for only one broad commodity group. Nevertheless, it is appropriate, because of this allocation rule, to consider the moved weights by category *estimates* only.

A movement was completed within a day; requests that took longer to complete would result in several movement records, each for a separate day (not necessarily all on consecutive days). Based on this structure, and on the mapping of destinations to Union Councils, weights moved, by category and dates, were aggregated to receiving Union Councils (a Council area may enclose several destinations).

Three tables were produced, one each for the major commodity groups for which we estimated separate models:

- Food, kitchen supplies and water
- Shelter and clothing
- Construction material and tools

of the estimated weights of completed movements for each day of the period covered by the database and for each of the 87 Union Councils that ever were the object of a movement request. Five of these Councils received zero shipments under the three broad commodity groups analyzed.

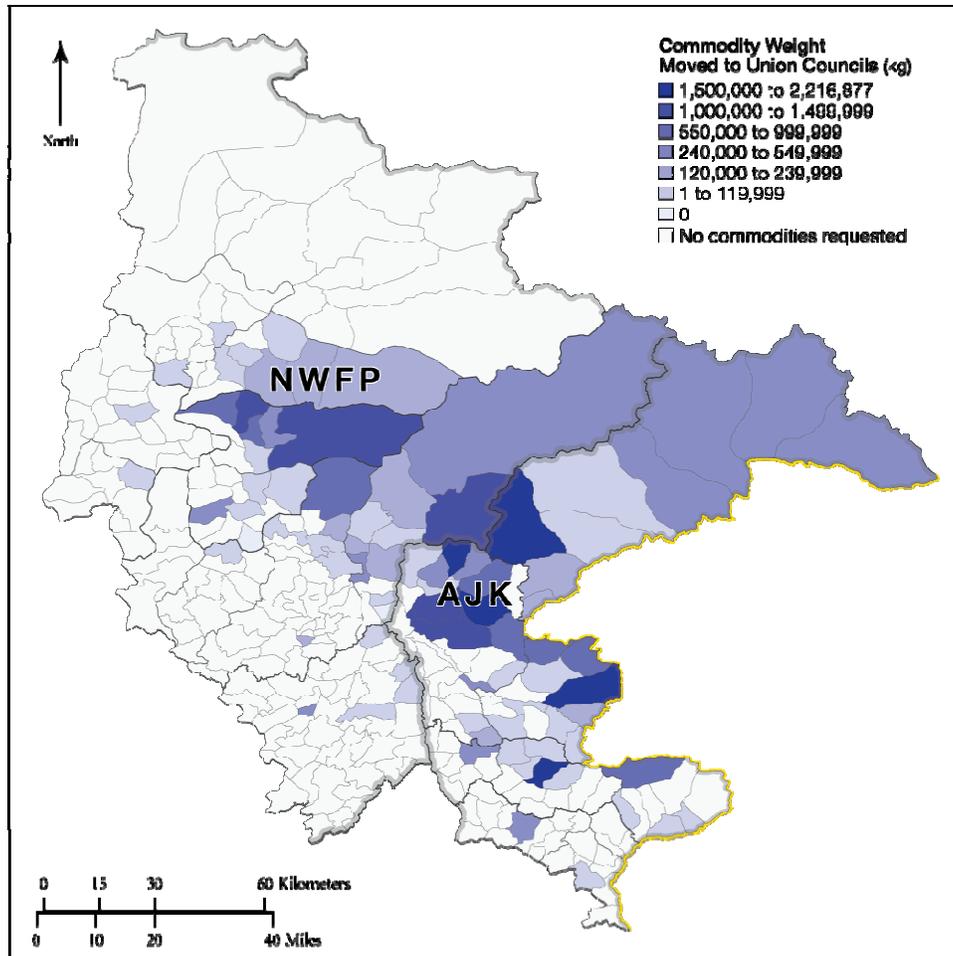
These 222 days-after-the-disaster (rows) x 87 Union Council (columns) tables of estimated weights moved are known as wide-form tables in STATA terminology. They were reformatted into long-form tables that hold the weights in one column, to make the data accessible for regression analysis.

Excluding the October 2005 records, which were considered highly incomplete, the regression models would use information on 199 days x 87 Union Councils = 17,313 Union Council-days. Most of these observations are censored, i.e. no cargo movement in the commodity group in point was observed to that Council on that date. The exact numbers are given in the descriptive statistics below. To account for dependency on unobserved Union Council factors, observations in the model syntax were clustered on Council ID codes.

Figure 8: Union Councils with UNJLC-coordinated delivery requests

[Next page:]

Most of the 87 Union Councils to which UNJLC was requested to coordinate the delivery of relief goods and reconstruction materials lie in a oblong oval that stretches SE to NW.



Population 2005

1998 Pakistan Census (provided by RISEPAK), extrapolated to 2005 values using – subdistrict (Tehsil)-wise annual growth rates provided by WFP

Damage levels

USAID- Disaster Assistance Response Team (DART) and US military digitized damage locations until October 17th, 2005, using aerial imagery and classified according to severity. We intersected the results to Union Council polygons. We calculated the Union Council areas by each damage level. The Union Councils with measurements, however, were few, and we found this dataset unusable.

Instead, we used a seismic measurement, the Modified Mercalli Index (MMI, aka Measured Instrument Intensity]. The US Geological Survey (USGS) made MMI values, compiled from field instrument readings, available as shapefiles, graded by tenths of MMI units, together with two other seismic measurements, Peak Ground Acceleration and Peak Ground Velocity

(http://earthquake.usgs.gov/eqcenter/shakemap/global/shake/dyae_05/, 8 October 2005).

We intersected the shapes with Union Council Polygons and calculated an area-weighted average for each Union Council in each of the three measures. They were highly

correlated among each other (between 0.94 and 0.98; 287 Union Councils). The choice of MMI over the other two measures was arbitrary. A correlation with DART/US military damage estimates was not attempted.

Rugosity

Rugosity comes in two flavors, volume-based and surface-based. The algorithm calculates the projected area, surface area, and volume of a surface relative to a given base height, or reference plane. The surface can be a raster or Triangulated Irregular Network. The volume-based rugosity is the ratio of this volume to the projected area. The surface-based rugosity is the ratio of surface area to the projected area.

We used ArcGIS Spatial Analyst's "Surface Volume" tool, which compares a polygon's perimeter to a digital elevation model (DEM), and then measures the volume/surface of that area utilizing the DEM. For this model, volume and surface were calculated from the minimum elevation from within the polygon. – For the Digital Elevation Model, we combined datasets from two sources, SRTM-2F and GTOPO30, in order to remove DEM "spikes" and flaws from SRTM data. Shuttle Radar Topography Mission, Finalized 2nd Version, NASA-National Geospatial-Intelligence Agency, distributed by United States Geological Survey (<http://srtm.usgs.gov/>, 2004[?]).

In the statistical model, we used the surface-based rugosity. This measure is less sensitive to unique high peaks and more to the "ups and downs" of hilly terrain than the volume-based companion. The correlation coefficient between the two rugosity measures (put to their logarithms) within the 87 Union Council sample was + .82.

Base elevation

Same source as noted under "Rugosity"

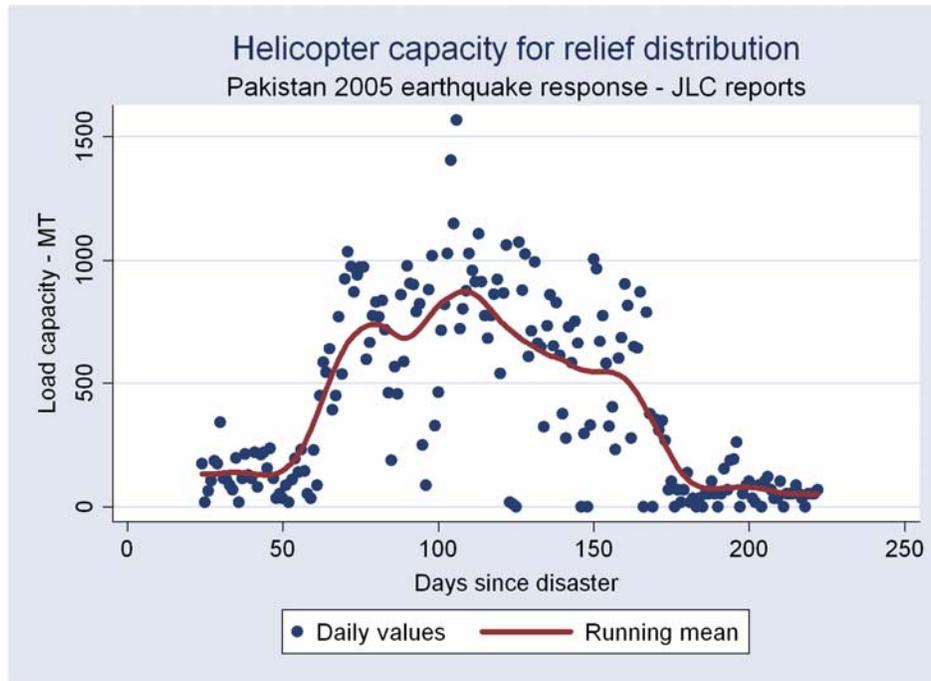
Distance from supply hub

Euclidean distance from supply hub point coordinates to Union Council centroid. The supply hub was not necessarily the closest hub, but the one from which Council destinations could be expected to be serviced as per UNJLC logistics plans.

Helicopter capacity on a given day

Using information contained within the UNJLC cargo movement database, the daily availability of specific helicopters types and quantities were derived based upon cargo movements being tasked to those vehicles. In addition, a maximum number of sorties was derived for each helicopter type, then combined with known maximum lift capacities in order to produce a maximum daily movement allowance for each vehicle, and summed to give a UNHAS tasked daily maximum allowance.

Figure 9: Daily helicopter load capacity



From these daily values, a running mean was computer (through locally weighted regression); the smoothed values were the ones used in the Heckman regression estimates.

Road access to Union Councils

To determine Union Council accessibility by road for any day since the disaster, available road reports were compiled into a table that was joined to UNJLC routes within ArcGIS. Definition queries were performed to isolate open roads on individual days, and the results were used to select the Union Councils through which the routes passed. Any Union Councils which could not then be linked back to a logistics hub using open routes were then deselected due to their being cut off from those hubs by conditions further along the route. These daily results were then exported back to a table and combined for all days since the disaster. Dates with missing values were backfilled with the more recent data (with one exception, see next paragraph). If available, weather observations and personal knowledge of the conditions within the affected area were used to enhance the backfilling of road statuses.

Exception: 27 Nov through 13 Dec 2005 was forward-filled with values of 26 November because a dramatic change of weather happened at beginning of that period, and fresh observations were not available until December 14.

Movement requests on the previous day

Derived from the cargo movement database. The dichotomous variable, taking the value 1 if the Union had been the object of some open the previous day, else 0, was calculated based on a pivot table of the number of requests, no matter whether completed or not, by date and Union Council. The type of commodity requested does not matter either.

Bayesian analysis of time-variant effects

The graphs of time-variant coefficients on proxy needs variables shown on page 41 are results of Bayesian regression methods. Given the purely exploratory character of these estimates, we give a brief model description only.

The selection equation in the Heckman model is formulated as a Probit regression. We used this model, interacting the needs-related variables with a function of the days since the disaster, with predictor

$$\eta = \gamma_0 b_0 + \sum \gamma_i b_i + \sum f_k(\text{days}) b_k$$

where all logistics variables b_i have fixed effects and the three needs indicators b_k have coefficients that are smooth functions of time. The functions are obtained through P-splines with second order random walk penalties. Inference, particularly for establishing during which time periods the samples of f_k have 95%-credible intervals outside zero, is based on a Monte Carlo Markov Chain (MCMC) algorithm. Estimation was done using the software BayesX (Brezger, Kneib et al. 2005) with 12,000 iterations and 2,000 burn-in.

The Probit models were estimated for each of the three major commodity groups. This produced 3 functions x 3 models = 9 time-variant effects graphs. The visual inspection of their shapes and of the credible intervals is the basis of our interpretation in the sidebar “Needs-related factors in space and time” and was done with help from a former UNJLC GIS Officer who continued after co-author Dittimore had left Pakistan (Wielgosz 2006b).

The sidebar makes use of three graphs, those for the food deliveries model. For readers not concerned with the usual Bayesian graphic output, we did away with the credible intervals. Instead we used two hues for line color, depending on whether the interval was outside zero at that point or not.

But, what exactly are the values on the y-axis? They are the original $f_k(\text{days})$ -values multiplied with the standard deviations of b_{kj} over the 87 Union Councils j . This operation, the counterpart of standardizing the needs indicators to $sd = 1$, makes their coefficients comparable *within* a given commodity model. Thus, the y-values are *coefficients* of standardized covariates. The product of the original $f_k(\text{days}=X)$ and (unstandardized) b_{kj} is the contribution to the linear predictor of the (normally distributed) probability that Union j received some delivery on day X .

It bears repeating that these Bayesian analyses are purely exploratory. In our literature searches, we have not come across Bayesian variants of the full Heckman model with a semi-parametric interaction term such as our “days since the disaster”, and we have deliberately limited our exploration to the unproblematic selection equation.

Descriptive statistics

In the following tables, the logarithmic transforms are included when the variable was entered in this format.

Uncensored observations

Uncensored observations are Union Council days with deliveries > 0. A delivery can be the result of more than one movement, such as when on the same day commodities within a commodity group were moved to several destinations (helicopter landing sites, or road trip end points) within the same Council area.

Table 8: Uncensored observations

	N	Sum	Mean
Food delivery took place	17313	844	.05
Shelter and clothing delivery took place	17313	444	.03
Constr material and tool delivery took place	17313	430	.02
Valid N (listwise)	17313		

Dependent variables: Commodity deliveries

Table 9: Food, water, kitchen utensil deliveries

	N	Minimum	Maximum	Sum	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Food delivered (kg)	844	10	458000	18596781	22034.10	32018.185	5.466	.084	54.285	.168
Food delivered (kg) - log ₁₀ (x+1)	844	1.0414	5.6609	3396.7614	4.024599	.5767775	-.575	.084	1.152	.168
Valid N (listwise)	844									

Table 10: Shelter material and clothing deliveries

	N	Minimum	Maximum	Sum	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Shelter and clothing delivered - kg	444	16	112000	3228676	7271.79	12736.130	4.468	.116	24.875	.231
Shelter and clothing (kg) - log ₁₀ (x+1)	444	1.2383	5.0492	1558.5127	3.510164	.5645720	-.245	.116	.919	.231
Valid N (listwise)	444									

Table 11: Construction material deliveries

	N	Minimum	Maximum	Sum	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Construction material and tools - kg	430	45	192850	6922260	16098.28	23030.299	4.164	.118	21.786	.235
Construction material and tools (kg) - ln(x+1)	430	3.8286	12.1697	3895.7190	9.059812	1.2202111	-.818	.118	2.204	.235
Valid N (listwise)	430									

Independent variables

Variable in both space and time

Table 12: Road access and previous-day movement requests

	N	Mean
Some road to Union Council area is open	17313	.39
Movement request previous day (for any commodity for this UC)	17313	.11
Valid N (listwise)	17313	

Variable in space only

Table 13: Time-invariant covariates

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Population 2005 (est.)	87	7035	179153	1857139	21346.43	22043.232	5.991	.258	38.469	.511
Population 2005 (est.) - ln	87	8.8587	12.0960	853.1466	9.806283	.4590265	2.291	.258	10.121	.511
Modified Mercalli Intensity (MMI) - area-weighted UC value	87	5.39	9.89	708.19	8.1401	1.32527	-.276	.258	-1.218	.511
Surface-based rugosity	87	1.01	1.39	104.58	1.2021	.07257	-.243	.258	-.055	.511
Volume-based rugosity - ln(x)	87	4.3663	7.6636	584.8466	6.722374	.5921728	-1.195	.258	2.584	.511
Lowest elevation of Union Council Area (meters)	87	470	2006	96476	1108.92	319.861	.538	.258	.295	.511
Distance from supply hub - km	87	2.30	115.86	3087.85	35.4925	22.23669	1.292	.258	2.655	.511
Distance from supply hub (km) - ln(x)	87	.8329	4.7524	291.0421	3.345312	.7478878	-1.002	.258	1.371	.511
Valid N (listwise)	87									

Variable in time only

Table 14: Global covariates

	N	Minimum	Maximum	Sum	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Helicopters available	199	0	50	2928	14.71	12.798	.619	.172	-.834	.343
Helicopter capacity - MT per day - smoothed	199	46.29	853.68	82450.05	414.3218	286.10020	.041	.172	-1.617	.343
Helicopter capacity - MT per day (smoothed - ln(x+1))	199	3.8564	6.7507	1125.8020	5.657296	.9701258	-.461	.172	-1.386	.343
Valid N (listwise)	199									

Correlations

Among independent variables

		Population 2005 (est.) - ln	Modified Mercalli Intensity (MMI) - area-weighte d UC value	Surface-bas ed rugosity - ln(x)	Lowest elevation of Union Council Area (meters)	Distance from supply hub (km) - ln(x)	Helicopter capacity - MT per day (smoothed - ln(x+1))	Some road to Union Council area is open	Movement request previous day (for any commodity for this UC)
Population 2005 (est.) - ln	Pearson Correlation	1	.011	-.262**	-.003	-.307**	.000	.129**	.045**
	Sig. (2-tailed)	.	.144	.000	.698	.000	1.000	.000	.000
	N	17313	17313	17313	17313	17313	17313	17313	17313
Modified Mercalli Intensity (MMI) - area-weighted UC value	Pearson Correlation	.011	1	-.127**	-.240**	-.321**	.000	.087**	.031**
	Sig. (2-tailed)	.144	.	.000	.000	.000	1.000	.000	.000
	N	17313	17313	17313	17313	17313	17313	17313	17313
Surface-based rugosity - ln(x)	Pearson Correlation	-.262**	-.127**	1	.083**	.485**	.000	-.308**	.145**
	Sig. (2-tailed)	.000	.000	.	.000	.000	1.000	.000	.000
	N	17313	17313	17313	17313	17313	17313	17313	17313
Lowest elevation of Union Council Area (meters)	Pearson Correlation	-.003	-.240**	.083**	1	.271**	.000	-.222**	.086**
	Sig. (2-tailed)	.698	.000	.000	.	.000	1.000	.000	.000
	N	17313	17313	17313	17313	17313	17313	17313	17313
Distance from supply hub (km) - ln(x)	Pearson Correlation	-.307**	-.321**	.485**	.271**	1	.000	-.255**	.026**
	Sig. (2-tailed)	.000	.000	.000	.000	.	1.000	.000	.001
	N	17313	17313	17313	17313	17313	17313	17313	17313
Helicopter capacity - MT per day (smoothed - ln(x+1))	Pearson Correlation	.000	.000	.000	.000	.000	1	-.182**	.196**
	Sig. (2-tailed)	1.000	1.000	1.000	1.000	1.000	.	.000	.000
	N	17313	17313	17313	17313	17313	17313	17313	17313
Some road to Union Council area is open	Pearson Correlation	.129**	.087**	-.308**	-.222**	-.255**	-.182**	1	-.053**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000
	N	17313	17313	17313	17313	17313	17313	17313	17313
Movement request previous day (for any commodity for this UC)	Pearson Correlation	.045**	.031**	.145**	.086**	.026**	.196**	-.053**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.001	.000	.000	.
	N	17313	17313	17313	17313	17313	17313	17313	17313

** . Correlation is significant at the 0.01 level (2-tailed).

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