Mortality in eastern Democratic Republic of Congo

Results from Eleven Mortality Surveys

Kalonge displaced, D.R. Congo. Photo: IRC

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I. INTRODUCTION

In June 2000, the International Rescue Committee released a report on mortality in eastern Democratic Republic of Congo for the 22 months beginning with the resumption of fighting in August 1998. Using normal baseline mortality rates, the report estimated that 1.7 million deaths occurred in excess of the number normally expected.

To update its findings, the IRC conducted a second survey in March 2001. As a result, the IRC now estimates that 2.5 million excess deaths have occurred during the 32-month period beginning in August 1998 and ending in March 2001.

The 2000 and 2001 surveys both indicate that the overwhelming majority of deaths were related to disease and malnutrition, while a proportionately smaller number were directly attributable to violence. This year's survey puts the number of such violent deaths at 350,000.

The ongoing fighting has driven hundreds of thousands of people into forests, jungles and other remote areas, where they have no food, medicine or shelter. Health care systems in the region have been decimated. War-affected areas have been largely inaccessible to aid organizations because of the insecurity.

The IRC's second mortality survey in eastern Congo confirms the general findings of the first report—the death rate remains shockingly high. Indeed, the numbers are so high as to invite skepticism in some quarters. Nonetheless, the statistics presented in the report are based on a survey that was carefully conducted by a widely respected epidemiologist following rigorous scientific procedures. And while the exact precision of the numbers may be subject to discussion, there can be no doubt that the survey reveals a humanitarian crisis of staggering proportions. And that is the point of the two surveys: They demonstrate the compelling need to respond to the situation in the east, and throughout Congo, with a massive, well-conceived and well-organized international program of humanitarian assistance.

Fortunately, such a response is now feasible. For the first time in years, humanitarian action can be undertaken with reasonable safety in many parts of the country. The cessation of organized combat, the initial withdrawal of combatants, the revitalization of the peace process and the presence of UN- contingents in key areas do not guarantee total safety, much less a successful political outcome. However, these factors do remove some of the major obstacles that have so severely restricted humanitarian activity.

Moreover, in certain areas scattered throughout the country, modest humanitarian aid has been ongoing, providing bases for rapid expansion by international, governmental and nongovernmental actors, in conjunction with the invaluable remnants of Congolese government and civil society. Taken together with improved security, this means that a

rapid increase in humanitarian relief is possible. Such action will not only save countless lives, but will also provide a strong boost to international and indigenous efforts to bring about a permanent end to the conflict.

The IRC, for its part, is already expanding its operations in the east, thanks to recent grants from the United States Agency for International Development (USAID) and the Office of Foreign Disaster Assistance (OFDA), and has established a consortium for further expansion in consultation with other non-governmental organizations (NGOs). The IRC has been in discussions with the European Union (EU), the United Nations Office of Coordination for Humanitarian Affairs (OCHA), and the United Nations High Commission for Refugees (UNHCR), as well as with USAID and Department of State Bureau for Population, Refugees, and Migration (BPRM), about a still broader international program for eastern Congo where assets can be pooled and activities coordinated for the most effective, rapid action.

International Rescue Committee

II. BACKGROUND

Since August 1998, war has raged across much of the eastern half of the Democratic Republic of Congo (DRC). With numerous rebel groups, involvement by at least seven foreign powers, and widespread exploitation of minerals and other natural resources, the conflict has given new meaning to the term "complex emergency." In June 2000, the International Rescue Committee (IRC), an international aid organization that provides humanitarian assistance to civilians on both sides of the conflict, released a report chronicling mortality in five areas surveyed during the early months of 2000. That report estimated that 1.7 million people had died in addition to the expected number in eastern DRC during the first 22 months of the conflict. In March and April 2001, the IRC completed another five surveys in eastern DRC, along with one in the rebel-held area of Kasai Orientale Province.

This report summarizes the results of these five surveys. For the purpose of this report, the eastern DRC is defined as the provinces of North Kivu, South Kivu, Orientale, Maniema, and Katanga. The results of these surveys, along with the five from 2000, and one from 1999 (see: *Lancet* Jan. 26, 1999, 353(9171):2249-50.), will be used in an attempt to create a portrait of mortality associated with this conflict. As a tool for describing the mortality conditions for the 20 million people who lived in the eastern provinces in August 1998, the IRC's data are intermittent over both space and time. Nonetheless, the IRC believes that these 11 surveys constitute the bulk of the mortality data recorded recently in eastern DRC and, thus, the best means at present for describing the health consequences of this war.

Therefore, the goals of this report are:

1) to make a footnote in the public record (either through this report or by inspiring other organizations to create a more complete record) regarding the level of suffering and death that has occurred among civilians, and
2) to provide a profile of mortality to guide political or humanitarian responses which may be initiated.

III. METHODS

Estimation of Mortality

In each of the five surveys conducted in eastern DRC during 2001, the Crude Mortality Rate (CMR) was estimated by employing a two-stage cluster survey approach. This method is similar to that used by the World Health Organization (WHO) Expanded Programme for Immunization (EPI) for estimating vaccination coverage. In the first stage, clusters were assigned to clinic areas systematically, proportional to population (the WHO method). In the second stage, specific locations were selected using the Global Positioning System (GPS) . The following steps were followed:

1) A minimum sample size was selected so as to detect a doubling of mortality above the baseline rate over a one-year period. Where time and logistics permitted, a larger sample was taken. Baseline mortality was assumed to be 1.5 per 1,000 population per month (expressed as 1.5/1,000/mo.). This calculation assumes that visiting clusters of 10 households each would reduce the statistical power of the sample by 50 percent (the "design effect" = 2). For example, 20 clusters of 10 houses (200 households) would result in a sample statistically equal to a random sample of 100 households. Clusters of 10 houses were chosen instead of clusters of five houses (as was employed in the previous six surveys) because:

a) The design effect measured in the 2000 surveys never exceeded 1.6, indicating there was not much "clustering" of deaths.
b) 70% to 90% of survey time was spent riding to sites or obtaining clearance to interview people; thus, it was deemed more "time effective" to interview 10 households when a site was reached.
c) The perceived security risks in the sites visited were less than those of Moba and northern Katana during the 2000 surveys, diminishing the need to finish clusters quickly.

2) Clusters of 10 houses were assigned to specific clinic areas by a systematic technique that allocated clusters proportional to population size. A list of clinic-area populations was constructed with a cumulative total marked beside each entry. The total was divided by the number of clusters necessary to define the sampling interval. A random number was selected between one and the sampling interval. The point where that number fell in the cumulative list was assigned a cluster. The sampling interval was added repeatedly to that number and the clinic areas corresponding to the cumulative sums were assigned clusters (as with the WHO, EPI methodology). The population figures were provided by local authorities or gleaned from IRC experience.

3) Within each clinic area, a crude map was made, usually by measuring the distance across the clinic area with a GPS unit. An imaginary grid was superimposed on the map. Random numbers were assigned to locations on the grid. For example, if an area was 1.00 km north-south by 1.00 km east-west, and the reference point (0,0) was the southwest corner, two numbers between 001 and 100 would be chosen. The first number would correspond to the distance that interviewers would travel north from the reference point, and the second number would correspond to the distance they would move east to the starting point. A GPS unit was used to guide investigators to the targeted locations (± 10 meters). The 10 households closest to each location were visited.

4) If no one was home, or if members of a household refused to be interviewed, that house was skipped and the next was visited. The age and gender of each household member were recorded. Only those who had slept in a particular household on the preceding night were included in surveys. Interviewees were asked if anyone in their household had died since Christmas 2000, or during the year 2000.(Deaths that occurred during the 6 days after Christmas 2000, which could have produced a positive response to both questions, were counted once). The age of the decedent, the month of death, and the

cause of death (as reported by the family) were recorded. Interviewees unsure about such details were asked to give best estimates.

Estimation of Survivor Bias

Following the 2000 surveys, interviewers became concerned that entire families were killed in those areas with the most violence, leaving no one to be interviewed, thus creating a bias toward a lower estimated mortality rate. Such a survivor bias could also arise if most members of one family resided with another "host" family. If interviewers visited the host family and asked, "Did anyone in your household die last year?" the deaths of the other family were not "in their household" and would not have been included. To determine if a survivor bias was occurring, and the rough magnitude of the problem, the following evaluation was conducted:

a) In two of areas of Kalemie (one urban, one rural, combined population approximately 80,000), random starting points were selected as described above and clusters of 10 houses were visited.
b) Members of households were asked if they remembered where they were living in August of 1998 (at the start of the war). If they did not, the interview was terminated.
c) Members of households were asked, "If you stepped out of your hut in August of 1998, do you remember the household that was the nearest neighbor to your right?" If they did not or if there was no neighbor, the interview was terminated.
d) If they remembered the household, they were asked, "How many people lived in that household?" and, "Do you know where those individuals are now?" The number of former neighbors dead and alive was recorded and no attempt to determine cause of death or age of the deceased was made.

IV. ANALYSIS

CMR is defined as:

[(the number of deaths in sample) / (the number of living in sample + ½ deaths in the sample population during the recall period – ½ those born during the recall period)] X (1,000) / (the recall period).

Mortality in this report is expressed as 'deaths/1,000 population/month'. (For comparison to the "emergency" mortality unit of 'deaths/10,000/day': 3 deaths/1,000/mo. = 1 death/10,000/day.)

The under-five CMR is estimated using the equation:

[(Deaths among those <5) / [(those alive <5 + ½ deaths during recall period)] X (1,000)/(recall period).

This equation makes the assumption that the total number of children born during any window of the recall period and the number of children turning five during any window of the recall period was the same.

The under-one mortality is expressed here as a fraction of all births occurring in a year that result in death before the child reaches 12 months of age. Unlike the two rates described above, many if not most of the under-one deaths which occurred in the preceding year were among children born before the recall period. Thus, this estimation makes the assumption that the birth rate has remained constant throughout the recall period. Because this estimate is typically based on data from a 15-month period, the rate was assumed to be:

(<1 deaths during 1.25 years of recall/1.25)/[(children <1 alive) + (deaths<1 during recall/1.25)] X 100.

The factor of 1.25 was used for the surveys occurring around April 1, The numerator for other studies was divided by the true recall period (e.g. 1.20 years, 1.35 years, and so on).

The recall period was defined as the length of time between January 1, 2000, and the median day of the specific survey. That is, if a survey was conducted from March 21 through March 25, the recall period was said to end March 23.

The design effect associated with visiting clusters of households instead of individual households was estimated using Epi Info Version 6.0 software. Confidence intervals were estimated using a sample size corrected by the estimated design effect. Confidence intervals and Chi-squared test for trends were calculated using Epi Info 2000.

V. RESULTS OF INDIVIDUAL SURVEYS

Kalemie (Katanga Province)

Households visited:	300 (1 refusal)
Sample population:	2204 alive at time of interview (Avg. household (HH) size= 7.3)
Population from which sample is drawn:	196,000
Population under five years (<5) of age:	15% (321 alive at time of interview)
CMR 1/00 – 3/12/01:	10.8 deaths/1,000/mo. (95% CI: 9.5–12.1)
< 5 Mortality Rate (MR):	23.8 deaths/1,000/mo. (95% CI: 19.8–27.8)
< 1 Mortality:	37%

Among those households interviewed in and around Kalemie, violence was the major reported cause of death, followed by febrile illness and diarrhea. The reported cause of death of those under five in the interviewed households is presented in Figure 1. Cause of death among those five or greater is presented in Figure 2. It was estimated that 38% of sample children who were in their second year of life died during this recall period died during the year (23 deaths aged 12–23 months, 49 survivors aged 12-23). If these

conditions have existed for the past two years, 75% of children born two years ago have died. Also of note, 10 maternal deaths were reported among an estimated 149 births during the 14.2 months preceding the interviews. This is a maternal mortality ratio of 6.7 percent.

Of the 196,000 people accessible in this area, about half (51.8%) live in the town of Kalemie and half in outlying villages. For this reason, the sample was stratified with 15 clusters assigned to the urban areas and 15 clusters to rural areas. This stratification was not weighed in the analysis because the urban CMR (11.0/1,000 mo.) was statistically similar to the rural rate (10.5/1,000/mo.). Malnutrition attributed deaths appeared to occur in rural areas (37 deaths reported) and urban areas (32 deaths reported) at a similar rate.

The possibility of survivor bias was described in the methods section above. This was conducted in Kalemie because it was the only site visited in 2001 with violence levels similar to those seen in Moba and Kalonge during the 2000 surveys, where the initial concern over survivor bias arose. Of 150 former neighbors, interviewees knew the present whereabouts of 122 (81%). Of these 122 households, 114 (93%) were reported as "mostly" still alive. In four families (3%), all the members were believed dead. The average size of these deceased households was four persons, as compared to seven in the Kalemie area. In four additional families, a majority of the household members had died. Mortality among households for whom former neighbors could not account (19%) is unknown. To simplify things, it will be assumed that these households had the same mortality experience as those that were counted. Thus, it's estimated that 3% of people living in this area before the war have died but were undetectable by our household survey methodology.

Kalima (Maniema Province)

Households visited:	240 (2 refusals)
Sample population:	1,958 alive at time of interview (Avg. HH size = 8.2)
Population from which sample is drawn:	91,000
Pop. <5 years of age:	14% (280 alive at time of interview)
CMR 1/00 – 3/18/01:	7.5 deaths/1,000/mo. (95% CI: 6.3–8.7)
<5 MR:	17.1 deaths/1,000/mo. (95% CI: 13.2–21.0)
<1 mortality:	41%

Of the 154,000 people who reportedly live in Kalima Health Zone, only 91,000 (59%) were accessible at the time of the survey due to fighting between Mayi-Mayi and Rwandan/Rassemblement Congolais pour la Democratie (RCD) soldiers. Thus, survey results can be said to represent only the southern two-thirds of the health zone. Children in interviewed households reportedly died predominantly of malnutrition, febrile illness and measles (see Figure 3). Among those five years of age and older reportedly died of tuberculosis (TB), malnutrition and other causes (See Figure 4).

Figure 5 shows the number of deaths reported by month. While death rates are often seasonal in malaria endemic areas, a trend toward increasing mortality appears over the course of the year.

Katana (South Kivu Province)

Households visited:	300
Sample population:	1,802 alive at time of interview (Avg. HH size = 6.0)
Population from which sample is drawn:	347,000
Pop. < 5 years of age:	17% (313 alive at time of interview)
CMR 1/00 – 2/23/01:	4.9/1,000/mo. (95% CI: 3.8–6.0)
<5 MR:	12.9/1,000 mo. (95% CI: 9.3–16.5)
<1 mortality:	20%

The most common cause of both childhood and adult deaths was febrile illness, often reported as malaria, accounting for approximately half of all deaths reported. Figures 6-7 show the cause of death among those under five years. Figure 8 shows the number of reported deaths by month in interviewed households. No apparent decline in the crude mortality is seen.

This mortality rate is markedly higher than that measured in the Katana survey in 2000. Residents and IRC staff were asked informally what had changed since the preceding year. Both groups reported that security had diminished and many household members slept outdoors due to security concerns. The increase in malaria mortality between 2000 and 2001 accounts for all of the increase in the CMR.

Kabare (South Kivu Province)

Households visited:	300
Sample population:	1,778 alive at the time of interview (Avg. HH size= 5.9)
Population from which sample is drawn:	112,000
Pop. <5 years of age:	19% (333 alive at the time of interview)
CMR 1/00 – 3/00:	4.4 deaths/1,000/mo. (95% CI: 3.7–5.1)
<5 MR:	5.6 deaths/1,000/mo. (95% CI: 4.0 – 7.2)
<1 mortality:	20%

Among those households interviewed, children under five reportedly died mostly of febrile illness, malnutrition and measles (Figure 9). Among those five and older, malaria, violence and diarrhea were the most common causes of death (Figure 10). Seven deaths were related to uvulectomies, prevalent in Kabare during the 2000 survey. A review of the number of deaths-per-month shows no apparent decrease in the mortality rate over the recall period.

Lubunga (one of three health zones in Kisangani, Orientale Province)

Households visited:	300
Sample population:	2,317 alive at the time of the interview (Avg. HH size = 7.7)
Population from which sample is drawn:	157,000
Pop. <5 years of age:	17% (395 alive at the time of the interview)
CMR 1/00 – 4/6/01:	2.8 deaths/1,000/mo.
<5 MR:	6.9 deaths/1,000/mo.
<1 mortality:	19%

Febrile illness, often attributed by family members to malaria, was the primary reported cause of death among children and adults in Lubunga. Among children, measles, malnutrition and respiratory disease were the next most common causes of death (see Figure 11). Among those five and older, TB and diarrhea were the next most common causes (Figure 12). There is no apparent increase or decrease in mortality over the course of the recall period.

Lusambo (RCD-controlled Kasai Orientale Province, not in eastern DRC, not included in later discussions about mortality in the eastern provinces.)

Households visited:	200
Sample population:	1,288 alive at the time of the interview
Population from which sample is drawn:	113,000
Pop. < 5 years of age:	16% (203 alive at the time of the interview)
CMR 1/00 – 3/8/01:	3.0 deaths/1,000/mo. (95% CI: 2.1–3.9)
<5 MR:	10.0 deaths/1,000/mo. (95% CI: 6.5–13.5)
<1 mortality	18%

Among the households interviewed in Lusambo, an estimated 55 children were born over the preceding 14.25 months. This is identical to the number of deaths reported in these households. Febrile illness, usually called malaria by the interviewee, was the primary cause of death. Among children under five, measles, convulsions and respiratory infections were the next most common causes. Among family members five and older, hernias and diarrhea were the next most common causes of death. The significance of the five hernia-attributed deaths is not clear to the investigators although all were male.

VI. OVERALL FINDINGS

1) There is a dearth of children.

As in 2000, there appear to be far fewer young children than older children in the surveys conducted in 2001. Figures 13–18 show the number of children under five in the sample populations as a function of their age. Consistently, there are significantly fewer children one and two years old than three and four years old. This is evidence that the mortality experience has changed over the past four years.

The fraction of the population alive in the various survey samples who are children under five appears to be inversely associated with the level of mortality measured, and the time between the start of the war and the survey. In particular, in Kalemie and Kalima in 2001, the samples under age five are only 14.6% and 14.3% respectively. In Katana, where the IRC has surveyed the population each of the past three years, the fraction of children under age five compared to the entire sample population has gone from 224/1038 to 223/1219 to 313/1803 (Chi squared for trend, p=.03), a reduction from 21% to 17%. This is particularly noteworthy given the high mortality rates experienced by everyone else in the population.

Finally, the mortality rate experienced by all children in the surveys is extraordinary. Table 1 shows the results of the 11 mortality surveys conducted in eastern DRC since the onset of the war in August 1998, plus the survey from Lusambo in Kasai Orientale Province. Note that five of the seven locations in eastern DRC have an under-five mortality rate over 10/1,000/month. While rates this high frequently are recorded during public-health crises, these appear to have been experienced for years. A continuous under-five mortality rate of 10/1,000/month means that 60% of children die before their fifth birthday! These findings are in no way normal or a background rate, but instead indicate a health crisis.

2) Violence and death from other causes are linked.

Figure 19 shows the rate of death from violence and the rate of death from other causes in the seven areas of eastern DRC where the IRC has conducted surveys. (Multiple surveys in the same area have been averaged; Lubunga is considered part of Kisangani). There appears to be a correlation between areas with more violence and areas with higher death rates from non-violent causes, specifically infectious diseases and malnutrition. We believe that people in those areas with the most violence suffer the most displacement (but we did not attempt to measure the phenomenon). This makes them vulnerable to disease and death. Also, we strongly suspect that increased violence disrupts the economy and destroys the health-care system.

3) **Violence is indiscriminate and perpetrated by all sides.**
In the surveys, deaths that were caused by a person with a weapon or by beating were considered violent deaths. Thus, while a small fraction of these deaths may have been the unintentional consequence of the actions of combatants (such as a two year-old who aspirated vomit and died during a mortar attack), it is believed that the majority of the reported violent deaths were intentional murders. Approximately two-thirds of the victims were shot, with burnings, stabbings and hackings accounting for most of the others. Figure 20 tracks violent deaths by age group and gender. Figure 21 tracks those responsible for the deaths, according to interviewees. Evidence indicates that all sides in this conflict have been complicit in widespread and intentional murder.

4) **Pregnant women experience unique risks in eastern DRC.**
In the five surveys conducted in 2000, there were 3% as many maternal deaths as births. Maternal mortality was not reported separately from Kabare and Kisangani, but maternal deaths and births were reported in the other four surveys conducted in 2001: Kalemie 10/149, Kalima 5/73, Katana 0/74 and Lusambo 1/55. This tally translates to a 5% maternal mortality ratio.

Similarly disturbing is the fact that while not asked, five of the adult females who suffered violent deaths were reportedly pregnant: one in the sixth month of pregnancy, one in the eighth month, and the other three unknown. Two were shot, two died of heart attacks during episodes of violence and one was strangled during or after being raped. If five of 32 adult female deaths were pregnant women, and four were believed to be over 65 years of age, then 18% of reproductive-age women killed were likely to have been pregnant. Making some assumptions (women experience 6.2 pregnancies per lifetime [State of the World's Children, 2001. UNICEF, NY], and women have 30 child-bearing years), and combining these assumptions with the suspicion that the five reported deaths involved women in the last half of their pregnancy, it would appear that pregnant women are two to three times as likely to die a violent death than are other women. While these small numbers have little statistical meaning, they merit further investigation into the possibility that pregnant women are killed disproportionately.

5) **An estimated 2.5 million deaths have been caused by this war.**
IRC has now surveyed approximately 2,600 households from seven populations in eastern DRC, with results that represent the mortality experience of 1.27 million people. In four of these seven survey areas, at least 8% of the population is dying per year (see Table 1). In five of the seven populations surveyed, deaths exceeded births among interviewed household members. In the other two populations, Lubunga and Kabare, the rate of natural growth (births minus deaths) is now less than 1%, while the annual population increase was documented to be 3% in both areas during the 1990's. These results are not subject to poor

population estimates or a misperception of population whereabouts. The deaths were attributed to the population of the households interviewed, and the survey results are the sum of many household rates.

Unfortunately, stating that more than half the places surveyed experienced 6.5 deaths/1,000/month or greater is not meaningful to most policymakers. Moreover, the data contained in this report will most likely be the best record of the mortality experience in eastern DRC for the near future. Therefore, we will attempt to extrapolate our findings for 1.3 million people to the 19.9 million people who lived in the eastern five provinces of DRC in 1996 (Source: Zaire Bureau of Statistics, Bukavu 1996). In order to maintain the focus on the general magnitude of this crisis rather than the precision of an exact estimate, we believe we are conservative in our assumptions.

In order to extrapolate these findings, we made the following assumptions:

- The baseline mortality rate in this region was 1.5/1,000/mo.
- The population would grow 3% per year in peacetime.
- Where the crude mortality rate is greater than 4.8%/year (baseline rate of 1.5/1,000 mo. + 3% growth), the population decreases at a rate equal to the percent dying per year, minus 4.8%. Correspondingly, where the CMR has been less than 4.8% per year, the population has increased at a rate of 4.8% per year minus the yearly CMR.
- The 1996 Zaire Ministry of Health population figures are a reasonable estimate for the populations of the eastern provinces for the period beginning August 1998.
- In places documented by multiple surveys, the best estimate of the overall experience is an average of the two measures, weighting the measure proportional to the length of recall period during this conflict.
- The overall mortality experience in North Kivu Province has been similar to the overall experience in South Kivu Province.
- The mortality experience in Manima Province has been similar to that of Kalima Health Zone.
- The mortality experience in Orientale Province has been as bad or worse than Lubunga and Kisangani Health Zones.
- Katanga Province can be thought of as three distinct and approximately equally populated areas, one controlled by the RDC, one by the Kinshasa forces, and one by neither side or one or the other intermittently.
- The mortality experiences of Kalemie and Moba represent all of the RDC-controlled areas of Katanga.
- Areas of Katanga controlled by neither side have at least one half the excess mortality experienced by areas of Katanga controlled by the RCD..
- The mortality in areas of South Kivu can be reasonably attributed a mortality rate based on knowledge of the seven survey areas assessed and their similarities to the areas not surveyed with regard to access and security.

Table 3 estimates the mortality experienced in South Kivu Province. Table 4 estimates the overall number of deaths in the eastern DRC since August 1998.

It is estimated that ***approximately 2.5 million people have died as a result of this war,*** above and beyond the million people who might have been expected to die otherwise. Approximately 350,000 of these deaths are believed to have been from violence.

6) The mortality rates are increasing.

IRC revisited three of the sites surveyed in the early months of 2000. Two of these sites, Katana and Kabare, experienced a 50% or greater increase in the CMR since the previous year. In a third location, Lusambo, mortality remained unchanged. In the two new eastern areas surveyed this year, Kalemie and Kalima, the mortality rate has increased over the recall period. Thus, it appears that over the past 11 months, the mortality rate has not improved and probably has gotten worse in eastern DRC.

VII. LIMITATIONS

There are several limitations to these surveys that should be considered by those who will use these data. Some of these include:

- The areas visited may not have been typical of eastern DRC. In particular, local officials and Congolese protested repeatedly that interviewers were going to the safest areas and their findings would understate the severity of the situation. Given that adequate security was one of the major criteria for selecting sites to visit, this criticism is probably valid.

- There was no follow-up or confirmation of the information provided by interviewees. This has two problematic aspects: People may have lied to interviewers or may have been mistaken about the cause, month or age of reported decedents. Interviewers and survey staff are convinced that families were not inventing deaths, and that the overall CMR estimates are probably accurate. The survey staff are equally convinced that some cause of death data are suspect. For example, less than 10 AIDS-related deaths were reported, even though Congo suffers from an AIDS epidemic and two of the visited areas (Kalima and Lusambo) had households report that TB was one of the two primary causes of death. Likewise, malaria, fever and diarrhea deaths may not be distinguishable from malnutrition. It is believed that violence-related deaths have not been over-diagnosed by the households and, if anything, incentives existed to underreport violent deaths.

- Spatial sampling is suspect to a rural bias. That is to say, those in the most sparsely populated areas are over-sampled. The staff are convinced that this bias is not at play in the surveys, because in most areas (Lubunga, Moba, Kalemie, Kalima, Lusambo), the population lived in distinct villages or towns and a cluster of 10 houses was usually assigned within a village. In the rural samples of Katana, analysis of the data as a function of population density (data not shown) found no correlation between population density and the mortality rate within a cluster. In this case, GPS-based sampling probably helped combat the common biases related to ease of access, as well as imperfect knowledge concerning village and population locations.

- The recall period may be too long for accurate mortality reporting. Because surveys typically involved 14 to 16 month recall periods, deaths occurring more than a year before may be remembered as being closer in time than they really were, or may be forgotten. Recall cut off dates were chosen around Christmas, the most noteworthy holiday in this region, to avoid this bias. Moreover, as most surveys asked 2 questions, deaths in the preceeding couple of months and deaths during the preceding year, rates from early and late in the recall period could be compared. In most surveys, the report mortality was higher in the preceding couple months than is was during those same months the year before. While this may be because mortality is increasing over time, a large bias of "extra" deaths in the early part of the recall period would likely show the opposite result. We have no way of testing if deaths were forgotten, but we feel that this is highly unlikely.

- The overall death toll of 2.5 million fatalities was estimated, not measured. This estimation is fraught with potential for error. Some inclination of the magnitude of this imprecision can be obtained by substituting a range of plausible assumptions into our mortality estimate. A test of the most influential assumptions follows below.

VIII. SENSITIVITY ANALYSIS

Consideration 1: Change the assumption about the baseline mortality rate.

Lowest Reasonble Baseline Mortality Rate
The lowest reasonable CMR to use as a baseline is: 1.1/1,000/month. This is the given rate for the (assumed) government-held areas of DRC [see: State of the World's Children, 2001, UNICEF, NY 2000].

Using this baseline mortality rate would result in **2.8 million excess deaths.**

Highest Reasonable Baseline Mortality Rate
The highest reasonable CMR to use is: 2.0/1,000/mo. This is the highest national mortality rate in the world [Sierra Leone] according the UNICEF [see: State of the World's Children, 2001, UNICEF, NY 2000]

Using this baseline mortality rate would result in **2.3 million excess deaths.**

Consideration 2: Change the assumption that Orientale Province is experiencing the same mortality rates as Lubunga and Kisangani.

Lowest Reasonable Assumption of Number of Excess Deaths in Orientale Province
The lowest reasonable assumption is that there were NO excess deaths in Orientale Province.

Using this assumption, the total number of excess deaths would be **2.2 million.**

Highest Reasonable Assumption of Number of Excess Deaths in Orientale Province
The highest reasonable assumption is that the excess mortality rate in Orientale Province was similar to that of South Kivu Province.

Using this assumption, the total number of excess deaths would be **3.1 million.**

Consideration 3: Change the assumption that the North Kivu is experiencing the same mortality rate as South Kivu.

Lowest Reasonable Assumption of Number of Excess Deaths in North Kivu.
The lowest reasonable mortality rate to apply to North Kivu is that the rate of excess mortality is only half as high in North Kivu as it was in South Kivu.

Using this assumption, the total number of excess deaths would be **2.3 million.**

Highest Reasonable Assumption of Number of Excess Deaths in North Kivu
The highest reasonable mortality rate to apply to North Kivu is that the rate of excess mortality in North Kivu is similar to that experienced in Kalima.

Using this assumption, the total number of excess deaths would be **2.7 million.**

Consideration 4: Change the assumptions about the mortality rates applied to Katanga Province.

Lowest Reasonable Assumption
The lowest reasonable assumptions about the mortality rates applied to Katanga Province would be that the Moba and Kalemie rates only represent the RCD areas; that the one-third area of Katanga in 'no-man's land' has only experienced low level conflict as seen in Katana; and that the government areas have experienced no excess mortality.

Using this assumption, the total number of excess deaths would be **2.3 million.**

Highest Reasonable Assumption
The highest reasonable assumptions about the mortality rates applied to Katanga Province would be that the Moba and Kalemie rates are typical of all of Katanga.

Using this assumption, the total number of excess deaths would be **3.6 million.**

Consideration 5: Change the assumption that the war has been displaying effects evenly over the 33 month period of August 1998 through April 2001.

Lowest Reasonable Assumption
The lowest reasonable assumption would be that the mortality rate initially remained unchanged and took five months to increase to the rates detected by our surveys.

Using this assumption, the total number of excess deaths would be **2.1 million.**

Highest Reasonable Assumption
The highest reasonable assumption would be that the CMR of 6/1,000/mo. measured in Katana in the first months of the war (indicating twice as much excess death as the period after January 1999 in Katana) was typical of the excess mortality throughout the eastern provinces during the first five months of the conflict. That is, excess mortality was twice as high during the initial attacks and displacements and this initial elevation lasted for five months.

Using this assumption, the total number of excess deaths would be **2.9 million.**

IX. DISCUSSION

The results of these surveys can be interpreted two ways: in a strict epidemiological sense, as in, "Four of seven areas visited have 8% or more of the population dying annually and deaths outnumber births in those areas by two or three to one"; or as a conclusion, as in, "Approximately 2.5 million excess deaths have occurred in eastern DRC, making this perhaps the most deadly African conflict in recent decades." Both interpretations are functionally identical; they strongly imply that a horrific situation has evolved in eastern DRC. This report should elicit one of two responses from epidemiologists and policymakers alike. Either the results are suspect and a trusted independent institution should be charged with evaluating the situation; or the results are credible and should be accepted. If the results are accepted, they indicate (as suggested in the Humanitarian Times, June 2000) that more people have died in this war since August 1998 than have died in all of the other wars in the world combined over this period. The diplomatic and humanitarian response therefore should be proportional to the gravity of the situation.

Given the anecdotal evidence of the areas of conflict in Katanga over the past year, and given the reported levels of violence in North Kivu, it is difficult for the investigators to imagine a scenario where the excess death toll induced by this war is presently less than 2 million. The sensitivity analysis shows that the range of possible results spans from horrific to horrific. It is hoped that this report will be seen not just as a death toll, but also as a portrayal of hardship useful to guide humanitarian efforts.

In this regard, the mortality profiles indicate that the underserved areas of eastern DRC need:

1) Security and corresponding humanitarian access and,

2) The logistic and financial capacity to treat malaria and diarrhea and other treatable illnesses. (For example, measles deaths, perhaps the easiest and least expensive of all diseases to combat, were reported in five of the six areas surveyed last year.)

Several aspects of this data portend human suffering. Aside from the mortality rates themselves, having approximately 3 to 4% as many maternal deaths as live births (in a collective sample which represents 1.3 million people depicts a situation of extreme suffering. Figures 13-18 portray a shortage of young children that can only be explained by decreased fertility, increased infant mortality or decreased conception. The high estimates of under-five and under-one mortality found in the surveys implicate increased infant mortality as the most likely explanation. Finally, the 11 surveys encompassing 18,450 people in the eastern provinces recorded 148 violent deaths. Given that an average household has seven people, that violent deaths tend not to cluster, and that the surveys typically covered a period between 14 and 16 months (less than half the war), the findings indicate that one in eight households has experienced the murder of a family

member in a 33-month period. This level of violence and social disruption is difficult to fathom for people in a stable nation.

The findings in this report are corroborated by reports from other organizations. In January 2001, Merlin conducted a nutritional survey in Kalima Health Zone that included questions about deaths in the household. The Merlin estimate of mortality was 10/1,000/month, as compared with 7.5 in the IRC Kalima survey. These two results are consistent: The Merlin survey covered a three month period beginning in late 2000; the IRC survey covered 14 months beginning in January of 2000. Specifically, in the IRC data, the mortality rate increased over the course of the year (see Figure 5). Thus, the IRC estimate of mortality from October to December 2000 (9/1,000/mo.) or November to January (12/1,000/mo.) is similar to the Merlin finding. The World Food Program has been quoted as saying that a recent nutritional survey in South Kivu found more malnourished adults than children. They interpreted these results to mean that the malnourished children had already died. Human Rights Watch released a report in May of 2000 entitled "Eastern Congo Ravaged: Killing Civilians and Silencing Protest" which, in human-rights terms, portrayed the severity and geographic breadth of the situation in language consistent with this epidemiological assessment. Human Rights Watch described geographically dispersed and indiscriminant violence on a massive scale.

While the report paints a bleak picture of the conditions of life—and death— in eastern DRC, in no way should this report dishearten those determined to ameliorate human suffering in Congo. Both in terms of security on the ground, and the political climate since the death of Laurent Kabila, the situation in Congo has become more hopeful. Because of increased openness and communication with the humanitarian community, NGOs are gaining access to areas on both sides of this conflict that have not been visited by aid workers since the start of the war. The arrival of UN troops in DRC has the potential to further increase the stability of and access to the region. Many Congolese organizations and government workers are becoming adept at operating in the bizarre setting of this conflict. It is hoped that this report will be seen as an account of what has been, and will redouble the world's efforts to capitalize on the new opportunities for improving what can be.

Table 1: Summary of Mortality Surveys Conducted by IRC in Eastern DRC Since 1998.

Place & Date	Live in HH int.	CMR – Deaths/1,000/mo	<5 Mort.	Methods
Katana, 1/98 – 2/99	1051	3.8 (2.2 – 5.4)	10.1	Spatial grid, clusters spaced 1Km. E. to W., 3.5 Km No. to So.
Katana, 1/99 – 4/00	1219	3.0 (2.2 - 3.9)	6.9	" " " 7 Km No. to So.
Katana, 1/00 – 3/01	1803	4.9 (3.8 – 6.0)	12.9	2 stage, syst., proportional to pop. assignment of clusters, random grid to find starting pt.
Kabare, 1/99 – 4/00	1273	2.7 (2.0 – 3.8)	5.8	" " " "
Kabare, 1/00 – 3/01	1778	4.4 (3.7 – 5.1)	5.6	" " " "
Kisangani, 1/99 – 3/00	2305	2.9 (2.3 – 3.9)	4.8	" " " "
Lubungu, 1/00 – 3/01	2317	2.8 (2.1 – 3.6)	6.9	" " " "
Moba, 1/99 – 5/00	1212	12.1 (10.5 - 13.8)	24.5	" " " "
Kalonge 1/99 – 4/00*	1330	6.4	14.1	Spatial based convenient sampling, rural and urban via dif. Methods
Kalamie 1/00 – 3/01	2204	10.8 (9.5 – 12.1)	23.8	2 stage, syst., prop. to pop. Clusters, random grid to find pt.
Kalamie, 1/00 – 3/01	150 HH	4/122 HH dead (3%), 4/122 most dead (3%)		10 clusters in Kalamie survey (on 2 axies) had additional survey tacked on regarding fate of those who were neighbors at start of war.
Kalima, 1/00 – 3/01	1958	7.5 (6.3 – 8.7)	17.1	2 stage, syst., prop. to pop. Clusters, random grid to find pt.
Lusambo 1/00 – 2/01**	1288	3.0 (2.1 - 3.9)	10.0	" " " "

* Because the Kalonge survey was not a probability survey, and was not sampled evenly with regard to space, this survey has the greatest limitations in terms of validity.

** Not in eastern DRC, not to be included in extrapolations.

Table 2: Characteristics of Mortality Surveys Conducted by IRC in Eastern DRC Since 1998.

Place & Date	Live in HH	CMR – Deaths/1,000/mo	Basic Design Clusters X HH/clust.	Design Effect	Pop. of Area	Pop. of accessible areas, actually surveyed
Katana, 1/98 – 2/99	1051	3.8 (2.2- 5.4)	32 X 5 spatial	2.67	285,000*	285,000*
Katana, 1/99 – 4/00	1219	3.0 (2.2 - 3.9)	34 X 5 spatial	1.02	305,000*	305,000*
Katana, 1/00 – 3/01	1803	4.9 (3.8 – 6.0)	30 X 10 2 stage	1.75	347,000	347,000
Kabare, 1/99 – 4/00	1273	2.7 (2.0 – 3.8)	40 X 5 2 stage	1.11	111,000	111,000
Kabare, 1/00 – 3/01	1778	4.4 (3.7 – 5.1)	30 X 10 2 stage	0.79	112,000	112,000
Kisangani, 1/99 – 3/00	2305	2.9 (2.3 – 3.9)	48 X 5 2 stage	1.35	402,000	402,000
Lubunga, 1/00 – 3/01	2317	2.8 (2.1 – 3.6)	30 X 10 2 stage	1.93	157,000	157,000
Moba, 1/99 – 5/00	1212	12.1 (10.5 - 13.8)	40 X 5 2 stage	1.6	~100,000 62,000 officially	~100,000
Kalonge 1/99 – 4/00	1330	6.4	Spatial convenient	NA	62,000	59,000 (95%)
Kalamie 1/00 – 3/01	2204	10.8 (9.5 – 12.1)	30 X 10	1.66	~400,000	196,000 (~49%)
Kalima, 1/00 – 3/01	1958	7.5 (6.3 – 8.7)	30 X 10	1.62	154,000	91,000 (59%)
	N = 18,450				Total = 1,576,000	Total=1,268,000

*2001 # used for Katana, even though all of this growth is believed to be due to the arrival of displaced who probably had a higher mortality than the residents.

Table 3: Estimation of Overall Mortality Rate for South Kivu

Place	population	Similar to	Excess Rate**	17mo. Deaths 8/98-12/99	16 mo. Deaths 1/00 - 4/01	Total over 33 months
Bukavu	350,000		0			
Bunyakiri	213,188	Kalonge & Katana	3.7	13410	12553	25943
Fizi*	184,538	Moba & Kalamie	9.95	31208	27463	58671
Idjwe	111,692	Kabare	2.2	4178	3963	8141
Kabare	130,000	Kabare	2.2	4862	4613	9475
Katana	305,000	Katana	2.4	12444	11782	24226
Kaziba	115,512	Kabare	2.1	4123	3916	8039
Lemera	120,160	Kalonge	4.9	10013	9247	19258
Mwenga*	273,712	Kalima	6.0	27917	25487	53404
Nundu*	165,000	Moba & Kalamie	9.95	27909	24561	52470
Nyangezi	115,000	Kabare	2.2	4301	4080	8381
Shabunda*	125,556	Kalima	6.0	12811	11696	24507
Uvira*	263,103	Kalima	6.0	26836	24500	51336
Walungu	375,907	Katana	2.4	15337	14521	29858
						373,709

*Correct for survivor bias in high violence areas by adding 3% of population to death toll = 30,357

** Excess death rate is the CMR, the assumed baseline (1.5), as deaths/1,000/mo.

Estimated total deaths in South Kivu = 404,066 out of a late 1999 population estimate of 2,848,400 = 14.2% of population, or an excess CMR of 4.3/1,000/mo. The 1996 population estimate of 3.028 million will be used as a population for August 1998. These two numbers are consistent in the sense that the overall population is suspected of declining during this period.

Table 4: Estimation of Deaths from August 1998 – April 2001 in Eastern DRC

Area	Pop. in 1996 in millions	Excess Rate	17 mo. Deaths 8/98-12/99	16 mo. Deaths 1/00 – 4/01	Total over 33 months
Maniema	1.353	6.0	138,006	122,112	260,118
South Kivu	3.028	4.3	221,347	202,014	423,361
North Kivu	3.515	4.3	256,947	234,504	491,451
Orientale	5.691	1.3	125,771	120,740	246,511
Katanga RCD	2.106	9.95	356,230	292,728	648,959 (+3%) = 712,139
Katanga Gov.	2.106	0	0	0	0
Katanga Neither	2.106	5.0	179,010	163,426	342,436(+1.5%) =374,026

Total = 2,507,606