Rapid Needs Assessment and Loss Estimation from Natural Hazards: Lessons Learned from Hurricane Marilyn, U.S. Virgin Islands

by

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ABSTRACT

Rapid epidemiologic assessment of needs and estimation of losses in areas affected by disasters is becoming recognized as one of the most important first steps in guiding the relief and recovery efforts (1). A cluster sampling technique adapted from one developed for the Expanded Program on Immunizations of the World Health Organization is currently being refined. This technique was used in the United States Virgin Islands after Hurricane Marilyn (and in Florida after Opal). In this paper, the results of that work, and the lessons learned, are summarized. In addition, future directions for further refinement of the technique are discussed.

KEYWORDS: disaster; cluster survey; hurricane; needs assessment; loss estimation

1. INTRODUCTION

On September 15 and 16, 1995, Hurricane Marilyn struck the U.S. Virgin Islands (St. Thomas, St. John and St. Croix). The greatest extent of damage was to St. Thomas, the most populated of the three islands, and the economic center of the islands.

In the aftermath of the hurricane, U.S. Federal relief plans came into effect, and soon approximately 3000 Federal workers were transported to St. Thomas to assist in relief and recovery.

Disaster managers needed to identify health and medical needs of the population on the island, and also to estimate the nature and extent of structural damage. Initially, no reliable information was available. A team of epidemiologists from CDC, began the daunting task of estimating the damage.

2. METHODS

In order to survey the island, a cluster sample survey design was chosen, based on the one used by the Expanded Program on Immunization (EPI) of the World Health Organization for assessing vaccination coverage levels in areas for which lists of inhabitants are not available (2,3) This technique had been used for needs assessment after Hurricane Andrew devastated Florida in 1992 (4).

In addition to the proportional estimates of needs used in previous experiences, we attempted to use a new modification to the sampling technique to enable the estimation of the *number* of people remaining in the affected area, as well as the *number* of housing units damaged and destroyed. This technique had been proposed, (5) but never field-tested.

2.1 Cluster Selection

We obtained an accurate map of St. Thomas from the FEMA Disaster Field Office, and divided the island into 440 clusters (Figure 1).

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Each cluster was approximately 0.5 miles by 0.5 miles. Based on estimates of population density provided by the U.S.Census (1990 population of St. Thomas 48,166) and the Virgin Islands Department of Health, we stratified the 440 clusters into 4 zones: East, North, Central (encompassing the only city, Charlotte Amalie) and West.

A random sample of clusters from each zone was chosen, with the number chosen in each zone proportional to the population density. A total of thirty clusters was chosen, with replacement.

2.2 Housing Unit Selection

The sampling units within each cluster were housing units, defined as a building, or part of a building, used to house a group of associated individuals such as a family. A total of 7 housing units were chosen from each cluster, by random selection similar to that used in the EPI method.

Our survey was not concerned only with particular attributes of surveyed *individuals* (access to drinking water, for example): we also wanted to assess attributes of included housing units. Housing units that were not occupied, or were destroyed, were therefore included in our survey, unlike the standard EPI method.

2.3 Total Housing Unit Counts Per Cluster

In order to estimate population remaining on the island, and to estimate numbers of damaged and destroyed housing units, according to the method proposed by Malilay *et al* (5), it was necessary to count, if possible, or estimate the total number of housing units per cluster.

2.4 Survey Content

The survey team rated the housing unit as either destroyed/uninhabitable, substantially damaged or undamaged. The survey team interviewed an adult member of every housing unit selected, if there were inhabitants. Adult members of each housing unit were asked about the number and the age of inhabitants, number of sick and injured persons, supply of food and water, access to sanitary facilities, method used for purifying water, access to telephone and motorized transportation, and attentiveness to local radio broadcasts.

2.5 Analysis

Data were analyzed in the Microsoft Excel software program using the cluster sampling methods described by Malilay, *et al* (5).

3. RESULTS

A survey was conducted approximately one week after the hurricane, and again one week later. There were no inhabited housing units without at least one adult. Data were analyzed in the Microsoft Excel software program.

The results of the two surveys are presented below in two categories: proportional estimates and numerical estimates of population (counts).

3.1 Proportional Estimates of Needs

Table 1 shows the results of the proportional estimates for both iterations of the survey.

11% of inhabitants included in the first survey (14% in the second survey) were living in (i.e., camping on the site of) housing units that were completely destroyed, with 67% (78%) in housing units that were damaged but habitable.

The proportions of ill and injured persons were low: 5% (10%) and 2% (4%), respectively. Nearly 100% of inhabitants surveyed were purifying their water in some way, and had access to a flushing toilet.

Most importantly, only 12% (9%) of inhabitants reported access to a working telephone, but 86% (89%) had access to a motorized vehicle, and nearly 100% were monitoring local radio broadcasts.

3.2 Numerical Estimates of Population

The 1990 U.S. Census for the Virgin Islands reported the St. Thomas population as 48,166 persons.

Our initial estimates of the population remaining on St. Thomas after the hurricane were based on our field estimates of housing units per cluster. In many cases we had to estimate, rather than count, the numbers of housing units per cluster. The resulting population estimates were an improbable 69,082 for the first survey and 112,030 for the second survey.

Suspecting that inaccurate estimates of housing units per cluster were causing the inaccurate estimates of population, we modified the technique to incorporate 1990 U.S. Census housing unit counts. Specifically, we correlated census Block Numbering Areas (BNAs) with the zones of our sampling map. We then divided the total number of housing units given for the BNAs in a particular zone by the total number of clusters in that zone, giving us a figure for housing units per cluster.

The estimates made using this modified method were 53,640 for the first iteration and 55,898 for the second The average for the two iterations was 54,769.

4. DISCUSSION

4.1 Proportional Estimates of Needs

The estimates of needs provided by us to disaster managers were invaluable in shaping mitigation strategies.

An example of this concerned communication with the affected population, and transportation. Initially, disaster managers were issuing informational bulletins on local radio stations, and mentioning a phone number to call for further information, or to report an urgent need for assistance. In addition, initial plans called for house-to-house provision of essential items, a very time- and personnel-intensive endeavor.

As our survey showed, however, only a small proportion of the affected population had access to a telephone. A large proportion, however, had access to a motorized vehicle, and attention to local radio broadcasts was almost universal.

As a result, disaster managers set up centralized distribution points around the island and publicized these locations on local radio stations. This centralized strategy required fewer personnel and less time, thus freeing up much-needed personnel for other tasks.

4.2 Numerical Estimates of Population

Estimates of population incorporating our field estimates of housing units per cluster were unreliable: 69,082 and 112,030. These numbers were especially unlikely since it was felt that few inhabitants had left the island as a result of the hurricane:[3] one would expect the post-hurricane population to be equal to or slightly lower than the pre-hurricane population. The inaccuracy was the result of difficulty in counting housing units per cluster in the field, a task complicated by rough terrain, over-large clusters, limited maps with very little detail and a very large proportion of unmarked roads.

Realizing that our estimates were not reliable, we obtained an alternative means for estimating housing units per cluster, using 1990 U.S. Census data and overlaying it onto our map.

As reported above, this modification produced

[3]This may have been partly the result of initial weather forecasts which predicted that Marilyn would not significantly hit St. Thomas, and partly because St. Thomas, as an island, has limited routes for departure.

estimates of 53,640 and 55,898. The difference was therefore 2,258, with an average of 54,769.

We later found that the 1995 Population and Housing Survey of the U.S. Virgin Islands[4] produced a population estimate for St. Thomas of 54,259. This estimate differs from our average estimate by only 510.

This very clearly illustrates the importance of obtaining accurate counts of housing units per cluster in order to obtain valid estimates of population.

5. LESSONS LEARNED

As discussed above, it is of critical importance to obtain accurate counts of housing units per cluster. In situations where census data (or other reliable source) is available, this data should be used.

The matter is more complex in instances when accurate housing unit counts are not known. In these instances a number of strategies can be used to increase the ability to good counts of housing units in the field.

5.1 Maps

For a map to be useful for cluster sampling in a disaster setting it must accurately represent the area being surveyed, and must include the names of major natural and artificial landmarks: rivers, roads, etc.

5.2 Cluster design

It is important to realize that while clusters must be exhaustive (i.e., include the entire area being surveyed) and mutually exclusive, they do not need to be the same size. Far more important than uniform size is "manageability". By this we refer to two factors: size and boundaries.

A cluster must be small enough to enable the team to accurately count housing units. A five-mile-by-five-mile cluster will confound even a conscientious effort on the part of the surveyor.

In addition, a cluster should be designed in such a way that the surveyor in the field with map in hand will be able to locate all the boundaries of the cluster. That is, she should be able to "define" the cluster in the field. Defining clusters on a map without incorporating physical boundaries which can be located in the field will render the team unable to find any particular cluster in the field.

6. CONCLUSIONS

We field-tested the modified cluster sampling method described by Malilay *et al* (4). We were able to use it to describe not only proportions of inhabitants with needs, but also to accurately assess the population remaining in the area.

Accurate counts of housing units in the area being surveyed, we found, were critically important to this method.

7. ACKNOWLEDGMENTS

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Table 1. Proportional Estimates of Needs after Hurricane Marilyn, St. Thomas, U.S. Virgin Islands, September 1995 (figures are percentages of persons included in the survey)

HOUSING	**9/23**	**9/30**
housing unit completely destroyed	11	14
housing unit damaged but habitable	67	78
HEALTH		
ill	5	10
injured	2	4
lacking prescription medicines	3	6
purifying drinking water	99	99
access to a flushing toilet	99	99
NUTRITION		
sufficient food for three days	86	88
drinking water within one mile	65	71
TRANSPORTATION/COMMUNICATION		
listening to local radio station	98	99
working telephone	12	9
working motor vehicle	86	89

Figure 1: Map of St. Thomas, U.S. Virgin Islands, depicting clusters chosen for sampling.