In the initial phase of a complex emergency, an immediate population size assessment method, based on area sampling, is vital to provide relief workers with a rapid population estimate in refugee camps. In the past decade, the method has been progressively improved; six examples are presented in this paper and questions raised about its statistical validity as well as important issues for further research.

There are two stages. The first is to map the camp by registering all of its coordinates. In the second stage, the total camp population is estimated by counting the population living in a limited number of square blocks of known surface area, and by extrapolating average population calculated per block to the total camp surface.

In six camps selected in Asia and Africa, between 1992 and 1994, population figures were estimated within one to two days. After measuring all external limits, surfaces were calculated and ranged between 121,300 and 2,770,000 square metres. In five camps, the mean average population per square was obtained using blocks 25 by 25 metres (625 m²), and for another camp with blocks 100 by 100 m². In three camps, different population density zones were defined. Total camp populations obtained were 16,800 to 113,600.

Although this method is a valuable public health tool in emergency situations, it has several limitations. Issues related to population density and number and size of blocks to be selected require further research for the method to be better validated.

**Keywords:** refugee and displaced person camps, population estimates, complex emergencies.

**Introduction**

It is estimated that over 50 million displaced persons and refugees are scattered around the world, most of them in refugee camps (UNHCR, 2000). A rapid initial assessment
Rapid Assessment of Population Size in Disaster Situations

must always be carried out during the first phase of any emergency situation involving large population displacement, where excess mortality is usually reported (Toole, 1990). This should include the estimation of the population figures of the camp(s). However, while the importance of drawing good camp lay-outs has long been recognised (Cuny, 1977; UNHCR, 1982), the use of camp maps to estimate population data has never been documented in the literature.

In the past decade, a rapid population estimate method based on area sampling enabled an assessment of the magnitude of population displacement during disasters, and provided relief workers with the necessary data to plan relief activities (Moren, 1992). This concerned both health-related activities and all aspects of relief planning such as food, water and shelter (CDC-MMWR, 1992). If carried out during the first weeks of acute emergencies, the area-sampling method proved to be useful to estimate population figures within one or two days, while total population census or alternative registration methods were completed several weeks later when the situation had stabilised (Telford, 1997).

This method has been progressively improved and refined over the years. Six examples of its use in refugee camps of Asia and Africa are described in this paper and questions are raised concerning its statistical validity and priority issues for further research.

Area sampling and rapid population assessment method

The method can be implemented in two stages. The first one concerns mapping the camp. In the second stage, the total camp population is estimated by counting all of the population living in a limited number of square blocks of known surface, and then extrapolating average population calculated per block to the total camp surface area.

Mapping the camp

At first a precise map is drawn by walking all around the camp or site. Camp dimensions measured in metres are determined either by measuring the width and length of all camp sections or by measuring all camp sides. A starting-point or landmark is chosen. All external limits of the camp are defined by their bearings. Bearings are measured in degrees by aiming a compass arrow in that direction. Depending on exposure to satellites, in some instances the Global Positioning System (GPS) was used. At each point for which a new direction is taken, GPS provides coordinates for the geographical point at which one is standing. For each new direction taken, when going from one specific landmark to another, distances to cover each side of the camp are measured. Knowing an individual’s precise footstep measure, camp dimensions are worked out by counting the total number of steps needed to cover each side. For large camps, side dimensions are determined by driving around it in a car measuring the distances with the car’s odometer. Although empirical, this approach is necessary in the context of difficult working conditions inherent in emergencies.

When landmark and distance measures are obtained, the map is outlined on paper at a 1: 10,000 scale (one metre measured at field level corresponds to 0.01 centimetre on the paper map) and squares drawn. The map can also be drawn by
entering the latitude and longitude data from GPS in a computer. The camp surface is obtained by counting on the paper map the total number of squares, or from the computer.

**Estimating population size**

To estimate the total camp population, a step-by-step procedure is followed. First, a random sample of five to 12 square blocks is selected on the paper camp map or by computer after numbering all squares. With the compass or GPS co-ordinates, and the distance and angle from a given camp side, each square selected can be identified at field level. Depending on the size of the camp, blocks’ dimensions vary from 25 by 25m$^2$ to 100 by 100m$^2$. Second, population data are collected in each block selected by interviewing all heads of households. A household is defined as all people living under the same roof, or in the absence of shelter as all close family members living together. The average population per block is then calculated, and the total camp population is obtained by extrapolating the average population per block to the total camp surface.

However, population is rarely distributed regularly throughout a camp. Usually, population tends to be more densely gathered in the middle of the camp where most of the facilities are initially located, while it is dispersed at the periphery. For such camps, several ‘density zones’ can be defined to enhance precision. This is done by observation while walking around the camp, or better, by measuring distances between households. For practical reasons, density zones are usually limited to two or three, and each is measured and mapped with all its external limits. To calculate the estimated population, the step-by-step procedure described above is then applied for each density zone. The total camp population is determined by adding up estimates obtained for each population-density area.

**Results: review of the use of the method**

The six situations that we have selected include camps in Bangladesh, Kenya, Tanzania, and ex-Zaire between 1992 and 1994 where population figures were estimated within one to two days and ranged between 16,800 and 113,600 (see Table 1).

**Deschwapalong, Dumdumbia I and Dumdumbia II**

In Bangladesh, 1992, rapid population size assessments were done in three Myanmar refugee camps: Deschwapalong, Dumdumbia I and Dumdumbia II (see Table 1).

At Deschwapalong: on 21 February 1992, the total camp surface was estimated at 121,300m$^2$ by measuring the length and width of the 11 camp sections with dimensions ranging from 40 to 220 metres. High- and low-density zones were defined empirically. Sections where shelters were tightly set up, in between rice fields, constituted the high-density zone. Other sections represented the low-density zone.

Mean population estimates were obtained from six 25 by 25 metre square blocks (625m$^2$) selected at random, of which three were in the high population density zone, and three in the low-density zone.
Table 1  Population estimates obtained by area sampling, six refugee camps in Asia and Africa, 1992–1994

<table>
<thead>
<tr>
<th>Camps</th>
<th>Total surface (m²)</th>
<th>Number squares (25x25m = 625m²)</th>
<th>Number density zone(s)</th>
<th>Mean population/square*</th>
<th>Population per zone*</th>
<th>Total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deschwapalong</td>
<td>121,300</td>
<td>6</td>
<td>2</td>
<td>LD: 71</td>
<td>HD: 181</td>
<td>17,264</td>
</tr>
<tr>
<td>Dundumbia I</td>
<td>212,500</td>
<td>5</td>
<td>1</td>
<td>109</td>
<td>–</td>
<td>37,060</td>
</tr>
<tr>
<td>Dundumbia II</td>
<td>340,000</td>
<td>5</td>
<td>1</td>
<td>81</td>
<td>–</td>
<td>44,064</td>
</tr>
<tr>
<td>Liboi</td>
<td>682,000</td>
<td>6**</td>
<td>2</td>
<td>LD: 410***</td>
<td>LD: 13,202</td>
<td>43,082</td>
</tr>
<tr>
<td>Kumgogo</td>
<td>350,000</td>
<td>12</td>
<td>1</td>
<td>30</td>
<td>–</td>
<td>16,800</td>
</tr>
<tr>
<td></td>
<td>2,770,000</td>
<td>26</td>
<td>3</td>
<td>LD: 7</td>
<td>LD: 12,432</td>
<td>113,600</td>
</tr>
<tr>
<td>Kibumba</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

* LD: low density; MD: medium density; HD: high density.
** In Liboi, six squares measured each 100 by 100m (10,000m²).
*** Mean population per 10,000m².

In April 1992 in a matter of hours, an unknown number of refugees invaded the southern part of Bangladesh, in Cox’s Bazaar district. Exhausted refugees stopped along the main road creating wild camps Dundumbia I and Dundumbia II. On the road, long distances were measured with the odometer of a car, and section widths were measured by foot. Each camp stretched over a distance of 2.5 and 4.0km. Average distance from the main road was 85 metres (range: 20 to 150 metres). Total surfaces amounted to 212,500m² and 340,000m² for Dundumbia I and Dundumbia II, respectively. Due to the emergency, only one density zone was considered. For each camp, the average population living in 25 by 25m squares was calculated from a random sample of five blocks. This represented 109 and 81 refugees per 625m² in Dundumbia I and Dundumbia II, respectively. Based on these figures, the extrapolation to total camp surfaces yielded population estimates of 37,060 and 44,064 refugees.

**Liboi camp**

In Kenya, following the fall of Siad Barre in 1991, a massive flow of Somali refugees was reported in Liboi camp, 18km inside the Kenyan border. In the absence of any census figures, it became urgent to carry out a rapid population size assessment to plan major relief operations. In May 1992, the width and length of all camp areas were measured, and the camp surface was estimated at 682,000m². Depending on distances between tukuls (traditional huts), less than or equal and above 12 metres, two camp zones of high and low population density were defined. The high-density zone near the airstrip and warehouses represented 360,000m². There were 322,000m² of low density.
On the camp map, this amounted, respectively, to 36 and 32.2 blocks of 10,000m$^2$ (100 by 100m$^2$) for each density zone. In each zone, the average population was estimated from a random selection of three 10,000m$^2$ blocks. The average population per 10,000m$^2$ was estimated at 830 and 410 refugees in the high- and low-density zone, respectively. From these results, the total Liboi camp population could be estimated at 43,082.

**Kumgogo camp**

On 10 December 1993, a rapid population size assessment was done in Kumgogo camp, as Burundi refugees fled into neighbouring Tanzania. It was decided to define only one population density zone as shelters were regularly distributed throughout the camp. All external limits of the camp were measured by walking around the camp and angles to the north were measured with a compass. The co-ordinates of 44 landmarks were reported on a paper map (Figure 1), and 35 square blocks of 100 by 100m were counted, representing a total estimated camp surface of 350,000m$^2$. After numbering all blocks, a random sample of 12 blocks was drawn. In each of these 12 blocks, one 25 by 25m block was drawn at random. The population was counted in each block selected, representing an average of 30 refugees per 625m$^2$. By extrapolating these results to the total 350,000m$^2$ camp surface (or 560 blocks of 625m$^2$), the total camp population was estimated at 16,800 refugees.
Kibumba camp
Following the genocide in Rwanda in 1994, over half a million refugees fled to Goma, in the eastern part of ex-Zaire. Using the area sampling method, several camps were mapped and total population was estimated. In the camp of Kibumba, there were three population density zones. All camp landmarks were identified with their GPS co-ordinates and a paper map was drawn. A total of 277 square blocks of 10,000m² (100 by 100m) were counted on the paper map, representing a total estimated camp surface of 2,770,000m². Low-, medium- and high-density zones represented 1,110,000m², 890,000m², and 770,000m², respectively. For each density zone, a random sample of six, eight, and 12 blocks 25 by 25m was drawn. The population was counted in each block, yielding an average of seven refugees per 625m² block for the low-density areas, 20 for the medium density and 59 in the high density. By extrapolating these results to the total surface area, for each zone estimated this represented populations of 12,432, 28,480 and 72,688. By adding up these results, the total camp population calculated was 113,600 refugees.

Discussion
In the past decade, rapid initial assessments have been recommended as the most important first step in guiding an emergency response (Glass, 1992). It has also been commonly admitted that rapid population size assessments were necessary to prioritise emergency health responses (UNHCR, 1999; MSF, 1999). Our review of six examples of rapid assessment of population figures confirms the efficiency of the area-sampling method in providing population estimates within one to two days, even in dramatic circumstances. During the first weeks of such emergencies, population estimates were useful in providing baseline data for immediate planning and to measure mortality. Census data were obtained a few weeks later.

The validity of the method could only be evaluated in Liboï, where a population census conducted a few weeks after our assessment estimated the camp population at 45,000 refugees (UNHCR, June 1992), as compared to the 43,000 figure obtained with the rapid population assessment method. No important population displacement was registered between the two events. However, high discrepancies in total population figures occur, depending on the sources. For instance, concerning Rwandan refugees in Goma camps, total numbers varied from 500,000 to 800,000 (Goma Epidemiology Group, 1995). This underlines the difficulties of obtaining reliable estimates in emergency situations.

Although it is a valuable public health tool in emergency situations, the method presented here has several limitations. In Bangladesh, the evaluation of camp surfaces was mainly based on the measurements of the length and width of all camp sections. In the other examples, the identification of camp co-ordinates with a compass or GPS was likely to achieve better precision. In Kibumba, ex-Zaire (Republic of Congo), the GPS proved to be efficient, although in practice the use of GPS depends on a good exposure and an easy access to satellites (UNHCR, 1999). Before 1 May 2000, access to satellites was still limited by the military. The other matter of concern regarding the method relates to the empirical selection of the population density zones, and to the number of square blocks needed. Stratification per density zone is mainly used as a way to enhance precision. Eventually a single population density zone could
be considered if the sample was constituted with a sufficient number of square blocks. For the time being, this constantly varied between the different camp experiences, and is mainly driven by the working conditions met in emergency, and by logistical constraints. As a matter of fact, the area-sampling method is based more on purposive rather than probability sampling.

The question of selecting the most adequate number and size of square blocks remained unanswered. In our experience, the number of blocks varied from five to 26, and the dimensions of blocks’ sides varied from 25 metres for five camps, to 100 metres for one camp. Statistical principles suggest that the higher the number of square blocks selected, the more accurate would be the samples’ representativeness, and that selecting a higher number of small blocks would be better than relying on fewer 100 by 100m blocks. These hypotheses were confirmed by recent results obtained from statistical modelling (Espié, 2000).

In the absence of any reliable source of population data at the initial phase of emergencies involving major population displacements, it is likely that rapid population estimates will continue to be of prime importance in the future. In our experience, the area-sampling method was limited to refugee camps run by UNHCR. In other camps, population estimates are thought to be most reliable, while this may be different in situations where internally displaced persons are spread over a large area (NRC, 1998).

While using the area-sampling method, experiences reported have tried to respect basic statistical principles, such as representativeness. Nonetheless in the light of aforementioned limitations of the method, issues related to population density and the number and size of blocks to be selected remained unresolved and require further research for the method to be better validated.

Statistical models based on exhaustive population data directly collected from the field would help to test the accuracy of results obtained by rapid population size assessment methods. Statistical validity of rapid population estimates should be tested by comparing results to those of an exhaustive population count, both carried out simultaneously. Alternative area sampling methods such as the T-square are also interesting to consider. Such methods were used in agronomy and relied on the calculation of the average occupancy area of a unit (Diggle et al., 1976). As only the measurements of 50 points selected at random would be necessary, the T-square method could be faster to implement and, thus, useful in situations with limited resources. Nonetheless it is anticipated that the use of such a method may be limited by the heterogeneity of population distribution (Diggle, 1977). In order to improve the accuracy of rapid population estimates, both the area sampling method presented here and the T-square method envisioned, need to be further tested.

References


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