Practical Approaches to Spatial Estimation of Disaster-Affected Populations

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ABSTRACT

When a disaster occurs, the response depends critically on an estimate of the affected population. However, retrieval of crucial statistics can be time consuming, often at the expense of the neediest populations. This article reviews spatial population estimation techniques and datasets that facilitate disaster response and management. The authors conclude that the LandScan population distribution estimates best suit the needs of Population Explorer, an Internet GIS that presents a way to quickly deliver answers to queries about local population and demographic composition to users who may not be formally trained in GIS or demography. By referencing LandScan population distributions, Population Explorer retrieves adjusted, official census population counts, for user-defined point buffers, line buffers, or polygons on a global map. Participants from a variety of agencies, i.e., government and non-government, local and international, can collaborate in updating baseline population estimates with local information that can then be queried with the baseline counts.

Keywords: Disasters, Disaster Response and Management, GIS, Population Estimation, Spatial Population Estimation

INTRODUCTION

There is a consensus that good demographic data are a precondition for good planning (Duffy & Behm, 1964; Hirschman, 1981; Keyfitz, 1993; National Research Council, 2007b; Preston, 1993). However, a number of enumeration challenges arise in disaster prevention and response (Board on Natural Disasters, 1999; Noji, 1992; Wallace & Balogh, 1985), as catastrophic events rarely respect the administrative or political boundaries for which official population data are collected (Wood, 1994). Furthermore, official demographic data tend to be weak, outdated, and statistically representative only at relatively high levels of administrative aggregation in...
many developing countries (Brown, 1971; Grosh & Glewwe, 1996; Nordhaus, 2006). Despite deficiencies in this information, there has generally been no more objective alternative available to use to estimate the number of crisis or conflict-affected populations, much less to provide programmatically-important information on age and sex cohorts and groups with special needs (such as orphans, pregnant women, or HIV/AIDS infected populations).

The recent availability of global gridded population datasets holds promise for quick and accurate retrieval of spatial population estimates (Deichmann, Balk, & Yetman, 2001). However, two major obstacles limit the ability of humanitarian organizations, ranging from the United Nations to NGOs, to access demographic geo-data: first, the underlying data range widely in quality and are not accepted as official statistics (Deichmann, 1996), and second, demographic geo-data are readily accessible only to experts in Geographic Information Systems (GIS). In a sense, spatial demographic estimates are locked away from the neediest information-seekers (e.g., Balk, Gorokhovich, & Levy, 2005; Lerner-Lam, Seeber, & Chen, 2005; National Research Council, 2007a). This article begins to address these concerns by reviewing available population databases that provide flexible, spatial estimates. Of the datasets reviewed below, the LandScan dataset (Dobson, Bright, Coleman, Durfee, & Worley, 2000), developed by Oak Ridge National Laboratory, is chosen as the backbone for distributing official population statistics across 1 km² areal units. The estimates from LandScan are compared with official statistics, and an algorithm for adjusting LandScan distributions to additively match “official” population statistics is described.

The article also presents results from a US Agency for International Development (USAID) Project, “Implementing the Famine Early Warning System Network’s LandScan Baseline Population Dataset and Software for Population Estimation” (herein referred to as Population Explorer), which was undertaken by the authors. The article presents a conceptual framework for delivering responses to queries for local demographic information over the Internet. By offering geospatial population data to a large audience, improving accessibility to spatially flexible population estimation will also pave the way to providing a greater breadth of spatial demographic information, such as age and sex-specific estimates, as well as more advanced population estimation techniques, such as those used in scenario planning. Though data limitations for all countries where census statistics are out of date or of poor quality cannot be completely resolved without conducting a new census, the use of LandScan for accessing local population statistics is a step forward in planning and aid delivery. The article concludes with suggestions for managing collaborative population updates from inter-agency aid workers, within a framework of spatial demographic information delivery.

**Spatial Demographic Data**

Global, population databases that generate population estimates across a spatial grid overcome a number of obstacles caused by associating population attributes to areas defined by international, national, or sub-national boundaries (Balk et al., 2006). First, administrative boundaries may change, making this type of data difficult to use and compare over time; and second, hazards rarely respect national or administrative boundaries (Deichmann et al., 2001; Raleigh & Urdal, 2007). Third, though political and administrative boundaries are typical for social research (and often necessary for administration itself, as well as to protect the confidentiality of residents), most geographic data collected on the physical environment are gridded (raster) rather than vector (with often irregular geometric definitions) (Balk et al., 2006). Gridding social data makes it more comparable to environmental data. Non-administrative regions like agro-ecological zones or livelihood zones, which reflect the spatial distribution of economic activities, cultural practices or natural resources, can be better studied in relation to disasters without the constraints of population data that are re-
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