Estimating the number of malnourished children in the Democratic Republic of the Congo: potential from the AfriPop and CEDAT databases

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Summary

The Democratic Republic of the Congo (DRC) is a country where demographic and health information is scarce, particularly in areas with chronic insecurity. These are however the areas where population needs are highest. Here, two freely available databases were combined in order to estimate the number of children under 5 affected by acute malnutrition in DRC. Geostatistical methods were used to produce a predicted malnutrition map based on small-scale surveys conducted by humanitarian agencies and estimates of children at risk were derived from high resolution population maps. Results showed that 41% of children are in serious or critical nutrition situation in DRC. This paper showed that combined analyses of different sources of data can provide key insights on populations on whom information is scarce.

1. Introduction

Whilst high-income countries generally have extensive mapping resources and demographic data at their disposal, in low-income countries relevant data tend to either be lacking or of poor quality. In the Democratic Republic of the Congo (DRC), the last national census was undertaken in 1984, when the total population was about 30 million. Today, the United Nations estimate that 68 million people live in DRC. The population growth rate is currently around 2.8% per year and DRC population is expected to double in the next 30 years (United Nations Population Division 2012). In addition to this high growth rate, population displacements are massive. Since the last census, DRC has suffered from 15 years of conflict, which forced thousands of people to displace and deprived millions of basic health and social services. According to the Central Emergency Respond Fund report in 2008, conflict has generated up to 1.35 million internally displaced persons (IDPs) in only 3 provinces, corroding the coping mechanisms of millions of people.

The major changes in population size and distribution that are occurring in DRC undermine the fidelity of the population estimates derived from last censuses. Instability also hindered the establishment of a national system that routinely collects demographic and health information. However, nationwide surveys such as the Multi Indicators Cluster Surveys or the Demographic and Health Survey were conducted quite regularly in DRC (1995, 2001, 2007, 2010). Statistics extracted from national household surveys are more uncertain because of the relatively small sample sizes

used (< 5% of the total population for DHS 2007), but have the important advantage of providing updated estimates.

National health statistics very often have low coverage from areas with chronic insecurity. These are however the areas where population needs are highest and change rapidly as violence evolves. While nationwide household surveys provide crucial data for the long-term monitoring of a country's living conditions, their 5-year frequency does not allow for a timely identification of population needs. On the contrary, small-scale surveys are conducted by humanitarian agencies in their area of intervention with a higher frequency and can provide updated key information on population needs in between the major surveys. CEDAT is the global repository of nutrition and mortality surveys and serves as an essential source of nutritional, health and mortality data for rational decision-making in disaster situations (Centre for Research on the Epidemiology of Disasters 2013).

In many low income countries, census population counts and nationwide surveys are only reported in large spatial units that limit their potential use for health metric derivation and resource allocation (Linard & Tatem 2012). In DRC, census data are aggregated at the administrative level 3 (Territoires) that divides the country in 188 administrative units with an average size of 12,500 km². However, any attempt to estimate the population affected by conflict requires reasonable information on the resident population in the area and for the time period considered. Ideally, population distributions and counts should therefore be resolved to higher levels of spatial detail than large regional estimates. Modelling techniques for the spatial reallocation of populations within census units have been developed based on satellite-derived land cover data (Linard & Tatem 2012; Linard et al. 2012). Comprehensive and contemporary sub-national information on the demographic attributes of these populations were also combined in order to depict age and sex compositions at sub-national scales (Tatem et al. 2013).

The objective of this paper is to estimate the number of children under 5 affected by acute malnutrition in DRC by combining two existing databases: the CEDAT collection of survey data from emergency situations and the AfriPop detailed population maps. Combined analysis of different sources of data can provide key insights on populations on whom information is scarce.

2. Data and methods

2.1. Nutrition data

Nutrition data were obtained from survey reports compiled in CEDAT. These surveys are conducted by field organisations such as UN agencies, non-governmental organisations and Ministries of Health in their area of intervention. This usually corresponds to a health zone in DRC. The surveys are population-based and use a two-stage cluster sampling methodology. Anthropometric measurements are conducted and nutritional indexes calculated. In emergency, weight-for-height is the most commonly used indicator as it indicates level of wasting: this reflects the short-term loss of weight. Global Acute Malnutrition (GAM) is defined as – 2 weight-for-height z-score [1] according to WHO standard population (WHO & UNICEF 2009). We included in the analysis all available surveys undertaken in DRC from the period 2008-2011. In total, we used 221 data points. Data quality checks were performed.

2.2. Population data

The AfriPop project [2] has recently completed construction of 2010 and 2015 estimates of population distribution for continental Africa and Madagascar at approximately 100 m spatial resolution (Linard et al. 2012). A GIS-linked database of census and official population estimate data was constructed, targeting the most recent and spatially detailed datasets available, given their importance in producing accurate mapping (Linard et al. 2012). Land cover data were then used to redistribute population counts within administrative units to map human population distributions at 100 m. Figure 1 shows the AfriPop population dataset for DRC.

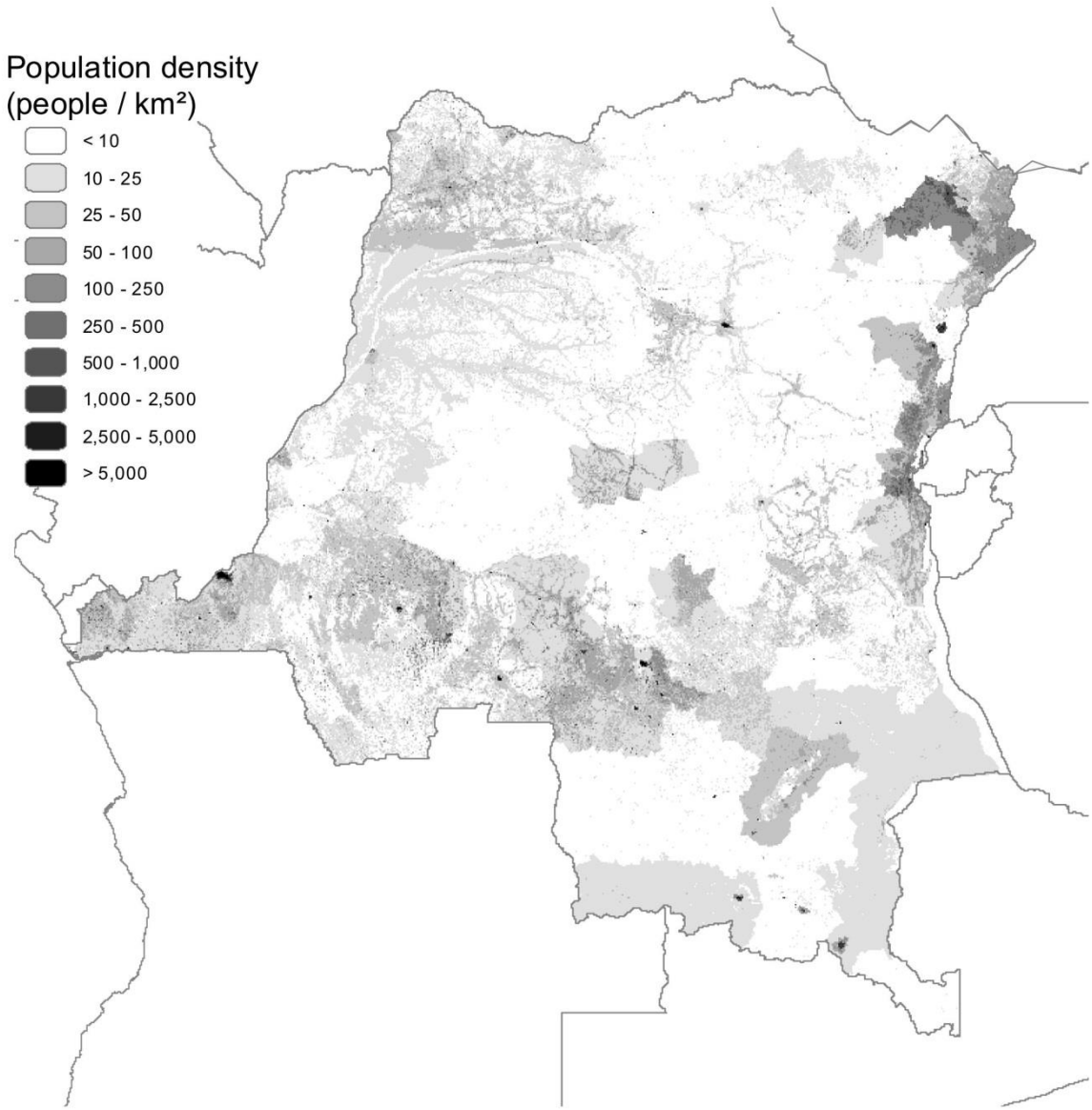

FIGURE 1: Population density in DRC as estimated by the AfriPop database.

Data on subnational population compositions from the last 20 years were obtained from a variety of sources to derive demographic maps from the AfriPop total population map. For DRC, the most recent Demographic and Health Survey (DHS 2007) was exploited to provide the most contemporary and spatially detailed estimates as possible of age and sex proportions, given the constraints of its sampling framework. The derived age and sex subnational proportions were used to adjust the existing AfriPop 2010 spatial population dataset, to produce estimates of the distributions of populations by sex and five-year age group across Africa in 2010. The datasets were then adjusted to ensure that national population totals by age group matched those reported by the UN (United Nations Population Division 2012). For the analysis outlined in the remainder of this paper, the summation of the datasets representing males and females in the 0-5 year age group was undertaken to produce a 2010 distribution dataset of children under 5 year old.

2.3. Estimating the number of children affected by acute malnutrition

The spatial dependence in survey data was first examined using the 'ncf' package in the R statistical software (Björnstad 2013). Geostatistical methods were then used to spatially interpolate GAM values estimated at the 221 survey locations from the CEDAT database and produce a predicted GAM map for DRC. Geostatistical methods make the assumption that the value at an un-observed location is a distance-weighted average of known neighbours. We used a universal kriging method with quadratic drift (Cressie 1986) to predict GAM values at locations were measurements have not been made. The resulting GAM map was overlaid with the map of children under 5 years old in order to derive estimates of children affected by malnutrition.

3. Results

Figure 2 shows the degree of spatial dependence in the GAM data from the CEDAT survey database. The average distance between CEDAT survey points in DRC was 49 km. The positive index for distances below 500 km means that GAM values are spatially autocorrelated below this distance. Figure 3 presents the predicted GAM map resulting from the spatial interpolation. GAM values were categorised according to WHO classification of emergency (World Health Organisation 2000): acceptable (< 5%), poor (from 5 to 9.9%), serious (from 10 to 14.9%) or critical (> 15%).

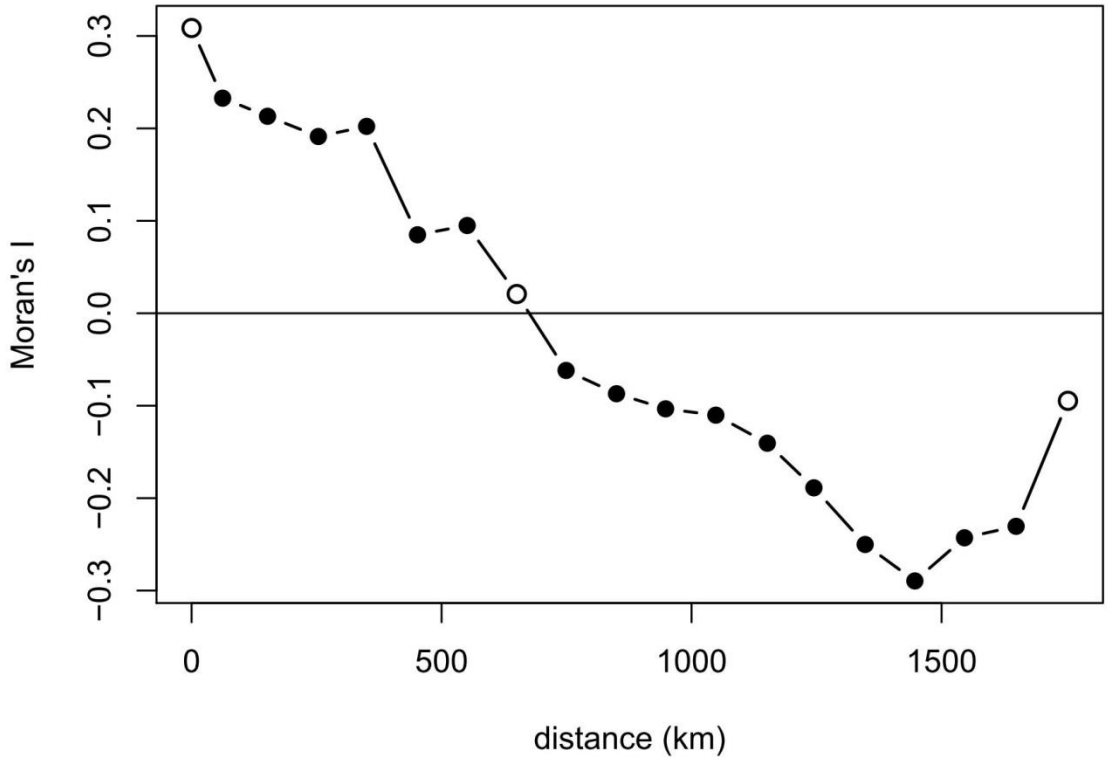

FIGURE 2: Spatial correlogram showing the spatial dependence of GAM values as measured by Moran's *I* at discrete distance classes. The zero-line (reference line) represents the regionwide similarity. The x-intercept represents the distance at which GAM values are no more similar than that expected by chance across the region (Björnstad 2013).

According to our estimated map of GAM shown in figure 3, the East and North regions of DRC (South-Kivu, North-Kivu and Orientale Provinces) are mostly in acceptable or poor nutritional situation. We can observe high variation in GAM values in North and South Kivu. The nutrition level is acceptable in large areas of Katanga, while critical situations are predicted in some parts of the Kasai Province and in South Bandundu.

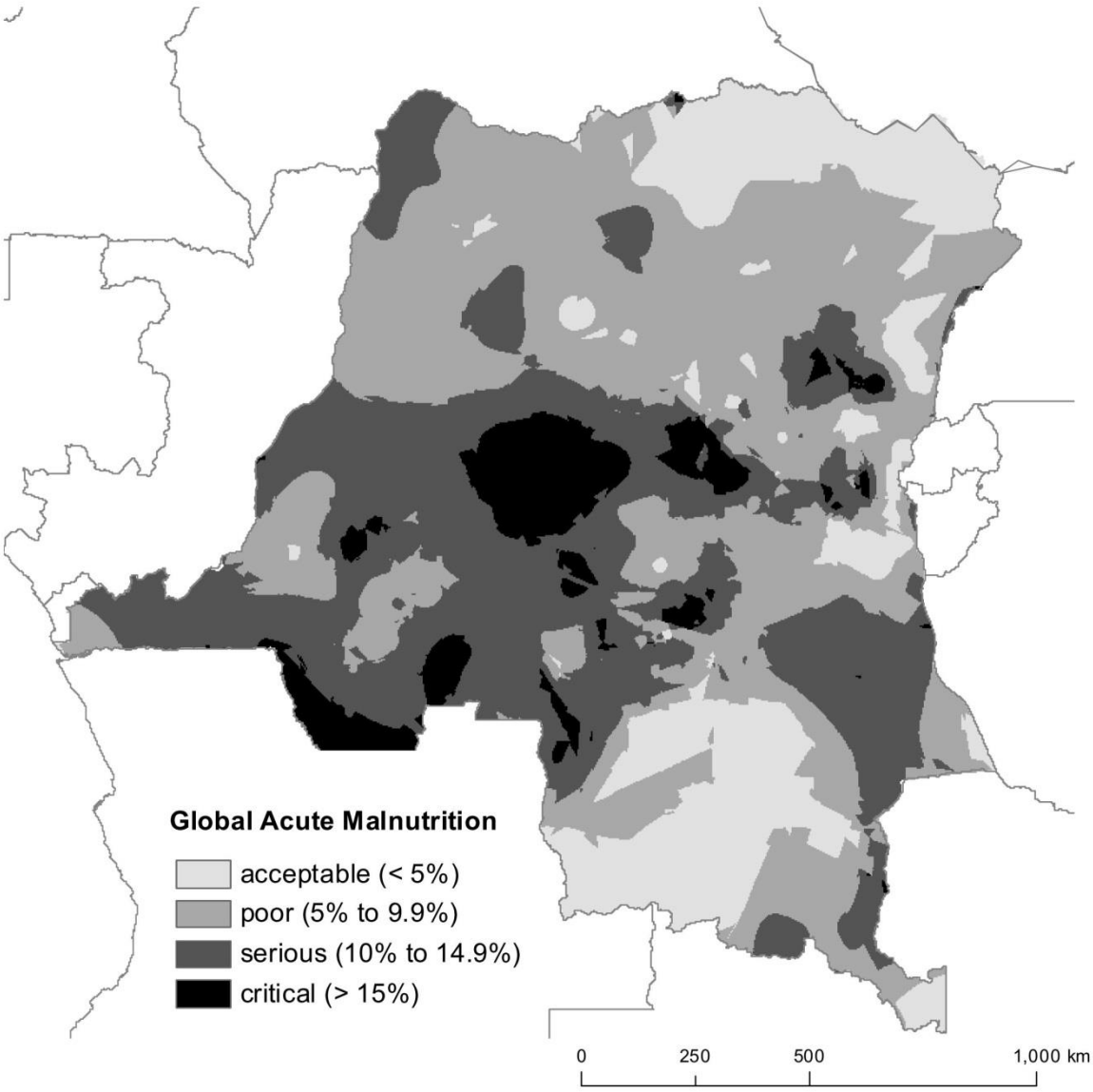

FIGURE 3: Results from the spatial interpolation of GAM values extracted from 221 survey locations from the CEDAT database (2008-2011 period). GAM values were classified in four commonly used categories: acceptable (< 5%), poor (from 5 to 9.9%), serious (from 10 to 14.9%) or critical (> 15%).

By combining the estimated GAM map with the under 5 population surface, we can approximate the number of children affected by Global Acute Malnutrition. Figure 4 shows the estimated number of children under 5 in each Global Acute Malnutrition category. About 41% of children under 5 are in the serious or critical categories, while nutritional conditions of less than one fifth are acceptable.

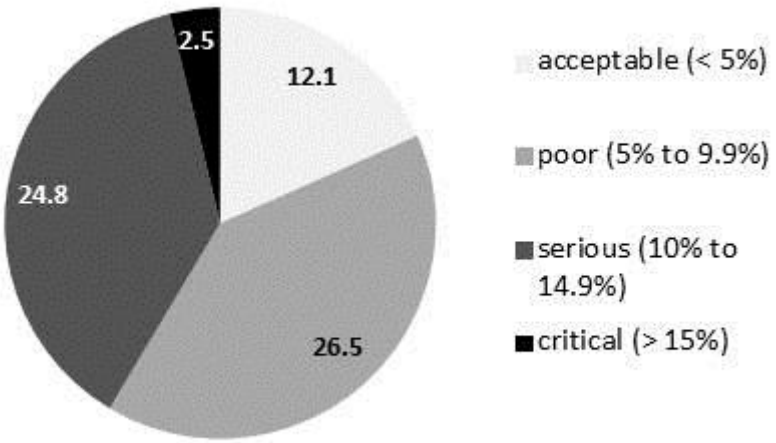

FIGURE 4: Number of children under 5 years old in each GAM category in DRC (in millions).

4. Discussion

DRC is a country where demographic information is scarce both in spatial and temporal resolution. The two databases we have presented here – CEDAT and AfriPop – aimed at improving available demographic and health data for low-income and conflict-affected regions such as DRC. The main objective of the AfriPop project was to provide spatially detailed population data. Its resulting map is particularly useful as denominator for the calculation of health metrics that vary across space. CEDAT provides updated information on population health status, including standardized health and nutrition indicators, between major surveys, thus with a better temporal resolution. Here we showed the potential of combining these two datasets. Their different and complementary information allowed us to estimate the number of children in emergency situation in DRC. It also allowed the identification of high-risk areas for targeting humanitarian help.

North and South Kivu reported acceptable and poor nutritional situations, despite being the most affected by conflict. The presence of nutrition programmes in these areas is probably responsible for the relatively good GAM values reported. Average GAM in locations with existing nutrition programmes is lower than in areas without nutrition programmes. At the same time, the high variability observed in the conflict affected areas indicates that insecurity can worsen nutritional status as it hinders humanitarian interventions to reach all affected areas. Survey reports from Kasai and Bandundu, where critical situations are predicted, indicate that few or no nutrition programmes exist in these regions and that water and sanitation conditions are poor. In the Kasai, few people are involved in agriculture because mining is a more attractive employment alternative (Kandala et al. 2011) and income therefore largely depends on the market price of diamonds. High poverty prevalence among Bandudu's population (Institut national de la statistique de la DRC 2004) can explain the poor nutritional situation. Undernutrition is a complex condition that can be due to multiple factors (Black et al. 2008): semi-quantitative causal analyses at community-level are more and more used by field agencies to understand the main causes of malnutrition (Nyawo & Myatt

2012; Ratnayake et al. 2013). Our analysis provides insights in spatial associations, rather than identifying causes.

Estimating the number of children by category of severity can contribute to a more evidence-based allocation of development and humanitarian aid. Absolute numbers are necessary to estimate the required financial and in-kind resources to feed people in need. Yet, uncertainties are associated with our estimates. First, population estimates are based on the 1984 census and on DHS 2007: the availability of updated population data would allow for more precise geographical distribution of malnourished children. Second, nutrition data cover the period 2008-2011 and are patchy: increased coverage and availability of recent nutrition surveys would provide a more updated picture of the situation. Third, population displacement due to insecurity continues to occur in eastern DRC, therefore increasing the uncertainty about numbers and location of malnourished children.

Detailed, spatially disaggregated and standardized population data are essential resources in the assessment of the number of impacted people for planning health and food service delivery and for decision-making processes related to developmental or health issues. We have shown here that various datasets exist to map the distribution of key vulnerable groups, and to study demographic evolution through time. However, we also outlined the importance of acknowledging, measuring, and accounting for uncertainty in demographic datasets.

5. Acknowledgments

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6. References

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7. Footnotes

[1] Oedema is included

[2] AfriPop project : www.worldpop.org.uk