Methods, results and policy implications of poverty and food security mapping assessments

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Introduction

Improved agricultural technology has benefited both producers and consumers in less developed countries over the last several decades but bypassed many areas with large numbers of rural poor (Freebairn, 1995, Pachico et al., 2000, Evenson and Gollin, 2003). Recognizing the need to reach the poor in marginal

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environments, the international agricultural research community has reoriented many of its programmes towards poverty reduction (CGIAR, 2000).

Together with the increased emphasis on poverty reduction, agricultural and food security researchers are analysing the geographic dimensions of poverty and food security (UNEP-GRID-Arendal, 1998). Several studies show that geographic targeting of small administrative areas improves cost effectiveness of development spending, more efficiently reaching poor or bypassed areas (Baker and Grosh, 1994, Bigman and Fofack, 2000, Elbers et al., 2004). Thus, these targeting approaches could be well suited to addressing the neglected rural areas that did not benefit from improvements in agricultural technology. Such targeting requires the development of detailed maps and analyses over broad areas, showing the distribution of the poor and other indicators associated with poverty and welfare.

Recent methodological advances in poverty mapping include the development of techniques to link survey and census data for estimating income and consumption for small administrative areas throughout a country or region (Ghosh and Rao, 1994, Larrea et al., 1996, Hentschel et al., 2000, Elbers et al., 2003). The small area estimation (SAE) approach involves determining the relationship between income or expenditure variables found in a household survey and more common variables found in a national census. The analyst can then use the derived statistical relationship to map the survey's welfare indicator onto the detailed geography of a national census. The method utilizes surveys of thousands of households throughout a country, based on standardized questionnaires such as the Living Standard Measurement Study (LSMS) or the Demographic and Health Survey (DHS). Household-level census data may include between 5% and 30% of the entire population of a country.

The survey and census methods cover an entire country with welfare estimates at geographically fine resolutions, unlike studies that include relatively small numbers of households, lack comparability or have limited geographical extent. Farming systems and integrated natural resource management research has dealt with poverty-environment-geography relationships (Collinson, 2000, Lovell et al., 2002). But these studies are rarely for an entire country, using detailed geographic data with typical poverty line indicators such as the headcount ratio or the poverty gap ratio (Foster et al., 1984).

The method of producing SAE using regression models is one of a number of available simulation methods for interpolating from a detailed source to a more general data set. Alternatives include using neural networks (Leclerc et al., 2000) and iterative proportional fitting (Birkin and Clarke, 1989). One advantage of using regression models is the availability of user-friendly software (UCB-World Bank, 2002). These methods have advanced a line of research that produces country-level poverty maps for sub-national administrative units equivalent to counties or districts (Davis, 2003). The use of these SAE resolves the problem of lack of household income and expenditure data for most or all administrative areas in a country. Hentschel et al. (2000) showed this method to be practical and within the capacity of analysts studying poverty in countries throughout the world.

In addition to welfare indicators developed from SAE, spatial analysis tools and geographical information systems (GIS) have opened up new possibilities to integrate poverty indicators and their correlates into national- or broad-scale poverty assessments (Deichmann, 1999, Stoorvogel et al., 2004). For example, measures of distance and accessibility are rarely found in censuses but can be derived from maps of facilities, services and the transportation network (Higgs and White, 2000). Numerous efforts have been developed to provide measures of climate variability, topography or soil fertility (for some examples of broad-scale environmental information, see Antle, 1996, Jones and Thornton, 1999, CIAT, 2005, Hijmans et al., 2005). These fine-resolution data can reveal environments that are marginal for agriculture and can be summarized for administrative units to make them comparable with socio-economic data. Land cover indictors from satellite sensors can be aggregated to units comparable to census and survey data (Lo and Faber, 1997, Liverman et al., 1998).

The role of spatial patterns and processes in welfare outcomes is another issue that has received little attention in poverty assessment. High living standards in a given area usually have spill-over effects in surrounding areas such that these areas group together. Prosperous communities and households generate well-being in their neighbours through diffusion of innovations, social capital, trade, economies of scale and other factors related to proximity and spatial interaction. On the other hand, areas of high poverty are often surrounded by neighbouring areas that are also poor. Poverty-stricken communities and their neighbouring areas often lack opportunities for trade and interaction.

A growing literature addresses neighbourhood effects, proximity and spatial patterns and processes in social science (Goodchild et al., 2000) but less work is available on these topics in studies of poverty. Jalan and Ravallion (1997) found evidence for geographic poverty traps in rural China. A similar study controlled for location in analyses of living standards in Bangladesh (Ravallion and Wodon, 1999). After including location as a variable and controlling for non-geographic characteristics of households, these two studies found that geographic effects are important. The studies imply that targeting poor households without regard to the living standard of the area is less effective than targeting poor households in poor areas.

In the late 1990s, specialists in spatial analysis in the international agricultural research community recognized the need to better clarify the links between rural poverty and agriculture (UNEP-GRID-Arendal, 1998). Some of this work has now been completed, motivating the compilation of articles for this special issue of Food Policy.

The volume considers several questions that are relevant to addressing the gaps in poverty mapping research for agriculture and rural areas:

- How can poverty mapping take a more explicit approach to considering geographical, environmental and agricultural aspects of food security and welfare at geographically fine resolutions over broad areas?
- How important are spatial patterns and processes in poverty and food security outcomes?

- What are the implications of the poverty maps for food and agricultural policies in developing countries?

This special issue reports on advances in poverty and food security mapping and their policy implications for case studies in Mexico, Ecuador, Kenya, Malawi, Bangladesh, Sri Lanka and Vietnam. An additional study compares geographic measures of underweight children across countries. The studies illustrate spatial analysis approaches to poverty and food security assessments and their relevance for agricultural and rural policy design.

Advances in poverty and food security mapping

Small area estimation for analyzing rural poverty and food security

Six studies presented in this volume illustrate the use of the SAE procedure to calculate a welfare indicator relevant to rural areas and food security concerns. Of these studies, the Mexico, Ecuador, Bangladesh and Sri Lanka studies use a food poverty line—the expenditures for buying food to meet minimum nutritional requirements. The Vietnam, Malawi and Kenya studies employ a poverty line that includes minimum food needs plus a minimum number of additional non-food expenditures.

Minot and Baulch in this volume compare the SAE technique to other methods used in Vietnam. Since they establish regression relationships based on data from over 5 million households from the national census and nearly 5000 households from detailed living standards surveys, their method has clear advantages over local and non-standardized measures of poverty.

Two of the studies in this volume had no access to household-level census data for estimating the welfare variable. Where household-level data from a census are unavailable—as in the Mexico and Sri Lanka studies—estimates can be made with aggregated data (Bigman et al., 2000). While this alternative is less than ideal, these two studies showed the estimates to be reliable in the scope of project objectives.

Measures of distance and physical accessibility for poverty mapping

Analysts can assess the importance to welfare outcomes of travel time to facilities, services and markets using relatively new algorithms and tools (Geertman and van Eck, 1995, Bateman et al., 1996, Farrow and Nelson, 2001, Kwan et al., 2003). Income generation for small-scale farmers often depends on distance to markets and associated transport costs (Van De Walle, 2002, Jacoby, 2000). Many other general areas of welfare and development are related to accessibility (Leinbach, 1995). Impoverished households and communities often suffer from difficult access to health clinics, schools, markets and other facilities.

The studies in this special issue demonstrate the calculation of GIS-based measures of travel time to markets and facilities, providing evidence that, for small areas and across countries or provinces, accessibility and distance to markets and services are important explanatory factors in poverty and food security outcomes. In the Kenya study area, distance to schools and water sources are important for Kaijado Province. The Sri Lanka study shows that average distance to towns is associated with clustering of poor communities. Travel time to provincial capitals, but not district capitals, is found to be associated with food poverty in Ecuador. However, in the cases of Mexico and Malawi, accessibility is less important than expected. These studies provide opportunities to scale-up previous research for limited geographical areas (for example, see Windle and Cramb, 1997).

Environmental information in wide-area poverty assessments

The articles in this volume demonstrate how to integrate environmental information into poverty assessments for small administrative units at national or regional levels. Methods to incorporate environmental information are particularly important since standardized household surveys such as the LSMS and DHS rarely collect these types of data.

Among the studies, soil characteristics, topography, rainfall, evapotranspiration and vegetative vigour proved to be important explanatory factors in describing poverty. For example, whether farmers are in lowland valley or highland hillside environments is important in welfare outcomes in Mexico. A measure of soil fertility is associated with food poverty in Ecuador. A soil texture measure is related to underweight status in a cross-country comparison. In Mexico, the poorest areas have less than ideal rainfall and high evapo-transpiration. In the Kenya study, vegetative vigour as measured by the normalized difference vegetation index (NDVI) is associated with poverty.

The Mexico and Ecuador studies illustrate resourceful use of 90-m digital elevation models in their food security assessments. We may also expect to see greater use of NDVI from satellite sensors, as in the Kenya study.

Spatial relationships in poverty and food security analysis

The studies in this volume treat location as a variable in statistical analyses, evaluating the importance of spatial relationships and proximity to welfare. For example, in the Sri Lanka study, spatial autocorrelation is measured, showing significant clustering of areas of relatively high and low living standards. The study measures the degree to which poverty outcomes in a district are associated with having high or low levels of poverty in neighbouring districts.

Geographically weighted regression models perform better than standard regressions, showing that explanatory factors of poverty vary substantially across a country. The Bangladesh, Ecuador and Malawi studies showed significant spatial variations in the strength of relationships between welfare and explanatory variables. Mapping the R^2- and the *t*-statistic, as is done in the Malawi study, can give insights into how well models perform in different places. The Bangladesh study illustrates how mapping beta coefficients suggests the importance of a variable at different places.

Although geographic effects on welfare are included in these studies, the specific nature of the process affecting living standards is often unknown. These processes might include diffusion of technology, spill-over effects, social capital, neighbourhood effects and others (Anselin, 2002). Even though the geographic effects may be hidden, they provide a basis for subsequent policy analysis because they quantify the degree to which poverty is related to place.

Policy implications of poverty maps

Poverty and food security analysis and mapping should be directed toward developing improved policies. One type of policy intervention that can utilize poverty and food security maps is the direct transfer of money or food aid throughout a country. The Sri Lanka study demonstrates the potential effectiveness of targeting by quantifying numbers of poor households that did not receive benefits versus number of non-poor households that did receive financial assistance in a national poverty reduction program.

Poverty assessments and maps reveal the importance of prioritizing interventions based on poverty prevalence, absolute numbers of poor and measures of inequality. The Vietnam case study shows that more poor people live in areas with lower prevalence of poverty. Interventions targeted to individual households would fare well in these areas. Interventions that broadly affect the population of an area, such as infrastructure and public works, may work better in areas where a large proportion of the population is poor. Similarly, the Bangladesh study shows that some areas with lower prevalence of poverty are also areas of high inequality. Neglect of these regions would miss a great number of poor people in a country.

Poverty mapping assessments can help plan interventions according to sector. Several of the studies have implications for agricultural policy. Field testing of new technologies can be targeted to locations with high numbers of food poor, as indicated by the Mexico study. The Sri Lanka poverty map illustrates the importance of irrigation and land access to welfare outcomes, indicating that land reform policy and agricultural infrastructure could impact on rural poverty. The Malawi, Bangladesh, Sri Lanka and Ecuador studies show the importance of non-farm income and non-agricultural employment, implying that employment and small enterprise policies could be effective in selected regions of these countries. These policies might promote agribusiness, artisan production, tourism and ecotourism.

Further research

A number of issues related to poverty and food security mapping warrant further research. Although many of the methods described in this volume have been developed to overcome data limitations, research can benefit substantially from better temporal frequency and geographic coverage for surveys and censuses. All efforts in this regard should be encouraged.

Unlike topography, vegetation and climate data, reliable soil information at detailed scales remains difficult to acquire. The high costs of conducting soil surveys and the extensive fieldwork they require limit progress. While the inclusion of environmental information in poverty assessment is a positive development, uncertainty remains about the quality of the data. Poverty mapping should draw on the history of GIS research on data uncertainty (Goodchild and Gopal, 1989).

The measurement of accessibility in poverty assessments is an encouraging development but one that can be further improved. We can refine our measures of travel times and accessibility by better specification of what constitutes a market, service or facility, matching the functions of a particular place to transport costs. Travel times in the tropics need better specifications of changes between wet and dry seasons.

The studies in this volume show improved results by accounting for location and geographic effects. These techniques still have not been widely applied in poverty mapping studies. The presence of spatial autocorrelation suggests that location is an important factor in welfare outcomes. But the exact nature of this factor remains hidden. In some cases, welfare may be associated with economies of scale of neighbouring areas, as the Sri Lanka study suggests. Improved livelihoods may reflect community and regional social networks that diffuse information and technology for reducing poverty. Spill-over effects from particular interventions in education, health, transportation or other service provisions may reduce food insecurity and poverty. More effort is needed to identify these hidden variables.

After mapping the poor and the causes of their deprivation, poverty assessments should be directed towards designing better policies. This special volume of Food Policy aims to demonstrate how poverty mapping can support policy making. Towards that end, greater collaboration is needed between analysts, policy makers and local communities. If the main stakeholders are not involved in poverty assessment and strategy development, policies are likely to be unacceptable or ineffective.

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