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Poverty and Food Security Mapping at Country-level: Lessons Learned from Seven Case Studies

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Abstract

The increased importance of poverty reduction to the global development agenda has motivated greater interest in poverty mapping. However, many obstacles create poor conditions for developing national-level poverty assessments and maps. This paper reviews the experience of seven national-level assessments of poverty and food security in three continents.

Digital maps of administrative boundaries and transportation infrastructure are two important framework data sets needed for poverty mapping. For our case studies, government agencies often lacked well-developed programs to provide these data sets in up-to-date and well-documented formats, hindering the construction of accessibility models and thematic maps from census data.

Our experience showed that data from censuses and household surveys needed for poverty estimation and mapping using small area estimation (SAE) methods can generally be acquired. However the difficulties in finding compatible time frames for censuses and surveys, and the lack of compatibility between household surveys and censuses with respect to the types of variables that are measured, compromised some key assumptions of the SAE approach. These two data sources should be made compatible to

facilitate the SAE method. Our case studies and other evidence demonstrated the need for household level data from the census (microdata) and that census agencies could release microdata to the benefit of poverty assessments, without compromising the privacy of citizens. We found that a great deal of social data is not in the public domain.

The geographic resolution of social and infrastructure data sets is also usually coarse, limiting comparability with biophysical data sets, which are often available at detailed scales. This puts a premium on the development of reliable methods that reconcile data at different scales and spatial resolutions. Analytical capacity also declines at higher levels of aggregation. Countries should assess the possibilities for improving access to these data sets and make greater efforts to release social data at the finest geographic resolution possible. Trends in adoption of information technology and geographic information systems are likely to resolve some of the difficulties in developing poverty maps. However future assessments will depend heavily on more government commitments to carrying out regular and frequent censuses and household surveys. Our experience also suggested the importance of engaging policy makers in poverty assessments. They should know about the data requirements and processes involved in developing poverty maps. More importantly, they should be engaged in discussions on the implications of the spatial patterns and their determinants.

Introduction

Interest in poverty mapping has grown substantially since the early 1990's, mostly as a result of the high priority placed on poverty reduction by the international development community (UNEP/GRID Arendal, 1998; Bigman and Fofack, 2000; Henninger and Snel, 2002; Davis 2003; Dixon et al., 2003, Hyman et al., 2005). Spatial analysis and geographic information systems technology are clearly useful in analyzing poverty (Deichmann, 1999). Analysts and policy-makers have recognized that there is a spatial dimension to poverty (Ravallion and Wodon, 1999; Jalan and Ravallion, 1997). Geographic proximity to poor communities is one factor, and poor areas tend to be clustered. Perhaps most important in explaining increased interest in poverty mapping is the evidence that shows that geographic targeting is a more efficient way to allocate research and development assistance aimed at poverty reduction (Baker and Grosh, 1994; Bigman et al., 2000; Bigman and Fofack, 2000; Elbers et al., 2004). Development programs cannot target individual households but will more effectively use resources when these are transferred to the poorest areas using fine geographic resolution targeting. For all the reasons cited above, interest in poverty mapping is growing and will likely continue to grow in the coming years.

While there is a clear consensus that poverty mapping is useful, the difficulties in developing these assessments are considerable and unlikely to be resolved quickly. The data needed for making assessments is often unavailable, either because governments and other organizations lack the resources or capacity to collect it, or else the data exists but cannot be accessed because of policies and bureaucratic structures that limit dissemination. When both the census and the household survey data necessary for poverty mapping are available, they frequently have incompatible spatial units or time

periods, making information their integration difficult. Geographic scale and resolution issues also limit the utility of data and analysis for poverty assessment. The lack of engagement and involvement of stakeholders – including policy-makers, poverty experts and the poor themselves – is another difficulty limiting the accuracy and utility of poverty maps. These difficulties raise the question of how governments, research organizations, development groups and others can reduce obstacles to developing poverty maps and assessments.

This paper addresses problems and opportunities in developing poverty mapping initiatives. We summarize the lessons learned from seven case studies that assessed poverty and food security at the country level. Case studies were carried out for Ecuador (Farrow et al., 2005), Mexico (Bellon et al. 2005), Nigeria (Legg et al. 2005), Kenya (Kristjanson et al., 2005), Malawi (Benson et al., 2005), Bangladesh (Kam et al., 2005) and Sri Lanka (Amarasinghe et al., 2005) as part of a global project on methodology development for poverty mapping (Povertymap.net, 2006). Our aim is to review the issues and problems that any poverty mapping project would confront. The paper should be useful for researchers and analysts starting a new initiative. We include recommendations for developers and users of poverty maps, as well as the community of information providers that support these efforts. Careful attention to issues of data availability, spatial and temporal data compatibility, geographic scale and engagement of stakeholders can help projects avoid critical obstacles to developing poverty maps.

The next section of the paper is a discussion of issues of data availability and access. We discuss census and survey data, as well as biophysical information that can be used in poverty assessments. The discussion includes our experience and difficulties in accessing data for poverty mapping exercises. The following section is a discussion of spatial scale issues, including compatibility of data sets and effects on quality and methods of analysis. The subsequent section deals with issues of stakeholder involvement in poverty mapping initiatives. The paper concludes with recommendations for the development of poverty maps and for the larger community of data providers and users.

Data availability and access issues

The most immediate issue facing the developer of a poverty map is acquiring the data needed for the assessment. The poverty indicators must be chosen. If the assessment also includes analysis of the drivers of poverty and associated factors, additional variables must be collected. Most poverty maps with fine geographic resolution will require census data. Survey data with estimates of income or consumption will likely be needed. Analysis of associated factors will require information on biophysical and socioeconomic factors, as well as information on the physical infrastructure of the country.

Census data

Census data is often unavailable for recent dates or is of limited quality. In our case study countries in Latin America, Asia and Africa, census coverage varied. Bangladesh has carried out six censuses since 1950. Mexico has carried out five censuses, each at the

decade mark, since 1950. Ecuador has also carried out five censuses, although the time between the censuses varied. Malawi and Kenya carried out four censuses since 1950. The worst case is Nigeria, which has only carried out one census since the middle of the last century. Many developing countries simply do not have the resources or capacity to carry out frequent censuses, and must often depend on international donors for funding. When they have the resources, the relevant statistics or census agency may not have the capacity to carry out a high-quality census. However, from the small sample of our seven case study countries, the track record of frequency of conducting censuses is not bad.

In many cases researchers making poverty maps experience difficulties linking tabular census data to accurate and up-to-date administrative boundaries. Often the boundaries are either poorly defined in surveys or lack standardization across the country. In many countries new administrative units are created because of changing political considerations and the most recent available maps may lack the latest changes in administrative boundaries. Many census agencies lack well established GIS departments. The geographic institute or survey department may have the responsibility of mapping administrative units, but their work may not be tightly integrated with that of the census and statistics institute. Researchers may find data in the census for which there is no corresponding administrative unit on the map. Conversely, but less common, is to find map units for which there are no corresponding census data. Most of our studies had several mismatches between the census and the administrative boundary map.

The quality of census data is often very difficult to determine. Censuses frequently have a reputation for inaccuracy, although the evidence to support this assertion is unclear. A common problem in most countries is the lack of independence of the statistics and census agencies. Because the results of their analyses tend to have political implications, interested parties often seek to influence what these agencies do or what they report. Even if data products are unbiased and independent, they can be suspect to some simply because they are produced by the government. Our experience suggested that the quality of the census and the level of bias varied between the seven countries in our group of studies. In a couple of the countries, the reputations of the statistics and census agencies were highly suspect. One national statistics agency produced data products that had serious errors, and substantially limited the value of their information. Other agencies have established good reputations for doing credible work.

The breadth of variables found in census data has increased over the last few decades, mostly due to the efforts of international organizations seeking comparable cross-country information and who want to provide support to partner countries (McCaa and Ruggles, 2002). Although censuses used for our case studies generally had an ample selection of variables, we had difficulties matching the data to household surveys that contain much richer information.

Finding common questions in household surveys and censuses is important because the small area estimation (SAE) method requires matching variables. SAE was developed because censuses rarely if ever include information on direct poverty measures such as income or household consumption (Elbers et al., 2003). Household surveys do have that

information, but they are only representative of large areas or an entire country. The method is a way to map direct measures at fine geographic resolutions. SAE involves the determination of a statistical relationship between a poverty outcome indicator, such as household consumption, and other variables in both a household survey and a census. Then, the statistical relationship is used to map the poverty indicator at the detailed resolution of the census.

The availability of microdata – household level information for a sample of the census – is increasingly important for poverty maps. The household data is critical for methods that estimate poverty measures from surveys and censuses using the small area estimation (SAE) method (Elbers et al., 2003). The availability of census microdata from our SAE analyses in our case studies varied from no microdata accessible for Mexico, to a 5 percent sample for Bangladesh, to 100 percent samples for Ecuador and Malawi (Table 1). Bellon et al. (2005) estimated poverty from municipal level data instead of the household level for Mexico. Although the method is less than ideal, it does resolve the lack of access to microdata (Bigman et al., 2000). Of the seven case studies, five were able to access microdata. However, special agreements with statistical and census agencies were often necessary to acquire this data. The government agencies do not have well established policies and procedures to offer microdata to researchers. Access to microdata is a sensitive issue for census and statistical agencies because of the need to protect the privacy of individuals surveyed. McCaa and Ruggles (2002) argue that throughout the world access to microdata has been improving in the last decades and is likely to improve in the future. No cases of private data escaping to the public have been reported. As the number and frequency of censuses being carried out has increased since 1950, the number of countries offering microdata to researchers has also increased.

Survey data

The main advantage of survey data is that it usually holds a poverty indicator that is critical for mapping, but almost never found in the census (Elbers et al., 2003). Household surveys can acquire consumption and income information. The disadvantage of survey data is that usually the number of surveys limits detailed spatial analysis because the samples are not representative for small areas. The SAE method overcomes this obstacle by mapping poverty indicators onto the census geography.

The quality and breadth of information is greater in household survey data compared to census information. Because the number of survey workers can be relatively small, it is easier to train them. The number of variables can also be greater, covering many more topics than a census can cover. Unfortunately, finding matching variables in the census can be difficult, limiting the possibility to apply SAE. We would recommend that questionnaires for all new nationally representative household surveys for a country include all of the questions asked in the national census in order to ensure comparability between these two rich data sets.

The most common source of survey data is some kind of national household survey carried out by the central government. Other useful sources are standardized surveys such

as the Living Standards Measurement Study (LSMS) and the Demographic and Health Surveys (DHS). Of our seven studies, five used household survey data. Two countries – Sri Lanka and Bangladesh – had national household survey data available. The Ecuador and Malawi studies used the LSMS surveys. Since the LSMS is standardized, there are opportunities for comparison across countries. Another advantage of the LSMS is that World Bank researchers have invested heavily in developing high-quality surveys. The disadvantage of the LSMS is that often there are no surveys available for a given country, or the date of the survey is too far in the past. Of our seven case study countries, LSMS surveys are only available for Ecuador and Malawi (World Bank, 2006). Survey data for Nigeria was collected entirely within the project.

Biophysical and infrastructure data

Poverty assessments may include environmental data and information on the physical infrastructure of the country. These data can be useful for analyses of relationships between measures of poverty and associated factors. There is growing interest in links between poverty and natural resources. Insufficient natural resource endowments may limit the productive capacity of households, leading to greater poverty. On the other hand, the poor may speed up environmental degradation when they overexploit natural resources in efforts to lift themselves out of poverty. Information on facilities and physical infrastructure of a country can be used to assess the population's access to education, health and economic opportunities.

Our experience acquiring environmental data varied widely across the 7 countries (Table 2). Fortunately there are some variables for which standardized data can be found worldwide. Global, one kilometer pixel resolution data of rainfall and temperature can be downloaded from the Internet (Hijmans et al., 2005). Elevation and elevation derivatives from the Shuttle Radar Topography Mission (SRTM) are available at 90 m spatial resolution, with the expectation of acquiring 30 m data in the near future (CIAT, 2005). One of our studies used a globally available vegetation index from satellite data to study relationships with poverty (Kristjanson et al., 2005), while another used Africa-wide vegetation maps derived from MODIS satellite imagery (Legg et al, 2005).

Collecting information on soils and land cover proved to be the most difficult environmental information to acquire. Soils data that discriminates soil quality at detailed spatial scales is notoriously hard to find. The scale of soil maps in many developing countries may not be sufficient for linking the location of the poor to a given soil characteristic. While land cover maps generally exist for most countries, finding a recent date could be difficult. Satellite imagery is an alternative for making land cover maps, but conventional interpretation may represent high costs in time and labor. The new continuous field vegetation products from the new generation of earth observations satellite (Hansen et al, 2003) may help to resolve this problem.

In general, information on physical infrastructure and facilities is more challenging to acquire than environmental information. High quality transportation data is particularly

difficult to acquire. One analysis of digital maps of transportation networks showed that at continental scales, less than one third of roadways are available in digital maps (Nelson et al., 2006). Although a greater proportion of roads will be available in country level data sets, many roads will not be digitized. One problem is that roads are built after the date of existing maps. Many roads, especially unpaved ones, may have been missed by cartographers. Compiling infrastructure data was a challenge in most of our studies. However, in Bangladesh high-resolution comprehensive GIS road infrastructure and public facilities databases are available.

Educational and health facilities are another example of physical infrastructure information that is often difficult to acquire. Apparently, these data are sometimes lacking in geo-referenced digital formats because they have not been heavily used for spatial analysis. In two of our group of studies – Nigeria and Kenya – information on facilities was collected during large household surveys. Otherwise studies will need to depend on existing maps and relevant government department who manage this type of data. We found that some government department had made recent efforts to inventory physical infrastructure and facilities using GPS and GIS (e.g. Bangladesh). Funding from international donors helped several countries improve infrastructure and facilities data.

Institutional and policy environment for data access

Acquiring census, survey, biophysical and infrastructure data partly depends on how the institutions and policies of each country deal with questions of data provision and availability. The countries in our assessments had very few policies or laws that governed data access, and government data may often be available. If this data is difficult to access, it remains unclear whether there are any laws or policies that inform data providers and users how to proceed.

In our experience, each government institution in each country has its own norms and customs regarding sharing the data they produce. In Nigeria, government data was unavailable for the poverty mapping study, but subsequent experience has shown the benefits of developing good working relationships with government data suppliers. In Kenya, government agencies provided data in exchange for training and expertise in how to analyze it. Both strategies hold true for Bangladesh as well. In some countries, like Ecuador, the data providers are the military, whose institutional mission is not often oriented towards serving social science researchers. The Sri Lankan census agency made government data available at a nominal charge and a similar situation existed in Mexico.

Several strategies can be employed to acquire data from government and non-government agencies. Our experience acquiring data for poverty assessments suggest several recommendations for future initiatives. Researchers should develop sustained relationships with data providers in key government agencies. Non-governmental organizations can be useful allies in poverty mapping initiatives. Developers of poverty maps should look for ways to acquire government data by exchanging knowledge, skills and training, as well as the results of the assessment. Poverty mapping initiative should include agreements that clearly define the terms of use of the data and the relationship

between user and provider. Such poverty mapping initiatives should employ experts from the data provider that have experience working with the data that will be used. Joint publications between analysts and data providers are recommended. The path to data acquisition can be made easier by cultivating a high-level champion willing to support the project within the government.

Methodological issues related to spatial resolution and scale

Researchers developing poverty maps face substantial challenges in integrating and working with data from different spatial resolutions and different spatial units. Can we justify using data at widely different scales? How do we correctly integrate vector and raster data sets in GIS? What are some of the problems of using aggregated data? How can we map poverty indicators for small areas when our source data is only representative for large areas? This section of the paper deals with these questions. First, we discuss working with data at different scales and the necessity to convert between vector and raster data. Second, we discuss two related concepts that any poverty mapping initiative should take into account – the modifiable areal unit problem and the ecological fallacy. Finally, we discuss our experience using the small area estimation method for making spatially disaggregated poverty maps.

Differing scales and vector-raster conversions

The scale and resolution of multiple data sets are rarely comparable. Since most data is created for use with limited applications, very little thought is given to whether it will be comparable to other data sets. Ideally, scale and resolution would be the same for all data sets used. The more different the resolutions of the data, the greater the possibility for errors in the analysis. A scale and resolution problem usually occurs with surveys that may be representative only at the national level, or at the second administrative division (equivalent to USA or Mexican states). In the best case scenario, census data can be acquired for the smallest geographic unit for which maps exist. But in most cases the census is available for the second administrative division (equivalent to counties in the USA or *municipios* in Latin America).

Environmental and remotely sensed data present particular scale and resolution problems since they are usually in raster formats. In our studies, we aggregated raster data sets to the size of the administrative unit used in the analysis. Another alternative is to disaggregate socioeconomic data to the pixel size of environmental data. There is a growing literature on linking social and environmental data (Liverman et al., 1998). Although integrating social and environmental data is a great strength of geographic information system (GIS) technology, the prospects for resolving scale and resolution issues remain challenging.

Two key scale and resolution problems are encapsulated in the concepts of the modifiable areal unit problem (MAUP) and ecological fallacy (Robinson, 1950; Openshaw 1984). Data is usually aggregated to arbitrary units such as political districts in order to represent

it in mapped formats. Data could be just as easily and justifiably aggregated to other units giving a different result. The arbitrariness of boundaries for aggregating data is referred to as the modifiable areal unit problem (MAUP). Ecological fallacy occurs when one makes inferences about individuals or households based on aggregated data. These problems can be minimized by using data with appropriate spatial resolution. While there are no easy solutions to the MAUP and ecological fallacy problems, developers and users of poverty maps should make concentrated efforts to understand them, and thus avoid incorrect use and interpretation of data.

Small area estimation

Small area estimation (SAE) allows the researcher to attribute poverty measures to fine-resolution administrative boundaries for which there is no representative source data. As mentioned above in the discussion on data needs for SAE, the technique resolves the difficulty of the lack of poverty measures at fine geographic resolutions. Typically, poverty measures can best be collected from household surveys that are representative at the national level or for broad regions within a country. These measures can be predicted for small administrative areas by establishing statistical relationships between the poverty measure and variables typically found in a population census. The analyst uses the statistical relationship derived between household surveys and census to estimate the poverty measure for unit-level census data. There is a growing literature on the technique (Hentschel et al., 2000; Elbers et al., 2003; Elbers et al., 2005) as well as software to lead the analyst through the analysis (University of California – Berkeley and the World Bank, 2002).

Our experience employing the SAE technique suggested careful attention should be given to four considerations for successful application of the method. First, poverty map developers will need to identify censuses and surveys carried out within only a few years of each other (Table 1). Preferably, the census and the survey will have been carried out in the same. There is no rigid rule about how far apart in time the census and survey should be, but since poverty conditions might change between the date of the census and the survey, only SAE poverty maps based on dates close in time can be considered credible. A second consideration was mentioned earlier in the paper – the need to have access to microdata for carrying out the statistical analysis. Although variations on the SAE technique can be conducted without microdata, the main alternative method – synthetic SAE – does not allow the generation of error estimates (Bigman et al., 2000; Henninger and Snel, 2002; Amaresinghe et al., 2005; Bellon et al., 2005). A third consideration is whether the surveys and censuses have a good mix of matching variables that will lead to a robust statistical analysis. A final consideration is whether the developers have the resources and expertise to successfully carry out the method. Many researchers and statistical agencies have the capacity to employ the SAE technique. However, the method requires strong statistical expertise and close cooperation with data providers. Developers of SAE-based poverty maps must carefully plan their projects to ensure that they will have the necessary resources.

Engaging stakeholders

Engaging stakeholders in poverty mapping initiatives is clearly a necessity. Henninger and Snel (2002) recommend that countries conduct needs assessments with the main stakeholders before carrying out poverty assessments. Aside from determining the needs within countries for poverty maps, why is it important to engage stakeholders? What level of engagement is necessary? How can stakeholders be engaged in using the results of poverty mapping assessments? In this section of the paper, we address these questions in the context of engaging the poor, average citizens, experts, analysts and policy- and decision-makers. An important caveat should be mentioned about our group of studies. The terms of reference for each of the research projects required that researchers worked with different stakeholders. Our aim in this section is to share our experience about how our relationships with stakeholders developed, including what worked and what did not work.

Citizens and the poor

Developers of poverty maps can improve their initiatives by consulting with the poor and typical citizens of a country. The average person in a country may be able to reveal special poverty conditions that would remain hidden with standard methods of poverty assessment. The perceptions of the poor themselves may give greater insights into the nature of poverty in a given country (Ravnborg, 1999). The World Bank has incorporated this approach in their efforts to include the "voices of the poor" in poverty debates (Gregoire Leclerc, personal communication; World Bank, 2001).

Two of our studies (Nigeria and Kenya) included substantial dialogue with the poor and typical villagers in the country. Researchers working on these two poverty maps also participated in the household surveys. As might be expected, a great deal of information supporting the poverty map was acquired in the process of completing household questionnaires. In a sense, data collection in censuses and surveys is a way to engage the poor. After all, they are being asked about their living conditions. Poverty assessments should strive to acquire the kind of contextual information that comes from informal interactions and subjective views, and this kind of information is often acquired by spending time with poor people.

Analysts and experts

The terms of reference of our poverty mapping initiatives obligated all of us to work with analysts and experts in the country. Project designers included this objective as a way to foster interaction and knowledge transfer to national programs working in poverty mapping. A more immediate reason to work with analysts and experts is because they provide critical information and knowledge for any assessment. Our experience is that there is a strong relationship between the level of engagement of national analysts and experts and the quality of the poverty assessment. These experts may include social and

environmental scientists, census and survey workers, officials in national mapping agencies and workers in non-governmental organizations.

Policy- and decision-makers

Working closely with policy and decision makers can improve the design of poverty mapping initiatives as well as the chances that the work will be used later in development programs targeted to the poor. An additional advantage is that if the project has the support of these government officials, cooperation and collaboration from officials lower in the government hierarchy is more likely.

Our contacts were mainly with policy and decision makers at the middle, in some cases the top, levels of management of government agencies. We had closer engagement with officials in non-governmental organizations (NGO). In one of our case studies, local politicians reviewed the results and were interested in the poverty level of their district compared to others in the country.

Use and dissemination of poverty maps

Poverty mapping initiatives should have a strong component focused on dissemination of results as part of the overall effort to engage stakeholders. The main way our group of poverty mapping initiatives disseminated results was through publications and initiatives with our partners to share the maps. The country case study project had some successes and clearly had some unsatisfactory experiences in dissemination. In the following paragraphs we discuss lessons learned and list some recommendations based on our experience.

Publishing our results in an international journal and making the data available were two collective efforts to disseminate the results of our poverty mapping projects. The journal publication allowed us to reach a wide audience (Hyman et al., 2005). Quality of the maps and studies was to some extent ensured through publication in a peer-reviewed journal. The researchers of our collection of initiatives worked to develop a web site with information, data and poverty maps available in the public domain (Povertymap.net, 2006). The web site includes pre-prints of the journal publication, the map graphics, standardized geospatial metadata, contact information and the capacity to download the digital maps from the studies. Data sets from the web page have been downloaded 386 times in a period of a little less than one year (Figure 1). But we not yet know how the users came to find out about the availability of the poverty maps. Users told us they are using the maps for research and development in conservation, health, education, food security and poverty reduction. The users came from universities, the private sector and NGO's. Representatives of government agencies rarely downloaded information from our web site. Research on the Web site as a dissemination mechanism needs to be carried out in the future.

The dissemination of our results by each individual project team was the most important way that we engaged stakeholders following completion of the research. The initiatives in this regard varied widely from printed atlas volumes, to multimedia CD's, to web sites with all the project information. To date, we have no synthesized or systematic information on the number of volumes published, CD's produced, or Web site traffic.

Our consensus opinion is that the overall dissemination effort has shown mixed results. In some cases we attracted the attention of important government officials. But many of our studies have not yet captured their attention. Even in cases where government officials were aware of the poverty maps, it is unclear if they ever used them to guide decision-making. Unfortunately, to date, we have no examples of the use of our poverty maps as definitive evidence for guiding official government development programs. Many government agencies suffer from employee turnover. When employees leave the interest of particular officials goes with them. Our poverty maps have been well received by NGO's and academic researchers, from whom we have received a greater number of requests for the data and information. The difference between governmental and NGO use of the poverty maps may reflect the weakness of national government agencies and possibly the dynamism of many NGOs. The government agencies we worked with often lack the funding resources to make good use of poverty maps. NGOs are often financed by international donors. While there is greater use of poverty maps by NGOs, it is limited by the size of their projects.

Conclusion

Poverty mapping initiatives have become more common over the last decade. Henninger and Snel (2002) developed a publication with useful recommendations for governments and their agencies that are planning poverty mapping initiatives. Their suggestions include recommendations for how governments can promote programs and activities that improve the capacity of countries to develop poverty maps. They suggest improved census and survey programs, participation by high-level government officials, poverty mapping strategy development, data access and increased support for research on methods, among others.

Our experience is from the perspective of carrying out a poverty mapping project under the less than perfect conditions that exist in most countries today. While poverty mapping is well within the technical and organizational capacity of many agencies and institutions, numerous obstacles can easily detract from the success of the initiative. Careful attention to issues of data availability, spatial and temporal data compatibility, geographic scale and engagement of stakeholders can help projects avoid obstacles to developing poverty maps. With this observation in mind, we offer the following recommendations to any individual or organization embarking on a poverty mapping project:

1. Engage stakeholders throughout the development phases of the project, especially government officials that will use the assessment later and can help to acquire information from the government. Identify a high-level government official who will be a "champion" of the initiative. Identify a committed host

institution who is prepared to continue using the outputs (both the final results or intermediate products).

2. Conduct needs assessments and identify users of the poverty maps. Examine how these poverty maps could be used as policy instruments by the government. Try to get an agreement that the results will be used for specific targeting programs.
3. Develop sustained relationships with individuals and agencies that provide critical government data that can be used in poverty mapping projects.
4. Nongovernmental organizations can be important partners and users of poverty maps. Develop alliances with NGO's that will strengthen the initiative.
5. Involve government officials and other experts with strong knowledge of the data sources that are used for making poverty maps.
6. Acquire government data in exchange for the results of the assessment, training that might be provided and the knowledge and skills that can be shared with national programs.
7. Ensure that the information and data variables that are needed are available from data providers.
8. Investigate quality and geographic level of the data to be used to ensure that it will serve your purposes
9. Investigate problems that may be encountered from using data sets of widely differing scale and resolution. Will these differences invalidate or weaken the results?
10. Users of small area estimation technique should take advantage of the World Bank software for running the analysis. They should also become well versed in the literature on the method and its application.
11. Develop agreements with data providers that address concerns of intellectual property rights. Acknowledge their support and resources. Plan joint publications, workshops and presentations with government agencies.
12. Develop a dissemination plan that will ensure that poverty maps used in the future have positive development impacts.

There is a great deal of literature, information and advice on how to develop a poverty mapping initiative. Future projects should build on past initiatives to replicate their successes and avoid their failures.

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Table 1. Some characteristics of data used for small area estimation in case studies considered in this paper

Country	Census date	Survey Date	Census sample
Mexico	2000	2000	n/a
Ecuador	2001	1998	100%
Malawi	1998	1997/98	100%
Bangladesh	2001	2000-2001	5%; 1.26 million housholds
Sri Lanka	2001	2002	n/a

Table 2. Characteristics of environmental and remote sensing data used in case studies considered in this paper

.

Country	Environmental and remote sensing data employed.	Pixel resolution or original map source scale
Mexico	Soil type, digital elevation model, climate classification (megaenvironments)	1:250,000; $1km^2$,
Ecuador	Digital elevation model (SRTM), land use suitability, potential agriculture,	90 m DEM; $1km^2$ climate surface;
Kenya	NDVI, soil suitability, P/PE ratio	$1km^2$ climate data set, 1 km^2 NDVI
Malawi	Rainfall, soils, flooding	1:250,000; $1km^2$

Figure 1. Downloads of poverty maps from http://casestudy.povertymap.net/