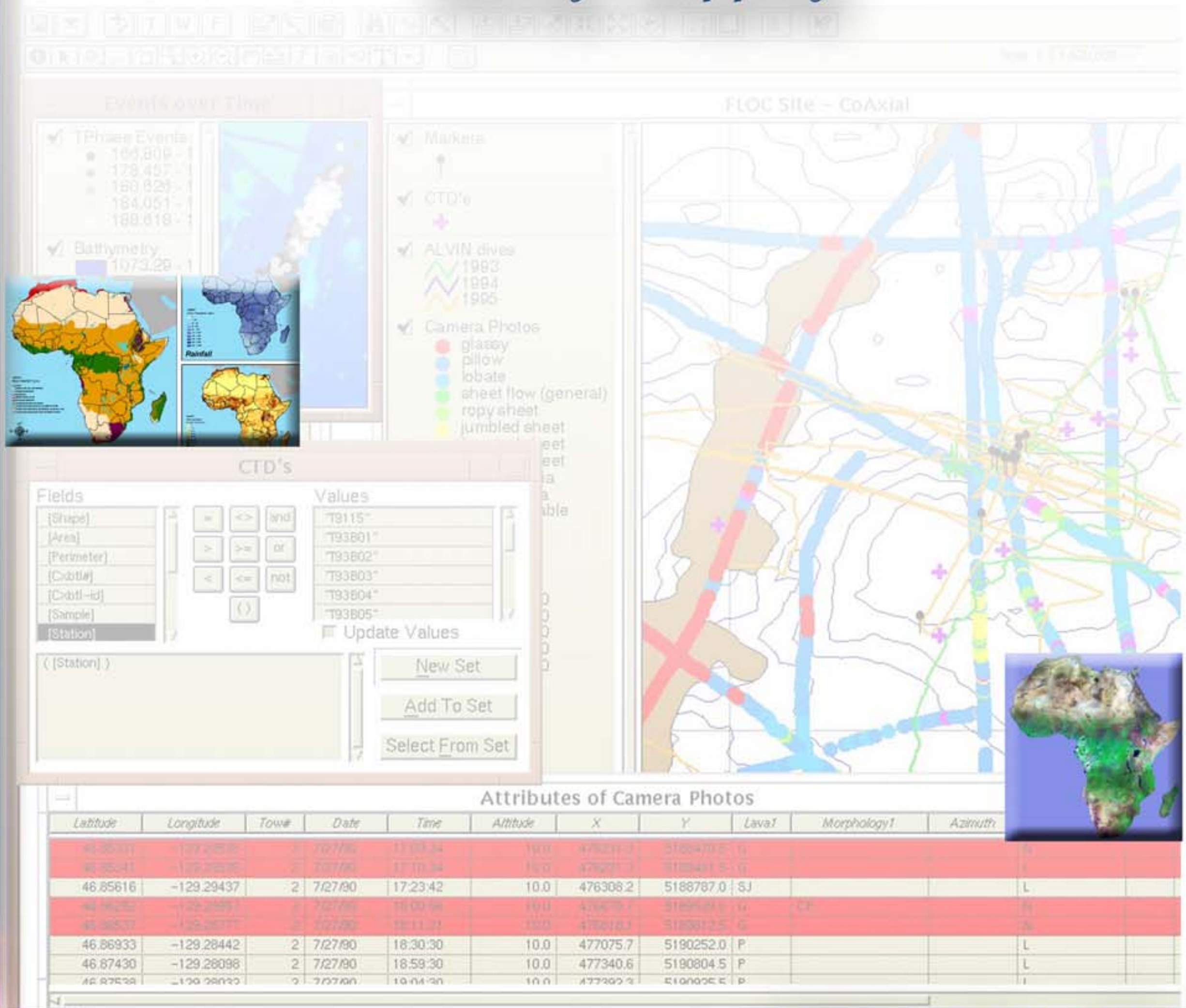
UNECA

The use of Geographic Information System in National Statistical Offices for Data Collection and Poverty Mapping



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1. Introduction

1.1 Background

1. Poverty alleviation is at the forefront of the global development agenda. As a result, there has been an increase in the demand for quality statistics to evaluate and monitor progress towards internationally and national agreed development agendas such as the Millennium Development Goals (MDGs) and the Poverty Reduction Strategies (PRSs).

2. The latest evaluation of the progress towards achieving the MDGs[1] shows that African countries are lagging behind with increasing number of poor, lack of school, and poor access to water and basic health care in their search of sustainable development.

3. One of the recommendations emerging from this evaluation process to put the continent on track of sustainable development is to develop capable states that maintain peace and security, create an enabling environment for the private sector and deliver public goods efficiently. This implies that decision-makers have the capacity to identify those in needs and direct investments in infrastructures and services where they could have the greatest impact. Sound and transparent statistics are essential for evidence-based policy-making. Information is the basis of knowledge and therefore enhances wisdom in taking appropriate actions and correct decisions on issues of development and human progress.

4. The use of Geographic Information Systems (GIS) through Spatial representation and analysis of poverty indicators is an important tool aimed at helping identify “where the poor are”, explain the

[1] UN, Millennium Development Goals, 2005

interrelationships among the influencing factors, and to know '"why they are poor". This spatial representation, known as poverty mapping, is critical for pinpointing the high poverty incidences.

5. Previous ECA studies of the use of Geographic Information Systems in African countries have underlined the insufficient knowledge of this new tool by National Statistics Offices (NSOs), policy makers and the private sector. The present study will give an update of the use of GIS in NSOs with an emphasis on poverty mapping.

1.2 Objective of the study

6. The objectives of this study are:

(a) To promote the development, standardization, dissemination and sharing of GIS data at national, sub regional, and regional levels through appropriate information networks and infrastructures;

(b) To contribute to the improvement of cartographic information management capabilities and accessibility in statistical offices;

(c) To strengthen the effective use of spatial information technologies for producing and disseminating statistics;

(d) To support the development and management of national statistical information systems in quality and integrity of social and economic development;

(e) To assist in formulating policies and strategies on adopting modern spatial information technologies in National Statistics Offices in Africa;

(f) To sensitise policy makers on the role and uses of geographic information systems in policy formulation and decision making; and

(g) To emphasize on the critical role of GIS in the analyse of poverty

1.3 The Scope of the Study

7. The study covers all ECA member States. Written questionnaires were sent to all national institutions or agencies responsible for producing official statistics in Africa; and soft copies of the questionnaires were posted on the ECA Statistics web page. The results of the survey have been used to produce this report.

2. Poverty and geographic targeting

2.1 Poverty mapping

8. The challenges in poverty alleviation and eradication programmes facing both research and development practitioners and policy-makers are twofold:

   - ensuring that developmental interventions have the greatest impact on the poor; and
   - targeting these interventions for impact in the future.

   From the answer to the question “who is poor?” poverty mapping helps to answer the questions “where the poor are” and “why there are poor”. In addition to household surveys or specially designed surveys, fine resolution maps are prepared to enable small area targeting of interventions. Such activities lead to the preparation of what are sometimes called “poverty maps” to study the incidence and magnitude of poverty across space and over time, and examination of the links between poverty and natural resource endowments, education, health, environmental change, etc.

9. Poverty maps and spatial databases are an effective mechanism for integrating information and identifying interventions that benefit more than one sector. Poverty maps are currently being seen by governments and many donors as an area where investments in

information and information infrastructure will yield multiple benefits and high returns because these maps may provide valuable information that could lead to better poverty reduction strategies.

10. Researchers also established a close correlation between access to sanitation, clean drinking water (from more detailed census data) and the prevalence of the disease. Other users working on crime issues combined information on the location of crime hot spots with census data onto poverty maps to characterize communities neighboring these hot spot areas. This helped to formulate first hypotheses on potential linkages between community characteristics and crime.

2.2 Method of poverty mapping

11. There are a variety of methods used for poverty mapping. This chapter presents the most widely used. Further methods could be found in the comprehensive paper of Benjamin Davis (2003), Choosing a method for poverty mapping (FAO). That paper is the source of the story below.

Small-area estimation

12. Small-area estimation is a statistical technique that link survey and census data to a set of predictor variables known for small domains, in order to predict domain-level estimates. Small-area estimation applies parameters from a predictive model to identical variables in a census or auxiliary database; the assumption is that the relationship defined by the model holds for the larger population as well as the original sample. The method may produce greater precision than would do direct surveys to identify the poor.

13. There are two principal methods used for small-area estimation. The first uses census data on household units. It was developed by staff at the World Bank and is the main methodology used and promoted by the

Bank's new poverty-mapping group (World Bank, 2000). The second uses community-level averages instead of data on household units and has been employed by researchers at the World Bank and various centers of the Consultative Group on International Agricultural Research (CGIAR) system.

Household-level method

14. The household-level method requires a minimum of two sets of data: household-level census data and a representative household survey corresponding approximately to the same period as the census. The maximum allowable time difference will vary by the rate of economic change in a given country. Most studies have used a population census with data on household units. An agricultural census that includes basic demographic information could be used, such as the 1997 Chinese agricultural census or other sufficiently representative large-scale survey. Elbers et al. (2001) provide an example of small-area estimation in Brazil using a large-scale household survey instead of a population census. Minot and Baulch (2002a) use a 3 percent sample of the 1999 Vietnamese population and housing census. Efforts are currently underway to test the use of the standardized demographic and health surveys (DHS) on health and nutrition in small-area estimation (Macro International, 2002).
15. The first step is to estimate a model of consumption-based household welfare using data from the household survey. This model should be estimated by statistically representative regions, or urban or rural areas, with explanatory variables limited to those found in both data sets.

Community-level data method

16. An alternative small-area estimation method uses average values from disaggregated geographical units such as communities or small towns instead of household-unit data. This has the advantages that data requirements are less stringent and national statistical agencies may be

more likely to release community averages on request; indeed, this data may be published. This is particularly important for researchers who, unlike the World Bank researchers, do not have institutional backing or resources to form formal collaborative arrangements with national statistical agencies. Apart from the difference in the scale of the predictive model, the two small-area estimation methods follow essentially the same steps. The first step is to estimate a model of consumption-based household welfare using the household survey data. The resultant parameters are then used to predict the expected level of well-being for communities.

Multivariate weighted basic-needs index

17. Various basic-needs indices are used for disaggregated poverty mapping. They differ among themselves in terms of the choice of variables and weighting schemes. This section focuses on an assortment of weighting schemes. Three are based on multivariate statistical techniques - principal components, factor analysis and ordinary least squares. The others have no weighting scheme; all components are valued equally.

2.3 Case studies

18. Government institutions in South Africa were among the first major users of poverty maps in the continent. Poverty maps have been instrumental in guiding researchers in educational outreach campaigns to slow further spread of cholera outbreaks that had started in Durban in September 1999. By combining epidemiological information with poverty data and demographic profiles from the census, the outbreak of the disease could clearly be linked to some of the poorest areas in Durban.

19. In East Africa, there were some multidisciplinary efforts by different institutions such as the International Livestock Research Institute (ILRI), the World Bank, the Rochester Foundation, and the World Resources Institute (WRI)) that were aimed at producing fine resolution poverty maps (Ndeng' e G. et. al, 2001). Among these efforts was a workshop that brought together specialists in areas such as statistics, economics, GIS and remote sensing, environmental and natural resource management, indicator development, survey and census design, and demographic and policy research to discuss and develop strategies for poverty reduction. The workshop came up with two main recommendations, namely:

- to launch a broader co-ordinated strategy to strengthen the capacity within African institutions for producing poverty maps based on small area estimation; and

- to build spatial databases and produce selected rough-cut maps of human well-being.

Box. Applying the lessons learned to poverty mapping in East Africa

In early 2001, research and policy teams in Kenya and Uganda embarked, with support from the International Livestock Research Institute (ILRI), the Rockefeller Foundation, the World Bank, and the World Resources Institute (WRI), on producing poverty maps based on small area estimation using household unit-level data. The Kenya teams linked the 1997 Welfare Monitoring Survey (WMS) to the 1999 national household census. The Uganda teams first applied the techniques to the 1992 WMS and the 1991 national census to gain experience and intended to base their final maps on the census (2002) and more recent household surveys. The results from both works were expected by the end *of 2002.*

This project approach has built on the experiences of poverty mapping efforts in other countries. The approach featured: (i) three-person teams of highly motivated analysts from key institutions (e.g., census bureau, survey department, ministry of finance and planning, and universities); (ii) small teams of senior advisors representing policymakers, major users, and major data producers (e.g., ministry of finance and planning, secretariat responsible for poverty reduction strategy paper, and heads of central bureau of statistics); (iii) hands-on training workshops to review progress; (iv) technical assistance from the World Bank's Research Group as well as countries with experience in small area estimation (e.g., Statistics South Africa), and (v) regular briefings for senior policymakers. A sixth element to this package was envisioned, which would encourage country teams to compile, in addition to the poverty maps, about two dozen maps showing household characteristics, educational background, access to sanitation and water, and other variables that are relevant for poverty analyses. These data could be taken directly from the census, an often-underused source of information, and would provide an important context for the poverty maps. (See for example Malawi's upcoming *Atlas of Social Statistics* as an excellent example how to communicate these census data.)

It was anticipated that the Kenya and Uganda maps would raise awareness about poverty, communicate its important spatial aspects, and facilitate policy dialogue and planning. In addition, Kenyan and Ugandan policymakers expect to improve the targeting and allocation of government expenditures, emergency response and food security planning, and poverty alleviation programs.

Lessons from the process in these two countries mirror the findings in this report, namely, the importance of senior-level support, the need for collaborative approaches, the importance of an active dissemination strategy, and the importance of viewing poverty mapping as critical long-term capacity development and institutional-strengthening exercises. With an upcoming election in Kenya, it remains to be seen whether these maps will be released for further analyses and policymaking at various levels, or viewed by those in power as too politically sensitive to be made available for such uses.

A rich area for further research utilizing poverty maps relates to better understanding the problems of low productivity, natural resource degradation, and poverty in the intensifying rural sectors of both Kenya and Uganda. In some areas, it appears that land-use change has been part and parcel of a productive and sustainable pattern of agricultural development; in other areas the reverse is true, and tremendous population growth and land-use changes have led to severe land degradation. These new poverty maps may hold the key for determining agricultural land use and related technological options that lead to the former rather than the latter.

Sources: Presentations by T. Benson, P. Kristjanson, G. Ndeng'e,
(From: Where are the poor, Norbert Henninger and Mathilde Snel, 2002)

3. The Geographic Information System (GIS)

3.1 The concept

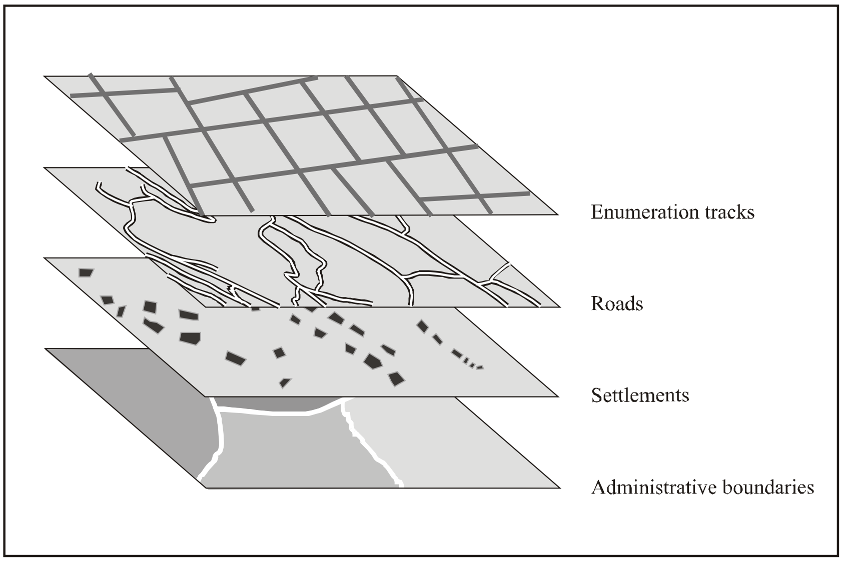
20. Geographic information systems (GIS) are computer-based information systems that enable capture, modeling, manipulation, retrieval, analysis and presentation of geographically referenced data. They are essentially database management systems that allow the simultaneous analysis of information from heterogeneous sources, as long as they have geographic location coordinates. They also permit the analysis of spatial association between different dimensions. They allow the simultaneous analysis of variables, which are observed at different levels; for instance some infrastructure might serve broad areas (hospitals, major roads, colleges) while others serve smaller zones (primary schools or health posts).

21. A complete geographic information system consists of hardware, software, data, and skilled personnel to operate the system and carry out analysis for interpreting the results generated. The information in a GIS relates to the characteristics for geographic locations or areas. In other words, a GIS provides answers to questions about where things are or about what is located at a given location. Uses of GIS technology include land use planning, market research, surveillance of epidemics, natural resources management, demographics and education planning.

22. Until recently, the organizational costs involved in creating a GIS were high, this limited widespread use of these emerging technologies. Also, they ran on mainframes, staff training was extensive, and data collection and data entry remained labour intensive. Within the past couple of years, changes in these areas have made GIS more affordable. With hardware performance advances, including more powerful data collection tools and equipment, a GIS can operate on personal

computers. User-friendly interfaces have been developed, and pre-packaged databases are available.

Fig.3.1: The map layer concept in GIS



3.2 The GIS and statistical processes

23. Geographical Information Systems (GIS) add value to the various stages of the statistical process by optimizing data collection, and enhancing the accuracy and timeliness of statistical data. GIS also enhances the data dissemination through the visual impact of maps. A typical urban GIS might let users view an aerial photograph of every building in the city by simply clicking on a plot number in a digital map. The plot number can also be linked to a database of census data, zoning classifications, tax assessments, and traffic patterns related to that building's plot. Equipped with that kind of spatial information, city administrators can make informed decisions about where to authorize the construction of new clinics, schools or hotels, to name just a few applications.

3.2.1 The GIS and data gathering

Census and Survey Mapping

24. Census mapping is to support the enumerators and supervisors to carry out their specific assignments that include identification of their enumeration areas, location of households, agricultural holdings, establishments, and demarcation of supervisory areas on basis of size, population and manageable distances.

25. Further, census mapping assists in eliminating omission and duplication of information; ensuring that data are allocated to the proper administrative units; determining the number and distribution of census personnel; and comparing data from other censuses or surveys.

26. Maps are needed during all stages of a census or survey. They are required in the planning stages, data collection and analysis and presentation of the results. Since the mapping programmes involve inputs of labour, time and money, the question may arise on the importance of the maps in a census or survey activity.

27. As the ultimate goal of a census or survey is to produce data that are accurate, timely and useful, then the role of maps as tools that help make this attainable becomes crucial. Further, census is a time-bound activity and so are the cartographic activities involved in the different phases of the census programme.

Health

28. The uses of GIS in health statistics include mapping of demographic characteristics of the population, distribution of diseases, location of health facilities, epidemiological research and the decisions that are made on the basis of the information from such analyses. As mapping is

an excellent means of communicating a message clearly even to those who are not familiar with the methodology, GIS, through the visualization techniques, can be used effectively to convince the leadership at the various administrative levels on the priorities and the problems and options for the implementation of various health programmes of a department, region or district. Mapping is also used in participatory learning and evaluation techniques for community health projects.

Agriculture

29. In agricultural censuses and surveys, GIS may be used in crop area estimation and determination of the field area locations as well as in estimating the crop yield. Further, GIS is a substantive component in food early warning systems of regional food security programmes in Eastern and Southern African countries. The use of GIS allows the integration and analysis of data on population, climate, price, soil, and the various types of crops in order produce an assessment of the vulnerability of the food situation at the regional, national and local levels.

3.2.2 The GIS and data dissemination

30. GIS enhances the data dissemination through the visual impact of maps. A typical urban GIS might let users view an aerial photograph of every building in the city by simply clicking on a plot number in a digital map. The plot number can also be linked to a database of census data, zoning classifications, tax assessments, and traffic patterns related to that building's plot.

31. The final set of tools provide the ability to create output such as maps, geographical summaries or reports, and geographical base files (files containing both the digital map and attribute data). Output can be either hard copy, digital files, or displayed on a computer monitor. The

sophistication of the GIS software and the output capabilities of the hardware/software system dictate the quality and variety of options available to the operator. In most cases, the GIS allows maps, summaries, and base files to be written in a number of different digital export formats so that they may be used by another GIS. Most systems have the ability to translate or directly import and export these files.

32. Generating graphic output, commonly in the form of maps, requires that a GIS have a wide variety of symbols and format options. Most offer numerous line, polygon, and point symbols to represent geographical phenomena as well as text options for labeling and annotating output. Since these utilities allow maps to be produced at various page sizes and map scales, output can be custom-designed to a format that is most appropriate for the situation.

33. Geographical and tabular summaries are common types of GIS output. Such summaries differ from those created by a traditional database query because they are based on map analysis. For example, upon completion of a windowing of clipping function, summary statistics presented in tabular form for the clipped area are often necessary to complement the analysis. A GIS will usually offer this type of report-generating capability and it is especially useful during complex spatial analysis or database documentation.

34. Use of reference maps is an important part of the output (mapping) process. It is common for a GIS to contain a library of basic, often-used map and attribute data of the study area for creating these simple reference maps. Such base files could include county, section, parcel, or zip code boundaries, major transportation routes, or hydrological features. When included in output maps, these cartographic features provide a useful frame of reference for the map user.

4. Planning and Implementing a GIS

4.1 Justification for investing in GIS

35. The shift from traditional cartographic methods to digital GIS techniques requires a significant investment. There are both high initial short-term costs and ongoing long-term expenses. Short-term costs include the conversion of hard copy maps to digital data, the purchasing of hardware, GIS software and other spatial data, and the hiring and training of staff. Long-term costs include ongoing operational costs such as system maintenance and upgrade, spatial database updating and staff training.

36. A GIS infrastructure must be viewed as a long term-term investment in order to maximize its benefits. Despite the initial high costs in establishing a GIS the following arguments indicate that the benefits, some of which are listed below, justify the acquisition of such systems. These benefits include (Korte, 1992):
    - Map data is better organized and more secure;
    - Map data is easier to store, search, analyze and present;
    - Map revisions are made easier and faster; and
    - Map data can be integrated throughout the organization

37. As the challenges involved in introducing GIS are often more institutional and organizational than technical, mobilizing co-operation among all stakeholders is essential in order to establish and run a functioning GIS facility.

4.2 User Needs Analysis

38. Geographic information systems are successful when they comprehensively and consistently meet well-defined user requirements. The planning and implementation of a GIS in an organization requires a clear understanding of the nature of outputs expected of the system; the

inputs required to achieve them; the cost of operating and maintaining the system; and the identification and education of future stakeholders who would be critical for the success of the systems.

39. Thus it will be necessary to identify all users and undertake a comprehensive user needs analysis of existing and future needs and operations, the prioritization of information products and data required to satisfy such needs. This would be supplemented with a definition of system requirements and the related functional capabilities. The user needs analysis should also provide the foundation for evaluating different GIS software options in order to define the expected GIS capabilities.

40. For the national statistical office, it is also important that a needs analysis should take into account both the subject-matter dissemination requirements and the needs of the decennial programme of statistical activities and the different uses to which GIS could be put in the implementation of those activities.

4.3 Hardware and Software Assessment and Acquisition

41. The hardware and software assessment involves an evaluation of GIS equipment and software alternatives based on the results of the user needs analysis. A major problem in implementing GIS has been the failure to match GIS capabilities with user needs. The high cost of GIS software necessitates that user needs are fully understood prior to equipment and a software assessment.

42. The software assessment focuses on rating GIS capabilities based on a weighted prioritization of specific requirements. However, the software assessment must also consider secondary technical factors, e.g. user friendliness, documentation, training, system management and security, etc., as well as operating system characteristics, the RDBMS, supported

computing environments, software licenses and modularity, programming interfaces and supported data structures.

4.4 Implementation Plan Development

43. A detailed implementation plan to direct the acquisition process, start-up, and the operational phases of implementation must be prepared next. Such a plan would normally include a strategy to address issues such as database design, data conversion, and the definition of realistic goals and timeframes. The implementation plan is essential for the successful implementation of GIS technology. A draft outline plan is attached to this paper for use as a guide in drafting future plans.

4.5 Staffing and Training

44. Training is an important aspect for the successful implementation and operation of a GIS facility. Training is needed at various levels and with differing goals and durations. The training should be provided for both managers (awareness training) and operational staff. In addition, training should be organized for users in other government departments, the private sector and NGOs on the potential of the new technology. Short-term training courses may be arranged as an in-house activity and combined with on-the-job training. The duration of courses for operational staff could last between two to four weeks and that for users could last from two to four days. If the statistical office is close to a university, that institution could be hired to provide some of the training.

5. Surveys results

45. African National Statistical Offices (NSOs) were surveyed in 2002 and 2005 with the purpose of collecting information on the use of maps and the applications of GIS in their organizations. The questionnaire contained 11 questions (see Annex). The first four addressed the use and availability of maps, source of the maps, and the remaining addressed the use of GIS, the planning of GIS and the institutional capacities for GIS.

46. Of 53 countries, responses were received from 28 countries giving a response rate of 53 percent. The summary data presented below refer only to those 28 countries that responded to the questionnaire in 2002 and/or 2005.

5.1 Use and availability of maps for statistical activities

47. All the 28 countries that responded use maps, mostly for planning of censuses and surveys activities including presentation of statistical data.

48. 15 countries (54%) use both topographic and thematic maps and 5 countries (18%) use only topographic maps. The major themes underlined in the thematic maps are:
    - Administrative Units maps;
    - Enumeration area maps;
    - Census maps;
    - OrthoPhoto Maps; and
    - Orientation maps of statistical/sample areas using aerial photos as backdrop.

49. Country coverage of NSOs maps

- All urban and all rural areas are covered in the maps of 22 countries (79%); for the remaining 6 countries, maps coverage is in some urban only (1 country), some urban and some rural (2 countries), all urban and some rural (1 country) some urban and all rural (1 country) and all urban (1 country).

50. Data collection for maps updating

Data for maps is collected through a combination of fieldwork of NSOs census/survey teams, air photos and satellite imagery.

51. Linkages and collaboration with other agencies

- Most of the NSOs maintain collaborative relations with the National Mapping and Survey Agency and other public sector agencies
- 23 NSOs (82%) prepare the maps in their offices with the collaboration of the National Mapping and Survey agencies for 19 of them. Five NSOs have their maps prepared exclusively by the National Mapping and Survey agencies or other national or foreign sources.
- 16 countries (70%) from the 23, where this question is relevant, maintain an inventory of maps of the country in their statistical office.

5.2 Status of GIS in the NSOs

52. The study revealed that 18 (67%) of the National Statistical Offices use Geographic Information Systems and 8 NSOs (29%) are planning to introduce GIS in an average of 2 years time. The reasons for using or wishing to introduce GIS are quite varied and include:

- The desire to improve information processing;
- To improve the quality of the data processed;

- To meet the request of data users; and
- In some cases the GIS was introduced upon receipt of technical assistance in the form of GIS equipment and software.

53. According to the survey the average number of months taken by the NSOs for planning, analysis and implementing the GIS are respectively 11.8, 8.5 and 15.4.

5.3 Major problems encountered in using the GIS

54. The surveys identify the following problems in using the GIS:

Organizational problems:

- Lack of awareness of the value and potentiality of these new technologies;
- Shortage of skilled manpower or insufficient training of staff; and
- Lack of financial resources to timely carryout cartographic mapping.

Technical problems:

- Hardware reliability and software compatibility;
- Limitations in sharing the GIS software due to license restrictions; and
- High cost of data collection and capture, level of geographic detail at which data are collected and lack of compatibility of data sets.

54. The table below summarises the status of GIS use by country:

Use of and plans to introduce GIS in NSOs

Country	Currently using GIS	Planning to introduce GIS	GIS Software being used or planned for use.	Map coverage of the country by area
Botswana	Yes		ESRI Products, ArcGIS 9	All urban and all rural
Benin	No	Yes	...	...
Burundi	No	Yes	...	...
Cameroon	No	Yes	...	...
Cape Verde	No	Yes	…	…
Chad	Yes		ESRI Products and MapInfo	All urban and all rural
Congo	Yes		Pop Map	All urban and all rural
Egypt	Yes		ESRI products and MapInfo	All urban and some rural
Ethiopia	Yes		ESRI products	All urban and all rural
Gabon	No	Yes	...	...
Gambia	Yes		ESRI Products, MapInfo and Pop Map	All urban and all rural
Ghana	Yes		ESRI products	Some urban and all rural
Kenya	Yes		ESRI products	All urban and all rural
Liberia	Yes		ESRI products	All urban and all rural
Madagascar	Yes		Pop Map	Some urban and some rural
Mauritius	Yes		MapInfo	All urban and all rural
Morocco	Yes		ESRI products, Micro station and SYGER (SYstème de GEstion des Ressources)	All urban and all rural
Nigeria	No	Yes	…	…
Senegal	No	Yes	…	…
Seychelles	Yes		ESRI products	All urban and all rural
Sierra Leone	Yes		ESRI products	All urban and all rural
South Africa	Yes		ESRI products	All urban and all rural
Swaziland	…	…	…	All urban and all rural
Tanzania	No	No	...	...
Tunisia	Yes		ESRI products	All urban and all rural
Uganda	Yes		ESRI products and WGEO for image rectifications	All urban
Zambia	Yes		ESRI products, AtlasGIS and MapInfo	All urban and all rural
Zimbabwe	No	Yes	...	...

6. Conclusions and recommendations

55. The GIS technology has many critical uses in statistical offices. The integration of data from various sources and their visualization in causal relationships, an opportunity provided by GIS, enhances analysis and understanding of complex data and phenomena. Decision-making is then made easier and more accurate. Therefore, in order to promote its use in Africa, the following recommendations are made:

56. National statistical offices should endeavor to introduce or strengthen the use of GIS in their offices. This should be preceded by user needs analysis followed by an assessment of the hardware and software requirements. The use of GIS will contribute to the efficient and cost effective implementation of Housing, Population and Agricultural Censuses, and other Surveys such as the Demographic and Health Survey (DHS). Mapping is a fundamental requirement for the implementation of any census or survey, as operations cannot be properly implemented without the timely preparation of good and reliable maps.

57. There is a need to improve awareness at the senior management level on the potential benefits of GIS. Core information technology (IT) applications such as data processing and management, word processing, spreadsheets and email are becoming well established in National Statistical Offices in many African countries. GIS has evolved into an integral part of IT that can support the various activities of these organizations.

58. The personnel involved in GIS require frequent training to keep up with advances in the technology. Any efforts to establish a GIS must include funds for ongoing staff training as part of the annual operating budget.

59. Poverty maps are becoming important tools for developing effective policies aimed at reducing disparities within a country, and in designing intervention schemes to reach the most needy groups. Therefore, National Statistics Offices as custodians of socio-economic data should strengthen their capabilities in GIS so as to facilitate poverty mapping and poverty analysis.

60. Strategic development of the national information infrastructure will have to include a national spatial data infrastructure (NSDI) component and also address how the NSDI and the new technologies could be used to disseminate or access statistical information.

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