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**The Use of GPS to Design Enumeration Areas:
a convenient solution for developing national sampling frames***

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INTRODUCTION

Census is the largest statistical data collection undertaken by Statistics Sierra Leone (SSL) and perhaps the most important. In the Sierra Leonean context the absence of reliable data which had placed the country in the bottom of the Human Development Index (HDI) was a major factor that called for an urgent need to conduct a census.

However the approach using GIS and the use of The Global Positioning System (GPS) techniques was determined by the following reasons:

- Absence of necessary digitized maps for most urban areas and small towns
- Obsolete nature of available maps in the country, the recent available ones dates as far back as 1963.
- The absence of administrative and other boundaries in digitized forms. Those available were wrong or had been changed.
- The recent expansion of towns and cities and change of street names, thus there was the need to include these changes in town maps.

GIS and its accompanied technologies played a vital role in all the stages of the 2004 Population and Housing Census- i.e. Pre-enumeration, Enumeration, and Post-enumeration activities. But most importantly in the pre and post-enumeration activities.

- Pre-enumeration activities include Spatial data collection and capture.
- Post –enumeration activities which involves digitization of EA maps and linking of Census data base to Spatial data base (EA shapefiles for analytical and planning purposes with respect to health, education etc.)

DATA COLLECTION

Mapping for the 2004 national population and housing census

1. To conduct a census through direct interviews, it is essential to delineate the country into enumeration areas (EAs) in order to ensure that there is no duplication or omission of persons or households at the time of enumeration. The delineation of EAs also helps to fulfill the following functions:

- Assess the size of the manpower, questionnaires and other equipment required for the census;
- Provide comparable workloads to the enumerators;
- Ensure that the census is completed in the specified time;

- Follow up on the quality of the data collected (four to five EAs were designated as a supervision area (SA), and a supervisor was assigned to follow up on the quality of the data collected by the enumerators); and
- Provide a statistical frame for future socio-economic and demographic surveys.

2. The first stage in the process of the 2004 census map work consisted of collecting of all the maps that were available for the rural areas and the Geo-referencing of urban maps that were available. These maps were used as the base on which the census maps were prepared. The major maps for the purpose of census mapping that were available at Statistics-Sierra Leone for most parts of the rural areas were large-scale maps (1:50,000 or 1:25,000) and medium-scale maps for urban areas (1:5,000 or 1:10,000) of the country.

3. In the 2004 census mapping work, enumeration areas were constructed by tracing an area which contains a certain number of households or housing units on the base map. For this purpose, it is necessary to go from one housing unit to the next, listing all households (Quick count) to determine the enumeration Area. Global Positioning System (GPS) points were taken for all localities in the enumeration areas

Manual for census mapping

In undertaking census mapping work, it is essential to prepare a manual which will be used for the training of census mapping field staff and during the actual census mapping fieldwork. The manual for census mapping was prepared by two census mapping consultants and the Cartographer of Statistics Sierra. The manual covered different aspects of census mapping work, such as geographic concepts, map reading, and the delineation of enumeration and supervision areas in rural and urban areas. Moreover, the manual covered the use and operation of the GPS Gamin 12 which was used in the exercise.

Recruitment and training of census mapping field staff

The second phase of the census mapping work involved recruiting and training of census mapping field workers. Graduates of Geography bias were recruited together with high school leavers.

The existence of small administrative units like the section in the rural areas greatly facilitated the census mapping work. This was because these sections had distinct characteristics and loyalty and in some cases boundaries were well recognized. The chiefs in charge of these sections also substantially helped the cartographic work by providing consultations, publicity, lodging and other facilities to the field teams.

Organization of the field operation during census mapping and data collection

During the census mapping fieldwork, field staffs were organized into teams. Each team consisted of a team leader, mapping officers (mostly graduates) and mapping assistants

and a driver. Each team was provided with a four-wheel-drive vehicle; each member of the team was provided with a mattress and other logistics

During the census mapping field operations, the teams were deployed in chiefdoms within districts. The teams were charged with the following duties among others to:

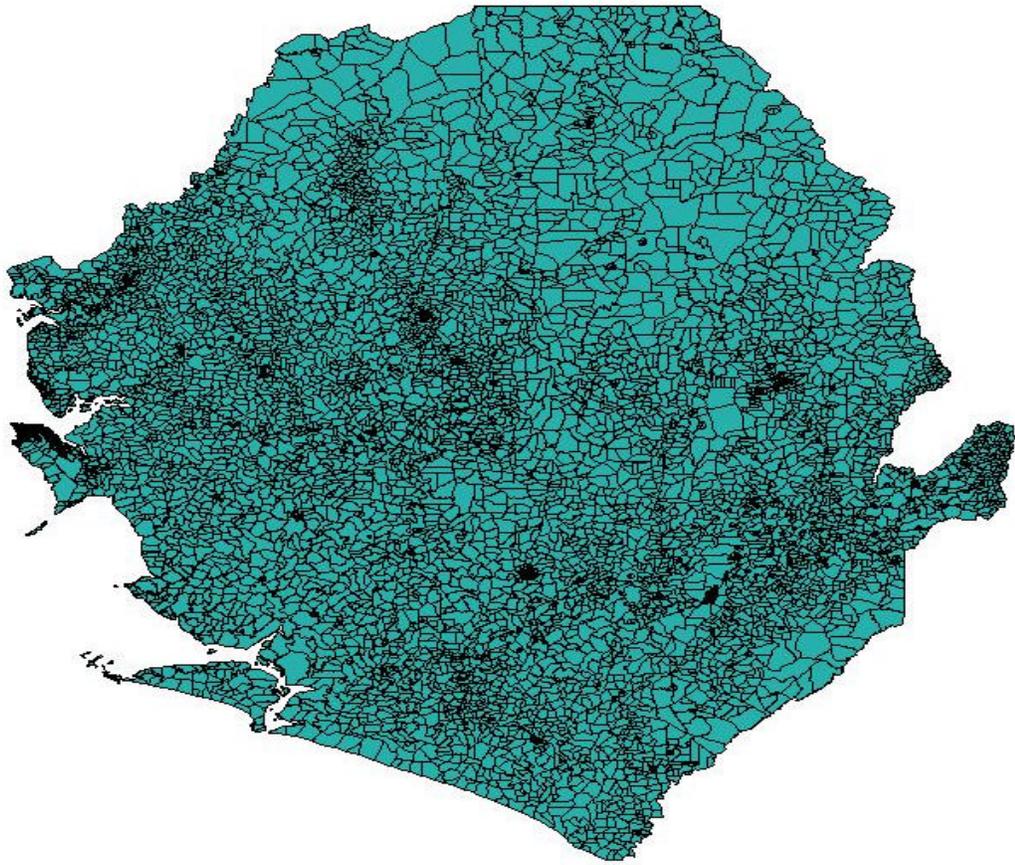
- Review the list of localities with the local authorities in order to ascertain which ones were existing and which ones had been abandoned. Similarly, localities which were not in existence by the time of the initial compilation were then included;
- Tally count of households in each locality visited. This was done in order to be able to delineate Enumeration Areas (EAs). The number of household was the key determinant in the EA delineation exercise though other factors were also taking into consideration, for example distances between localities and the nature of the terrains;
- Collect GPS Coordinates for localities, health and educational facilities in all of the localities;
- Visit administrative boundaries- i.e. Districts, Chiefdoms and section boundaries and the collection of GPS coordinates for these boundaries and the subsequent plotting of these boundaries on the base maps;
- Delineate EAs and describe EA boundaries especially for urban EAs;
- Update maps and sketch big villages and small towns with more than one EA using GPS.

DATA CAPTURE

Data capture involved the following:

- Drawing of and demarcation of EA and administrative boundaries;
- Data entry was done in excel by the Data entry clerk using field forms returned from the field;
- Redrawing of maps showing all boundaries from the EA to the provincial level. This was done after proper alignment of boundaries especially administrative boundaries;
- Scanning of maps sheets using AO scanner;
- On-screen digitization of all boundaries;
- Editing and cleaning of EA shape files using Arc Editor;
- Conversion of GPS co-ordinates from excel to dbase;
- Linking of census database to EA shape files.

DIGITIZED EA DATA BASE.



SAMPLE OF CENSUS DATA BASE

EA NO.	DIST	DIST.C ODE	CDOM	CDOM CODE	SEC	SEC.CO DE	MALE	FEMALE	TOT.POP	H/H
11010101	KAILAH UN	11	1101	DEA	BAIWAL LAH	110101	126	149	275	68
11010102	KAILAH UN	11	1101	DEA	BAIWAL LAH	110101	182	244	426	96
11010103	KAILAH UN	11	1101	DEA	BAIWAL LAH	110101	197	231	428	89
11010104	KAILAH UN	11	1101	DEA	BAIWAL LAH	110101	192	203	395	72

LESSONS LEARNT

In our experience as a country, the use of GIS and GPS in census operations had not only led to a complete and total coverage of the entire country, but had led to the development to a census and GIS database. This had enable statistics Sierra Leone to increase its services and hence its capacity to quickly and efficiently respond to public and other demands.

The availability geospatial data had enable Sierra Leone to demarcate constituencies' boundaries digitally. Statistics Sierra Leone had also provide the National Electoral commission (NEC) with constituencies maps with constituency boundaries digitally done

The data was also used for planning purposes, recently the Directorate of Planning of the Ministry of Health has benefited from the geospatial database as they have used the information provided for planning.

Also, despite the use of the data for national planning, there had been increase awareness and thus the demand for GIS products.

However, this is not to say that the use of the technology was not without implications. The cost involved (human, resource and finance) was so huge. Thanks to UNFPA and the EU without whose assistance the success story would not have been told.

CONCLUSION

The use of the technology in census mapping in Sierra Leone had not only led to a successful census taking, but had been a model for other African countries. There had been Missions and study tour from countries like Liberia, Sudan,etc. We can now boast of rich national geospatial database from which further developments can spring.