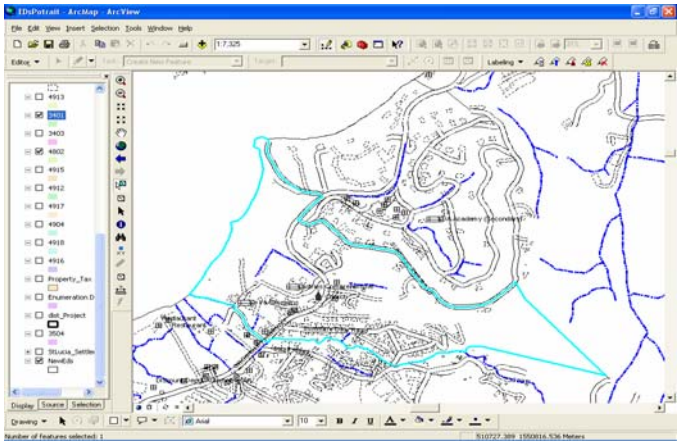
GIS and Census Mapping in St. Lucia



Presented by: Sherma Lawrence
Central Statistics Office, St. Lucia

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Introduction

Prior to the census in 2001 the Statistical Department of St. Lucia had to embark on a series of technological initiatives.

Part of these initiatives was to invest in both the human and physical resources of the department, taking the department into a new realm of Geographical Statistical Information. This was done through the development of a Statistical Geographical Information System.

The first step was to train the existing staff of the mapping section in GIS and the use of the software involved in such a discipline. The introduction of this training coupled with the experience in mapping and statistics gave the unit the tools to conceptualize the approach to the 2001 census and the possible outcomes of such an application.

The software and data sources were identified to support the initiative. The software chosen was ArcGIS and the data was topographical maps of St. Lucia in dxf file (AutoCAD) Format.

However there was a problem with this data since it was about ten years old and when used to develop or maintain the existing Enumeration districts(ED) the inaccuracy was found to be too great.

Background

Maps had been used in census enumeration prior to 1970. In 1980 aerial photographs were used to guide the enumerators along their designated enumeration districts. In 1991 the aerial photographs were used in collaboration with hand drawn maps provided by the Surveys and Mapping Section of the Ministry of Planning.

In order to obtain a full count the island had to be subdivided into enumeration districts consisting of approximately one hundred (100) households. Up until the 1991 census the enumeration district maps had been hand drawn by employees of the surveys Department of the Ministry of Planning. The drawing and updating has since become the sole responsibility of the Statistics Department whose purposes they serve. The Statistics Department was first engaged in a project to delineate all the Enumeration District (ED) boundaries onto a map of St. Lucia to ensure complete coverage. Topographic map sheets of a scale 1:2500 were used to delineate the ED boundaries and from these Topographic map sheets new ED maps were then drawn to scale.

GIS Software

The increasing demand for upgraded maps especially for the 2001 Census was a primary factor for the initiation of a Geographic Information System (GIS) at the Statistics Department. Heads down digitizing was used to transfer all the data from the Topographic maps into the new system. Arcview 3.0 was the initial software used and was upgraded to Arcview 3.1 then 3.2. Initially Arcview was used for heads-down digitizing of topographic maps sheets. Heads-up digitizing was then used to subdivide the EDs on the computer. The department also introduced the use of Global Positioning Systems (GPS) to assist in the continuous updating of the existing maps as well as in further subdivision of those EDs which has grown in excess of 160 households over the years. Weekly updating exercises were undertaken using the GPS, giving priority to highly developed and populated areas. After the automation process was completed, digital ED maps were now produced with the software. Arcview 3.x allowed for multiple ED layouts to be saved in one project. For the 2001 census a fair portion of the ED maps had been computer generated.

In 2001 the Department migrated from Arcview 3.x to Arcview 8.1 The staff of the Mapping Unit underwent training to assist in the transition. The new Arcview only allows one layout per map project therefore the new ED layouts were saved as .jpg image files and more recently .pdf because of the better print quality. The license for Arcview 8.2's Spatial Analyst, GeoStatistical Analyst and

Publisher were purchased along with Arcview 8.2 version. Arc Publisher was used to create map projects on behalf of agencies like the Poverty Reduction Fund and publish them. The maps could then be viewed and printed in ArcReader, which allowed access to geographic information and basic functionality of a GIS, when the resources are not available to have a GIS. The GIS software was recently upgraded to Arcview 9.2. A license for ArcEditor 9.2 was also acquired by the Department because of its advance tools to create topology for the ED and settlements and to remove slivers. The other analysis capabilities of ArcEditor continue to be explored.

ED Development

ED Development with GPS

The production of digital ED maps has certainly evolved since the introduction of GIS at the Statistics Department. From hand drawn maps to updated computer generated maps. *See Fig 1 below*

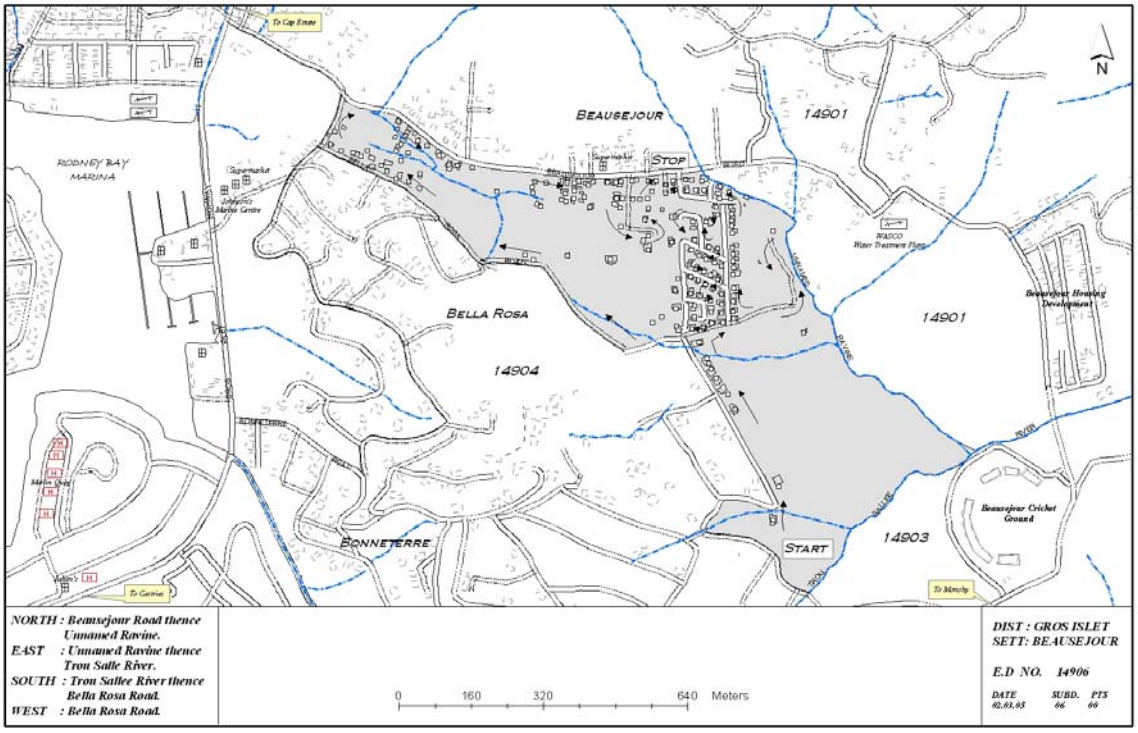


Fig 1 ***Digital ED Map***

ED maps are continuously being used by the Survey Section of the Department for their Quarterly Labour Force Survey. Enumerators use the maps in the field every week to collect data.

The regular updating of roads and building using GPS remains a priority for the Mapping Unit. Each week the staff would go out with the handheld GPS units to collect data. An average of three ED would be targeted each week for updating. Upon returning to the office the data would be transferred to the computer usinf

the Pathfinder office software which came with the Trimble GPS units. Differential corrections were made using base files obtained from the Cable and Wireless base station. The corrected files were then exported as shapefiles ready to be imported into the GIS project.

The Department has recently acquired a Trimble GeoXM handheld GPS unit. This new unit combines the Trimble GPS with Microsoft Windows CE operating system, introducing a mobile GIS unit.

Upgrading of the unit meant upgrading of the software. The office also purchased licenses for TerraSync and ArcPad 7.0., which made updating of roads and buildings just got more interesting. The Arcpad software whose primary use is for the updating of buildings, allows the one to import actual ArcMap projects to the unit. The extraordinary navigation facility allows someone to navigate easily. The TerraSync software is used mainly for the updating of roads. Corrections can be made to EDs in the field where new buildings can be added and non existing buildings removed. Verification of ED boundaries can also be done in the field to ensure that mapped roads and tracks coincide with the actual roads and tracks on ground. Most EDs will be updated

and the buildings renumbered sequentially to accommodate the re-listing of the EDs prior to the 2010 census.

Following the last census a number of EDs had to be subdivided to accommodate the increase in development in certain areas and there by maintain an average of 100 households per ED. Although the next census is still a few years off preparatory work is already underway with the production of newly updated maps for the 441 EDs on the island.

Updating ED's using Aerial Photographs

In 2004, the Survey and Mapping Department of the Ministry of Physical Planning acquired aerial photos of the Island. The Mapping Unit through relations with the Department was able to obtain a copy of these aerial photos in their un-rectified state. These images were inserted into the GIS as a picture and used as a backdrop to the vector layers which assisted in the updating of the roads and buildings. In certain areas there were too many trees which obstructed the view of existing buildings and parts of the road. A number of field trips had to be done for ground truthing. The use of the GPS has proven to be the most effective method for the updating Enumeration Districts for the Department.

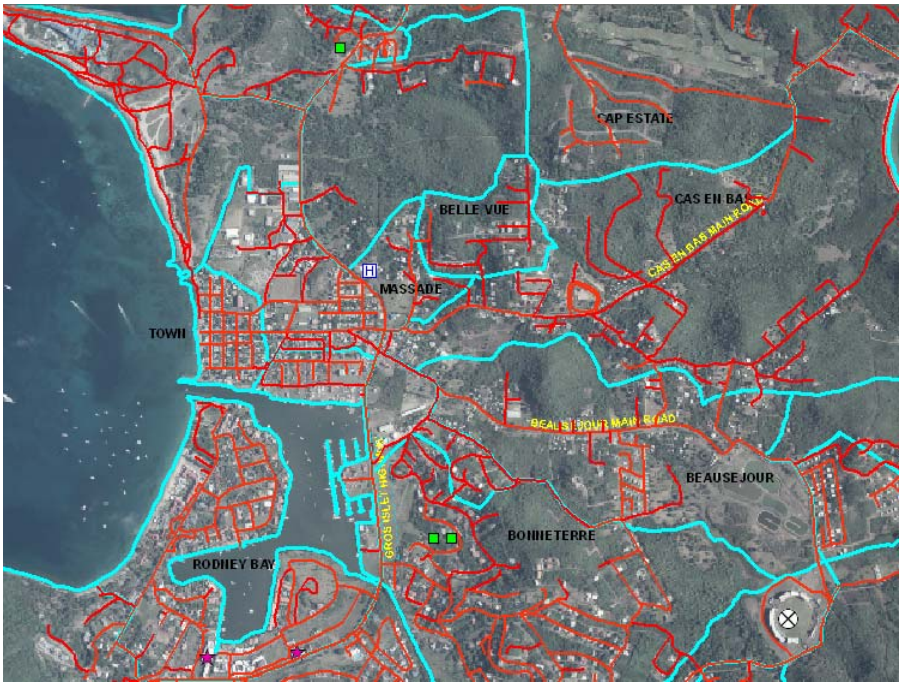


Fig 2 ***Aerial Photo overlaid with Roads and ED boundaries***

Developing Settlement Boundaries

The task of the field enumerators was made easier because the ED maps were more accurate. This also allowed the mapping unit to give every building a unique identification number. With the level of data generated from the 2001 census, the GIS would have been underutilized if it was used solely for updating and producing Enumeration District route maps.

The spatial data could now be collected at the building level to which all the respective questionnaire data would be linked. This data could then be aggregated up to the various administrative levels because the data at that granular level is confidential. The smallest level previously available to the public had been the Enumeration District level. Since the last census, the Mapping Unit of the department initiated the division of the island into Settlements. These new boundaries were derived based mainly on the location of the buildings and the addresses (supplied by the interviewee) as part of the census questionnaire. Using the GIS (nearest neighbour analysis), the locations with the same name were grouped and given a boundary. A number of ground truthing exercises were conducted to ensure proper demarcation of these boundaries. A unique settlement code was then applied to each settlement. This code was a nine-digit number comprising; a 2 digit district number representing the 12 administrative districts, 3 digit Settlement number (001-999), 2 digit sub settlement number (settlements contained within the main settlement 01-99) and

a 2 digit sub-sub-settlement number(settlements contained within the sub-settlement 01-99). The example below shows the hierarchy of the development of the Settlement codes; Gros Islet is the District represented by 12, Monchy is the main settlement, La Borne forms part of Monchy and Sans Souci forms part of La Borne. 120330000 – 120330400 - 120330403 respectively. This also allows hierarchal labeling for maps

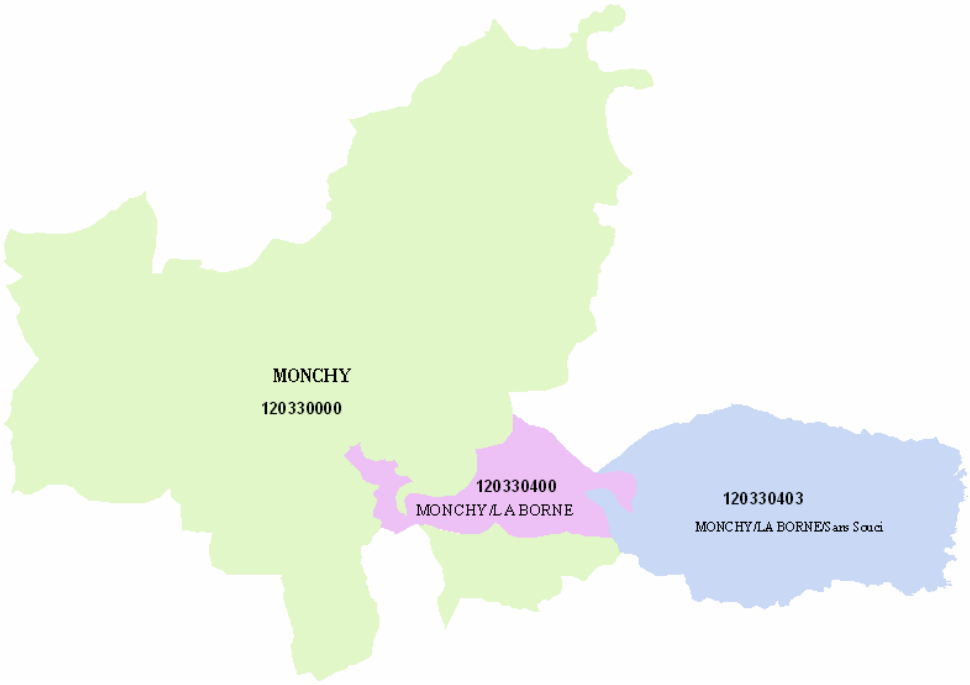


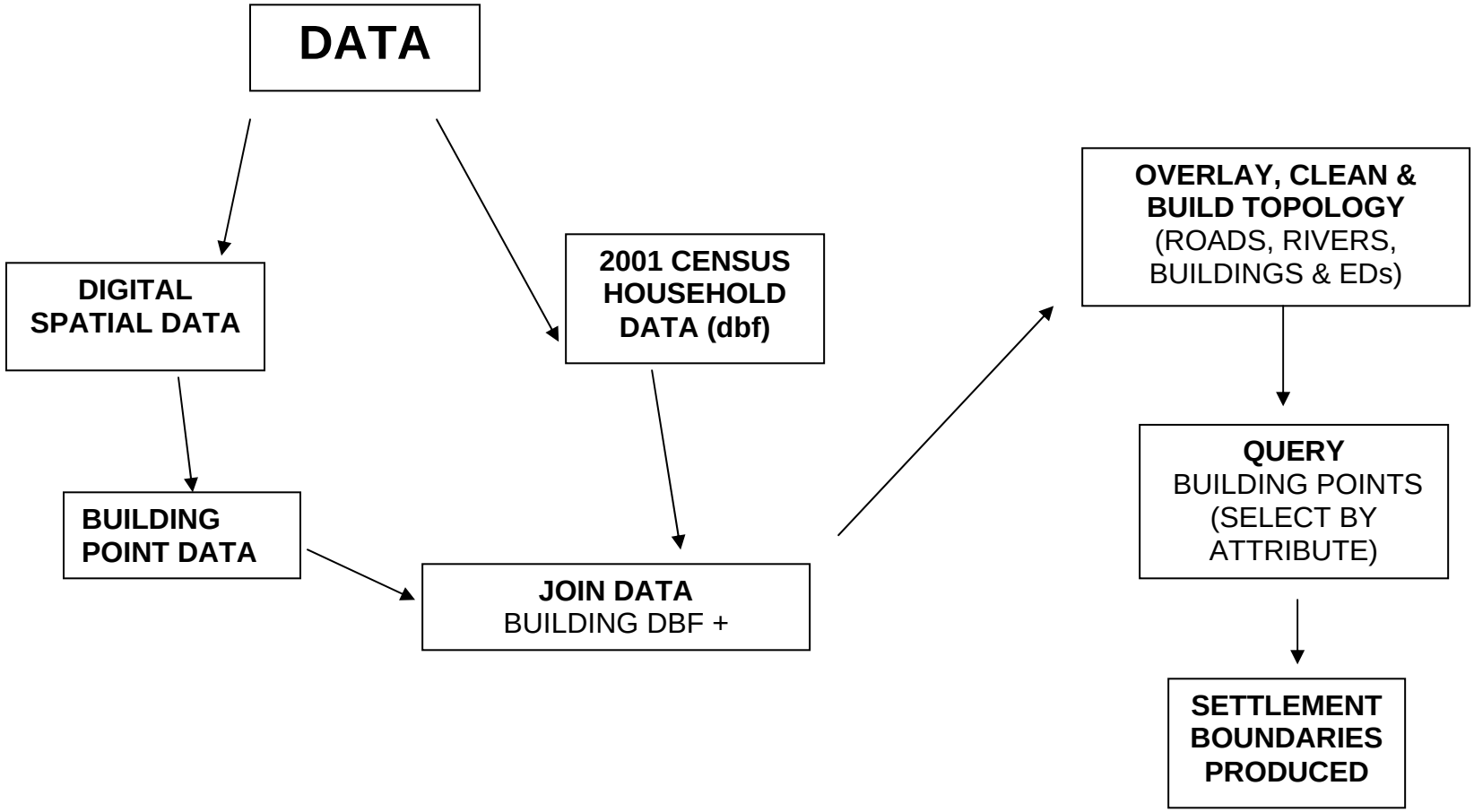
Fig 3 ***Settlement Boundaries***

The following chart shows the methodology used in the GIS to produce the Settlement Boundaries. All the relevant datasets were inputted into Arcview. Digital spatial data sets used were building points, roads, rivers, footpaths, ED boundaries and District boundaries. The non- spatial data set used was the 2001

census household database in .dbf format. The building point data was joined to the census database using the unique building number as the primary field. This building points layer was overlayed onto roads, rivers, ED boundaries. A select by attributes query was performed to group building with a same settlement address and a boundary digitized around these points to produce the settlement boundary.

Fig 4 ***Methodology on the Development of Settlements***

Methodology



GIS applications

Poverty

Settlement boundaries have revolutionized the dissemination of census data within the Statistics Department. One of the many applications of these new boundaries was in the area of poverty. Using a poverty index developed from the census data and linked in the GIS by the settlement code. A classification scheme was produced along with a map. Areas with a low poverty index would be indicated by the map as poor areas and areas with a high poverty index would be indicated as upper class areas respectively. (See *Fig 5)* The poverty index and associated map has assisted agencies such as the World Bank through local organizations like the Poverty Reduction Fund in targeting communities for poverty alleviation initiatives.

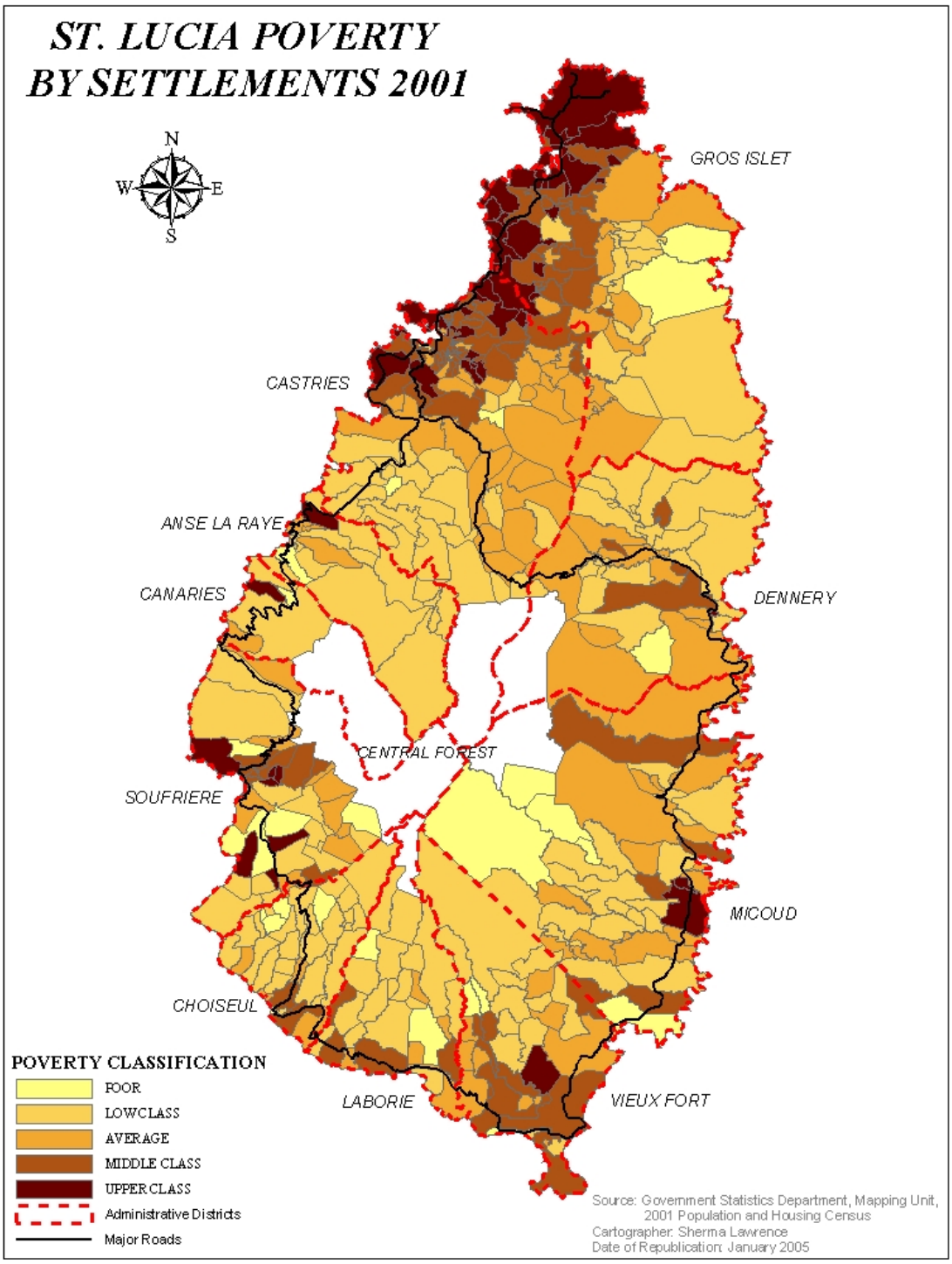


Fig 5 ***St. Lucia Poverty by Settlement***

Demographics

Population Density

A dot density map has a prominent feature of the Annual Vital Statistics Report published by the Demography Section of the Statistics Department. The production of the 'Population Density by District' map was the first GIS based link between the Demography Section and the Mapping Unit. A dot density map is a basic function of the GIS software where the population count is represented as 1 dot per **X** number of persons. In the case of St. Lucia 1dot = 200 persons.

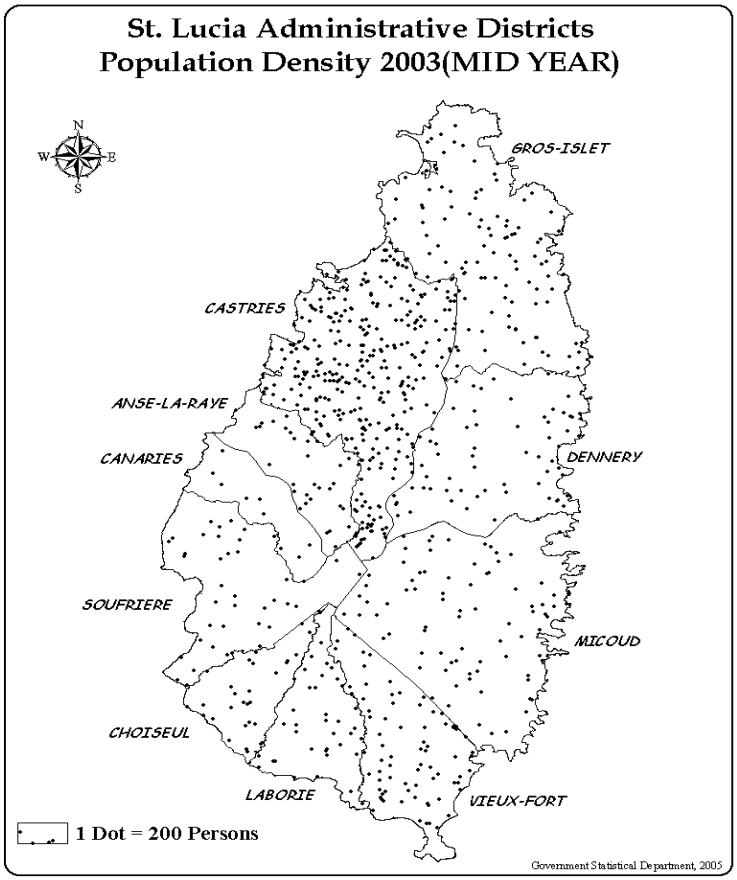


Fig 6 ***Dot Density Map***

Population by Settlement

Prior to the 2001 census population information was collected at the Enumeration District level although attempts were made to disseminate it at the settlement level. In some cases an ED encompasses more than one settlement, while in some instances a settlement would fall within more than one ED. Since the 2001 census dataset has settlement variable population information available at the settlement level in addition to ED and district level. Thus it is possible to provide demographic information with the appropriate settlement map. *See Fig7*

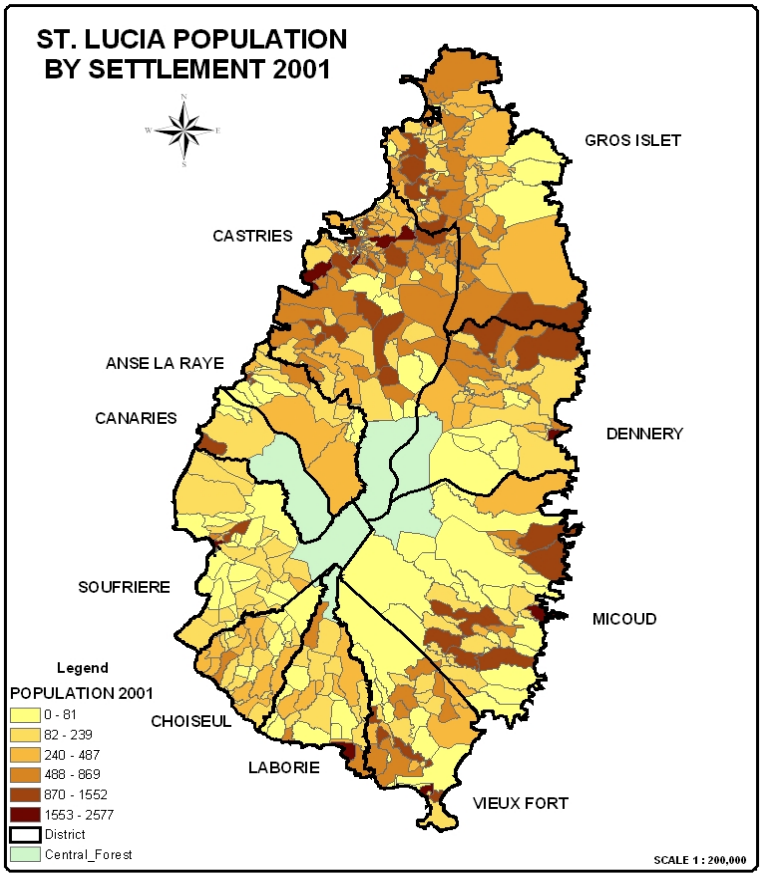


Fig 7 ***Population by Settlement***

Health

The Mapping Unit through GIS assisted the Ministry of Health with the digitizing of their eight Health Regions. Although the Min of Health did not have defined boundaries for their regions they were able to provide us with a list of the communities/settlements and health facilities encompassed in each region. All relative settlements were grouped together to demarcate the corresponding regions. Subsequently the Mapping Unit formed ties with the Epidemiology Unit of the Ministry of Health in the development of a Communicable Disease database as well as the mapping of Communicable disease by health region and settlement. The reported cases of diabetes have also been mapped. *See fig 8, 9 & 10.*

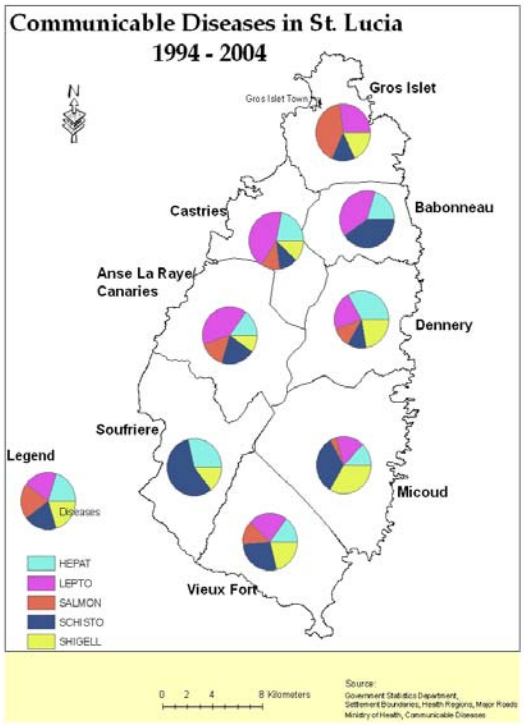


Fig 8 ***Communicable Disease by Health Region***

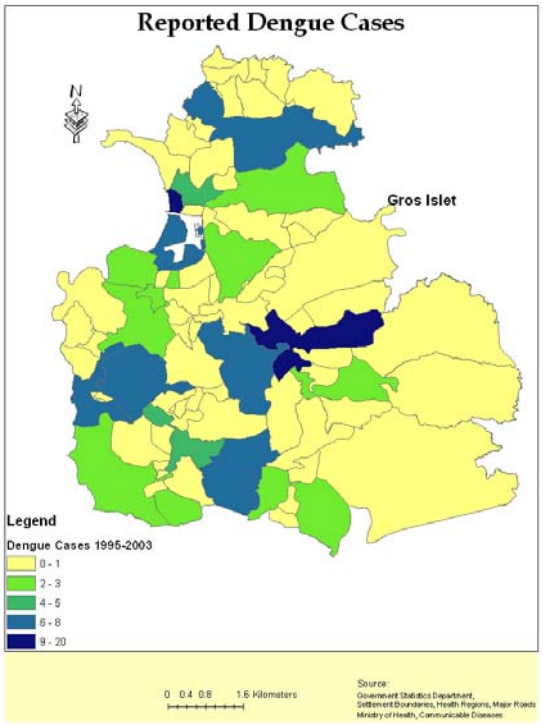


Fig 9 ***Reported Cases of Dengue by Settlement***

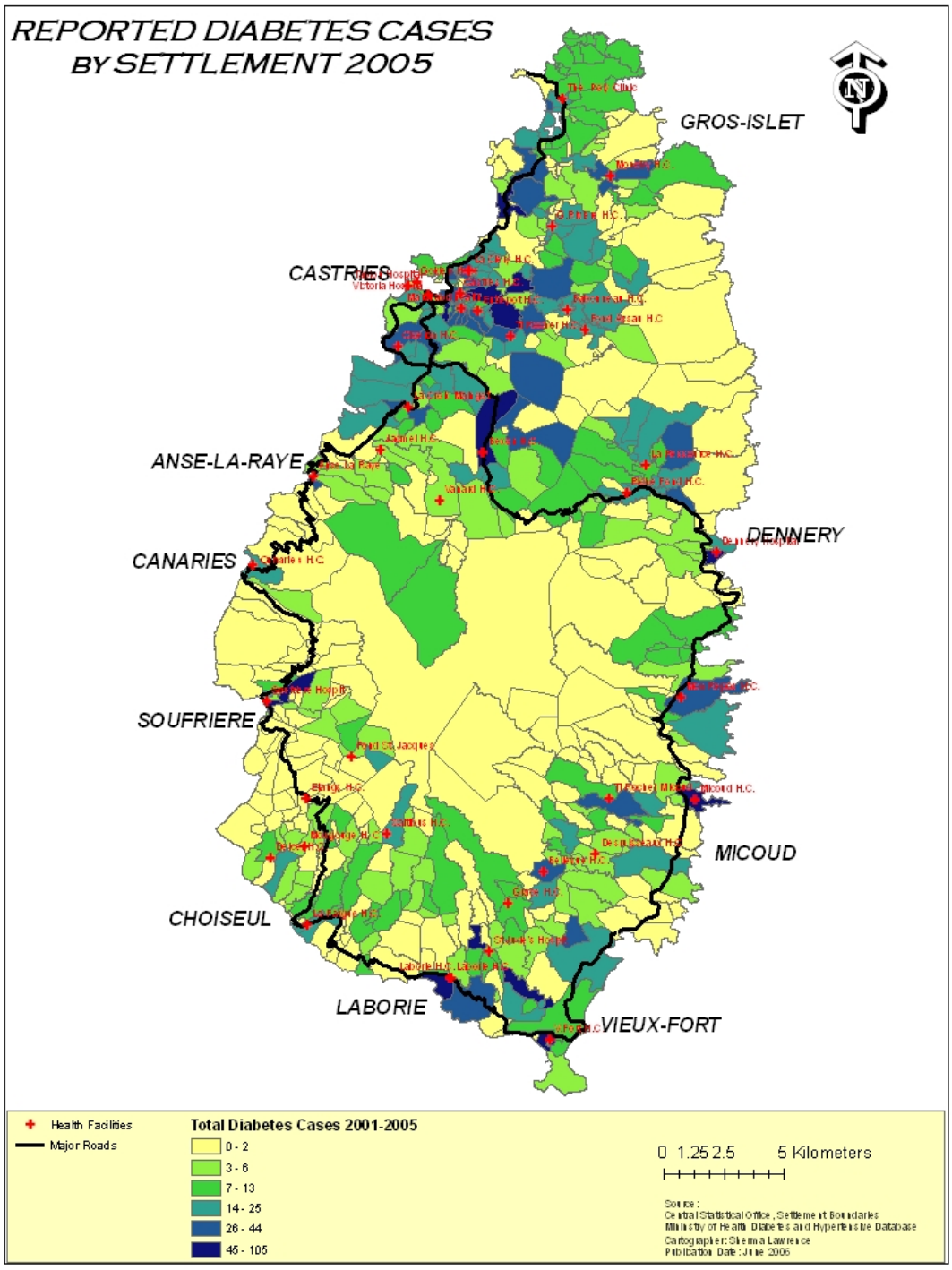


Fig 10 ***Reported Cases of Diabetes by settlement***

Crime

The use of GIS in crime analysis in St. Lucia has been slowly gaining recognition. A K-mean Cluster Classification Analysis was performed using the results of the 2001 census to determine areas most prone to crime. This analysis took into account variables such as income, age-group, poverty, unemployment and underemployment. *See Fig. 11 below*. Data obtained from the Police Department on crime hotspots for the period 2000-2006 was used to develop a database which was subsequently inputted to the GIS. *See Fig 12 below*. The National Crime Commission as well as the Police Department has benefited from this information which would assist in the allocation of resources and heighten police presence in selected areas.

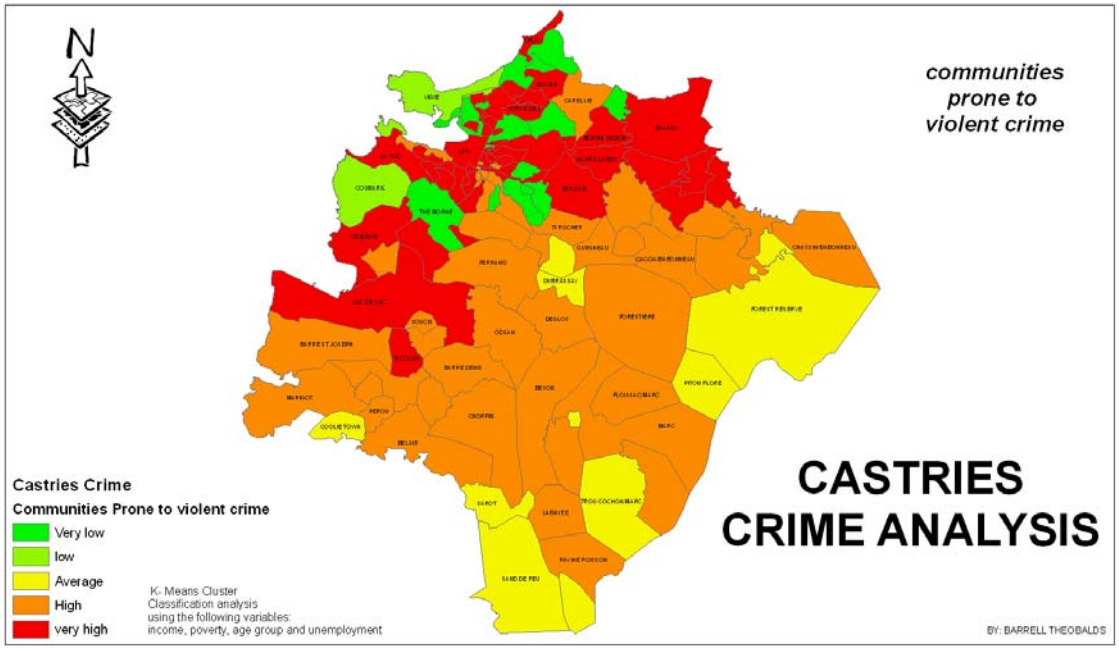


Fig 11 ***K-Mean Cluster Classification***

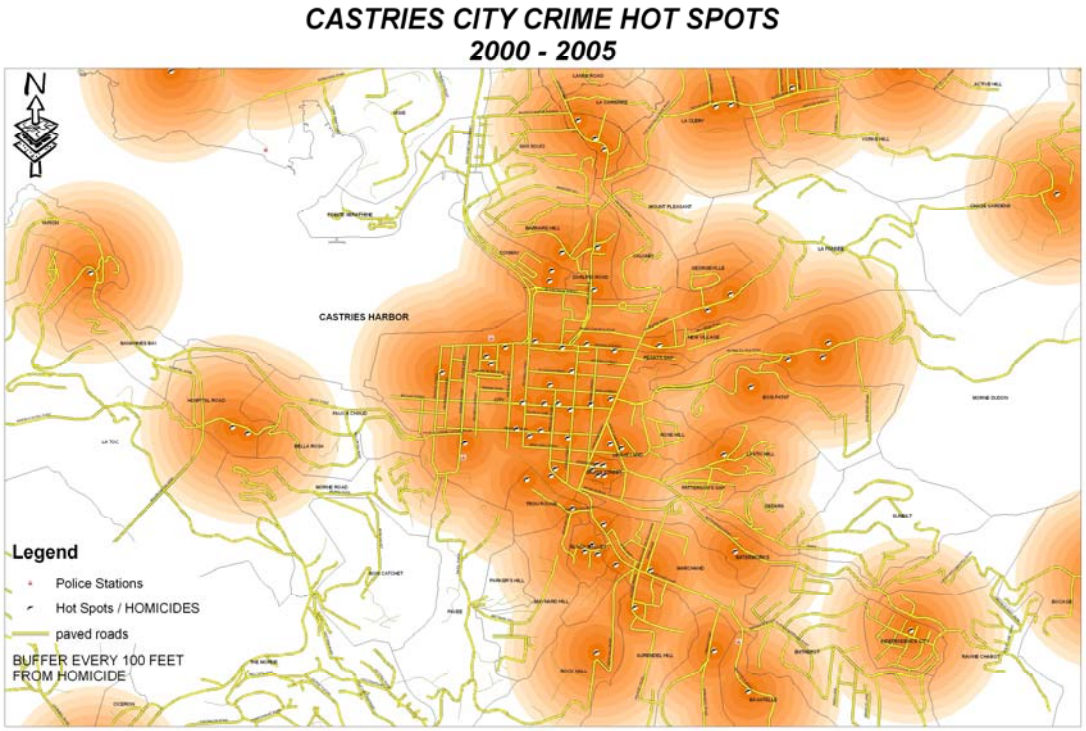


Fig 12 ***Crime Hotspots***

Economy

One area to consider for potential investors as well as to aid in poverty assessment would be the area of household income. At the Settlement level this takes into account the average income per household and multiplies it to average number of employed persons per settlement. *See Fig 13 below*

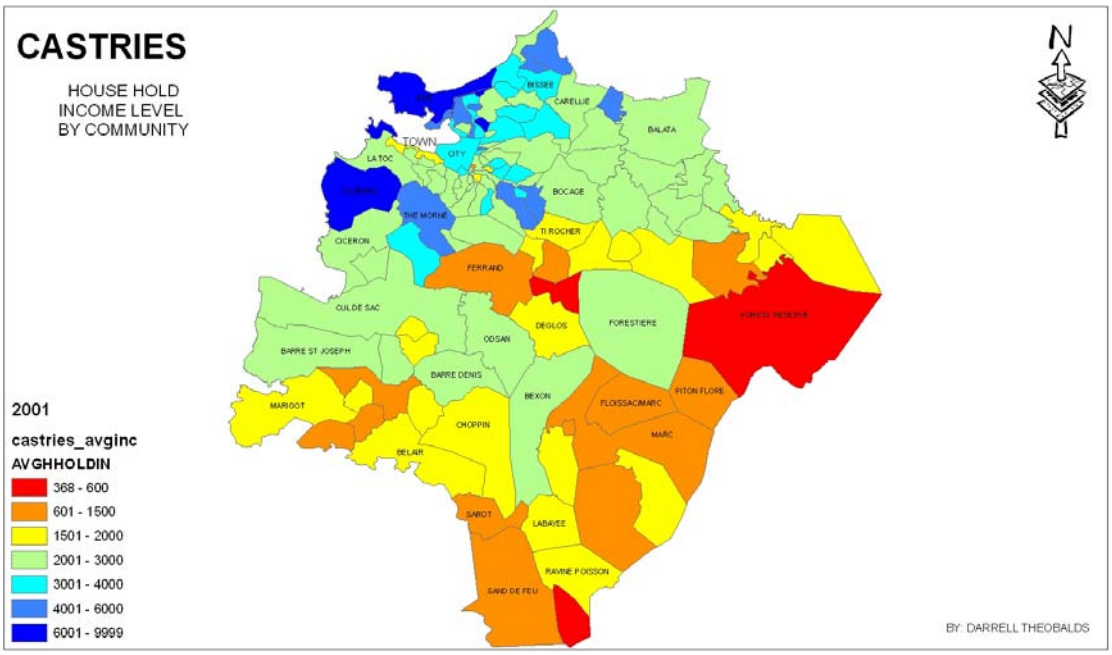


Fig 13 ***Household Income by Settlement***

General Elections

A redefining of the Political constituencies and subsequent digitizing was done prior to the 2001 General Elections with the use of GIS. In preparation for the 2006 General Elections it was taken to the next level, with digitizing of the Polling Divisions. *See Fig 145*. A national voter registration enumeration exercise was carried out by the Electoral Department. The Mapping Unit assisted with the provision of settlement maps and polling division maps. As a result the 2006 General Election Results were mapped out by polling division and political constituency and made available via the Department's website http://www.stats.gov.lc/election.htm . *See Fig 13 below*

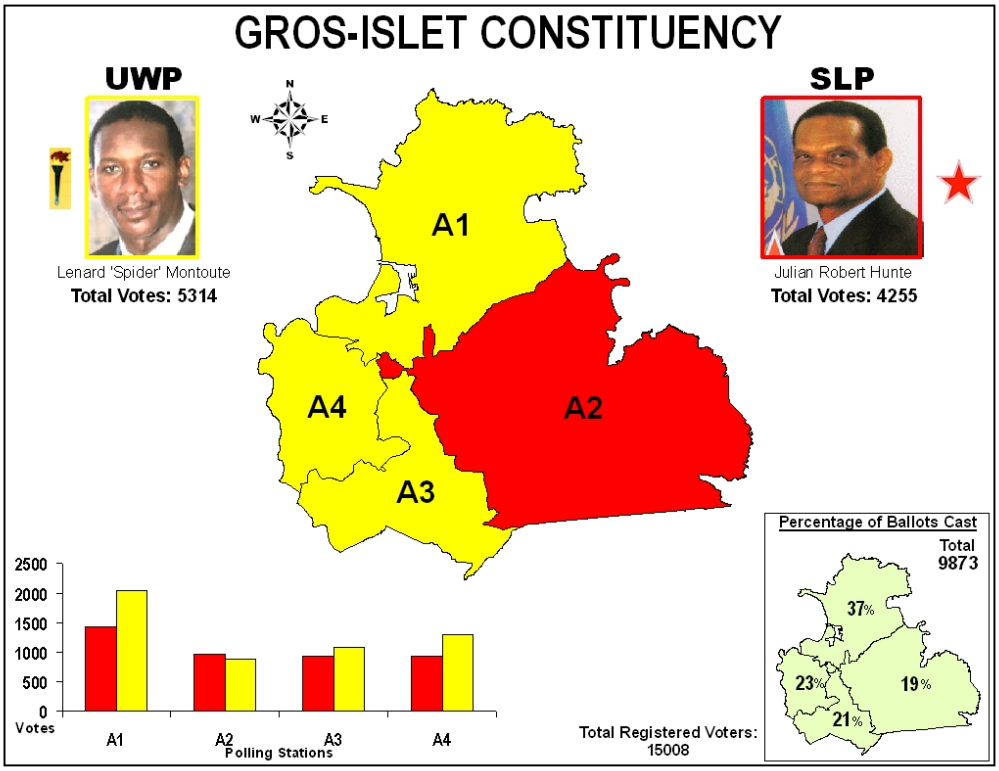


Fig 13 ***General Election Results 2006***

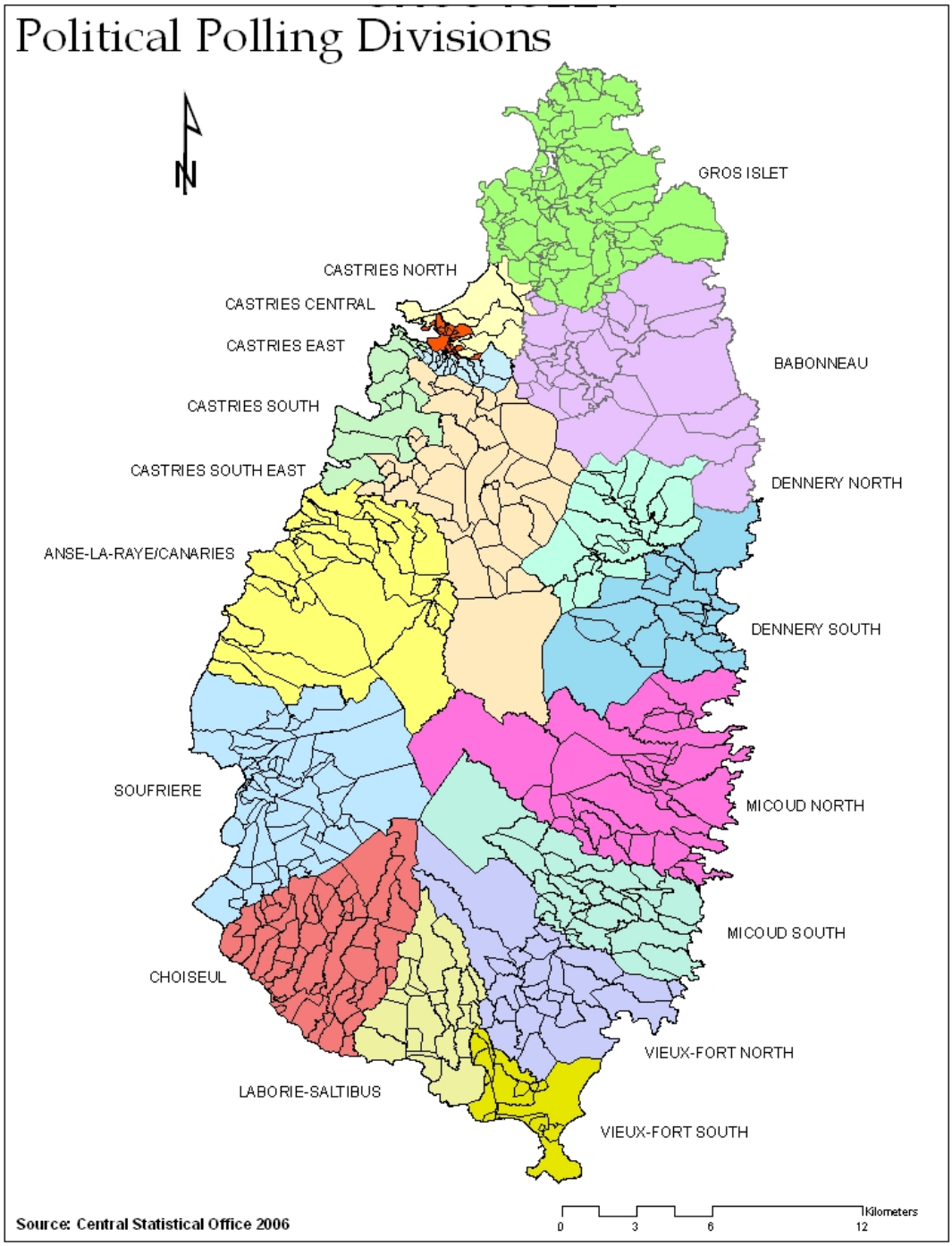


Fig 14 ***Polling Divisions***

Industry

Recently completed was the data entry for all the Visitation Records used during the 2001 census. This visitation record contains the household listing for each ED. This includes the building number, household number, Name of the head of the household or business, business number where applicable as well as number of persons employed in that building, size of farming land and also number and type of livestock. The application of this database has included the charting of the more prominent business classification by district (*Fig 15*) based on the International Standard Industrial Classification of All Economic Activities from the United Nations.

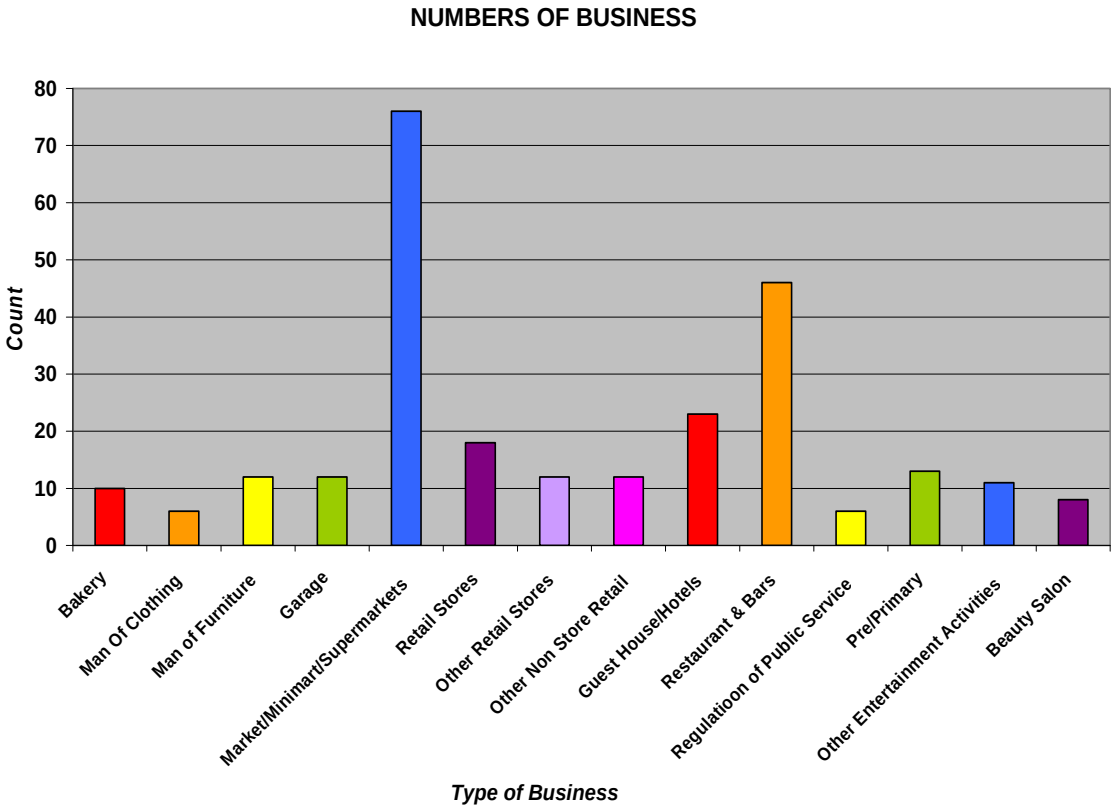


Fig 15 ***Business Classes for Soufriere 2001***

Another application of the database has been the zoning classification. This application serves to identify the various sectors within the District. This was done by joining the visitation database to the already existing building point's spatial dataset in the GIS. Businesses falling within a particular sector would be grouped together; boundary defined giving prevalence to the more prominent sector.

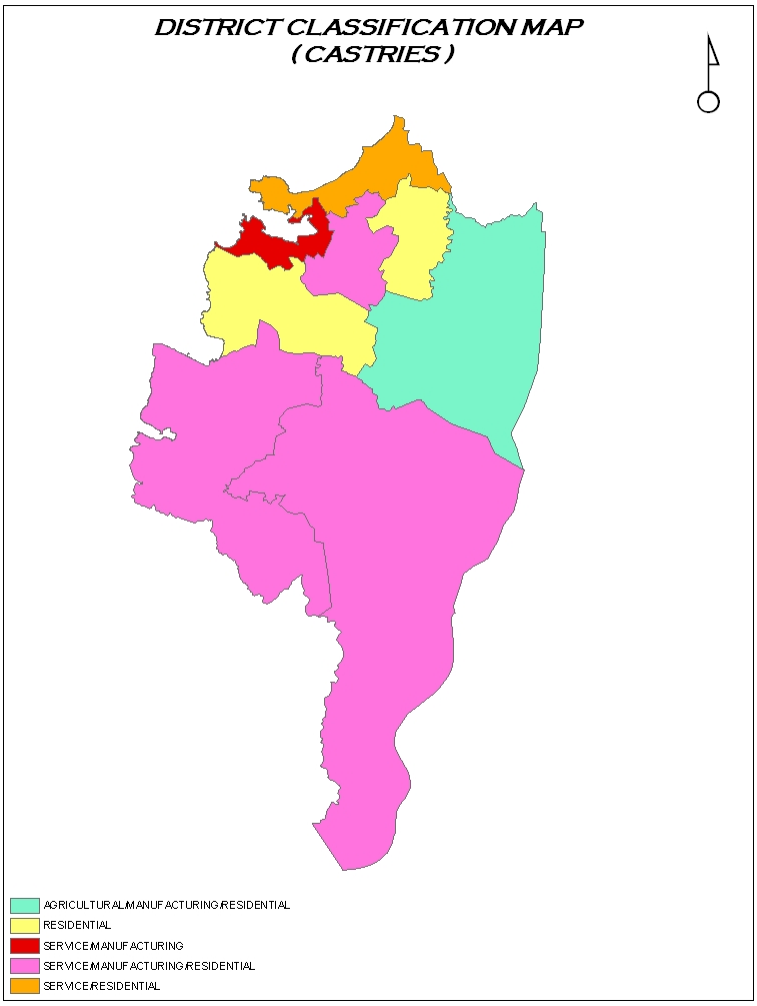


Fig 16 ***Zoning Classifications by District***

Web Maps

The Mapping Unit now has its own web page on the Statistics Department's website. Static maps are available displaying the Population, Poverty, Labour Force and Housing at the District, Settlement and in some instances Enumeration District level as well. These maps may can be printed and saved from the website at the convenience of the public. http://www.stats.gov.lc/mapping_page/map_index.htm

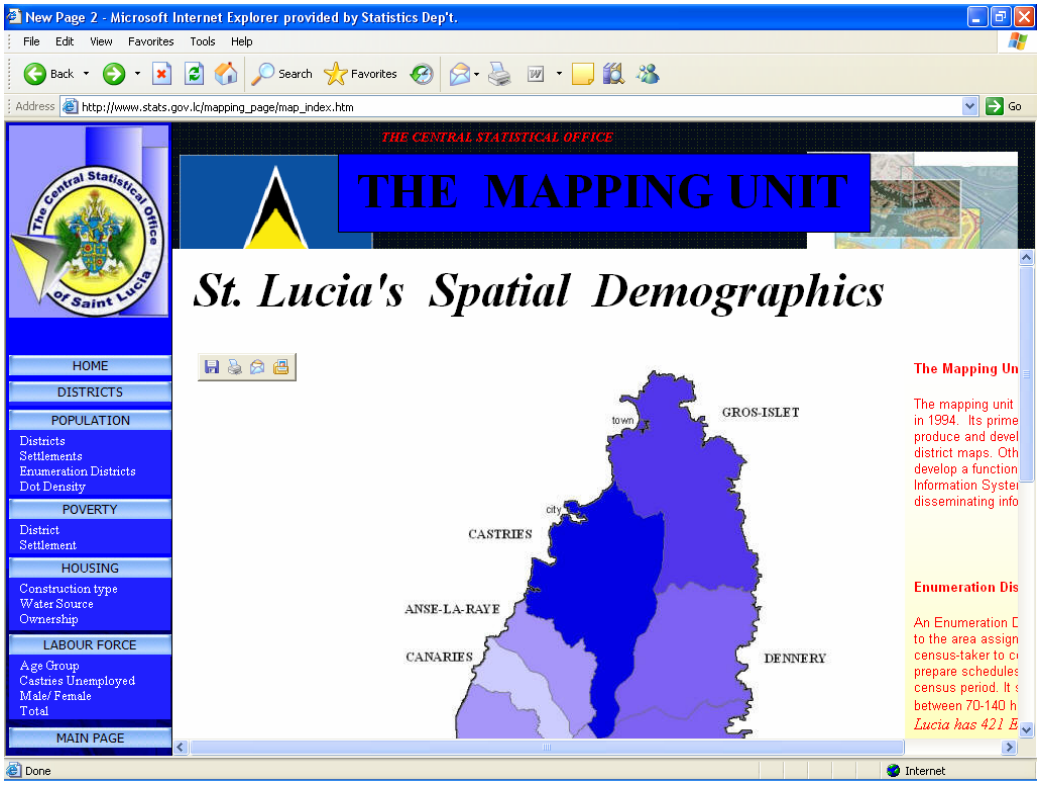


Fig 17 ***Mapping Unit Webpage***