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Geocoding and Census Mapping with GIS in the Philippines: current status and future developments[*]

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GEOCODING CONCEPTS

To identify each area for which tabulations will be made and to group EAs to form tabulation areas, a system of identification scheme will be needed. Each EA will be identified by a unique series of numbers. These numbers are called the geographic identification code scheme.

The Philippines have used this type of coding scheme not only in the 2000 Census of Population and Housing but also on all its censuses and surveys. We call this coding scheme PSGC or the Philippine Standard Geographic Codes. It contains 9 digits, first two for regional code, next two for provincial code, next two digits for municipal/city code and lastly, three digits for the barangay (or village) code.

Philippine Standard Geographic Code

Name	Code	Area Type	Rural/ Urban	Information
REGION V (Bicol Region)	05 00 00 000	Region		
ALBAY	05 05 00 000	Province		15 Mun. 3 Cities 720 Bgys
CAMARINES NORTE	05 16 00 000	Province		12 Mun. 282 Bgys
CAMARINES SUR	05 17 00 000	Province		35 Mun. 2 Cities 1063 Bgys
CATANDUANES	05 20 00 000	Province		11 Mun. 315 Bgys
MASBATE	05 41 00 000	Province		20 Mun. 1 City 550 Bgys
SORSOGON	05 62 00 000	Province		14 Mun. 1 City 541 Bgys
BARCELONA	05 62 02 000	Municipality	Partially Urban	
BULAN	05 62 03 000	Municipality	Partially Urban	
BULUSAN	05 62 04 000	Municipality	Partially Urban	
CITY OF SORSOGON (Capital)	05 62 16 000	Municipality	Partially Urban	Component City
Abuyog	05 62 16 001	Barangay	Rural	
Almendras-Cogon (Pob.)	05 62 16 002	Barangay	Urban	
Balogo	05 62 16 003	Barangay	Urban	
Barayong	05 62 16 004	Barangay	Rural	
Basud	05 62 16 005	Barangay	Rural	
Bibincahan	05 62 16 006	Barangay	Urban	
Bitan-o/Dalipay (Pob.)	05 62 16 008	Barangay	Urban	
Bucalbucalan	05 62 16 009	Barangay	Rural	
Buenavista	05 62 16 010	Barangay	Rural	
Buhatan	05 62 16 011	Barangay	Rural	
Bulabog	05 62 16 012	Barangay	Rural	
Burabod (Pob.)	05 62 16 013	Barangay	Urban	

Figure 1. Sample PSGC

Barangay is the smallest political unit in the country. Generally, its enumeration is assigned to one enumerator. For enumeration purposes, a large barangay is usually split into parts and each part is called an Enumeration Area (EA). Usually an EA is composed of 350 to 500 households

Uses of PSGC

Aside from being an instrument of securing uniformity and comparability of various statistics relating to geographic areas, the PSGC has the following other uses:

1. As a guide in national as well as local development planning
2. As a comprehensive area frame in the conduct of censuses and sample surveys and market studies
3. As a comprehensive list of LGUs in the internal revenue allocation (IRA)
4. As basis in the establishment of precincts/voting centers
5. Establishment of databases
6. Development of geographic information systems (GIS).
7. Updating of maps.

For censuses and surveys, the Philippine National Statistics Office uses 3-digit enumeration area code and maintains an Enumeration Area Reference Code or EARF that is used for the conduct of censuses and surveys.

NATIONAL STATISTICS OFFICE

EA REFERENCE FILE (CPH - 2000)

REGION V - BICOL

REG	PRV	MUN	BGY	EA	URB	Area Name/EA in Census 2000
05	**62**	**00**	**000**	**00**	**0**	**SORSOGON**
05	**62**	**16**	**000**	**00**	**0**	**CITY OF SORSOGON (Capital)**
05	62	16	001	00	2	Abuyog
05	62	16	001	01	2	Abuyog - EA 01
05	62	16	001	02	2	Abuyog - EA 02
05	62	16	002	00	1	Almendras-Cogon (Pob.)
05	62	16	002	00	1	Almendras-Cogon (Pob.) - EA 00
05	62	16	003	00	1	Balogo
05	62	16	003	01	1	Balogo - EA 01
05	62	16	003	02	1	Balogo - EA 02
05	62	16	003	03	1	Balogo - EA 03
05	62	16	004	00	2	Barayong
05	62	16	004	00	2	Barayong - EA 00
05	62	16	005	00	2	Basud
05	62	16	005	00	2	Basud - EA 00-00
05	62	16	006	00	1	Bibincahan
05	62	16	006	01	1	Bibincahan - EA 01
05	62	16	006	02	1	Bibincahan - EA 02
05	62	16	006	03	1	Bibincahan - EA 03
05	62	16	006	04	1	Bibincahan - EA 04
05	62	16	006	05	1	Bibincahan - EA 05
05	62	16	008	00	1	Bitan-o/Dalipay (Pob.)
05	62	16	008	00	1	Bitan-o/Dalipay (Pob.) - EA 00
05	62	16	009	00	1	Bucalbucalan
05	62	16	009	00	1	Bucalbucalan - EA 00

Figure 2. Sample Enumeration Area Reference File

Enumeration Area Code

After the geographic identification code scheme is established and the EA boundaries are final, the EAs will be numbered on the maps. A good method of numbering EAs on map is to begin at the northwest corner of each area and number in serpentine fashion; that is, go back and forth across the area. Thus, the lower numbers will be at the northern edge and higher numbers at the southern edge of the area.

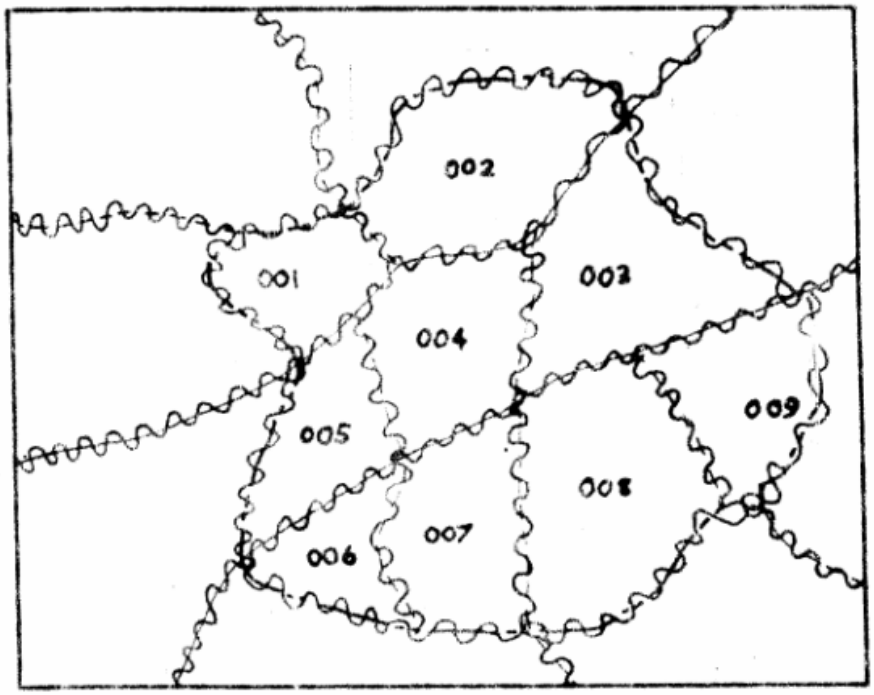


Figure 3. Numbering of Enumeration Area on map

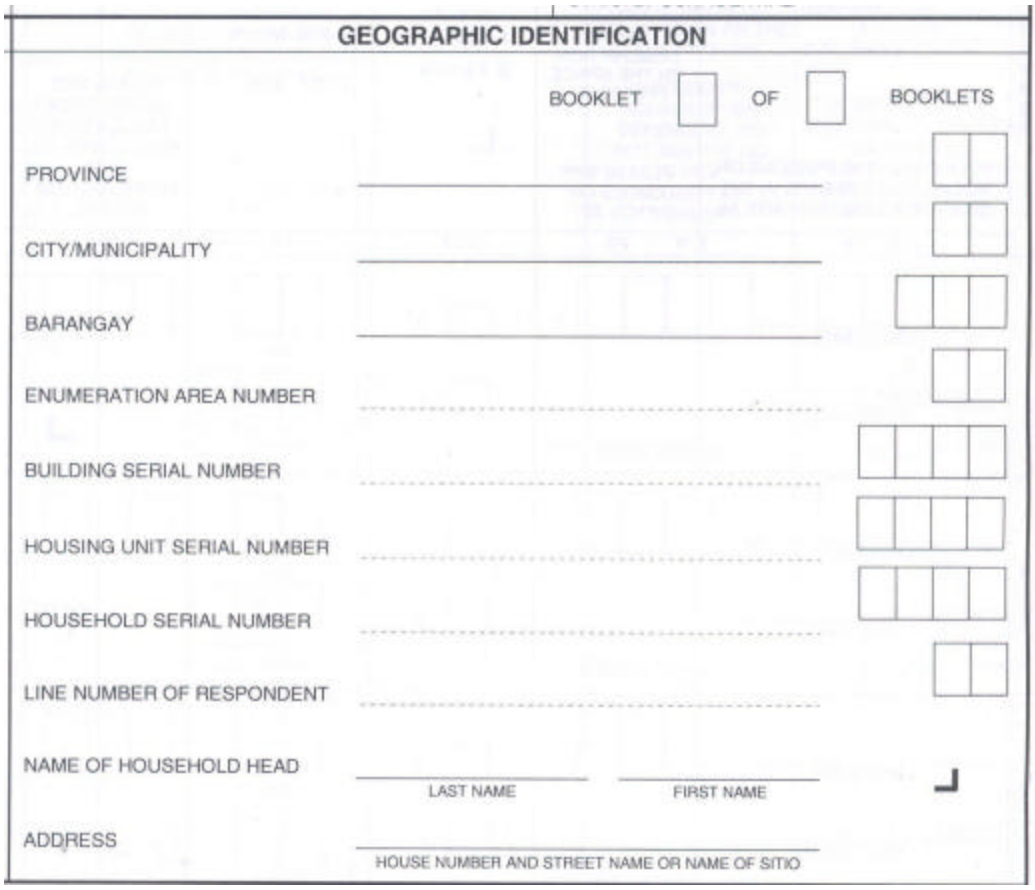
Geographic Identification

In our census questionnaires, there is a portion called Geographic Identification. It is composed of Province, City/Municipality, Barangay, Enumeration Area Number, Building Serial Number (BSN), Housing Unit Serial Number (HUSN), Household Serial Number (HSN), etc.

We consider the Province at the highest level and not the Region because all provinces have a unique code, regardless of its Region. While the City/Municipality code is unique only in its province, same with Barangay, Enumeration Area, BSN, HUSN, and so forth.

The BSN represents all the buildings and houses found in a given EA. It can be composed of one or more housing unit. The HUSN represents the housing unit within a building, the HSN within a housing unit.

Two-digit line numbers are assigned for every household member. In this way every record in our census data can have a unique identifier or code.


GEOGRAPHIC IDENTIFICATION

BOOKLET ☐ OF ☐ BOOKLETS

PROVINCE _____ ☐☐

CITY/MUNICIPALITY _____ ☐☐

BARANGAY _____ ☐☐☐

ENUMERATION AREA NUMBER ..... ☐☐

BUILDING SERIAL NUMBER ..... ☐☐☐☐

HOUSING UNIT SERIAL NUMBER ..... ☐☐☐☐

HOUSEHOLD SERIAL NUMBER ..... ☐☐☐☐

LINE NUMBER OF RESPONDENT ..... ☐☐

NAME OF HOUSEHOLD HEAD _____ (LAST NAME) _____ (FIRST NAME) ☐

ADDRESS _____ (HOUSE NUMBER AND STREET NAME OR NAME OF SITIO)

Figure 4. Sample Geographic Identification

Note:
A household is a social unit consisting of a person living alone or a group of persons who sleep in the same housing unit and have a common arrangement in the preparation and consumption of food.

EXPERIENCES IN CENSUS 2000

Digitized Aerial Maps

The latest mapping innovation introduced in the millennium census was the use of digitized maps translated from topographic aerial photos of all barangays in Metro Manila. This project was a result of the agreement signed between the National Statistics Office and BayanMap Corporation (BMC), a domestic and private corporation. The undertaking commenced on January 17, 2000 and expected to be completed on September 15, 2000.

Anticipating the need to come up with a comprehensive digitized map. BMC undertook an extensive field survey in the barangays of Metro Manila to gather basic map information such as house numbers, street names, and other relevant map information to supplement the quality of the digital translation. Eventually, BMC provided NSO with

the printed copies of digitized maps and household list of barangays. An estimated total of 1,694 barangays in Metro Manila, comprising of 4,883 Eas, were taken aerial photographs for the digital translation. However, due to two (2) barangays in Manila that were merged and abolished and unavailability of BMC coverage for the municipalities of Pateros and Taguig, the final count of barangays the NSO expected to receive from BMC was reduced to 1,664 barangays.

As reported by our regional office in National Capital Region, only 99.6 percent printed digitized barangay maps were received. After verification/delineation, only 91.3 percent segmented EAs were received for use during the census operations. Due to unforeseen volume of paper maps, EA maps from BMC were received very late. Just more than fifty (50) percent were received on the first week of May 2000. Not all the EA maps prepared by BMC were used for the census operations as majority of these were transmitted after the start of the enumeration period. The delay in transmitting the EA maps to the enumerators (ENs) caused problems during census operation like omission or duplication of certain areas, thus, the census operation in the National Capital Region (NCR) had to be extended to ensure the complete count of the population. Moreover, some teacher-ENs personally followed up their EA maps from BMC.

Problems Encountered

1. One district in NCR encountered a delay in delineating barangays during the pre-enumeration phase.
2. The BMC maps were not detailed in terms of street names, house numbers, and other notable features.
3. Inaccuracy of BMC maps caused more confusion among the hired teacher-enumerators as the BMC maps did not contain complete addresses of buildings and of other structures and did not even define the geometric figures on the digitized maps.
4. BMC maps for some areas in NCR were delivered late. And some building features did not match with the actual buildings during the ocular inspection.

Action Taken

On the delayed distribution of barangay/EA maps and land outdated maps. The concerned District Statistical Officer and Census Area Supervisors approached the proper government agencies for clarification and technical support.

In spite of the voluminous work, some provincial offices managed to pull out some of their staff to do cartographic works for census 2000, although some provincial personnel were not fully equipped nor fully prepared to do cartographic works.

Recommendations

The following were recommended for successful future data-gathering activities:

1. Updating of barangay lists, verification of maps, delineation of barangay boundaries, and other similar mapping and cartographic jobs should be undertaken six months to one year prior to the actual census enumeration.

2. A bigger budget allocation for future mapping operations, which includes the hiring of cartographers at the provincial offices.
3. Maps should contain the buildings, the streets and other geometric figures on the maps. It should also be properly labeled before distribution.

Data Dissemination

- **Census 200 Public Use File (C2KPUF)**

C2KPUF data files for the whole Philippines are stored in compact disc which can be accessed using standard CDROM readers. It comes with the Integrated Microcomputer Processing System (IMPS) version 4.1 developed by the US Bureau of Census. It is a software that allows creation and maintenance of data dictionaries, perform cross-tabulations, and viewing of tables and text files.

It contains population characteristics for the whole Philippines down to barangay level:

1. Relationship to household head
2. Whether or not a person was an overseas worker
3. Age as of last birthday
4. Sex
5. Age
6. Civil Status
7. Disability
8. Ethnicity
9. Highest Grade Completed
10. Trade Skills
11. Economic Activity

- **Data Kit of Official Philippine Statistics (Datos)**

Statistics come alive when plotted with interactive maps. NSO is now using Geographic Information System (GIS) to present its census and survey data. This tool enables researchers to visualize and present data that is more relevant to data users.

The Data Kit of Official Philippine Statistics is an information package in compact disc that offers you easy access to the statistical database of the country, region, province, city/municipality or barangay.

Datos contains the following physical and economic profile:

1. Population size (1980, 1990, 1995 and 2000)
2. Number of establishments
3. Characteristics of the barangay
4. Number of employed in each establishment in the business and industry sector
5. Membership in legal and economic organizations
6. Characteristics and services that can be found in a barangay.

Using Datos, you can do the following:

1. Start your own GIS by adding layers of data
2. Do instant analysis. (For example, you can find out where the population and manufacturing establishments are concentrated.
3. Compute simple calculations using the data included in this product.

4. Create or print thematic maps of the geographic level of your choice.
5. Download the database file in Excel.

CURRENT GIS DEVELOPMENT

2004 Updating of the List of Establishments (ULE)

The Updating of the List of Establishments is one of the regular activities of the Philippine National Statistics. It is undertaken primarily to provide an updated and reliable sampling frame for the census and survey of establishments. The ULE involves (1) capturing "new" establishments and listing their characteristics; (2) updating the status and characteristics of "old" establishments; and (3) de-listing "closed" establishments that should no longer form part of the List of Establishments (LE).

The 2004 ULE was conducted in preparation for the 2005 Census of Philippine Business and Industry (CPBI). Part of its field operation is to introduce the use of GPS (Global Positioning System) receivers in plotting the relative location of establishments, with Quezon City as pilot area. Quezon City is a highly urbanized city situated at the Northeast portion of Manila. It is the richest local government in the country in terms of current assets, cash in banks, share on internal revenue allotment, gross income, and gross net income. During this activity, we have recorded the coordinates of 2,087 buildings with establishment.

This pilot activity was conducted after the enumeration period. Several teams were formed for this activity; each team having two members will use a GPS receiver, printed copy of GIS barangay maps with plotted buildings with establishments and a ULE Form 8 to record the coordinates and basic building information. The idea is to have one team member familiar with ULE concepts and the other (usually from the NSO mapping group) familiar with the GPS mapping operation.

Since our GPS receivers (Garmin Etrex) has a maximum capacity of 500 waypoints or coordinates, each team is required to report to the Mapping Group at least once a week for downloading of recorded waypoints.

During this operation, each team is required to record 70 waypoints per day as an output. Those recorded waypoints were composed of a minimum of 40 coordinates of buildings with establishments, and the rest are prominent landmarks and updated road networks.

Some coordinates of establishments that are out of bounce have a very high GPS accuracy or poor satellite connection ranging from 25 to 50 meters. These are unavoidable situations where GPS signals are blocked by cloudy skies or tall buildings/structures. Most of these buildings with establishments were adjusted to its proper location or rectified during uploading process. The acceptable GPS accuracy must be at least 15 meters.

Some teams used bicycles for areas where buildings with establishments are distant from each other.

One big advantage of this activity is the one hundred percent verification of the location of buildings with establishments. The team found some establishments that were not included during enumeration. They recorded the coordinates of these buildings and report it to the concerned subject matter division for action matter. They also found some establishments that are plotted in the wrong area or streets.

Recommendations:

1. Additional information on buildings/houses must be included like name of buildings or owner's name, type of building (industrial, commercial, residential, etc.) and number of floors.
2. Since GIS road networks in Quezon City are drawn to scale and have an accurate location, and our GPS receivers yields 8 to 12 meters accuracy, it is better to plot some buildings/houses directly on the printed GIS maps without getting its GPS coordinates, especially those located on road corners.
3. Nowadays, most data users use GIS in their studies and researches, and it is better to have one BSN for both Household and Establishment surveys and censuses.

CURRENT STATUS OF GIS MAPS

Most of our GIS maps don't have road networks, only political boundaries down to the barangay level. Our barangay/ea maps are sketch maps drawn by the enumerators. Most of the barangay/ea maps when put together will not correspond to its municipal boundary.

The main problem in census mapping is on highly congested areas, where our field men are having a hard time plotting the road networks or alleys even with the use of GPS and high-resolution images. Most of the residents in these areas are informal settlers.

FUTURE GIS DEVELOPMENTS

I. Capitalizing on GIS Development in the Local Government Units

We have inventoried existing GIS in all Local Government Units (LGU) last 2005 and plans to acquire features of their GIS that are useful in census mapping in exchange for our census data.

II. Utilization of Google Earth Satellite Images

GIS Training will be conducted this coming October to all Regional Offices. This training will focus on the downloading, geo-referencing, and digitization of satellite images from Google Earth.

III. Updating of GIS Maps

A pilot activity in updating our GIS maps will be conducted this year in one of our major city (Angeles City, Pampanga) with available Google Earth map. The idea is to map all the road networks and prominent landmarks and make an assessment on its accuracy. This mapping activity will acquire the method of Mobile Mapping System (MMS) and combined use of magnetic compass with pacing techniques.

MMS is the process of using GPS to determine the coordinates of the center of a roadway. With road centerline, we can easily define political boundaries and determine approximate location of prominent landmarks. In the last ten years, the mobile mapping technology has grown from the theory to a standard mapping tool. It differs itself with other mapping method (satellite imagery and aerial photo) mainly by its fast data collection speed and its low cost.

For the Philippine National Statistics Office, we design our own Mobile Mapping System. A team composed of two field personnel, preferably with motorcycle, and a GPS receiver. One will drive the motorcycle and the other will handle the GPS mapping procedures. They will get the road centerlines by recording tracks from the GPS receiver while moving at varying speed, at the same time plot the location of prominent landmarks.

Combined use of magnetic compass with pacing techniques can serve as a backup should a GPS fail to operate properly. GPS receivers may fail electronically or encounter field conditions whereby satellite signals are unable to reach the receiver, such as heavy tree canopy or high-relief terrain, high rise establishments, highly congested areas, etc. A magnetic compass can indicate the direction you are headed relative to magnetic north, and pacing is a simple means of measuring linear distance by walking.

This activity is designed to be a continuing program. The idea is to have a mapping operation on every surveys or censuses to be conducted.

IV. Proposed Collaborative Mapping Project with Colleges and Universities

The NSO proposes a collaborative arrangement with selected Colleges and Universities to provide opportunities for their students to learn concepts of GIS and Global Positioning System (GPS) technologies and to apply such concepts in a real world setting. Under the program, the University allows its students to be involved in the digital mapping project of the NSO as on-the-job trainees. The students will then earn equivalent hours that will be credited towards fulfillment of the needed on-the-job training (OJT) hours normally required by the University.

A. What the NSO will provide under the program:

1. Technical introduction on the concepts of GIS and GPS
2. Orientation on the operation of a GPS receiver unit
3. Opportunity for students to apply the concepts
4. Acknowledgment of contribution of the University
5. OJT allowance per-8-hour completed assignment.

B. Benefits of the University:

1. Enhancement of its academic program through actual student exposure to the technology
2. University gets a complimentary copy of the digital map output for the area where its students were involved

C. Advantages of collaborative tie-up with universities:

1. Access to professors and graduate students who are highly skilled at data analysis and have a GIS infrastructure in place
2. Possible access to funding sources that support community-university partnerships
3. Low cost of manpower