

# FSM Experience in Census Mapping

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## Census Mapping and Household Listing in the 2010 Census Project (Document presented by the Statistics Division)

### 1. PURPOSE

- To briefly summarize census planning and design practices with particular reference to census mapping operations and housing listings in past and present FSM 2010 census project;
- To discuss the role of good census mapping and accurate household listings in census execution success, including lessons learnt from previous censuses and surveys that were incorporated into the 2010 census planning and design with a view to improving quality and timeliness;

### 2. BACKGROUND

Household listing is a process whereby each household including non private dwelling are identified and marked for the purpose of interview during the enumeration phase. It also forms a basis in the control of the enumeration especially in the absence of adequate and updated maps useful for estimating the number of enumerators materials needed in an area. It can be used also for estimating the time required for the enumeration and for compiling provisional results of the census. One of the main reasons is that it is useful for enumeration areas delineation.

In the past in FSM the collection of household location was known as MapSpots. While listers were local recruits, the work was mainly supervised by the United States Bureau of Statistics (USBS) including the technical cartographic work. Base maps were mainly the cadastral and topographic maps produced by the US Geological Survey in the early 80's. Capacity building for FSM NSO was limited to the "user" aspects of the geographical system basically for printing of the census maps.

Initial planning for the 2010 Census began in the middle of 2008 however actual preparatory ground work did not start until after the convening of a workshop in project management which was conducted in April 2009 in FSM by the Australia Bureau of Statistics (ABS) and SPC. The workshop produced a draft work plan for the 2010 Census. The development of the work plan set things in motion; a draft budget was formulated and funding proposals drafted, including that for the production of Enumeration Maps and Household Listing.

During the early part of the planning phase, FSM already anticipated the need to update its census maps which were last updated during the 1994 Census. These were MapSpots produced by the USBS using Tiger Lines and shapefiles of Enumeration Area (EA) with some alignment issues with updated maps. A critical decision which the FSM had to make in updating its census maps was whether to carry out a traditional map spot survey of households (where listers observe the location of houses and mark their location on maps) or to conduct a GPS-oriented mapping survey. With a little push from SPC's GIS

gurus and learning about the successful experience of Fiji in 2007, FSM decided to undertake the latter approach in conducting a mapping survey of households in the main islands of the FSM.

Hence, this report briefly describes the mapping process that FSM undertook to produce the census maps and develop the listing of households utilizing Global Positioning Systems (GPS) and geographical information system (GIS) application as aides to the preparation of maps. These maps would become an integral part of FSM Geographic Information System used in the processing and dissemination phases of the Census not to mention the wider applications of it by other agencies for other purposes.

### **3. AIM AND EXPECTED OUTPUTS**

The two main objectives of the Mapping Survey and Household Listing exercise were

- to efficiently update and produce quality census maps; and
- to produce GPS grade listing of households, a geo-registry.

The attainment of the objectives was necessary for the following reasons including: 1) the timely conduct of the enumeration; 2) to re-delineate EAs into manageable and equitable parts in terms of household composition; 3) to guide enumerators to ensure that every household or person is counted and no double counting; 4) to effectively monitor the enumeration process; 4) to appropriately allocate resources; and 5) to improve analysis and dissemination of census results.

The outputs of the Mapping and Household Listing exercise include:

- GPS waypoints of households in WGS84 format;
- Re-delineated shapefiles of Enumeration Districts projected to satellite images of the main islands (Quickbird);
- Basic household data (household head, count, gender);
- Household Listing Guide;
- Enumeration maps; and
- Trained GIS users

### **4. MAPPING AND HOUSEHOLD LISTING PROCESS**

#### **4.1 Current Status**

The FSM had successfully completed the mapping and listing of households utilizing geospatial technology and produced the EA maps and Household Listing Guide in time for use during the training sessions for enumerators and for the actual enumeration field work.

During the enumeration phase, enumerators had collected waypoints for new households found by simply making marks on their EA maps and listing them on the Household listing form. These forms are now being pulled from the batch of census Questionnaires for the updating process of the household geo-registry. Implementation of this process is currently underway.

#### **4.2 Duration and Workshops**

From the initial preparatory stage to completion, the mapping exercise took around 4 months worth of work. It required two short trainings for NSO staff and four concurrently held trainings for recruited mappers or listers in each of the four states. The actual mapping and listing of household took about a month to complete.

The first one-week training for NSO staffs covered basic application of the eTrex Garmin GPS units, collection and download of waypoints, use of a “cheat” sheet on GPS setup, basics of ArcMap and completion of the HH Listing form. The second two-week workshop for NSO staffs covered more specific uses of ArcMap in manipulating map datasets and delineation of ED boundaries. The one-week training of mappers explained how to use the GPS units to collect waypoints; how to systematically canvass their EDs; and how to complete the HH Listing form. They were also taught how to enter the HH sticker number in the GPS units.

Table 1: Schedule of Mapping Activities

GPS Technology in FSM 2010 Census		2 0 0 9							
Mapping and HH Activities	Duration	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Training of NSO - 1st Mapping Workshop on GPS	1 wk	_x__							
78 Mappers Recruited	4 wks		xxxx						
Procurement and distribution of equipments/materials	2 wks		__xx						
Training of Mappers - conducted in each State	1 wk			x___					
Conduct of Mapping and HH Listing Field Operation	4 wks			_xxx	x___				
Processing of Waypoints and Household Data	2 wks				__x_				
Training of NSO - 2nd Workshop/Re-delineation of Ends	2 wks				___x	x___			
Production and Printing of ED maps and HH Listing Guide	3 wks						___x	xx__	
Publicity	2 wks		xx__						

Notes: x – denotes week work carried out  
 \_ - denotes week no work carried out

### 4.3 Resources Required

To undertake the Mapping and Household Listing exercise, 78 mappers were contracted and trained; and 50 Garmin eTrex commercial grade global positioning systems (GPS), 10 Dell Precision M4400 laptop computers, and a color HP LaserJet printer were purchased for the mapping and listing activities. High resolution satellite imageries (Quickbird) of the subject islands already available from other agencies were used as base maps. Using already available ArcGIS (ArcMap ver. 9.3), the enumeration maps were produced using TIGER Line shapefiles for EDs from previous censuses super-imposed on the Quickbird imageries. These TIGER lines were projected to WGS84 and re-aligned with Quickbird imageries. Household stickers were also printed.

### 4.4 Technical Assistance Provided

The Secretariat of the Pacific Community (SPC) was the principal TA provider. SPC GIS Specialist, Mr. Scott Pontifex, visited the FSM twice; first one-week visit to conduct the NSO training in GPS technology and second two-week visit after the Mapping and HH Listing Exercise to train NSO in how to verify data and re-delineate ED boundaries in ArcMap. However, the trainings for mappers were conducted by NSO staffs that also provided supervision during the mapping field operation.

### 4.5 Mapping and Household Listing Field Strategic Operation

Using 2000 Census total number of households, the number of mappers was established and recruited. Recruitment was done as much as possible to recruit persons from the areas to be mapped to benefit the work from their knowledge of the area. Each mapper would cover 2-4 EDs with each ED encompassing around 50-70 households. These mappers were deployed in pair to share one GPS unit; one to operate the GPS unit and take the households GPS waypoints while the other to interview and complete Household

Listing form. When they complete the first person's EDs, they move to the other person's EDs and swap roles. The mappers were also provided household stickers to place on the houses found and input the 6 digit code of households in the GPS unit and record it also on the HH Listing form. The stickers served as identifiers for each household during the census proper. The supervisors (NSO staffs in each state) were responsible for downloading the waypoints and verifying the HH data collected. The mappers were instructed to follow a systematic canvassing strategy when conducting the field mapping and listing operation to ensure thorough coverage. Some mappers did not follow the strategy.

Table 2: Allocation of Mappers & GPS Units

STATE	No. of ED	No. of Mappers	No. of GPS units
Yap	38	12	8
Chuuk	131	33	22
Pohnpei	115	26	17
Kosrae	30	7	3
TOTAL:	314	78	50

At completion of the field operations, the waypoints were imported into a Microsoft Access database developed by NSO in which the data from Household Listing forms were also entered. The customized database system enabled an efficient creation of single table containing both the waypoints and the household datasets. This record becomes the HH Registry then used to re-delineate ED boundaries and from which enumeration ED maps and HH Listing Guide were produced for the Census proper. The database was imported into ArcMap and with a customized tool in ArcMap built by SPC, it was easy and quick to make and print the ED maps.

Superimposing the waypoints and ED boundaries on the Quickbird imageries, it was possible to quickly validate the waypoints. Mappers' knowledge of the area was also used for verification. Some waypoints were found to be way off their marks and with the HH data, the waypoints were projected to their correct location. In some cases, mappers were re-deployed to obtain validated waypoints. The GPS waypoints were verified against the HH Listing data using the 6 digit code HH identifier for verification. The quality checks were handled by the states but the data were re-verified by the FSM NSO staffs. The data from each state after being verified were then consolidated into a single geo-database establishing the FSM Household Registry.

As mentioned, some EDs were re-delineated to allocate the households equitably among EDs. Re-delineation was not thoroughly completed and during the enumeration field operation, it was found to be critically important that ED boundaries are aligned properly with the major geographical features such as road, rivers and others which can be identified on the Quickbird imageries. Some ED maps had to be re-delineated during the census proper field operation.

The Mapping and HH Listing process did not end at the time the Ed maps and HH Listing Guide were produced. It continues during the census proper and still in progress as of this Report's date. Enumerators were also asked to mark on their ED maps the houses newly discovered. In some states, the collection of GPS waypoints and additional household attributes was also done especially for the outer islands where initial mapping was not carried out. The new data will be entered into the HH Registry to ensure there is a match between the HH Registry and the Census Questionnaire database. It is anticipated that mapping for the rest of the outer islands in Chuuk and Pohnpei (Yap completed) will be carried out after census data entry is completed.

## 5. KEY POINTS

The main part of the Mapping and HH Listing exercise was successfully completed however certain problems or challenges were observed and encountered. In general, the biggest challenge was the actual mapping and listing of households especially with mappers who did not follow the canvassing strategy and compounded with inadequate supervision and field validation. Consequently, houses were not systematically mapped, listed or labeled.

### 5.1 Challenges

The following are some challenges that FSM faced during the mapping and listing of households:

- Printing of stickers had to be done off-island and in some states stickers ran out and folder labels were used instead.
- Systematic canvassing was not followed and some houses were not listed but only discovered during the census;
- Recruitment of mappers was rushed and actual recruit was made just before the Training for Mappers hence not allowing sufficient time for adequate training and field exercise;
- Incomplete delineation of ED boundaries to align with roads, rivers and equitably allocate households among EDs;
- GPS waypoints taken before adequate satellite fixes are obtained;
- Color ED maps were printed on letter size papers and both the size and color posed problems when marking new locations of houses on the maps during the enumeration. The paper size did not allow for better zoom-in level especially where houses are congested and the color makes difficult to mark new houses on the maps legibly using pencils;
- Lack of a readily accessible Plotter for printing of bigger size maps and timely production of the necessary maps;
- NSO had to improvise and develop tools and strategies due to lack of a detail operational handbook, like the UN Handbook on Geospatial Infrastructure in Support of Census Activities, tailored to the GIS infrastructure and approach used;
- Inadequate time to re-verify waypoints especially in the most populous Chuuk and Pohnpei before the enumeration.

### 5.2 Recommendations/Observations

Based on the above problems and experiences, the following are some recommendations or observation which may facilitate future census or surveys:

- Procedural and instructional documentations need to be produced and shared;
- Attachment with census taking country to observe firsthand the work is highly recommended;
- Allow lead time in the mapping and training of mappers to allow more field work exercises and verify their work;
- Free acquisition of annual or recent Satellite Imageries (SI) just before census mapping for Pacific Island Countries (PICs). This may be possible if the acquisition of satellite maps is justified on the basis of Climate Change issues and making it an important area to be funded by Climate Change funds. The current SI can make the mapping and listing so much easier. SI captures more accurately the view of the country at the point of census period making the SI an important part of census time series data which could advise the Climate Change process;
- SPC to develop a page to upload critical information on census taking for other countries yet to do census to be able to easily access;

- Making GIS programs and toolkits readily available and (with no cost) to governments of census taking countries in the Pacific by developing better relationship with the GIS developers or UN to establish a Census/Survey Trust Fund;
- Development of a scanning operational handbook for census and surveys from the experiences of countries which had already employed the scanning technology;
- Conduct of regional or sub-regional workshops in GPS technology, GIS and scanning technology where the providers of the technologies are invited, development of MapServers;

## 6. CONCLUSION

Overall, the Mapping Phase of the Census is believed to be a success, accomplished with a fare share of challenges. Despite of it all, it was an accomplishment in a sense that it was the first time that the actual work was done exclusively by local staff, FSM's own NSO staff, without any external expert ground supervision as had been the case for the last censuses.

In the beginning, the NSO took ownership of the process and commit its full attention and support in its execution. These staffs were trained in a very short period of time on a fairly new technology to pilot it on a major national project. They were able to take on several roles as trainers of mappers, supervisors and as innovative developers of solutions.

It shows that local capacity building in mapping technology can be easily done and the application of new technologies, including GPS technology, in censuses and surveys should be embraced. Countries yet to conduct census are encouraged to update their maps and household listing by employing the geospatial technology.

The benefits of the geo-database on households go beyond just census. It benefits other planning and development process undertaken by other government agencies and authorities, private sectors and the FSM public. The data would be useful in disaster management and monitoring activities. Many agencies are already calling for the data including the public utility corporations, telecommunications and other agencies undertaking surveys in health and education. The additional data collected on the attributes of houses in the outer islands would add more values to the geo-database and expanding its use and benefits. FSM is on the track to continue collecting and adding spatial data to its collection in preparation for the development and installation of a MapServer.