CENSUS CARTOGRAPHY

1. BACKGROUND

This paper refers to *UNFPA-SPC/Census Review 2012/Working paper 2* and discusses important lessons from the 2010 World Round of Censuses which can be used to improve census cartography for the 2020 round. This paper addresses best practice in regards to the creation/modification of census geographic boundaries, GPS household listings and preparation of geographic boundaries for data dissemination/analysis.

2. OTHER REFERENCE DOCUMENTS

1. Handbook on Geospatial Infrastructure in Support of Census Activities
2. QGIS for Census and Survey Mapping and Analysis

3. MAPPING IMPROVEMENTS

Technology continues to advance and costs continue to drop providing new and improved mechanisms to better plan and conduct population censuses as well as to analyse and disseminate the corresponding data:

1. Cheaper satellite imagery and better coverage. SPC now does in-house image cleaning/rectification.
2. Cheaper GPS units. Mobile phones also come standard with relatively high accuracy GPS receivers allowing for fully-automated data capture of household listings or even full enumeration.
3. Good free GIS software such as QGIS.
4. Automated map production within GIS applications means much faster output of field maps.
5. Data sharing amongst agencies is now being recognised as necessary and extremely beneficial, including sharing of hardware such as GPS.

4. MAPPING CONSTRAINTS

There are a range of reasons why mapping activities are not as streamlined as they should be and why mapping outputs are not as good as they could be:

1. Not enough time allocated to mapping. This includes cleaning of GPS points and enumeration boundaries and then the resulting analysis and dissemination phase.
2. Lack of GIS-savvy staff. Maintaining boundaries is an on-going process.

3. Insufficient budgeting and planning for GIS.
4. Many Lands departments and Statistics offices are sharing data and expertise (3.5), though this is not the case in all countries.

5. MAPPING ERRORS

Below is a basic summary of the main areas where mapping errors were identified in the 2010 round of censuses:

1. Poorly delineated boundaries. With the increased utilisation of high-resolution satellite imagery boundaries have greatly improved. Assuming layers are in the correct coordinate systems and hence don't have offsets, generally errors are due to poor editing practices such as not respecting topology and snapping rules resulting in overlaps, dangle nodes etc
2. Physical references (roads, landmarks etc) need to be used where possible when designing boundaries so that change is limited over time and Enumerators can easily find their EAs. (See UN handbook)
3. Poor coding or unnecessary re-coding. Nested codes are best practice and should be respected where possible. For example Province = 01, District = 01, EA = 01 would result in a unique EACode of 010101.
4. Not splitting correctly or re-drawing EAs resulting in difficulty comparing time-series data
5. Poor cleaning of GPS waypoints. This activity should ideally take place simultaneously with listing activities. As an EA is completed the GIS officer double-checks the GPS points against satellite imagery and other datasets. Any errors then get instantly rectified, possibly be returning to the field.
6. Overstepping of EA boundaries during fieldwork. This is hard to avoid, particularly in dense urban areas. Careful utilisation of road networks helps, though when splits between houses need to be made sometimes the only real way to be sure of no overlaps is to canvas the area with a supervisor prior to carrying out field work.
7. Sometimes EA boundaries are being modified after census enumeration resulting in data which cannot be correctly attached to the geographic areas.

6. MAPPING RECOMMENDATIONS

As a result of the constraints and errors mentioned above, there are certain recommendations which could potentially improve census-related mapping activities:

1. NSOs work closely with Lands Departments to update official village boundaries.
2. GIS expertise can be shared with other Government Ministries if resources and expertise are lacking.

3. Narrative descriptions can be used to stop overstepping boundaries, although this creates extra work. Additional field control can also assist here.
4. Don't modify EA boundaries after main enumeration to ensure correct joining of attribute to spatial data.
5. For very small countries there isn't a 100% necessity to use GPS for listing activities, household locations can be directly digitised over imagery.
6. Writing latitude and longitude GPS coordinates for households on listing forms provides a backup if there is a problem with GPS units. Data processing staff need to treat this as any other important geographic identifier and put in careful checks and no batch editing.
7. Tablets or smartphones now have very good GPS receivers and can be used to not only collect GPS locations but also the associated listing data.
8. First week of listing/GPS is the MOST important. All field work needs to be verified and errors/issues fixed and reasons for errors explained to listers. Field supervisors need to play a more active role.
9. GPS codes need the SAME quality control as rest of geographic Ids
10. Integrate GPS and GIS into all census activities.

7. RECOMMENDED GPS TRAINING:

GPS field work and household listing is not as complicated as a full census. There is however a minimum training which is required and important steps which cannot be ignored otherwise errors quickly work their way into the data. Below are recommended modules for robust GPS training:

1. Introduction to GPS – how the units work. Go outside and take a few points in carpark.
2. Send trainees out into the field with a map of EAs surrounding training venue. Each trainee has different locations/landmarks selected (4 per person) and must find them and take a GPS waypoint for each. Once completed come back to training venue and download into laptop to overlay on imagery. Mistakes are discussed with trainee and additional demo given if required.
3. Discuss correct way to fill in form
4. Start listing of only 10 households before trainee must download their points and check over imagery and have listing form double-checked. If ok then they may continue.
5. During the first week of fieldwork supervisors continually check work in field and download waypoints to make sure there are no mistakes.
6. Every time an EA is finished the supervisor downloads GPS points and double-checks listing form. Any errors are fixed and lister goes back to field if necessary.
7. Data entry should start ASAP and regular data exports done to match with GPS data and check for errors

8. RECOMMENDED ENUMERATION AREA SPLITTING AND NUMBERING

1. Ideally, EA boundaries should change as little as possible so data can be compared between consecutive censuses at the lowest level of geography possible
2. In the event that EAs are too large for a single enumerator, they can be split. Splits should follow semi-permanent features such as roads or rivers where possible to minimise the need to change them at a later date.
3. If EAs are too small due to population loss, they can be merged, though an alternative would be to simply have an enumerator work on two small EAs and then keep the boundaries consistent.
4. Renumbering of EAs should not occur for every census. Splits can be incorporated in a numbering system by adding an additional 1 or 2 digits to the end of the existing code. 101 would become 1011 and 1012. An EA with no split 102 would become 1020.
5. If EA boundaries absolutely need to be renumbered because they have become too large then a lookup table needs to be generated indicating the link between the old and the new.
6. EA numbering should be nested as with other levels of geography. Every province has a district 1 which has an EA 1. The resulting EA code could look something like 0101001

9. CONCLUSION

Cartography is not new during census operations, with maps having played an integral role for many years. The techniques and technologies have greatly improved though, rendering hand-drawn maps a thing of the past, and GPS, satellite imagery and automated field map creation the current norm. In the 2010 census round many countries adopted these new technologies with varying levels of success. There are a few considerations which need to be taken into account for a “spatial” census to be truly successful. With the right mix of resources and skills countries can greatly improve their map production and field monitoring while also collecting more precise household data which is extremely useful for other applications such as food security and disaster preparedness and management.