GEOGRAPHIC INFORMATION SYSTEMS

Session 8

Introduction

- Geography underpins all activities associated with a census
- Census geography is essential to plan and manage fieldwork as well as to report results
- GIS, GNSS (i.e., GPS), and the availability of affordable aerial and satellite imagery have enabled NSOs to collect more accurate and timely geospatial information about their populations
- GIS technology and other geospatial tools have enabled more efficient production of both enumerator maps and thematic maps of census results, improving the overall census data quality and supporting more efficient and impactful analysis of census data

The Global Statistical Geospatial Framework

- The importance of integrating statistical and geospatial data has been recognised at the international level, through the endorsement and adoption of the Five Global Statistical Geospatial Principles, under the Global Statistical Geospatial Framework (GSGF).
- 6th Session of the United Nations Committee of Experts on Global Geospatial Information Management (Augusts 2016) - Decision 6/107
- Reiterated that the 2030 Agenda and the 2020 Round of Censuses are important drivers for the integration of geospatial and statistical information in support of evidence-based decision-making across many sectors, whether public or private, at the national and global levels,
- Adopted the five guiding principles as referenced in the report as the foundation of the Global Statistical Geospatial Framework,

The Five Principles of the Global Geospatial Statistical Framework:

1. Use of fundamental geospatial infrastructure and geocoding;
2. Geocoded unit record data in a data management environment;
3. Common geographies for dissemination of statistics;
4. Interoperable data and metadata standards;
5. Accessible and usable geospatially enabled statistics.

- Adds an X-Y coordinate (or several) for each unit of census data

Geocoding: Locating Census Data on a Map

- Principle 1 of the GSGF considers the use of fundamental geospatial infrastructure and geocoding.
- Geocoding provides a systematic approach to dealing with all geographies that underpin census operations through X-Y coordinates or polygons
  - *enumeration area, census block, a building, or parcel/property*
- Geocoding is census data integration by another name:
  - *Establishes a consistent geography language through the systematic labelling of geographic phenomena*
  - *Ensures that all census phenomena are linked to these geospatial entities through X-Y coordinates*

Geocoding is vital for the census

- Geocoding is vital for producing high quality maps and performing census tasks such as:
  - *the operational planning of the census;*
  - *modelling and delineating administrative and enumeration area boundaries;*
  - *point locations of census units, even point locations of housing units and collective living quarters;*
  - *locating other relevant geographic features such as roads, rivers and landmarks (which can be useful for delineating enumeration areas or for providing navigational information); and,*
  - *supporting the dissemination, aggregation and disaggregation of data*
  - *aggregate data into new/customized units of analysis satisfying users' requirements; and, generate customizable map outputs.*

Geographic Databases

- Geodatabases allows for data to be (re)utilised for future purposes and needs, including for creating new geographies in a time-efficient and geographically consistent manner
- A comprehensive census database usually consists the following elements:
  - *spatial boundary database, consisting of area features (polygons) that represent the census units (e.g. EAs and administrative/territorial/statistical divisions).*
  - *geographic attributes table, a database file linked internally to the spatial database that contains one record for each polygon. This table contains the unique identifier for each census unit and possibly some additional static or unchanging variables, such as the unit's area in km^2.*
  - *census data tables containing non-spatial attributes, i.e., the census indicators for the spatial census units. Each of these files must contain the unique identifier of the census unit that provides the link to the corresponding polygon attribute table records. There will be one record for each census unit.*
  - *other vector (point or area) features, such as building/housing unit points, landmarks, roads, waterways, schools, health facilities or other buildings may be useful for orienting fieldworkers during the enumeration. Such features are usually recorded during preliminary field-canvassing or house-listing.*

Role of geospatial information in census operations

- Role of maps in the census process has expanded
- Traditionally: to support enumeration, operations management and dissemination
- Today, modern GIS systems:
  - *improve efficiencies and accuracy of the overall census project and products*
  - *optimize enumeration areas, workforce assignments and field offices*
  - *cost savings (e.g. labour and transport)*

Role of geospatial information in census operations: Pre-enumeration

- Creation/updates to census geographic database
- Creation/updates to Base Maps
- Creation of Map Services (this is the way to make maps available through the web)
- Creation or updating of enumeration areas (EAs)
  - *Production of digital EA maps for fieldwork and operations*
  - *Use of remote sensed data (images from satellite and aerial imagery) in EA creation*
  - *Integrating fieldwork using remote sensed data*
- Validation of EA's
- Conducting GIS analysis to ensure complete and balanced coverage (no omissions or duplications)
- Applying GIS analysis to facilitate efficient census operations (analysis on most efficient placement of field offices and allocation of field workers

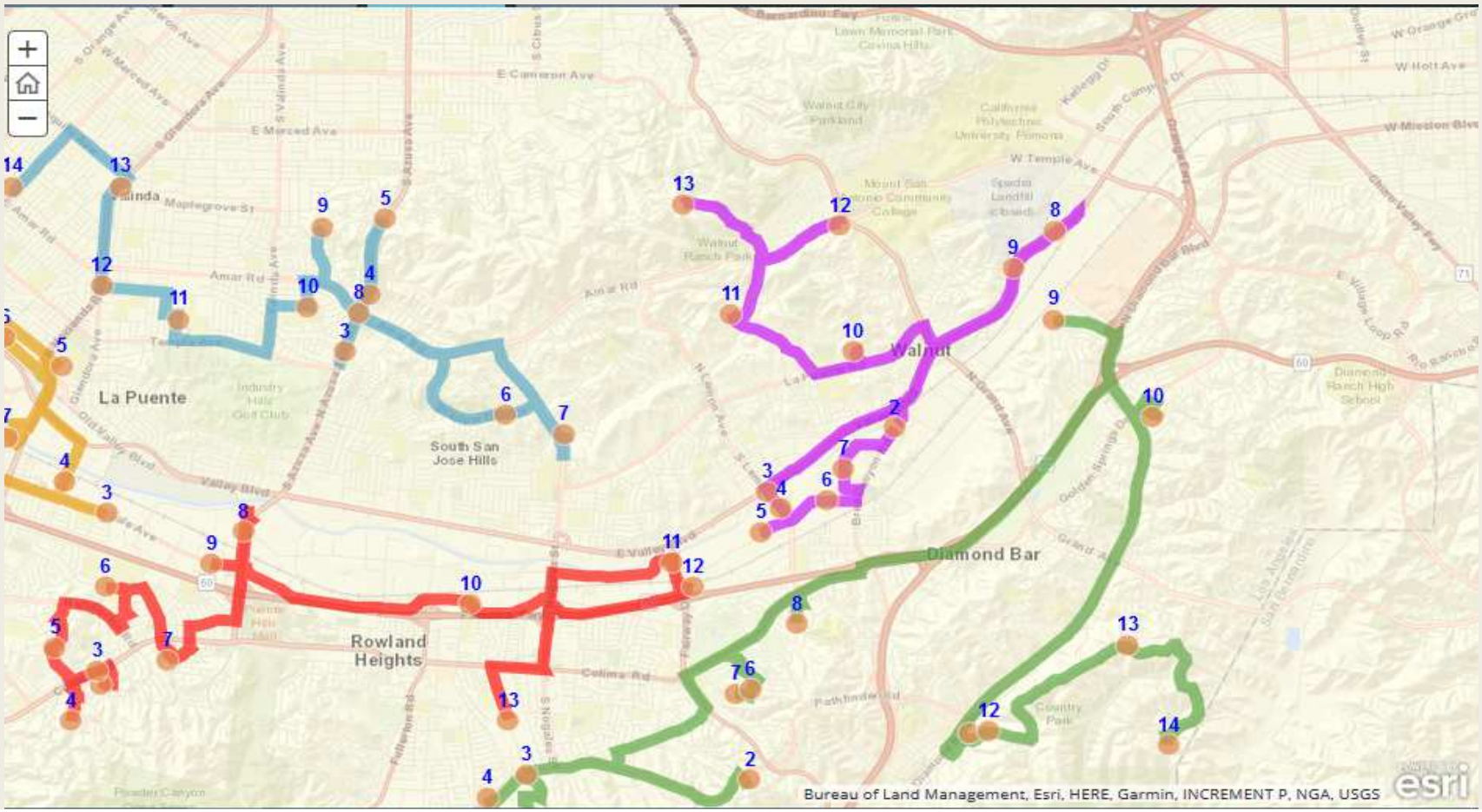
During enumeration: Workforce management

- Assign work to individual enumerators, monitor their activities and provide necessary assistance
- Improved time and resource management
  - *reduce labour costs*
  - *optimize travel time, travel costs*
  - *improve the overall quality of the census*
- Create efficiencies and providing transparency across the workforce
  - *forecasting of workload and required staff*
  - *management of working times*
  - *suggest best possible scenarios for completion of work*
  - *deploy technical or specialized skills and equipment*

Complex scheduling analysis and assignments

- GIS solutions allow for complex scheduling analysis and assignments.
- optimize routes by determining quickest/shortest/most cost-effective route through EA
- find closest facilities in order to estimate cost of traveling between locations
- pre-plan routes, saving time, labour and fuel for transport

Example of daily optimized routes for one enumerator. The routes for each day are depicted in different colors and include the optimal stop sequence number for each site visit

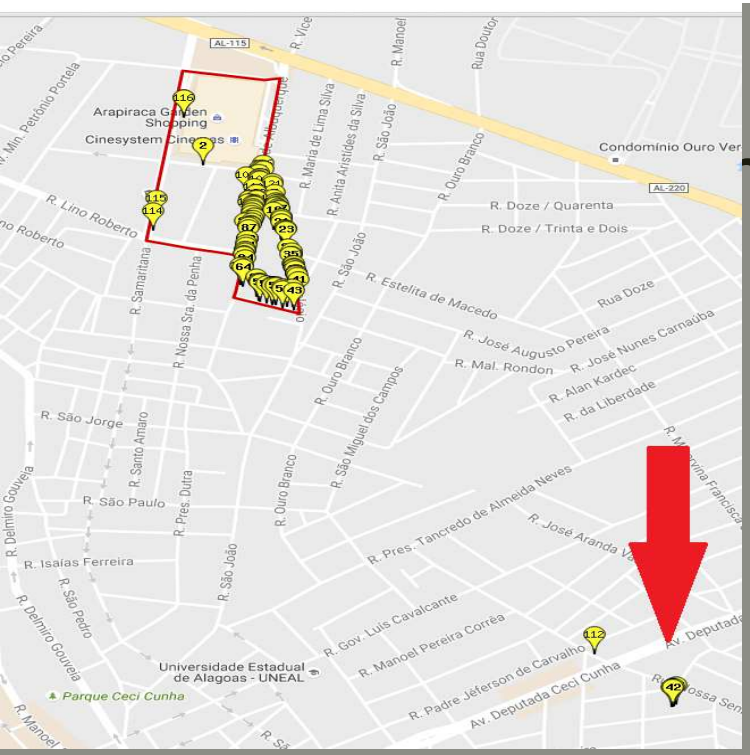


During enumeration: Monitoring and operation management

- Support planning and control tasks by supervisors
  - *make assignments, reallocate tasks, with the aim of ensuring a smooth and timely completion of the enumeration*
  - *real-time transmission of geo-data of enumerator route and household locations enable the supervisor to monitor the progress of the census enumeration locally*
  - *facilitate better management of the enumerator's workload by checking the effective progress, comparing the actual completions rates compared with those expected*
  - *identify problem areas and implement remedial action quickly*
  - *knowing they are being monitored, the enumerators are discouraged from making any fraudulent returns, knowing that their outputs can be easily verified by the supervisor.*

During enumeration: Monitoring and operation management

- GIS operational dashboards bring together a common view of the progress of the enumeration
- allow for monitoring of real-time data feeds for day-to-day operations
- monitoring progress at any level of geographic aggregation
- deliver information products needed throughout the operations processes including; maps, charts, and operational dashboards that provide an overview of the project status.
- Give decision makers updates on progress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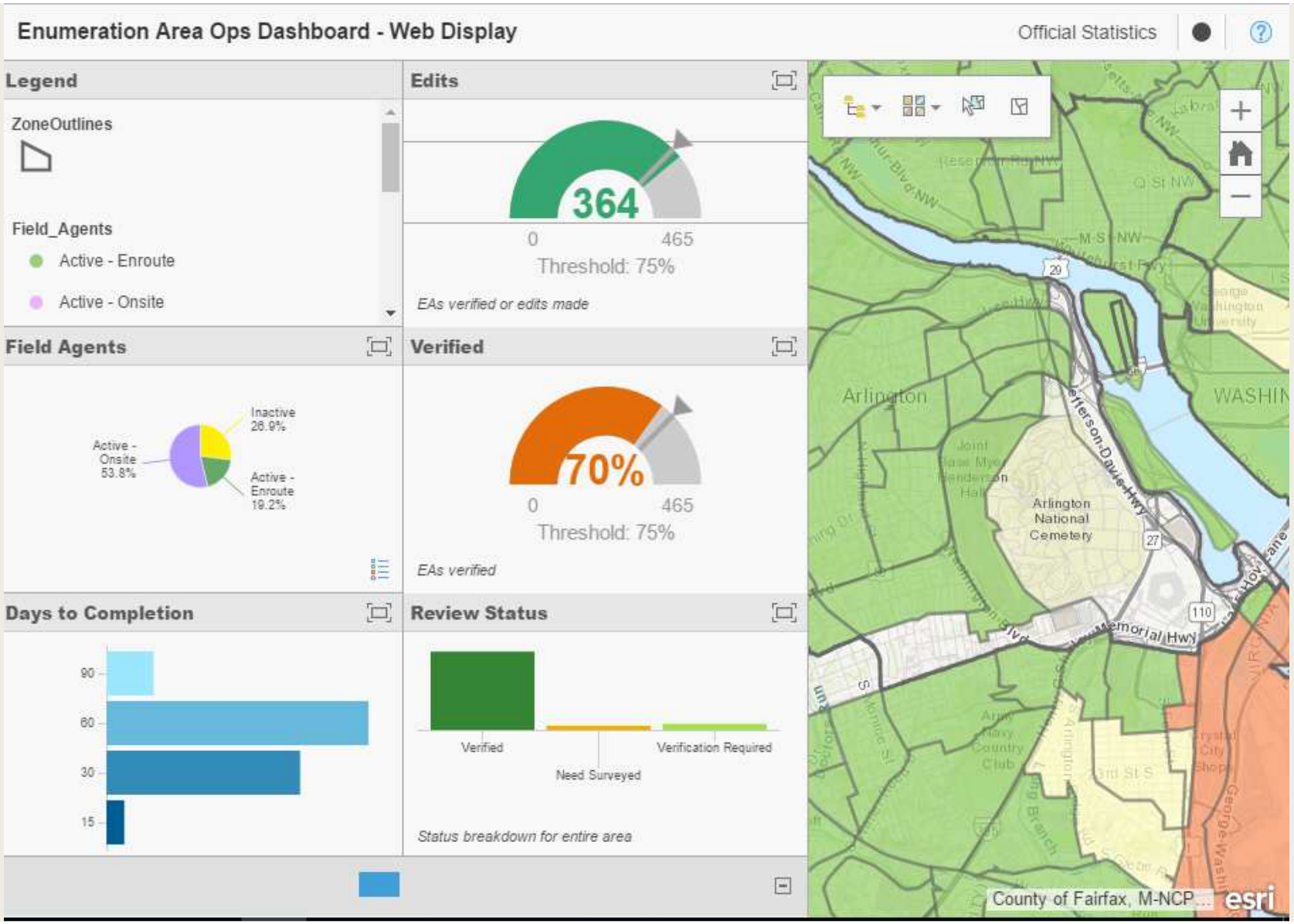
During enumeration: Support the work of enumerators

- Putting GIS mapping in the hands of the field staff improves the accuracy of census data.
- Ensure enumerators can easily identify their assigned geographic areas, follow a pre-determined path, and know their exact location in real time
- makes it easy for enumerators to organize their daily workloads by determining the optimum route to each household, report progress
- an alert function on the mobile application could ensure enumerators' safety through notification of supervisor in any emergency situations and the provision of support

During enumeration: Updating and correction of EA maps during enumeration

- Census maps are usually prepared several months, or even years, ahead of the actual enumeration
  - *new constructions and infrastructure developments may not be shown in the EA maps*
  - *census maps may contain errors that may lead to either under- or over-coverage*
- It is usual practice to verify EAs and units to be covered just prior to the actual enumeration.
  - *this round of validation of EAs is aimed verifying the existence of buildings and supplementing the address list with missing address points*
  - *this data will allow the statistical agency to correct and update the digital maps in good time for the enumeration itself*


Enumeration Area Ops Dashboard - Web Display
Official Statistics
Legend
ZoneOutlines
Field_Agents
Active - Enroute
Active - Onsite
Edits
364
0
465
Threshold: 75%
EAs verified or edits made
Field Agents
Inactive
26.9%
Active -
Onsite
53.8%
Active -
Enroute
19.2%
Verified
70%
0
465
Threshold: 75%
EAs verified
Days to Completion
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Status breakdown for entire area
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Role of geospatial information in census operations: Post-enumeration

- GIS and interactive mapping capabilities make it easier to present, analyse and disseminate census results at various levels of geographical disaggregation
- Provides a powerful means for visualizing the results of a census - identification of patterns and the analysis of important demographic and social indicators
- Data at census unit level can be aggregated to new units of analysis (such as climatic zones or ethnic regions)
- Link information from many different subject areas, leading to a much wider use of statistical information
- Provide advanced visualization techniques, animation and three-dimensional modelling capabilities
- Make accessible vast amounts of spatial information to users through the Internet

Example: Geo-coding census and survey data and deep learning

- In 2016, Stanford researchers used geo-coded DHS data (with a significant scatter) to train a neural network to predict poverty rates by only looking at a satellite image
- The result: a function that would take a satellite image as an input, and (no other socioeconomic data) and output a poverty rate (wealth index)
- The model in its very earliest form had an R-squared of about 76%--using nothing but an image
- Computational sustainability researchers in the AI world are actively pursuing prototypes that use geospatial information for a range of incredibly innovative applications
- Expect the range of new uses of geocoded census information to expand dramatically over the next decade

Planning considerations for developing a census geographic program

- Key considerations include:
  - *Needs assessment*
  - *Inventory of existing data sources*
  - *Collection of new geographic data*
  - *Geospatial data management system*
  - *Identification of geographic products and services*
  - *Staff skills and capacity*
  - *Outsourcing*

Inventory of existing data sources

- Identification of maps and other geographic information (both digital and hard-copy)
  - *reduce need to collect additional data using fieldwork and/or imagery*
  - *save time by keeping field-checking to a minimum, and focusing on rapidly changing areas*
- Cooperation with National Mapping Agencies, relevant government agencies, private sector
- Leverage resources of National Spatial Data Infrastructure (NSDI) institutions
- Data from external providers should be verified
- During incorporation into a GIS database, ensure the correct spatial relationships
- In order to ensure that these census maps can be integrated with other data sources, the census geographic programmes must adhere to existing national geospatial and geographic data standards

Staff skills and capacity

- Technical capacity and skills held by GIS staff critical
- Increased use of GIS packages requires considerable training
- Developing GIS capacity may entail reorganization and expanding the existing "cartographic unit"
- NSOs must evaluate training options
- Skills needed include:
  - *planning and project management;*
  - *systems administration.*
  - *geographical data conversion; map scanning and digitizing;*
  - *cartographic design;*
  - *field work with GNSS devices*