Resources Materials for Establishing GIS-based Database

The attachment link of the Resources for Establishing GIS-based Database is mentioned below:

D33_RM_GISDataCreation.pptx

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Context

This document contains the overall process of establishing GIS-based database required for establishing IMIS in a city including the process of preparing city's GIS data, household survey for establishing containment database, etc. This database will become a main source of data for IMIS for efficient planning, management, and M&E of sanitation system and service delivery with the principle of CWIS.

IMIS promotes sanitation as a public service and integrates sanitation data with inter related urban sub-sectors domain (e.g., water supply, solid waste management and transportation networks, sewer networks). Multiple types of spatial and non-spatial data sources have been carefully identified by the IMIS development team comprises of System Analyst, Data Analyst, GIS expert and sanitation domain experts with focusing on CWIS core outcomes and functions. IMIS data requirement checklist is presented in Appendix A which describes necessary data layers and its necessary attributes for efficient planning, management and M&E of sanitation system and service delivery as well as for overall urban management of the Local Governments.

Establishing a geo-database for IMIS involves creating a structured and organized repository for storing spatial data and non-spatial data. All these data layers are seldomly readily available in LGs. In addition, even available data is often outdated or missing key attribute information. Therefore, a series of steps need to be followed to establish required database of IMIS that may include data acquisition through field survey and conversion of relevant spatial data from various sources, such as satellite imagery, master plan data and existing paper maps as well.

Establishment of GIS database for IMIS shall be led by a competent, qualified, and experienced consultant who has a demonstrated track record in working in the geospatial domain with previous experience in conducting city wide geospatial survey for establishing the GIS database. The consultant must have a full time GIS Expert with at-least Bachelor's degree in GIS with 5 years of working experience in their team.

WorkFlow

The general workflow for establishment of GIS database for IMIS is outlined as follows:

Exploration data available with local government & other stakeholders

A key informant interview (KIIs) with local government officials and other stakeholders (e.g. Central Bureau of Statistics, Ministry of Local Government, etc.) is a first step in for ascertaining availability of various spatial and non-spatial data needed for IMIS. During
the KIIs, availability/unavailability, creation year and form of data(digital/paper) must be ascertained for each data. In case of unavailability of data, it must be inquired if the data can be generated with the help of KIIs with any officials of LGs or other stakeholders. In that case, the person who can provide information must be identified as well.

Acquisition of available data and standardization

All available data layers must be acquired from the LGs and other stakeholders. If the certain data layers are in the paper form, then scanning the map at high resolution, performing georeferencing to assigning spatial coordinates to the scanned map image and digitizing features on the scanned map using the GIS software's digitizing tools along with its attribute data is necessary. It's essential to perform quality control to ensure reliability of GIS data obtained from the paper maps. All available data layers must be subsequently scrutinized for its sufficiency with a detail comparison with the corresponding necessary attributes as mentioned in Appendix A. It is mandatory to perform data cleaning and pre processing procedure to identify errors, duplicates, missing values, and inconsistencies for all available data layers that have been identified as meeting the IMIS data requirements and therefore not needed to collect through the field survey.

Acquisition of high-resolution satellite imagery

A very high-resolution satellite imagery is a pre-requite to establish a robust and reliable base dataset required for IMIS specifically for digitizing building outlines, road data and water bodies. High-resolution satellite imagery can be created through downloading freely available high-resolution Google Imagery given that acquisition of images under Area of Interest (AOI) have been done recently (less than a year ago). A freely available SAS Planet software (https://www.sasgis.org/) provides a simplified procedure to acquire Google Imagery of highest resolution. The SAS Planet software outputs georeferenced single imagery under AOI in various raster formats (TIFF, JPEG or ECW). Some well-known commercial vendors that providers high-resolution satellite imagery include Maxar (formerly Digital Globe), Airbus Defense and, Space Planet etc. All commercial vendors have a catalogue service that can be inspected to ensure that they have data coverage for desired AOI and have acquired images recently with minimal cloud 2 Resource Materials for establishing GIS-based Database cover (\< 5 % cloud cover is desirable). However, purchasing high-resolution satellite imagery through reputable commercial vendors that offer high-resolution satellite imagery is preferable. Requirements about the data (e.g., data formats, spatial and spectral resolutions, requirements related to the data must be clearly outlined (e.g., AOI, data formats, spatial and spectral resolution) when placing any order to commercial vendors. Preparing high-resolution image using Drone Survey is highly recommend if the fund is available with LGs. This technology help producing high resolution images compare to the satellite image and also reduces field verification time.

Digitization of data-layers using high-resolution satellite imagery

The high-resolution imagery will be the sole basis for identification and digitization of intended features (e.g., building footprint, road network) through visual inspection and a manual digitization process by a person having proficiency in GIS within a GIS based software. A proprietary GIS software ArcGIS or an open-source software QGIS (www.qgis.org) can be utilized for the process of digitization of the data layers. During the digitization process, it is necessary to ensure that the digitized data is free from any topological errors and maintains geometrical requirements (e.g., right angle maintained for building outlines) that are needed to accurately represent the physical structure in the digital realm. During the process, a strict quality mechanism must be adopted such that digitized features are free from any errors. Topological errors (silver lines, over-shoot, under-shoot, cross breaks, and dangling objects) in case of road features and overlapping polygons, silver & dangles of polygon features must be carefully checked. In addition, it must be ensured that no features visible in the imagery are missed during the digitizing process. It is recommended that error checking is done by a person not involved in the digitation process to guarantee high accuracy and reliability of digitized data.

Field verification of buildings, roads, sewerage, drainage and water supply

Since building footprints, roads and containment data are the most crucial datasets for IMIS, a field verification process is needed to ascertain presence of all digitized features (e.g., building footprints and road networks) on the field and digitize features that are not visible on the high-resolution satellite imagery. In the process, some digitized buildings may require splitting if there are multiple buildings on the field within the boundary of the digitized buildings.

Field survey for collection of attribute data

Building data must be mapped with sanitation system available in the buildings, as well associated access road, drain, sewerage network and water supply networks for IMIS. This information must be collected through an extensive census field survey within the LG's boundary. A questionnaire that has been devised for collection of attributes related to 3 Resource Materials for establishing GIS-based Database buildings and containment data based on IMIS date requirement is presented in Appendix B. The questionnaire shall preferably be translated in the local language.

Between two modes of data collection for household surveys: paper and pencil interviewing (PAPI) and computer-assisted personal interviewing (CAPI), the CAPI is recommended due to numerous inherent advantages such as skip logics, recording geolocation ability, the ability to capture photographs and real-time monitoring of survey responses. Field survey conducted adopting CAPI tends to more efficient and of high quality because errors are greatly reduced as well. There are many digital tools (mWater, Open Data Kit (ODK) and KoBo Toolbox) available for field data collection, however MerginMaps has been adopted as a recommended tool based on previous experience of collecting geo-spatial data for establishing IMIS for Mahalaxmi Municipality in Nepal and Pourashavas (e.g. Kushtia, Benopole, Gazipur) in Bangladesh. MerginMaps is an ecosystem developed by Lutra Consulting that allows capture of geospatial easily through a mobile device and efficiently store and track changes of collected geodata on a cloud. Multiple surveyors can work simultaneous, and their data can be combined and shared securely though the MerginMaps web platform.

Composition of survey team

Three different group of persons are required to smoothly conduct the survey.

1. Enumerators: Responsible for collecting information on the field
2. Supervisors: Overall monitoring of enumerators
3. Coordinator: Setting the mobile and web application for survey and periodic data monitoring. A person with GIS knowledge is essential.

It is essential to carefully select enumerators as well as field supervisors to ensure that information to be collected meets the optimal quality standards in terms of accuracy and reliability. Some of the criteria in choosing enumerators include previous survey experiences, good interview skills, familiarity with the local language and familiarity with usage of mobile phones. It is advisable to select enumerators having at least Intermediate academic qualification and priority should be given enumerators having higher academic qualification. All pre-selected potential enumerators candidates are invited to participate in a training session where the final selection is made after their field performance is assessed. A training program is designed to acquaint enumerators with the content, flow, structure of the questionnaire as well as familiarity with intricate details of MerginMaps mobile application for conducting the field survey.

In addition to enumerators, field supervisors are needed to manage field work implementation and monitoring of enumerators to ensure that field survey get completed within the intended allocated time as well as to provide any assistance required by enumerators related to the filed mobile application or the questionnaire. Enumerators must maintain regular communication with the enumerators on the daily basis. The recommended ratio of supervisor and enumerator is 1:20.

Conducting field survey using MerginMaps

A field survey using MerginMaps requires extensive training to enumerators on how to use MerginMaps and conduct data collection accurately and efficiently. Besides training to enumerators, a curtailed training to a person with GIS knowledge to act as a survey coordinator who will setup/modify forms in MerginMaps and performs/monitors the synchronization of collected data with the use of QGIS software is required. The IMIS Field Data Collection User Manual for Coordinator and IMIS Field Data Collection User Manual for Enumerators are attached with this report. An elaborate training shall be provided for both Coordinator and Enumerators before the commencement of survey. A general workflow for conducting a field survey using MerginMaps is as follows:

- Designing the Survey Form in QGIS that includes the required data fields to capture information during the field survey. The form needs to be tailored to specific data collection needs.
- Configuring the GIS data and survey form in QGIS before conducting the survey in the field such that there is direct linkage between survey form with the relevant data layers with needed styling, field validation rules and skip logics. It is essential to incorporate data validation rules with the survey form to minimize errors during the field data collection.
- Acquiring necessary space privilege on MerginMaps for data storage by purchasing a suitable plan that is most appropriate as the requirement of the project and transferring the QGIS project in MerginMaps.
- Providing elaborate training to both coordinator and enumerators about the use of MerginMaps applications (web and mobile apps). Enumerators are given training related to mobile application only whereas coordinators are given training related to both mobile and web applications. Mobile application is primarily used during the field survey whereas web application is meant both for configuring the survey as well as monitoring and synchronization of collected field data.
- Collection of data in the field by enumerators with a mobile device loaded with MerginMaps application. Enumerators can collect data and input the information directly into the digital form.
- Synchronizing data collected in the field with the central database using MerginMaps cloud. The step ensure that all data is consolidated and updated in the main GIS database of the project. Enumerator performs the synchronization of data once the surveyors have a strong internet connection. Synchronizing data using mobile data connection is not recommended.
- Regular monitoring of collected data by coordinators to ensure that any inconsistencies or inaccuracies are identified and addressed properly by conveying the information to field enumerators through supervisors.

Appendix A. DATA DICTIONARY FOR GIS-DATABASE

Appendix B. CHECKLIST FOR CENSUS SURVEY OF BUILDING & CONTAINMENT ASSESSMENT FOR IMIS

Date: _ _/_ _/ _ _ _ _

Name of Surveyor:

Name of Respondent:

Gender (Male/Female/Others):

Contact number of Respondent:

Owner Information

1. **Name of Owner:**
2. **Gender (Male/Female/Others):**
3. **Contact number of Owner:**
4. **Ward:**
5. **House Address:**
6. **Road Code (XXX):**
7. **Road Name:**
8. **Tax Code/ Holding ID:**

Building Information

1.What is the construction type of the building?

- RCC
- Load bearing with cement mortar
- Load bearing with mud/lime mortar
- Wooden/Mud/CGI /Temporary
- teel structure
- Other (Specify):

2. What is construction year of the building (YYYY AD)?
3. Number of floor (including ground floor):
4. Is the Building Low Income Household?
   - Yes
   - No
5. If Q.12 is Yes, Low Income Community Name, if applicable?
6. What is the use purpose of the building?
   - Residential
   - Commercial
   - Mixed (Residential and Commercial)
   - Offices
   - Educational
   - Hospital/clinic
   - Industrial
   - Assembly
   - Other (Specify):
7. What business /governmental institutions/offices/educational entities are present in the building? List out names.
8. How many households (HHs) are living in the building?
9. How many people are living in the building including all households?
   - Male:
   - Female:
   - Others:

   If differently abled:

- Male:
- Female:
- Others:

Toilet & Containment Information

1. Do you have a toilet on your premises?
   - Yes
   - No
2. If Q18 "No", where do your family go for defecation?
   - Use Community Toilet
   - Open defecation at water bodies/ open ground
   - Others (Specify):
3. If Q18 "Yes", how many toilets do you have?
4. If Q18 "Yes", how many households have shared toilets?
5. If Q18 "Yes", Where does your toilet connection go?
   - Sewer Network
   - Drain Network
   - Septic Tank
   - Pit/ Holding Tank

- Onsite Treatment (e.g., Anaerobic Digestor/ Biogas, DEWATS)
- Composting Toilet (e.g., ecosan, UDDT, etc.)
- Water Body
- Open Ground ix. Shared Septic Tank

6. If Q22 "Septic tank", where does your outlet connection go?
   - Septic Tank connected to Sewer Network
   - Septic Tank connected to Drain Network
   - Septic Tank connected to Soak Pit
   - Septic Tank connected to Water body
   - Septic Tank connected to Open Ground
   - Septic Tank without Outlet Connection
   - Septic Tank with Unknown Outlet Connection

7. If Q22 "Holding Tank/ Pit", what type of Pit is it?
   - Double Pit
   - Permeable/ Unlined Pit/Holding Tank
   - Lined Pit

8. If Q24 "Lined Pit", where does your outlet connection go?
   - Lined Pit connected to a Soak Pit
   - Lined Pit connected to Water Body
   - Lined Pit connected to Open Ground iv. Lined Pit connected to Sewer Network
   - Lined Pit connected to Drain Network
   - Lined Pit without Outlet
   - Lined Pit with Unknown Outlet Connection
   - If Q 22 "Sewer Network" or Q 23 "Septic Tank connected to Sewer Network" or Q 25" Lined Pit connected to Sewer Network" then Sewer Code?
   - If Q 22 "Drain Network" or Q 23 "Septic Tank connected to Drain Network" or Q 25" Lined Pit connected to Drain Network" then Drain Code?

9. If Q22 "Septic Tank", does septic tank have at least 2 chambers, outlet at top, sealed/lined base, and walls?
   - Yes
   - No
   - Don't know

10. If Q22 "Septic Tank/ Pit/Holding Tank", When was the containment constructed (YYYY AD)?

11. If Q22 "Septic Tank/ Pit/Holding Tank", Where it is located?
    - Inside the building footprint
    - Outside the building footprint
    - Don't know

12. If Q22 "Septic Tank/ Pit/Holding Tank", have you ever emptied your septic tank/holding tank/pit?
    - Yes
    - No

13. If Q29 "Yes", when was it last emptied (year)?

14. If Q22 "Septic Tank/ Pit/Holding Tank", what is the estimated size of your Septic Tank/ Pit/Holding Tank"?

15. If Q19 "Use Community Toilet", then name of Community Toilet?

16. If Q22 "Shared Septic Tank", BIN of building that has septic tank pre-connected?

Water Use Information

1. What is the main source of water for drinking?
   - Municipal/Public Water Supply
   - Dug Well
   - Tube Well
   - Spring/River/Canal/Stone Spout
   - Rainwater
   - Private Tanker Water
   - Jar Water
   - Others
2. If Q24, "Municipal/Public water supply", what is your water supply customer ID?
3. If Q24, "Municipal/Public water supply", what is your water supply Pipe ID?
4. Do you have well on your premises?
   - Yes
   - No
5. If Q27, "Yes", what is distance of well from the nearest septic tank/holding tank/pit?

Solid waste Information

1. Do you have a solid waste collection service?
2. If Q29 "Yes", what is name of the solid waste service provider?
3. If Q29 "Yes", what is your solid waste customer ID