

Guidance for the management and use of geospatial data and technologies in health

Part 2 - Implementing the geospatial data management cycle: 2.4 Creating geospatial data - 2.4.2 Collecting data in the field

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Purpose and audience

The purpose of the Health GeoLab series of guidance is to inform concerned practitioners about the key elements they need to be aware of when it comes to managing and using geospatial data and technologies in public health and guide them through the processes to be followed in that regard.

The audience for this guidance includes geospatial data managers, technical advisors, and any other practitioners that are directly or indirectly involved in the collection and use of geospatial data and technologies in public health.

Please note that some of the sections in the present guidance require a basic understanding of concepts pertaining to the management and use of geospatial data and technologies.

Abbreviations

| | |
|---------|-------------------------------------|
| ADB | Asian Development Bank |
| AeHIN | Asia eHealth Information Network |
| APK | Android Application Package |
| BBS | Bangladesh Bureau of Statistics |
| DOH | Department of Health |
| GIS | Geographic Information System |
| GLONASS | Global Navigation Satellite System |
| GNSS | Global Navigation Satellite Systems |
| GPS | Global Positioning System |
| HGL | Health GeoLab |
| Max | Maximum |
| Min | Minimum |
| SDG | Sustainable Development Goal |
| SOP | Standard Operating Procedure |
| WHO | World Health Organization |
| WGS84 | World Geodetic System 1984 |

1. Background

The Health GeoLab (HGL) is a regional resource supporting low- and middle-income countries in Asia and the Pacific for them to fully benefit from the power of geography, geospatial data, and technologies to reach the health-related Sustainable Development Goal of healthy lives and well-being for all (SDG 3)¹.

The HGL uses the HIS geo-enabling framework to strengthen in-country capacity. The present document has been developed as part of this approach and with the objective of being used by the largest number of users possible.

This volume is part of a series of guidance started under the umbrella of the AeHIN GIS Lab and now continued by the HGL. The complete series is organized as follows:

- Part 1 - Introduction to the data-information-knowledge-decision continuum and the geospatial data management cycle [1]
- Part 2 - Implementing the geospatial data management cycle:
 - 2.1 Documenting the process and defining the data needs [2]
 - 2.2 Defining the vocabulary, the data set specifications, and the ground reference [3]
 - 2.3 Compiling existing data and identifying gaps [4]
 - 2.4 Creating geospatial data
 - 2.4.1 Extracting vector format geospatial data from basemaps [5]
 - 2.4.2 Collecting data in the field (the present document)
 - 2.5 Cleaning, validating, and documenting the data
 - 2.5.1 Documenting the data using a metadata profile [6]
 - 2.5.2 Using advanced Microsoft Excel functions [7]
 - 2.6 Distributing, using, and updating the data
 - 2.6.1 Creating good thematic maps using desktop GIS software [8]
 - 2.6.2 Using thematic maps for decision making [9]
 - 2.6.3 Developing and implementing the appropriate data policy [10]

This guidance is a living document made to evolve based on the inputs received from the users. Please don't hesitate to [contact us](#) if you have any suggestions for improvement.

The terms used in the present guidance are defined in the following glossary of terms maintained by the Health GeoLab: <https://bit.ly/3ctoHiS>

Please also contact us using the same email address should you use this document as part of your activities and would like to have your institution recognized as one of the document's users.

¹ <https://www.un.org/sustainabledevelopment/health/>

2. Introduction

Filling geospatial data gaps identified after having collected all the existing data [4] can be done in two ways, depending on the data in question and the availability of resources:

1. Extracting data from other sources (e.g. remote sensing images, paper maps);
2. Collecting the data in the field.

The present volume of the HGL guidance document focuses on the latter. Volume 2.4.1 focuses on the former [5].

Collecting data in the field can be very time consuming and costly. Having the necessary elements in place before, during, and after any data collection exercise is key to ensuring not only cost effective use of available resources but also the generation of data that correspond to the initial objectives and expected outcomes [2] as well as the pre-defined specifications and ground reference [3]. In other words, the collection of geospatial data in the field is an important step in the overall geospatial data management cycle [1].

There are two main types of data collection exercise relevant to the geography of public health:

1. Surveys for which the main purpose is the collection of health-related data and/or information at different levels of disaggregation (e.g. household, health facility, village, administrative division). This kind of exercise requires the data to be contextualized by geography and time to ensure its proper use in a Geographic Information System (GIS).
2. Exercises aiming at collecting the geographic coordinates of a specific geographic object to which health data/information is attached. In Public Health, this kind of exercise mainly concerns mobile or fixed-point type geographic objects [2] and requires the use of a GNSS-enabled device.

It is nevertheless important to note that in some cases, the absence of a geographic location for the geographic object being surveyed might require the survey instrument to also contain a section for collecting this location. In public health, this would be principally for point type geographic objects (e.g. health facilities, households, villages). Collecting the topology (location, shape, and size) of other types of geographic objects represented by polygons or lines would generally either be done by a specialist from outside the health sector or extracted remotely from other sources [5].

The present document's objective is to describe the processes in more detail and provide recommendations on the procedures to be followed for the above situations.

While other guides have been developed previously [9-15], they commonly focus on one data collection instrument and/or method for collecting the geographic location of geographic objects represented by points.

The present guide has been developed based on these previous documents [9-15] with the objective to:

- be more generic and therefore applicable to a broad range of potential field data collection exercises.
- cover all the geographic information that should be collected during surveys independently from the level at which they are implemented.
- account for the main intended use of the data that is being collected, taking into consideration the available resources, scalability, accuracy.

- ensure the data complies with the defined specifications and ground reference [3].

Sample datasets for Bangladesh and the Philippines are used for illustration purposes only. All the methods presented here are intended to be used for any country.

3. Collecting the geographic and time dimensions in health surveys

As mentioned in the previous chapter, health related data/information collected in the context of surveys needs to be contextualized from both a geographic and time perspective to ensure their proper use in a GIS. By this, we mean that each piece of data/information being collected through the survey:

1. Relates to the geographic object it is attached to (e.g. person, patient, health facility, village, administrative division) [2] and the geography of this geographic object is known.
2. Has a specific time stamp attached to it.

The relation between the data/information and the corresponding geographic object is ensured by capturing the unique identifier (code) and name from the official master list directly in the survey instrument.

The form reported under point A1.1 in Annex 1 provides an example of such fields when the geographic object being surveyed is an infrastructure located in a particular administrative division. In this case, fields 1a. and 1b. make the link with the infrastructure master list (a health facility, for example) while fields 2c. to 2f. allow linking to the administrative division master list.

The geography of the geographic object itself is captured either through its geographic coordinates (latitude and longitude) in the case of point type geographic objects or its topology (location, shape and size) in the case of line or polygon type geographic objects [2].

In an ideal situation, the geography of all the geographic objects being surveyed should be captured prior to the survey implementation and stored in one of two ways, depending on the type of geographic object [2]:

1. for point type geographic objects: directly in the corresponding master list [3].
2. for line or polygon type geographic objects: in a GIS format layer whose attribute table matches the content the corresponding master list.

Two cases should be considered when the geography of the geographic object(s) to be surveyed is unknown:

1. Point type geographic objects:
 - a. When the necessary resources are available, the survey should collect the geographic coordinates of the geographic object(s) as per the information reported in the next section of the present guide.
 - b. When the necessary resources are not available, the link to the master list should still be made to attach the data/information to the corresponding geography at a later stage.
2. Line or polygon type geographic objects: The link to the master list should still be made using the unique ID and official name of each geographic object while waiting for its

topology to be available as producing these types of geographic objects is generally not under the mandate of the health sector and collecting such topology could be expensive.

The time stamp of the data is generally that of the survey implementation date. It might be that some questions in the survey refer to past events and the date of those past events should therefore be captured accordingly. Capturing the time dimension is also important from a geographic perspective, the geography may change over time. Each collected data or information needs to relate to the geography as it was observed at that time.

4. Collecting the geographic coordinates of point type geographic objects in the field

The following sections describe in detail the different steps that are recommended to be followed to collect the geographic coordinates (latitude and longitude) of point type geographic objects (e.g. household, village, health facility).

4.1 Determining the data collection technology and method

Different combinations of technologies and methods exist nowadays for collecting geographic coordinates in the field. These combinations do not necessarily ensure the same level of accuracy and some of them require more resources and time to be implemented and are therefore less scalable than others.

While not exhaustive, Table 1 presents twelve options covering a range of technologies and methods. The options leading to the lowest level of accuracy, comparatively speaking, are located on the left side of the table (highlighted in orange) and those leading to the highest level of accuracy are on the right (highlighted in dark green). These different options are discussed in more detail in later sections of this document.

The main criteria used to organize the different options presented in Table 1 are as follow:

- Scalability:
 - Cost (manpower, equipment and associated material). While varying from one country to another based on the cost of the equipment and the level of effort required to implement each option, including staff cost, the relative costs between options remain generally the same.
 - Complexity of the process to collect the coordinates.
- Accuracy:
 - Capability to obtain geographic coordinates with an accuracy of 15 m through two indicators: number of satellite signals received and direct instrumental accuracy measure.
 - Possibility to perform a check on the coordinates while still in the field.

When selecting an option from Table 1, it is important to remember that:

1. These options do consider that there is no pre-existing electronic system in place for data collection in the country. If such system is already in place, then using it might be more scalable than implementing a new one.
2. The use of an electronic form, with predefined content when applicable, can considerably reduce data collection time as well as data entry errors. The use of such a form should therefore be preferred over paper ones. Please refer to section 4.2.1 for more information in this regard.
3. The higher the accuracy of the collected coordinates, the larger the number of potential uses of the collected geographic coordinates due to the direct relation that exists between accuracy and geographic scale [3]. It is therefore recommended to always aim at reaching the highest accuracy level possible.
4. Collecting geographic coordinates through the unique use of offline map applications (options 1 to 3) requires data collectors to know how to navigate on a map and be able to identify the location where they are and the geography of the area from an above/aerial view. This method can also be applied remotely with the help of people knowledgeable about the area being covered [5]. It is recommended to use both this method and the minimum/maximum expected coordinates described in Section 4.2.8

| <div>Needs</div> <div>Scalability</div> | Main data use: visualization | Main data use: Geographic component of a point type registry, visualization, spatial analysis and spatial modeling | | |
|---|---|---|---|---|
| | Accuracy: low to moderate | Accuracy: moderate to high | Accuracy: high | |
| High | 1. Paper form + device without GNSS + offline map application | | | |
| Moderate to low | 2. Paper form + device without GNSS + offline map application + min/max lat/long annex | 4. Paper form + GNSS enabled device with accuracy indicators | 7. Paper form + GNSS enabled device with accuracy indicators + min/max lat/long annex or offline map application | 10. Paper form + GNSS enabled device with accuracy indicators + min/max lat/long annex + offline map application |
| | 3. Electronic form (table) + device without GNSS + offline map application + min/max lat/long annex | 5. Electronic form (table) + GNSS enabled device with accuracy indicators | 8. Electronic form (table)+ GNSS enabled device with accuracy indicators + min/max lat/long annex or offline map application | 11. Electronic form (table) + GNSS enabled device with accuracy indicators + min/max lat/long annex + offline map application |
| Low | | 6. Data collection application integrated in the GNSS enabled device with accuracy indicators | 9. Data collection application integrated in the GNSS enabled device with accuracy indicators + min/max lat/long annex or offline map application | 12. Data collection application integrated in the GNSS enabled device with accuracy indicators + min/max lat/long annex + offline map application |

Table 1 - Set of options for collecting geographic coordinates of a point type geographic object in the field

It is also important to mention that options 1 to 12:

- Can be implemented without the use of internet in the field. Access to internet might nevertheless be required prior to going in the field to install applications and/or offline maps.
- Include the ability to verify the level of accuracy of the geographic coordinates being collected when using GNSS-enabled devices. Approaches that do not allow for verification of accuracy have not been considered because these lead to important reading errors that cannot be documented.

4.2 Elements needed to implement the different options

A certain set of elements is necessary for the implementation of the options reported in Table 1.

The following are required for all the options:

- **Data collection form:** set of fields used to capture the geographic component of the survey. This may be paper or electronic.
- **A Standard Operating Procedure (SOP):** a document describing the steps to be followed by the data collector to implement the selected option in the field.

In addition to the above, HGL highly recommends that any data collection exercise be based on the use of a Unique, authoritative, officially curated by the mandated agency, complete, up-to-date and uniquely coded list of all the active records (**master lists**) for the:

- **Geographic object:** generally, an infrastructure (e.g. health facility, school, household).
- **Administrative divisions:** for the country, or part of the country in which the geographic objects in question are located.

The following elements are only required for some of the options:

- **Administrative boundaries geospatial data:** GIS format data containing the boundaries of the administrative divisions down to the lowest level of disaggregation possible and matching the administrative division master list.²
- **Geographic Information System (GIS) software:** computer software to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.
- **GNSS-enabled device:** a handheld device that allows access to at least one of the Global Navigation Satellite Systems (e.g. GPS, GLONASS) to provide location and time information anywhere on or near the Earth.
- **Offline map application:** an application that can be used to identify the geographic coordinates of a place from an offline map. This type of application is especially useful when the device being used does not have GNSS capability.
- **Maximum-Minimum expected coordinates:** a document containing the minimum and maximum expected coordinates (latitude and longitude) for each administrative division being covered by the data collection exercise.
- **Purpose-designed data collection application:** an application that allows the creation of an electronic version of the survey form as well as the collection of the data in the field.

The following sections provide guidance and/or recommendations about the elements listed above.

² Although the guidance and recommendations provided here assume that sub national administrative units will be used during a field survey, the same process can be applied using other units of division.

While mostly reported in the same order as the bullet points presented above, the Standard Operating Procedures (SOP) are described last, as the content of these SOPs depends largely on the other elements.

4.2.1 Data collection form

The proper collection of the geographic coordinates attached to a particular geographic object requires the use of a specific set of fields that should include:

1. The official name and unique identifier (code) of the geographic object in question taken from an official master list.
2. The address and location of the geographic object expressed as the official name and unique identifier code of the administrative division in which the geographic object is located.
3. The geographic coordinates of the geographic objects as well as the fields used for assessment of the quality of these coordinates.

The above-mentioned fields should be captured in a specific data collection form. When data collection takes place as part of a health survey (See Chapter 3), it is recommended that the fields in question are included in the survey instrument.

If this is not possible, the use of a separate form for collecting this information requires a specific code, generally the unique identifier of the geographic object taken from the master list, to be recorded on both forms to be able to link them together. The date of data collection should also be collected on both forms as it may vary in some cases. This method requires more effort to process the data while also increasing the risk of losing data.

The content of the data collection form will vary based on the option that is being implemented (Table 1). Generic versions of the different forms recommended for each option are provided in Annex 1.

While the first two sections of the data collection form (name and code of the geographic object as per the master list, address and location of the geographic object) remain the same across all options, the third section (geographic coordinates of the geographic object) varies to account for the different approaches used to collect the geographic coordinates of the geographic object.

When using options 3, 5, 8 or 11 (Table 1), the forms in question can be converted into tables, stored in excel format for example. Such a table should contain all the fields reported in the corresponding form and could be pre-filled with the information for sections 1 and 2 (Name, code, address and location of the geographic object) when this information is available. As an example, Annex 14 illustrates the structure that the table in question should present when implementing option 11 with the A1.3 form (Annex 1).

Using the table approach on paper is also possible but the major limitation is the difficulty of keeping all the fields from the form on a single page while leaving enough space for the data collector to write the information into it.

This approach should therefore be limited to situations where the data collectors do neither have to collect nor correct the information reported in sections 1 and 2 of the form. An example of such simplified form is reported in Annex 2 and corresponds to the implementation of option 10 with form A1.3.

When looking at Annex 2, please note that:

- While the codes attached to the administrative divisions are not included to gain place, the code for the geographic object from the master list (Annex 5) remains (Working_place_code field).
- Some of the fields from section 3 of the form have been placed in the header of the form.
- The information for all the original fields will have to be captured during data entry to obtain a final table matching the structure such as the one presented in Annex 14.

Before using one of the data collection forms, it needs to be customized to account for:

1. The geographic object being surveyed and the associated coding scheme, which is based on the corresponding master list (see Sections 4.2.2).
2. The administrative structure of the country or area in which data will be collected and the official administrative coding scheme found in the corresponding master list (see Sections 4.2.2). Note that there are different administrative division coding schemes. Some coding schemes are hierarchical in nature, meaning that the code for higher level units is included in the code of the lower levels (see example in Annex 4). In this case, only the code for the lowest level administrative unit needs to be recorded. Other coding schemes have entirely separate codes for administrative units at different levels and, in this case, the whole code for each level should be captured in separate fields in the form. In both cases, the complete code should be captured as this is often what ensures its uniqueness.

An example of a customized data collection form is provided in Annex 3. This example corresponds to conducting a paper-based data collection in Bangladesh at the point location level of selected study sites with the use of a GNSS-enabled device with accuracy indicators but without the use of an offline map application or min/max lat/long annex (options 4 in Table 1).

4.2.2 Administrative divisions and other geographic object master lists

A master list can be defined as unique, authoritative, officially curated by the mandated agency, complete, up-to-date and uniquely coded list of all the active (and past active) records for a given type of geographic feature/object (e.g. health facilities, administrative divisions, villages) [2].

Two master lists are needed to properly collect the geographic coordinates of a given point type geographic object:

1. The first one covers the administrative divisions observed in the country or area covered by the data collection exercise.
2. The second one covers all the geographic objects (e.g. health facility, school, household) for which geographic coordinates are needed.

The following sections describe the structure and content of these master lists, as well as suggested sources for obtaining them.

Administrative divisions master list

An official master list of administrative divisions for the country or area to be covered during data collection is required to:

- Facilitate the work of the data collectors in the field.
- Form part of the content of the geographic object specific master list (see Section 4.2.2).
- Select the appropriate GIS boundary geospatial data (see Section 4.2.3).
- Create the minimum/maximum expected coordinates document (see Section 4.2.7).

- Verify the quality of the geographic coordinates collected in the field (see Section 4.2.9).

Administrative division master lists are typically maintained by the National Bureau of Statistics, the National Mapping Agency, or the Ministry of Interior for a given country.

When requesting access to an administrative division master list from a governmental entity, it is important to:

- Access the lowest level of aggregation available even if this means going below the level at which the data is being collected. In some cases, this may help with the creation of the appropriate administrative boundaries geospatial data (see Section 4.2.3).
- Request that the master list is shared in a Microsoft Excel or .csv format file format with a structure similar to that presented in Annex 4. Accessing the data in this format will reduce the amount of processing required to use the information before and during the survey.

For example:

- In Bangladesh, a master list provided at the Union/Ward level is freely accessible from the Bangladesh Bureau of Statistics (BBS). The official codes and names of the Zila and Upazila for Chittagong Division (division covered by the example survey) have been manually extracted and organized to generate the content of the example found in Annex 4.
- In the Philippines, the Philippines Statistical Authority (PSA) has the mandate of the Philippine Standard Geographic Code (PSGC), which is the official master list of administrative divisions in the country. The master list is updated quarterly and freely accessible from the following web page in Excel format: <https://psa.gov.ph/classification/psgc>. The file provided by PSA is structured differently than the one presented in Annex 4. Some adjustments would therefore be necessary to obtain the desired structure.

Other geographic objects Master list

As with administrative divisions, it is important to have access to a master list of the point type geographic objects (e.g. health facility, household, village) for which the geographic coordinates need to be collected [2].

When applicable, the master list should at least include the following information for each of the records it contains:

- Official unique identifier (ID) for the point type geographic object.
- Official name for the point type geographic object.
- Official name and unique identifier for the administrative division in which the geographic object is located at the lowest level of geographic disaggregation available.

These master lists should be obtained from the official agency in charge of developing, maintaining, and sharing them. This would be, for example, the Ministry of Health for health facilities, the Ministry of Education for schools, or the National Statistical Authority for villages or households.

In some cases, the master list already contains the geographic coordinates for the geographic objects. Accessing and using a master list that includes this information may therefore help in reducing the scope and level of effort required during data collection while also avoiding duplication of work [4]. However, it is important to note that the accuracy of the existing coordinates should be verified before they are used.

The master lists are also sometime being shared through an IT solution that stores, manages and shares the list. Such IT solution is referred to as a registry. For example, the National Health Facility Registry maintained by the Philippines' Department of Health (DOH) give a free access to the master list of health facilities in the country through the following online portal: <https://nhfr.doh.gov.ph/Home>. Geographic coordinates are also available upon request to the DOH. The method used to collect these coordinates as well as their expected accuracy level is also captured in the master list.

If a master list is not available, not accessible, or if the minimum information listed above is missing, it might be necessary to collect this information prior to the data collection exercise, through a consultation with the concerned official parties, and to organize it in the form of a temporary list. In cases where even this is not possible, a template data collection form with fields to be collected and a format for temporary codes should be prepared in advance.

This also applies to data collection exercises aimed at locating sites which, by their nature, cannot be listed before going into the field. Such exercise would, for example, include the identification of the presence of certain disease vectors (e.g. mosquitoes) or mapping of villages for which no master list exists.

Sometimes the master lists required for data collection will be accessed from sources other than government entities such as a research team responsible for study sites that will be surveyed; this is the case for the example presented in Annex 5. In this example, the geographic objects are research study sites in Chittagong Division, Bangladesh. Composed of different types of geographic object sites (health facilities, offices, and hospitals), the list for these site locations did not come from a government agency but rather from the research team responsible for the study. Therefore, the unique identifier code reported in Annex 5 does not correspond to an official code but a temporary code created for the purpose of the field survey. The administrative division names and codes used in Annex 5 are nevertheless the official ones from the corresponding master list (Annex 4). This helps the data collector to correctly identify the administrative division in which each study site is located.

4.2.3 Administrative boundaries geospatial data

Before data collection, the boundaries of the administrative divisions captured in a GIS format are needed to create the minimum/maximum coordinates document discussed in Section 4.2.7. This document is used when implementing Options 7 to 12 from Table 1.

After data collection, the same boundaries are needed to:

1. Check the accuracy of the geographic coordinates that have been collected.
2. Display aggregate health data by sub national unit.

The geospatial data containing the administrative boundaries should:

- Contain the boundaries of all the administrative divisions reported in the master list (see Section 4.2.2).
- Include an attribute table that matches the content of the master list in terms of official names and codes of the administrative divisions down to the lowest level of disaggregation. This information should be captured in separate columns as presented in Annex 4 to allow for the inclusion of the different levels in the administrative structure.

- Present a correct link between each record in the attribute table and the corresponding polygon on the map.

Although the above will ensure the completeness, uniqueness, timeliness, and consistency of the administrative boundaries geospatial data, it will not necessarily ensure its accuracy which depends on the scale at which the boundaries data has been created and on the method that was used [3].

In other terms, an administrative boundaries dataset that has been created at a medium (1:750,000 to 1:2,000,000) or even small scale (1:2,000,000 and above) will show important positional inaccuracy which could result in collected geographic coordinates falling outside the administrative boundaries of the division in which the geographic object is located.

This is one of the reasons why it is important to ask for the metadata associated with administrative boundaries geospatial data when collecting it. The metadata should at least contain [3]:

- The date when the data was created. This might help in identifying potential differences between the layer and the administrative division master list.
- The projection/coordinate system applied to the data. This is required to use the data effectively and combine it with other geospatial data.
- The scale at which the data was created. This will indicate the accuracy level of the data (see description above).
- Restrictions on the use or sharing of the data to avoid any problem when using or sharing the data.
- The contact information of the person to be contacted in case of any issues or questions related to the data.

The administrative boundaries layer should be obtained from the official agency in charge of developing, maintaining, and sharing this data [4]. This is generally the National Mapping Agency or the National Statistical Authority but this can in some cases also be the Ministry of Interior. It is important to note the agency in charge of the boundary layer is often different from the one in charge of the administrative division master list (see Section 4.2.2).

4.2.4 GIS software

A Geographic Information System (GIS) is an integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.³

For the purposes of this document, it is recommended that each user selects the GIS software that will most appropriately meet their data collection and use needs.

To implement options 1 to 12 presented in Table 1, GIS software needs to be able to:

- Display vector format layers (polygons and points).
- Join an Excel file and the attribute table of the map data uploaded in the software.
- Calculate the minimum and maximum latitudes and longitudes of a set of polygons.

The following sections present two GIS software options that are most commonly used, both of which are equally capable in fulfilling the requirements noted above.

³ <https://support.esri.com/en-us/gis-dictionary>

The Esri ArcGIS Platform

ArcGIS platform can be used for both mapping and analyzing geospatial data that is collected. The GIS tools provided by this platform range from thematic mapping and geospatial data editing to spatial analysis, modeling, and visualization. Additionally, the platform also allows for easily sharing and collaborating on the information created within the platform.

This platform can be useful primarily in three different workflows in the survey operations.

- Data Collection.
- Data Management and Modelling.
- Data Visualization.

For Data Collection, ArcGIS offers two mobile applications (Collector for ArcGIS and Survey123 for ArcGIS) that can also be used in combination to tackle some of the data collection requirements.

- Tile Package Kreator⁴ is a desktop utility designed to help quickly create Tile Package files. Tile Package files are used with out-of-the-box mobile apps like Survey123 for ArcGIS and Collector for ArcGIS to take basemaps offline. This application can be used to create the local basemaps of the region under consideration and loaded into the data collection apps for offline use.
- Collector for ArcGIS is a map-centric approach of data collection. This application is particularly useful in capturing not just point, but line and polygon health geographic objects identified during field data collection that are not part of the master list of the health geographic objects being surveyed.⁵
- Survey123 for ArcGIS is a form-centric approach of data collection. This application has smart form capability that implements logic and relevance to questions in the survey. This will enable the user to answer only the relevant questions to the input scenario. Survey123 has the capability to store locally a list of the max and min values for the coordinate ranges and can additionally implement constraints on them while collecting the survey points. Moreover, the application provides the capability to do front-end data validation and provides the option to pre-define choices to answers (dropdown and cascade options) that will reduce manual data-entry issues.⁶ Survey123 has the additional capability to average coordinates and perform coordinate transformations during data collection.⁷

Both above mobile applications are available for Windows, Mac, iOS, and Android devices, allow for media attachments, and can work in a disconnected environment which is very relevant to our data collection workflows.^{8,9} Collector and Survey123 have the capability to read coordinates from a GNSS receiver connected to the device containing the apps. Additionally, the two applications can be used in combination in scenarios where dynamic data needs to be preloaded into the survey, e.g., additional study sites/health geographic objects added every day to the list that needs to be surveyed the next day.

⁴ <https://www.esri.com/arcgis-blog/products/apps/data-management/introducing-tile-package-kreator-esri-labs/>

⁵ <http://www.esri.com/products/collector-for-arcgis>

⁶ <https://survey123.arcgis.com/>

⁷ <http://doc.arcgis.com/en/survey123/desktop/create-surveys/geopoints.htm>

⁸ <https://doc.arcgis.com/en/collector/windows/create-maps/offline-map-prep.htm>

⁹ <https://doc.arcgis.com/en/survey123/desktop/create-surveys/preparebasemaps.htm>

For Data Management and modelling, ArcGIS offers desktop and web-based configurable software applications that can perform lightweight to heavy geospatial analytics.

- ArcGIS Desktop and ArcGIS Pro provide simple to complex geoprocessing toolsets that can be used to clean, model, and aggregate survey information.¹⁰
- Insights for ArcGIS is a tool that can be used for data exploration and analysis and this will help the team in data-driven planning and decisions.¹¹
- Web AppBuilder for ArcGIS offers a variety of web-based templates and widgets that can be easily configured for mission-focused editing, review and approval workflows. The developer version of the application also allows for use of custom code/widgets.¹²

For Data Visualization, ArcGIS software provides the capability to do interactive and high quality cartographic maps and apps that can easily be shared with the organization.

- Webmaps are instrumental in visualizing spatial data and spotting spatial patterns. There are also multiple options provided by the software to render the data dynamically. (point map, heat map, thematic map, etc.)
- Operations Dashboard for ArcGIS can be used to visualize near real-time survey which is useful from an operational perspective, to measure the key performance indicators associated with data collection to make quick operational decisions.¹³
- Story Maps is an application template that can be used as a briefing tool for both internal and public briefings. This template allows for content from multiple sources to be summarized within one webpage.¹⁴

While ArcGIS is the more costly of the two options presented in this document, it provides access to the most extensive set of specialized tools currently available in GIS Technology and provides support to address a more holistic approach to the geospatial data collection, management and visualization process. Esri's ArcGIS Platform also has the biggest user community for support and to find answers. More information about ArcGIS can be found on Esri's web site.¹⁵

QGIS

QGIS (formerly known as Quantum GIS) is the leading open-source desktop GIS software. Developed by a group of volunteers and available for free, QGIS provides data viewing, editing and analysis capabilities. While not as extensive as ArcGIS for Desktop's library of tools, QGIS also comes with a large panel of tools and an extensive and growing community of users.

More information about QGIS can be found on the QGIS project web site and the version referenced in this document is QGIS 2.16 (Nødebo).¹⁶

4.2.5 GNSS-enabled device

¹⁰ <https://pro.arcgis.com/en/pro-app/>

¹¹ <https://www.esri.com/en-us/arcgis/products/insights-for-arcgis/overview>

¹² <https://doc.arcgis.com/en/web-appbuilder/>

¹³ <https://doc.arcgis.com/en/operations-dashboard/>

¹⁴ <https://storymaps.arcgis.com/en/>

¹⁵ <https://www.esri.com/en-us/home>

¹⁶ <http://www.qgis.org/en/site/>

Today, a large number of devices contain a receiver/antenna to connect to a Global Navigation Satellite System (GNSS) and use this to collect geographic coordinates.

There are three major types of GNSS-based devices:

1. Dedicated navigation devices.
2. Mobile phones and tablets with built-in GNSS receivers.
3. GNSS devices that require connection to a computer to work.

It is important to choose the type of device that will fulfill the original needs for collecting geographic coordinates.

Several factors will influence this choice. While the most obvious consideration is cost, other factors, such as the availability of devices and the environment in which the data collection exercise takes place, should also be taken into account.

The minimum specifications that are required to collect GNSS coordinates that comply with commonly accepted best practices are that the device:

1. Allows for setting the following specifications:
 - a. Position format: hddd.ddddd
 - b. Map datum: WGS84
 - c. Map Spheroid: WGS84
 - d. Distance and speed: metric
2. Provides coordinate readings with at least 5 decimal digits to reach a level of precision down to the nearest meter.
3. Displays the following information together with the reading:
 - a. Number of received satellite signals
 - b. Accuracy measure

For specifications 2 and 3, when taking a coordinate reading it is recommended that there is a minimum of 4 satellite signals and the accuracy measure is lower than 15 meters.

It is important to note that:

- Devices accessing the satellite signals from the GLObal NAVigation Satellite System (GLONASS)¹⁷, the Galileo¹⁸, BeiDou (BDS)¹⁹ and/or the Quasi-Zenith Satellite System (QZSS)²⁰ in addition to the GPS signals, will provide a better satellite coverage and therefore achieve higher accuracy.
- Devices that include a map or satellite image view that also displays the GNSS coordinates that have been collected can be useful for verifying data accuracy as it is being collected.
- Mobile phones/tablets with built-in GNSS receivers will require the use of an appropriate application that will also meet the above mentioned specifications in terms of settings, precision level, and associated information.
- Mobile phones/ tablets that have Bluetooth capability will be beneficial as modern GNSS devices are Bluetooth connectable. Once external GNSS devices are connected to the device, any application in the device will now be able to read the coordinates with higher accuracy from the GNSS receiver.
- When data will be downloaded directly from a device to a computer, the unique identifiers from the master list must also be included in each record of coordinates entered on the

¹⁷ <https://en.wikipedia.org/wiki/GLONASS>

¹⁸ [https://en.wikipedia.org/wiki/Galileo_\(satellite_navigation\)](https://en.wikipedia.org/wiki/Galileo_(satellite_navigation))

¹⁹ <https://en.wikipedia.org/wiki/BeiDou>

²⁰ https://en.wikipedia.org/wiki/Quasi-Zenith_Satellite_System

device. This information is required to match the coordinate from the device with the other information collected in the field. The data can be quickly downloaded from the device using a software (e.g. DNRGPS) or using a plug-in from QGIS which will also allows immediate visualization of the points.

- The use of an electronic form that is directly integrated into a GNSS-enabled device (options 6, 9 and 12 in Table 1) also requires an additional application to use the form and sometimes automatically collect the geographic coordinates and associated information (See Section 4.2.8). This automated data capture is recommended where possible to avoid transcribing errors.

The following sections provide an example of setting up two types of GNSS-enabled devices to fulfill the specifications listed above, although there are also other appropriate devices available:

- The Garmin eTrex GPS device series (10, 20, 20x, 30 or 30x)
- Android-based devices with a built-in GNSS receiver and the free GPS Essentials application

Garmin eTrex GPS device series (10, 20, 20x, 30 or 30x)

The Garmin eTrex GPS device is available in different models with different geographic objects (Main ones reported in Table 2). The price of each model depends on the number of geographic objects. The cheapest model is the eTrex 10. Despite their names, all these devices can access both the GPS and GLONASS navigation systems.

While the eTrex 10 model is sufficient to implement options 4, 5 as well as options 7 and 8 when choosing to use the min/max lat/long annex (Table 1), the eTrex 20 or 30 model is required to implement options 10 and 11. These devices can't be used for options 6, 9 and 12 as they do not allow for the storage and use of an electronic form.

Annex 5 provides a short user manual containing the basic information required to operate these devices. The full user manual can be downloaded here:

http://static.garmincdn.com/pumac/eTrex_10-20-30_OM_EN.pdf.

The recommended SOP to use these devices in the field using each applicable option is provided in Section 4.2.9.

| |  |  |  |  |  |
|---------------------|---|---|---|--|---|
| Model | eTrex 10 | eTrex 20 | eTrex 20x | eTrex 30 | eTrex 30x |
| Display | Gray scale | Color | Color | Color | Color |
| Ability to add maps | - | Yes | Yes | Yes | Yes |
| Built-in memory | - | 1.7 GB | 3.6 GB (316 MB free*) | 1.7 GB | 3.6 GB (316 MB free*) |
| Slot for µSD card | - | Yes | Yes | Yes | Yes |

Table 2– Features of the different Garmin eTrex models (* 3.3 GB are occupied by the pre-installed maps).

Android-based devices with a built-in GNSS receiver and the GPS Essentials application

Android-based devices with a built-in GNSS receiver can also be used to collect geographic coordinates and the same factors as for a dedicated GPS device will influence the selection of an appropriate device for field data collection.

The GPS Essentials application is available for free and complies with the specifications listed in Section 4.2.5. It can be downloaded from the Google Play Store for Android-based devices²¹. This document references the use of Version 4.4.11.

The following minimum device specifications are required to use the GPS Essentials application:

1. At least Android 4.0
2. More than 512 Mb of RAM
3. As for standalone GNSS-enabled devices, Android devices containing newer GNSS chipsets with GLONASS support will acquire the signals required to obtain the desired level of accuracy more quickly.

More information about the GPS Essentials application and the user manual can be downloaded from: <http://www.gpsessentials.com/>

GPS Essentials contains several modules but only two of them are necessary for collecting GNSS-based coordinates following the Standard Operating Procedures presented in this document (Section 4.2.9):

1. Settings
2. Satellites.

The portable map module in GPS Essentials was discontinued in July 2016. Other offline mapping applications are therefore presented in the following section to fulfill the requirements of implementing options 7 to 12 (Table 1).

These GNSS-enabled devices must also be tested first before being used for field data collection to ensure that their GNSS receivers are functioning properly. The steps to be followed to test the GNSS receivers of these devices are presented in Annex 15.

4.2.6 Offline mapping applications

Certain offline mapping applications are able to collect geographic coordinates even when the device does not have a GNSS receiver. However, it is still required (options 7 to 12) that the device can connect to the internet prior to conducting the survey so that the map that will be used in the field can be downloaded to the device.

Of the applications that allow users to download data to the device, there are two major differences:

1. Applications that are based on vector based datasets, such as Collector for ArcGIS²² and OpenStreetMap. The Maps.Me application²³ is an example of this type of application.
2. Applications that also give access to satellite images behind the vector based dataset. Collector for ArcGIS and Survey123 for ArcGIS²⁴ provide the capability to change the

²¹ Some developers have created an APK to use GPS essentials on Windows Phone as well. This APK is accessible for download from: http://windowsphoneapk.com/APK_GPS-Essentials_Windows-Phone.html

²² <https://doc.arcgis.com/en/collector/windows/create-maps/offline-map-prep.htm>

²³ <http://maps.me/en/home>

basemap to imagery or any other internally-sourced imagery basemaps. Google Maps²⁵ is also an example of this type of application.

The main advantage of the first type of application is that the vector data format uses less storage space than what is used to store satellite images. The disadvantage is that the available dataset may be incomplete and/or out-of-date for the area covered by the data collection exercise especially in remote areas. This can however be solved if the application can cache the most recent vector datasets available for the region under consideration. The surveyor can do this while connectivity exists, right before the survey data collection takes place. The application also would need to have a sync-up capability once connectivity is established. This application is therefore more recommended for data collection exercises taking place in urban areas.

By providing direct access to satellite images, the second type of application tends to provide a more complete and sometimes up-to-date picture of the situation on the ground, especially outside of big cities. However, the higher level of detail, while not as clear as the original image, results in the need for more storage space on the device. An additional limitation is that the satellite data is only currently available for download for some countries. For these countries, it may be possible to store the satellite images temporarily in the cache of a mobile device but this is not reliable as images are only stored for a particular level of zoom and the cache may be unintentionally cleared with loss of the prior to data collection.

Before implementing options 6 to 12 (Table 1), it will be necessary to determine which type of offline map data will provide the most appropriate background dataset over the area being surveyed and which type of application will be most appropriate for use during data collection. Depending on the area and the type of device being used, a good approach may be to have both types of offline mapping applications together with the respective data installed on the device so that both types of offline map data are available.

Once this choice is made, the map in question can be stored on the device using one of the processes described in Annex 7.

The process to be followed to collect geographic coordinates on these offline maps is described in the corresponding Standard Operating Procedure (see Section 4.2.9).

4.2.7 Minimum/maximum expected coordinates

A simple way to ensure that the geographic coordinates have been collected correctly while still in the field is to check if the resulting points are in the correct place on a base map (remote sensing images or vector layers).

While some GNSS-enabled devices allow this, many do not include this feature. For those that do:

- The map in the device may not be sufficiently detailed or complete for this to be useful. In these cases, it is sometime possible to upload a more detailed map into the device memory. Please see the instructions for the device for how to do this;
- The data collector might not have enough knowledge of the geography in the area to confirm the location.

²⁴ <https://doc.arcgis.com/en/survey123/desktop/create-surveys/preparebasemaps.htm>

²⁵ <https://maps.google.com/>

Another cost-effective approach is to ensure that the collected coordinates fall between the minimum (Min) and maximum (Max) latitude and longitude of the administrative division in which the geographic object is located (Figure 1).

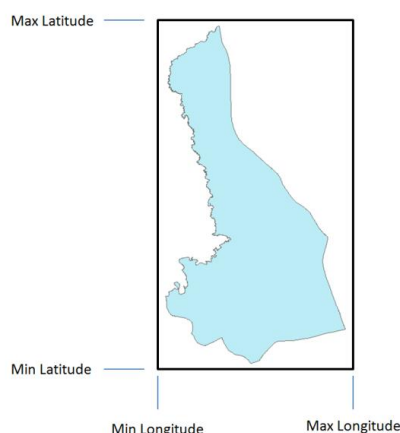


Figure 1 - Minimum (Min) and maximum (Max) latitude and longitude for a given administrative division.

Even if the Min/Max latitude and longitude coordinate box extends beyond the real boundaries of the administrative division the collected coordinates for a given point should fall within the Min/Max values. This verification practice has been used for several surveys and has shown a great improvement in the quality of the coordinates collected, especially when data collectors are not necessarily proficient in the use of GNSS-enabled devices.

A specific document containing the Min/ Max coordinates should therefore be prepared before the data collection exercise and given to the data collectors in order for them to perform this check while collecting coordinate data in the field.

Annex 8 describes the method for defining Min/Max coordinates using ArcGIS for Desktop or QGIS and an example of a completed table with Min/Max coordinates is shown in Annex 9.

While it is tempting to apply Annex 8 using geospatial data containing the boundaries of the lowest administrative level possible, it is important to remember that:

- It is more difficult to find a complete and up-to-date GIS dataset that matches the administrative division master list for lower administrative levels as boundaries tend to change more often further down the administrative structure.
- GIS data that are available for administrative boundaries are usually not as accurate as GNSS-based readings. Choosing the lowest sub national level may therefore result in accurate GNSS-based coordinates falling outside the corresponding administrative division on the map.

The challenge here is to find the best compromise possible between correctness, completeness, and accuracy.

While there is no absolute rule, experience has shown that the most appropriate administrative level to be used is the one for which the mean area among the administrative divisions is in the hundreds of km² range (between 100 and 999). The reasons behind this criterion are that:

- If the coordinates have been collected correctly, the point is most likely to fall within the correct administrative division despite potential accuracy issues in the administrative boundaries layer.
- If there are errors in the GNSS-enabled device settings or during data collection, the point is likely to fall outside the administrative division.

Table 3 illustrates how the appropriate level was chosen for Bangladesh and the Philippines based on the above.

| Administrative Level | Type of division at that level | | Mean division area at that level (km ²) | |
|----------------------|--------------------------------|--------------|---|-------------|
| | Bangladesh | Philippines | Bangladesh | Philippines |
| 1 | Division | Region | 17,504 | 17,300 |
| 2 | District | Province | 2,188 | 3,380 |
| 3 | Upazila | Municipality | 265 | 178 |
| 4 | Union | Barangay | 26 | 7 |

Table 3 - Mean area of the administrative divisions for different levels in Bangladesh and the Philippines.

As in Table 3, the third level appears to be the most appropriate level for these countries to create the minimum/maximum expected coordinates table and to verify the accuracy of the collected geographic coordinates during and after the survey (see Sections 5.2 and 5.3).

4.2.8 Purpose-designed data collection application

Whenever data are copied from paper documents to electronic formats, it is essential to implement standard methods that will minimize transcription errors. This is particularly important when copying GNSS-based coordinates from a GNSS-enabled device to a paper form and copying from paper to a spreadsheet or database.

The risk of transcription errors can be reduced by minimizing the use of paper wherever possible. This either requires use of electronic form (see Section 4.2.1) or of a purpose-designed data collection application to enter data in the field and automatically generate spreadsheets similar to the one presented in Annex 14.

Like for the electronic form, another advantage of such application is that part of the information to be entered can be standardized through the use of drop down menus. This mainly concerns the information reported in sections 1 and 2 of the forms (Annex 1).

Several purpose-designed data applications exist and can be used depending on the content of the questionnaire and the device configuration chosen for the survey. One example is GeoODK²⁶, which is an advanced version of the OpenDataKit (ODK)²⁷.

GeoODK is a free application that not only allows building data collection forms or surveys, collecting the data on a mobile device, aggregating it on a server, and extracting it in a useable

²⁶ <http://geoodk.com/index.php>

²⁷ <https://opendatakit.org/>

format, but also collecting and storing geographic coordinates with an accuracy measure using the GNSS receiver of the device, if any, or an offline map based on OpenStreetMap. However, the native form of the application does not allow for the form to automatically capture the number of satellite signals during the reading or automatically perform a check to ensure that the resulting coordinates are within the limits of the min/max lat/long annex. These would have to be programmed separately.

Survey123 for ArcGIS from the ArcGIS Platform will also not be able to grab metadata from the GNSS receiver but it will be able to constrain the GNSS captured coordinates within the min/max lat/long annex, provided the survey is published with this data for the particular jurisdiction. This can be implemented by utilizing the pulldata functionality available in the off-the-shelf capability of the application²⁸.

4.2.9 Standard Operating Procedure (SOP)

Despite the training received prior to the survey (see Section 5.1), providing data collectors with a checklist of the steps for the entire data collection and verification process is critical to effectively collect the geographic coordinates of a specific geographic object in the field. The description of these steps is documented in a Standard Operating Procedures (SOP).

To ensure that it is appropriate for use in the field, the SOP should focus on providing only the essential information, be as clear and simple as possible, cover all the fields in the form, and include illustrations that will help the data collector complete each step. Therefore, an SOP for Options 1 – 12 (Table 1) will be unique to the specific data collection and verification requirements of each option. Such an SOP might also need to be adjusted for the specific device being used.

Given the overlap of requirements among the options, the SOP for some options will be a subset of the steps found in other options. More specifically:

- Option 1 using Google Maps or Maps.Me: Annex 10 without steps 3.6
- Option 2 and 3 using Google Maps or Maps.Me: Annex 10
- Option 4 and 5:
 - Garmin eTrex device: Annex 11 without steps 3.17 to 3.19
 - GNSS-enabled Android device with GPS Essentials: Annex 12 without steps 3.7 to 3.10
- Option 6 using a GNSS-enabled Android device with GPS Essentials: Annex 12 without steps 3.7 to 3.10 integrated in a data collection application
- Options 7 and 8:
 - Garmin eTrex device: Annex 11 without steps 3.17 or steps 3.18 to 3.19
 - GNSS-enabled Android device with GPS Essentials, Google Maps or Maps.Me: Annex 12 without steps 3.7 or steps 3.8 to 3.10
- Option 9 using a GNSS-enabled Android device with GPS Essentials: Annex 12 without steps 3.7 or steps 3.8 to 3.10 integrated into a data collection application or Annex 13 for Survey123
- Options 10 and 11:
 - Garmin eTrex device: Annex 11
 - GNSS-enabled Android device with GPS Essentials: Annex 12
- Option 12 using a GNSS-enabled Android device with GPS Essentials: Annex 12 integrated into a data collection application

²⁸ <https://community.esri.com/groups/survey123/blog/2016/10/27/the-pulldata-function-access-external-data>

All the SOPs presented here are based on the administrative division and other geographic objects master lists respectively reported in Annexes 4 and 5. These will therefore have to be adjusted to match the specific context of the data collection exercise for which they are being used.

5. Implementation process

This section describes the steps that should be completed before, during and after the data collection takes place in the field.

5.1 Before data collection

This phase is critical to preparing the data collectors to be independent in the field and able to collect high quality geographic information with minimal supervision.

Two primary actions must be considered:

1. Preparing the material needed to implement the selected Option.
2. Selection and training of the data collectors and their supervisor(s).

The preparation of the material must cover the:

- Selection of the option that will be implemented (Table 1)
- Adjustment of the form to match the selected option (Annex 1)
- Creation of the electronic form, if required;
- Preparation of the associated annexes
- Development of the SOP to be implemented in the field
- Installation of the applications on the devices and testing of the devices, if required
- Verification that the data collection devices are operational and configured to meet the required specifications
- Preparation of the training material.

Knowledge and experience in using GNSS-enabled devices should be taken into account when selecting data collectors and their supervisor(s).

In addition to selecting qualified data collectors, training data collectors and their supervisor(s) is one of the, if not the most, important steps in the pre-survey process.

The training should aim to provide a good understanding and proper use of the different documents, the data collection equipment, and SOPs. The training should also cover appropriate troubleshooting methods regarding commonly encountered issues while in the field.

To achieve these goals, the training should at least cover the following topics (modified from [11]):

1. Short introduction to the geographic dimension of public health
2. The geographic component of the survey
 - Objective
 - Form, equipment, and associated documents
 - Anticipated use of the final results.
3. Overview of existing GNSS (GPS and GLONASS) systems and use of the chosen device
 - History of both systems.

- Systems components (satellites, ground stations, receivers).
 - How the GPS/GLONASS receiver calculates coordinates.
 - Errors that are present in GPS/GLONASS data and how to minimize them.
4. Introduction to the GNSS device (if used) including troubleshooting.
 5. Filling out the geographic component of the survey using the SOP.
 6. Hands-on practice session.

It is important to:

- Allocate enough time for the above-mentioned session.
- Ensure that the participants can ask questions.
- Give copies of the different documents to all the participants.
- Ensure every participant has the opportunity for hands-on practice of using a GPS device.

If it has not already been done, the training should also provide the opportunity to check that all the GPS devices are in good working order.

5.2 During data collection

During the survey, the data collectors should follow the SOP using the associated documents that will have been provided to them.

Despite a high-quality training session, it remains important to verify the methods used to collect the geographic location information and address any unexpected issues while the data collectors are in the field.

The following verification steps should be followed depending on available resources and the extent of the surveyed area:

1. On-site spot checks of data accuracy and completeness conducted by the data collection supervisor. Part of the check for accuracy can be performed using Survey123 for ArcGIS, Maps.Me, or Google Maps as way to ensure that the point is falling in the expected area.
2. Verification of the data remotely through periodic submissions of the collected data in a spreadsheet, either using Google Sheets online or emailing a Microsoft Excel spreadsheet to the data collection supervisor. For certain applications, a purpose-designed online database system may be used as well. However, these solutions usually require a regular access to the internet.

To complete on-site spot checks, the supervisor should ensure that all the fields of the geographic component of the survey are entered correctly and that the GPS coordinates fall within the min/max expected ranges (Annex 8).

Verifying the data remotely allows the supervisors to check that the geographic component of the survey is being recorded correctly and whether or not the collected coordinates are falling in the expected locations, either through the use of GIS software or by importing the data into an alternative tool, such as Google Maps. This option accelerates the data entry process as it directly produces the final table (Annex 12).

When internet connectivity is accessible, the use of email or a social media platforms can facilitate communication between the supervisor and the data collectors. Using group emails or social media

also allows all data collectors involved to view the communication and address similar issues that they may also be facing.

An example of successful use of this methodology was in the context of a household survey conducted to assess access to prenatal, delivery, and postpartum services in the Eastern Visayas Region of the Philippines [9]. In this case, data collectors added data to a Google Sheets spreadsheet on a daily basis and communication between the supervisor and the data collectors was done via Facebook.

When internet is not accessible, capturing and storing waypoints inside the GNSS-enabled device and downloading them to a computer might represent another alternative for checking that there was no error when capturing the coordinates and other information in the paper or electronic form. This process nevertheless requires the data collector to perform additional steps that are not being covered in this present version of the guide. When using this approach, it is important to ensure the link between each waypoint and the corresponding form through the use of a unique identifier, preferably the geographic object unique ID from the master list (see Section 4.2.2).

5.3 After data collection

Once the survey is completed, and if not already done as part of the data verification process implemented during data collection (see Section 5.2), it is important to ensure that the collected data is organized in a structured table that can be saved as a spreadsheet, e.g. in Microsoft Excel. If the data is collected in an electronic form, the data should be available for export in a similar structure.

Annex 14 gives an example of such a database. This example corresponds to the use of option 10 or 11 and the use of form A1.3 together with a GNSS-enabled device (Garmin eTrex in this case), the corresponding min/max expected coordinates and an offline map application.

Such a dataset should contain all the fields that are on the data collection form (Annex 1). The headers of each field can be simplified as reported in Annex 14. When doing so, it is important to remember that some software cannot handle more than a certain number of characters or accept certain characters e.g. spaces. This is the case, for example, with ArcGIS which will only keep 8 characters when importing such a table and has difficulties handling spaces. The labels reported in Annex 14 take this into account.

To simplify the work of the user, it is always preferable for the spreadsheet containing the dataset to be accompanied by two additional sheets containing:

- The data catalogue, i.e. the definition of the content for each field in the dataset (example in Table 4 for the dataset reported in Annex 14).
- The metadata associated with the data set.

This metadata should contain at least the following information:

- Title: short title describing the content of the dataset.
- Originator: source of the dataset.
- Publication date: date when the dataset was published.
- Abstract: short description of the dataset content and the purpose for which it was generated.
- Process: description of the process used for creating the dataset (can refer to a SOP).

- Progress: indication of the level of completeness of the dataset.
- Access constraints: any constraints limiting the access to/sharing of the dataset.
- Use constraints: any constraints limiting the use of the dataset.
- Disclaimer: any specific disclaimer attached to the dataset.
- Contact information: name, organization, telephone number, and email address of the person that can be contacted regarding the dataset (captured in separate fields).

Following each of these steps should ensure that the collected geographic information matches the specifications recommended in this document. However, performing a final data verification step before using the data is a recommended good practice.

| Field | Content |
|------------------|--|
| HF_Name | Official name of the health facility as per the master list |
| HF_Code | Official identifier of the health facility as per the master list |
| Address | Health facility street name and number |
| Pos_Code | Postal code for the health facility |
| Reg_name | Name of the Region in which the health facility is located as per the master list |
| Prov_name | Name of the Province in which the health facility is located as per the master list |
| Mun_name | Name of the Municipality in which the health facility is located as per the master list |
| Bgy_name | Name of the Barangay in which the health facility is located as per the master list |
| Bgy_code | Official Barangay code as per the master list |
| Nbr_Sat | Number of satellite signals received by the GNSS enabled device at the time of the reading |
| Accuracy | Accuracy measure provided by the GNSS enabled device at the time of the reading |
| Wtin_box | Geographic coordinates falling within the min/max expected coordinates (Yes/No) |
| Wtin_map | Geographic coordinates falling in the correct area on the map (Yes/No) |
| Latitude | Latitude (decimal degrees) of the health facility |
| Longitude | Longitude (decimal degrees) of the health facility |
| Waypoint | Position of the data collector at the time of taking the reading |
| Comments | Comments associated with the GNSS reading |
| Op_Name | Full name of the GNSS device operator |
| Dev_brand | Brand and model of the GNSS device that has been used |
| Dev_ser | Serial number of the GNSS device that has been used |
| Coll_date | Data collection date |

Table 4 - Example of data catalogue for the Philippines for the fields reported in Annex 12.

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Annex 1 – Forms for the collection of the geographic component

A1.1 - Example of fields to capture the geographic dimension in health surveys

SECTION 1 NAME AND CODE OF THE GEOGRAPHIC OBJECT AS PER THE MASTER LIST

| | |
|--|--|
| 1a. Name of the geographic object as per the master list | |
| 1b Code of the geographic object as per the master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 2 ADDRESS AND LOCATION OF THE GEOGRAPHIC OBJECT

| | |
|---|--|
| 2a. Street name and number | |
| 2b. Postal code | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 2c. Name of the 1st level administrative division as per the official master list: | |
| 2d. Name of the 2nd level administrative division as per the official master list: | |
| 2e. Name of the 3rd level administrative division as per the official master list: | |
| 2f. Name of the level administrative division as per the official master list: | |
| 2f. Code of thelevel administrative division as per the official master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

A1.2 - Form for options 1, 2 and 3 (remove field 3c for option 1)

SECTION 1 NAME AND CODE OF THE GEOGRAPHIC OBJECT AS PER THE MASTER LIST

| | |
|---|--|
| 1a. Name of the geographic object as per the master list | |
| 1b Code of the geographic object as per the master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 2 ADDRESS AND LOCATION OF THE GEOGRAPHIC OBJECT

| | |
|--|--|
| 2a. Street name and number | |
| 2b. Postal code | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 2c. Name of the 1st level administrative division as per the official master list: | |
| 2d. Name of the 2nd level administrative division as per the official master list: | |
| 2e. Name of the 3rd level administrative division as per the official master list: | |
| 2f. Name of the level administrative division as per the official master list: | |
| 2f. Code of thelevel administrative division as per the official master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 3 GEOGRAPHIC COORDINATES OF THE GEOGRAPHIC OBJECT

| | |
|---|--|
| 3a. Location of the geographic object visible on the map | <div> <input type="checkbox"/> <input type="checkbox"/> </div> <div> Yes </div> <div> <input type="checkbox"/> <input type="checkbox"/> </div> <div> No (clouds, blurry image, no features in the area..) </div> |
| 3b. Scale at the time of taking the coordinates (maximum: 50 meters) | <div> <input type="text"/> <input type="text"/> </div> <div> meters </div> |

| | |
|--|--|
| 3c. Coordinates fall within the min/max lat/long values | Yes <input type="checkbox"/> No <input type="checkbox"/> |
| 3d. Latitude (Decimal degrees): | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 3e. Longitude (Decimal degrees): | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 3f: Comments regarding the reading on the map: | |
| 3g: Name of the operator: | |
| 3h: Collection Date (dd/mm/yy) | |

A1.3 - Form for options 4 to 12 (Remove fields 3c and 3d for Options 4, 5 and 6 and field 3c or 3d for Options 7, 8 and 9)

SECTION 1 NAME AND CODE OF THE GEOGRAPHIC OBJECT AS PER THE MASTER LIST

| | |
|---|--|
| 1a. Name of the geographic object as per the master list | |
| 1b Code of the geographic object as per the master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 2 ADDRESS AND LOCATION OF THE GEOGRAPHIC OBJECT

| | |
|---|---|
| 2a. Street name and number | |
| 2b. Postal code | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 2c. Name of the 1st level administrative division as per the official master list: | |
| 2d. Name of the 2nd level administrative division as per the official master list: | |
| 2e. Name of the 3rd level administrative division as per the official master list: | |

| | |
|---|--|
| 2f. Name of the level administrative division as per the official master list: | |
| 2f. Code of thelevel administrative division as per the official master list: | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 3 GEOGRAPHIC COORDINATES OF THE GEOGRAPHIC OBJECT

| | |
|--|---|
| 3a. Number of satellite signals received | <input type="text"/> <input type="text"/> |
| 3b. Accuracy | <input type="text"/> <input type="text"/> metres |
| 3c. Coordinates falls within the min/max lat/long values | Yes <input type="text"/> No <input type="text"/> |
| 3d. Coordinates are in the right location on the offline map | Yes <input type="text"/> No <input type="text"/> Not sure <input type="text"/> |
| 3e. Latitude (Decimal degrees): | <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 3f. Longitude (Decimal degrees): | <input type="text"/> <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 3g. Waypoint (circle one option) | 1 At the location 2. At a nearby location (for example, at the gate, in a park or communal space) |
| 3h: Comments regarding the GNSS-based coordinates | |
| 3i: Name of the GNSS device operator | |
| 3j: GNSS device brand and model | |
| 3k: GNSS device serial number | |
| 3l: Collection date (dd/mm/yy) | |

Annex 2 – Example of paper based data collection form structured as a table - study sites in Bangladesh

| | | |
|-----------------------------|-------------------------------|-----------------|
| Name of the operator: _____ | Device brand and model: _____ | Comments: _____ |
| Data collection date: _____ | Device serial number: _____ | |

| Division_name | Zila_name | Upazila_name | Working_place_code | Working_place_name | Nbr sat signals | Accuracy | Within Min/Max | Place on the map | Latitude | Longitude | Waypoint |
|---------------|--------------|-------------------|--------------------|---|-----------------|----------|----------------|------------------|----------|-----------|----------|
| Chittagong | Bandarban | Alikadam | STS001 | Alikadam BRAC office | | | | | | | |
| Chittagong | Bandarban | Alikadam | STS002 | Alikadam Upazila Health Complex | | | | | | | |
| Chittagong | Bandarban | Alikadam | STS003 | Alikadam, Chokhyong Union, AKOTA office | | | | | | | |
| Chittagong | Bandarban | Bandarban Sadar | STS004 | Bandarban civil sergon office | | | | | | | |
| Chittagong | Bandarban | Bandarban Sadar | STS005 | Bandarban Sadar BRAC office | | | | | | | |
| Chittagong | Bandarban | Bandarban Sadar | STS006 | Bandarban Sadar Cantonment | | | | | | | |
| Chittagong | Bandarban | Bandarban Sadar | STS007 | Bandarban Sadar Hospital | | | | | | | |
| Chittagong | Bandarban | Lama | STS008 | Lama upazila AKOTA office | | | | | | | |
| Chittagong | Bandarban | Lama | STS009 | Lama Upazila Health Complex | | | | | | | |
| Chittagong | Bandarban | Lama | STS010 | Lama, Soroi Union, AKOTA office | | | | | | | |
| Chittagong | Bandarban | Lama | STS011 | Lama BRAC office | | | | | | | |
| Chittagong | Bandarban | Naikhongchhari | STS012 | Naikhongchhari BRAC office | | | | | | | |
| Chittagong | Bandarban | Naikhongchhari | STS013 | Naikhongchhari Upazila Health Complex | | | | | | | |
| Chittagong | Bandarban | Naikhongchhari | STS014 | Naikhongchhari, Balshari BRAC office | | | | | | | |
| Chittagong | Bandarban | Naikhongchhari | STS015 | Naikhongchhari, Ghumdum BRAC office | | | | | | | |
| Chittagong | Bandarban | Ruma | STS016 | Ruma BRAC office | | | | | | | |
| Chittagong | Bandarban | Ruma | STS017 | Ruma Upazila Health Complex | | | | | | | |
| Chittagong | Bandarban | Thanchi | STS018 | Thanchi Upazila BRAC office | | | | | | | |
| Chittagong | Bandarban | Thanchi | STS019 | Thanchi Upazila Health Complex | | | | | | | |
| Chittagong | Cox's Bazar | Chakaria | STS020 | Ramu Upazila Health Complex | | | | | | | |
| Chittagong | Cox's Bazar | Cox's Bazar Sadar | STS021 | Cox's Bazar Sadar Hospital | | | | | | | |
| Chittagong | Cox's Bazar | Ramu | STS022 | Ramu Cantonment | | | | | | | |
| Chittagong | Cox's Bazar | Ramu | STS023 | Ramu Upazila Health Complex | | | | | | | |
| Chittagong | Cox's Bazar | Ramu | STS024 | Ramu Mokti Office | | | | | | | |
| Chittagong | Cox's Bazar | Teknaf | STS025 | Teknaf Upazila Health Complex | | | | | | | |
| Chittagong | Cox's Bazar | Ukhia | STS026 | Ukhia Upazila Health Complex | | | | | | | |
| Chittagong | Khagrachhari | Dighinala | STS027 | Dighinala BRAC office | | | | | | | |

Annex 3 – Example of customized form for the collection of the geographic component of a field survey - study sites in Bangladesh

SECTION 1 NAME AND CODE OF STUDY SITE

| | |
|--|---|
| 1a. Name of the study site as per the master list (Annex 5) | |
| 1b. Code of the study site as per the master list (Annex 5): | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 2 ADDRESS AND LOCATION OF THE STUDY SITE

| | |
|---|---|
| 2a. Street name and number | |
| 2b. Postal code | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 2c. Name of the Division as per the official master list (Annex 4): | |
| 2d. Name of the Zila as per the official master list (Annex 4): | |
| 2e. Name of the Upazila as per the official master list (Annex 4): | |
| 2f. Code of the Upazila as per the official master list (Annex 4): | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

SECTION 3 GEOGRAPHIC COORDINATES OF THE STUDY SITE

| | |
|---|---|
| 3a. Number of satellite signals received | <input type="text"/> <input type="text"/> |
| 3b. Accuracy | <input type="text"/> <input type="text"/> metres |
| 3c. Latitude (Decimal degrees): | <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 3d. Longitude (Decimal degrees): | <input type="text"/> <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| 3e. Waypoint (Circle one option) | <p>1 At the location</p> <p>2. Near the location (for example, entrance gate, park or communal space)</p> |
| 3f: Comments regarding the GPS reading: | |
| 3g: Name of the GPS operator | |
| 3h: GPS device brand and model | |
| 3i: GPS serial number | |
| 3j: Collection date (dd/mm/yy) | |

Annex 4 – Example of administrative division master list - Upazilas for three Districts (Zila) in Chittagong Division, Bangladesh

| Division_code | Division_Name | Zila_code | Zila_name | Upazila_code | Upazila_name |
|----------------------|----------------------|------------------|------------------|---------------------|---------------------|
| 20 | Chittagong | 2003 | Bandarban | 200304 | Alikadam |
| 20 | Chittagong | 2003 | Bandarban | 200314 | Bandarban Sadar |
| 20 | Chittagong | 2003 | Bandarban | 200351 | Lama |
| 20 | Chittagong | 2003 | Bandarban | 200373 | Naikhongchhari |
| 20 | Chittagong | 2003 | Bandarban | 200389 | Rowangchhari |
| 20 | Chittagong | 2003 | Bandarban | 200391 | Ruma |
| 20 | Chittagong | 2003 | Bandarban | 200395 | Thanchi |
| 20 | Chittagong | 2022 | Cox's Bazar | 202216 | Chakaria |
| 20 | Chittagong | 2022 | Cox's Bazar | 202224 | Cox's Bazar Sadar |
| 20 | Chittagong | 2022 | Cox's Bazar | 202245 | Kutubdia |
| 20 | Chittagong | 2022 | Cox's Bazar | 202249 | Maheshkhali |
| 20 | Chittagong | 2022 | Cox's Bazar | 202256 | Pekua |
| 20 | Chittagong | 2022 | Cox's Bazar | 202266 | Ramu |
| 20 | Chittagong | 2022 | Cox's Bazar | 202290 | Teknaf |
| 20 | Chittagong | 2022 | Cox's Bazar | 202294 | Ukhia |
| 20 | Chittagong | 2046 | Khagrachhari | 204643 | Dighinala |
| 20 | Chittagong | 2046 | Khagrachhari | 204649 | Khagrachhari Sadar |
| 20 | Chittagong | 2046 | Khagrachhari | 204661 | Lakshmichhari |
| 20 | Chittagong | 2046 | Khagrachhari | 204665 | Mahalchhari |
| 20 | Chittagong | 2046 | Khagrachhari | 204667 | Manikchhari |
| 20 | Chittagong | 2046 | Khagrachhari | 204670 | Matiranga |
| 20 | Chittagong | 2046 | Khagrachhari | 204677 | Panchhari |
| 20 | Chittagong | 2046 | Khagrachhari | 204680 | Ramgarh |

Annex 5 – Example of geographic object specific master list - Study sites in 3 Upazilas, Bangladesh

| Working_place_code | Working_place_name | Division_code | Division_name | Zila_code | Zila_name | Upazila_code | Upazila_name |
|--------------------|---|---------------|---------------|-----------|--------------|--------------|--------------------|
| STS001 | Alikadam BRAC office | 20 | Chittagong | 2003 | Bandarban | 200304 | Alikadam |
| STS002 | Alikadam Upazila Health Complex | 20 | Chittagong | 2003 | Bandarban | 200304 | Alikadam |
| STS003 | Alikadam, Chokhyong Union, AKOTA office | 20 | Chittagong | 2003 | Bandarban | 200304 | Alikadam |
| STS004 | Bandarban civil sergon office | 20 | Chittagong | 2003 | Bandarban | 200314 | Bandarban Sadar |
| STS005 | Bandarban Sadar BRAC office | 20 | Chittagong | 2003 | Bandarban | 200314 | Bandarban Sadar |
| STS006 | Bandarban Sadar Cantonment | 20 | Chittagong | 2003 | Bandarban | 200314 | Bandarban Sadar |
| STS007 | Bandarban Sadar Hospital | 20 | Chittagong | 2003 | Bandarban | 200314 | Bandarban Sadar |
| STS008 | Lama upazila AKOTA office | 20 | Chittagong | 2003 | Bandarban | 200351 | Lama |
| STS009 | Lama Upazila Health Complex | 20 | Chittagong | 2003 | Bandarban | 200351 | Lama |
| STS010 | Lama, Soroi Union, AKOTA office | 20 | Chittagong | 2003 | Bandarban | 200351 | Lama |
| STS011 | Lama BRAC office | 20 | Chittagong | 2003 | Bandarban | 200351 | Lama |
| STS012 | Naikhongchhari BRAC office | 20 | Chittagong | 2003 | Bandarban | 200373 | Naikhongchhari |
| STS013 | Naikhongchhari Upazila Health Complex | 20 | Chittagong | 2003 | Bandarban | 200373 | Naikhongchhari |
| STS014 | Naikhongchhari, Baishari BRAC office | 20 | Chittagong | 2003 | Bandarban | 200373 | Naikhongchhari |
| STS015 | Naikhongchhari, Ghumdum BRAC office | 20 | Chittagong | 2003 | Bandarban | 200373 | Naikhongchhari |
| STS016 | Ruma BRAC office | 20 | Chittagong | 2003 | Bandarban | 200391 | Ruma |
| STS017 | Ruma Upazila Health Complex | 20 | Chittagong | 2003 | Bandarban | 200391 | Ruma |
| STS018 | Thanchi Upazila BRAC office | 20 | Chittagong | 2003 | Bandarban | 200395 | Thanchi |
| STS019 | Thanchi Upazila Health Complex | 20 | Chittagong | 2003 | Bandarban | 200395 | Thanchi |
| STS020 | Ramu Upazila Health Complex | 20 | Chittagong | 2022 | Cox's Bazar | 202216 | Chakaria |
| STS021 | Cox's Bazar Sadar Hospital | 20 | Chittagong | 2022 | Cox's Bazar | 202224 | Cox's Bazar Sadar |
| STS022 | Ramu Cantonment | 20 | Chittagong | 2022 | Cox's Bazar | 202266 | Ramu |
| STS023 | Ramu Upazila Health Complex | 20 | Chittagong | 2022 | Cox's Bazar | 202266 | Ramu |
| STS024 | Ramu Mokti Office | 20 | Chittagong | 2022 | Cox's Bazar | 202266 | Ramu |
| STS025 | Teknaf Upazila Health Complex | 20 | Chittagong | 2022 | Cox's Bazar | 202290 | Teknaf |
| STS026 | Ukhia Upazila Health Complex | 20 | Chittagong | 2022 | Cox's Bazar | 202294 | Ukhia |
| STS027 | Dighinala BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204643 | Dighinala |
| STS028 | Dighinala Upazila Health Complex | 20 | Chittagong | 2046 | Khagrachhari | 204643 | Dighinala |
| STS029 | Bandarban civil sergon office | 20 | Chittagong | 2046 | Khagrachhari | 204649 | Khagrachhari Sadar |
| STS030 | Khagrachhari Sadar BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204649 | Khagrachhari Sadar |
| STS031 | Khagrachhari Sadar Cantonment | 20 | Chittagong | 2046 | Khagrachhari | 204649 | Khagrachhari Sadar |
| STS032 | Khagrachhari Sadar Hospital | 20 | Chittagong | 2046 | Khagrachhari | 204649 | Khagrachhari Sadar |
| STS033 | Lakshmichhari BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204661 | Lakshmichhari |
| STS034 | Lakshmichhari Upazila Health Complex | 20 | Chittagong | 2046 | Khagrachhari | 204661 | Lakshmichhari |
| STS035 | Mahalchhari BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204665 | Mahalchhari |
| STS036 | Mahalchhari UNDP office | 20 | Chittagong | 2046 | Khagrachhari | 204665 | Mahalchhari |
| STS037 | Mahalchhari Upazila Health Complex | 20 | Chittagong | 2046 | Khagrachhari | 204665 | Mahalchhari |
| STS038 | Manikchhari BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204665 | Manikchhari |
| STS039 | Matiranga BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204670 | Matiranga |
| STS040 | Matiranga Upazila Health Complex | 20 | Chittagong | 2046 | Khagrachhari | 204670 | Matiranga |
| STS041 | Tubalchhari union health centre | 20 | Chittagong | 2046 | Khagrachhari | 204670 | Matiranga |
| STS042 | Panchhari BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204677 | Panchhari |
| STS043 | Panchhari Upazila Health Complex | 20 | Chittagong | 2046 | Khagrachhari | 204677 | Panchhari |
| STS044 | Ramgarh BRAC office | 20 | Chittagong | 2046 | Khagrachhari | 204680 | Ramgarh |
| STS045 | Ramgarh Upazila Health Complex | 20 | Chittagong | 2046 | Khagrachhari | 204680 | Ramgarh |

Annex 6 – Short user manual for the Garmin eTrex device

A6.1 - Device overview

Figure 5.1 shows the different parts of the Garmin eTrex GPS device. These parts are identical for all the models in Table 1.



Figure 5.1 - Parts of the Garmin eTrex GPS device

The buttons on the device are operated as follows:

- Move the Thumb Stick up, down, left and right to highlight menu selections or to move around the map.
- Press the centre of the Thumb Stick to select a highlighted item.
- Press **back** to move back one step in the menu structure.
- Press **menu** to display a list of commonly-used functions for the current page. Press **menu** twice to access the main menu from any page.
- Press ▲ and ▼ to zoom in and out on the map.

A6.2 - Installing the batteries

The eTrex GPS device takes two AA batteries. Here are the steps to install them:

- Turn the D-ring counter-clockwise (to the left) and pull to remove the cover.
- Insert the batteries, making sure they are oriented correctly for polarity.
- Replace the battery cover, and turn the D-ring clockwise (to the right).
- Press and hold the **On/Off** button.
- Select "Setup > System > Battery > Type"



Select Alkaline, Lithium or Rechargeable NiMH, as appropriate.

A6.3 - Troubleshooting

| Problem | Solution |
|---|---|
| The device does not respond. How do I reset the device? | Remove and reinstall the batteries as described in section 5.2 above. Note: this does not erase any of the data or settings. |
| The device does not acquire satellite signals | 1. Take the device out of buildings and parking garages, and away from tall buildings and trees. 2. Turn on the device. 3. Remain stationary for several minutes. |
| The batteries do not last long | Maximize battery life by: 1. Turning off the device whenever it is not in use by pressing and holding the on/off backlight button for around 5 seconds. 2. Leaving the backlight off when not needed. 3. Lowering the backlight brightness (while the device is on, press the on/off backlight button ; move the thumb stick left and right to adjust the brightness level). 4. Decrease the backlight timeout (under Setup>Display>Backlight Timeout). |

Annex 7 - Process to store an offline map on a device

This Annex describes how to download a map to be used offline in the Google Maps and Maps.Me applications once these have been installed on the mobile device. Please note that this process requires the device to be connected to the internet.

A7.1 Process in Esri ArcGIS Platform

Online documentation are available in the Esri website for the processes involved in caching vector or raster datasets into the application before data collection.

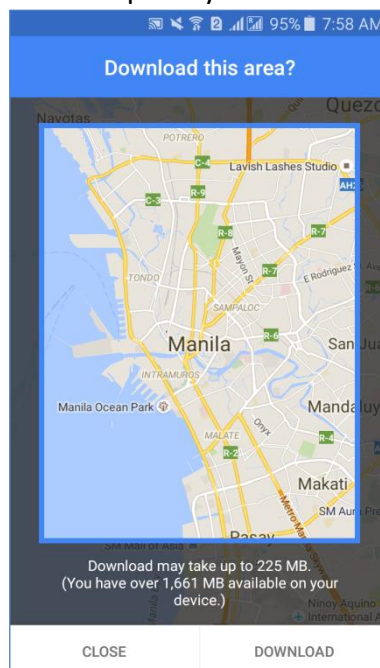
a) Tile Package Kreator: <https://www.esri.com/arcgis-blog/products/apps/data-management/introducing-tile-package-kreator-esri-labs/>

b) Survey123 for ArcGIS: <https://doc.arcgis.com/en/survey123/desktop/create-surveys/preparebasemaps.htm>

c) Collector for ArcGIS: <https://doc.arcgis.com/en/collector/windows/create-maps/offline-map-prep.htm>

A7.2 Process in Google Maps

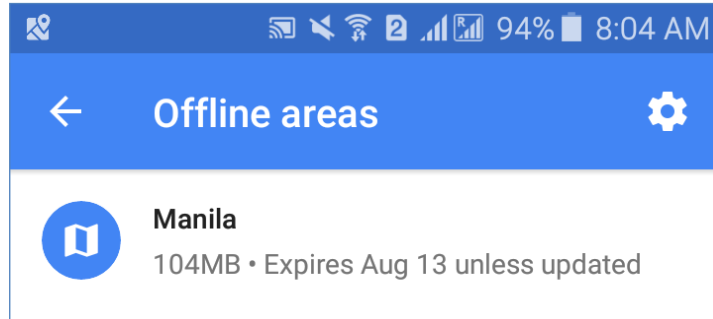
1. On your phone or tablet, open the Google Maps app.
2. Make sure the device is connected to the Internet and signed in to Google Maps.
3. Navigate to the area you would like to download on your device.
4. In the top left, tap the Menu icon (☰) and select the "Offline areas" item.
5. In the window that opens, tap the Add button (+). This will open the following window with the map centered on the place you moved to in step 3 (Manila in this case):



6. Use your fingers to pan, zoom in, or zoom out until the frame covers the area of the map you want to download.

(Notes: 1. The expected size of the downloaded map together with the indication of the available storage space on the device are displayed below the frame; 2. The biggest size for an offline area is 120,000 square kilometers. If you try to save a bigger area than this, you will be asked to zoom in to a smaller area.)

7. Click the "DOWNLOAD" button at the bottom of the window and enter a name for the download. Once this is done, the area in question should appear in the list of offline areas as in the example on the next page:

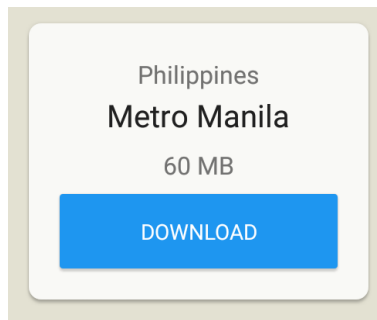


8. Close Google Maps, turn the wifi connection off and clear the cache memory.
9. Re-open Google Maps, move to the area you have downloaded and zoom in to make sure that the satellite image has indeed been downloaded to the device. If this is the case, you should be able to see more details when zooming on to the downloaded area than the surrounding areas as shown here:



A7.3 Process in Maps.Me

1. On your phone or tablet, open the Maps.Me application.
2. Move to the area you would like to download on your device. The search tool (🔍) can be useful to find the area needed.
3. Zoom in to the area until a window like this one appears on the screen:



4. Click the "DOWNLOAD" button at the bottom of the window. (A name is already attributed for each tile covering the world. For some countries, these are the country name and for some they are the names of administrative subunits.)
5. Close Maps.Me, turn the wifi connection off;
6. Re-open Maps.Me, move to the area you have downloaded, and zoom in to make sure that the area you need to cover has indeed been downloaded to your device.

Annex 8 - Protocol to calculate the minimum and maximum latitudes and longitudes of administrative divisions

This Annex describes how to use ArcMap10.4 or QGIS to calculate the minimum (Min) and maximum (Max) latitudes and longitudes, expressed in decimal degrees, for a set of administrative divisions.

Please note that similar tools also exist for previous version of ArcGIS, these can be downloaded from the following web pages which also contain the instructions on how to install the toolbox:

- For ArcGIS 9.x (Bounding Container toolbox):
<http://arcscrips.esri.com/details.asp?dbid=14535>
- For ArcGIS 10.1 to 10.3 (Bounding Container toolbox):
<http://www.arcgis.com/home/item.html?id=564e2949763943e3b9fb4240bab0ca2f>
- For ArcGIS Pro (Minimum Bounding Geometry)
<http://pro.arcgis.com/en/pro-app/tool-reference/data-management/minimum-bounding-geometry.htm>

Set the input parameters as follows when using one of the above mentioned previous versions:

1. Leave the "Each shape individually?" field checked.
2. Select "extent" under "features to create" to obtain horizontal rectangles bounding each administrative unit.
3. Leave the "Grouping Field (optional)" field empty.

The only data which is required to apply the protocol is a shapefile containing the boundaries of the administrative divisions in question.

The shape file in question needs to comply with the following:

1. It needs to be unprojected (geographic projection, WGS84 datum) in order for the Min and Max latitudes and longitudes values to be expressed in decimal degrees.
The following tool can be used in case the layer needs to be unprojected:
 - a. In ArcGIS 10.4: ArcToolbox> Data Management Tools > Projections and Transformations > Project
 - b. In QGIS:
 - i. Right click on the layer name and select "Save As".
 - ii. Specify the path and the name of the output layer in the "Save as" field.
 - iii. Specify WGS 84 as the coordinate reference system in the "CRS" field.
 - iv. Click "Ok".
2. Administrative divisions with multiple parts need to be stored as single records (multiple parts polygons). The following tool can be used to combine multiple polygons, where needed:
 - a. In ArcGIS 10.4: ArcToolbox> Data Management Tools > Generalization> Dissolve
 - b. In QGIS:vector> geoprocessing tools> dissolve

A8.1 Process in ArcMap 10.4

The following steps should be followed in ArcMap 10.4:

1. Install the AeHIN GIS Lab toolbox:
 - a. Download the AeHIN GIS Lab toolbox from the following link:
http://www.healthgeolab.net/DOWNLOADS/AeHIN_GIS_Lab_Tools.zip
 - b. Extract the AeHIN GIS Lab Toolbox from the downloaded zipped file and place it in the ArcToolbox folder (the toolboxes are generally placed in the C:\Program Files (x86)\ArcGIS\Desktop10.4\ArcToolbox\Toolboxes folder).
 - c. Open ArcGIS and the ArcToolbox window.
 - d. Right click on the "ArcToolbox" items of the ArcToolbox window, select "Add toolbox" and specify the path to the AeHIN GIS Lab Tools.tbx file. A new item named "AeHIN GIS Lab Tools" should then appear in the list of tools.
2. Add the unprojected administrative boundaries layer in the view and open its attribute table to make sure that the map contains all the relevant administrative divisions and their corresponding unique codes as per the administrative division master list (Annex 3 in this example).
3. Double click on the ArcToolbox> AeHIN GIS Lab Tools>Generate Envelopes tool to obtain a shapefile that contains the maximum extent of each polygon from the administrative boundaries layer. In the window that opens, specify the following before hitting the "OK" Button:
 - a. The administrative divisions shapefile under "Input Geography"
 - b. The folder path and file name for the resulting layer "Output Shapefile"
4. Open the attribute table of the resulting layer that will automatically be included in the view and check that it contains all the records from the original administrative boundaries layer.
5. Open Microsoft Excel and open the .dbf files of the resulting layer created under point 3 and save as an Excel file under a new name.
6. Add 4 columns to the Excel file created in step 5 and use these to adjust the Min/Max latitudes and longitudes to account for possible error in the administrative divisions shape file, as follows:
7. Populate these 4 new columns by adding or subtracting 0.01 decimal degrees (approximately equivalent to 1 km) and by setting the decimal places to 5 using the "Format Cells" option in Excel to be consistent with the data specifications recommended in the present guide. This is done using the following new column headers and respective formulae:
 - i. Min latitude = Y_MIN - 0.01
 - ii. Max latitude = Y_MAX + 0.01
 - iii. Min longitude = X_MIN - 0.01
 - iv. Max longitude = X_MAX + 0.01
8. Copy and paste as values the content of the entire table and delete the X_MIN, X_MAX, Y_MIN and Y_MAX columns. The final result should look like this:

| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude |
|--------------|--------------|--------------|--------------|---------------|---------------|
| 20304 | Alikadam | 21.34190 | 21.84540 | 92.21290 | 92.54240 |
| 20314 | Bandarban | 21.93280 | 22.36380 | 92.12800 | 92.32050 |
| 22216 | Chakaria | 21.56440 | 21.93310 | 91.92940 | 92.22350 |
| 22224 | Cox's Bazar | 21.37800 | 21.61920 | 91.93670 | 92.14330 |
| 24643 | Dighinala | 23.06320 | 23.74470 | 91.92450 | 92.19110 |
| 24649 | Khagrachhari | 22.99560 | 23.27760 | 91.88290 | 92.09010 |

9. Save the resulting table in Microsoft Excel format and using a different name.

10. This table can additionally be used within the Survey123 for ArcGIS app to limit the coordinate entries within the boundary limits for the jurisdiction.

A8.2 Process in QGIS 2.16 (Nødebo)

The following steps should be followed in QGIS 2.16 (NØDEBO):

1. Launch QGIS
2. Add the unprojected administrative boundaries layer in the canvas and open its attribute table to make sure that the map contains all the relevant administrative divisions and their corresponding unique code as per the administrative division master list (Annex 3 in this example)
3. Click on Project>Project Properties>CRS and set the canvas to WGS 84 if this is not already the case
4. Select the Vector>Research Tools>Polygon from layer extent... function
5. In the window that opens:
 - a. Select the layer on which to apply the process
 - b. Check the "Calculate extent for each feature separately" box
 - c. Specify the name of the shape file in which the bounding polygons will be stored in the "Output polygon shapefile" field
 - d. Click OK
6. In Microsoft Excel, open the .dbf file associated to both the unprojected administrative boundaries layer and the bounding polygon layer created under step 5;
7. Without changing the order of both tables, copy and paste the MINX, MINY, MAXX, and MAXY columns from the bounding polygon .dbf to the original boundary layer one and save the resulting table in an Excel file (Note: Do not save the modifications in the .dbf file or it will affect the shapefile).
8. Add 4 columns to the Excel file created in step 5 and use these to adjust the Min/Max latitudes and longitudes to account for possible error in the administrative divisions shape file, as follows:
9. Populate these 4 new columns by adding or subtracting 0.01 decimal degrees (approximately equivalent to 1 km) and by setting the decimal places to 5 using the "Format Cells" option in Excel to be consistent with the data specifications recommended in the present guide. This is done using the following new column headers and respective formulas:
 - i. Min latitude = MINY - 0.01
 - ii. Max latitude = MAXY + 0.01
 - iii. Min longitude = MINX - 0.01
 - iv. Max longitude = MAXX + 0.01
10. Copy and paste as values the content of the entire table and delete the MINX, MAXX, MINY, and MAXY columns. The final result should look like this:

| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude |
|--------------|--------------|--------------|--------------|---------------|---------------|
| 20304 | Alikadam | 21.34190 | 21.84540 | 92.21290 | 92.54240 |
| 20314 | Bandarban | 21.93280 | 22.36380 | 92.12800 | 92.32050 |
| 22216 | Chakaria | 21.56440 | 21.93310 | 91.92940 | 92.22350 |
| 22224 | Cox's Bazar | 21.37800 | 21.61920 | 91.93670 | 92.14330 |
| 24643 | Dighinala | 23.06320 | 23.74470 | 91.92450 | 92.19110 |
| 24649 | Khagrachhari | 22.99560 | 23.27760 | 91.88290 | 92.09010 |

11. Save the resulting table in Excel format and using a different name.

Annex 9 – Example of Minimum (Min) and Maximum (Max) Latitudes and Longitudes for Upazilas in Chittagong Division, Bangladesh

| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude |
|--------------|----------------|--------------|--------------|---------------|---------------|
| 20304 | Alikadam | 21.34190 | 21.84540 | 92.21290 | 92.54240 |
| 20314 | Bandarban | 21.93280 | 22.36380 | 92.12800 | 92.32050 |
| 22216 | Chakaria | 21.56440 | 21.93310 | 91.92940 | 92.22350 |
| 22224 | Cox's Bazar | 21.37800 | 21.61920 | 91.93670 | 92.14330 |
| 24643 | Dighinala | 23.06320 | 23.74470 | 91.92450 | 92.19110 |
| 24649 | Khagrachhari | 22.99560 | 23.27760 | 91.88290 | 92.09010 |
| 22245 | Kutubdia | 21.73200 | 21.93560 | 91.82310 | 91.90580 |
| 24661 | Lakshmichhari | 22.67750 | 22.89500 | 91.84180 | 92.01140 |
| 20351 | Lama | 21.59700 | 22.00630 | 92.04990 | 92.37230 |
| 24665 | Mahalchhari | 22.82300 | 23.06480 | 91.88920 | 92.12830 |
| 22249 | Maheshkhali | 21.46090 | 21.77580 | 91.83030 | 92.02930 |
| 24667 | Manikchhari | 22.75860 | 22.91710 | 91.73660 | 91.89900 |
| 24670 | Matiranga | 22.93280 | 23.41130 | 91.73330 | 91.98400 |
| 20373 | Naikhongchhari | 21.18280 | 21.67710 | 92.08690 | 92.36910 |
| 24677 | Panchhari | 23.16150 | 23.47560 | 91.81040 | 92.00930 |
| 22295 | Pekua | 21.71030 | 21.91400 | 91.87620 | 92.03050 |
| 24680 | Ramgarh | 22.85800 | 23.03530 | 91.70210 | 91.99290 |
| 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 |
| 20389 | Rowangchhari | 22.00960 | 22.36560 | 92.19470 | 92.49670 |
| 20391 | Ruma | 21.87970 | 22.20870 | 92.27430 | 92.55180 |
| 22290 | Teknaf | 20.56620 | 21.16840 | 92.07730 | 92.35920 |
| 20395 | Thanchi | 21.23360 | 21.99180 | 92.31250 | 92.69040 |
| 22294 | Ukhia | 21.06810 | 21.36070 | 92.03250 | 92.21330 |

Annex 10 - Standard Operating Procedure (SOP) for the Google Maps or Maps.Me application (Options 1, 2 and 3)

Equipment (hardware and software):

- Android device (Google Maps and Maps.Me) or iOS device (Maps.Me)
- Google Maps or Maps.Me application installed on the device

Documents to be used by the data collector:

- Paper or electronic version of the geographic form A 1.2 (Annex 1)
- Administrative division master list (Example in Annex 4)
- Geographic object specific master list (Example in Annex 5)
- Min/max expected geographic coordinates (Example in Annex 9)

Steps to be followed:

Please fill out the geographic form as follows once arrived on site of each study site to be surveyed:

1. Section 1 - Name and code of the geographic object as per the master list:

- 1.1 Write the official name of the study site as per the geographic object master list (Annex 5) in field 1a;
- 1.2 Write the official code of the study site as per the geographic object master list (Annex 5) in field 1b;

Example: The example below illustrates how the information for Ramu Upazila Health Complex (a community health facility in Bangladesh) should be entered for these two fields in the form:

| | |
|--|-----------------------------|
| 1a. Name of the study site as per the master list (Annex 5) | Ramu Upazila Health Complex |
| 1b. Code of the study site as per the master list (Annex 5): | S T S 0 2 3 |

2. Section 2 - Address and location of the geographic object:

- 2.1 Write the street name and number of the study site in field 2a. No other information (such as the name of an administrative division) should appear in this field.

If the study site is located in a place for which there is no street name or/ number then “NA” (standing for “Not Applicable”) should be entered here.

- 2.2 Write the official postal code (zip code) for the area in which the study site is located.

If unknown at the time of data collection, this code can be obtained from a country specific resource. In the case of Bangladesh, the Bangladesh Post Office (<http://www.bangladeshpost.gov.bd/postcode.asp>) provides this information online.

Example: The figure below illustrates how the information for Ramu Upazila Health Complex is entered in the fields 2a and 2b of the customized form:

| | |
|-------------------------------------|-----------------|
| 2a. Building number and street name | National road 1 |
| 2b. Postal code | 4 7 3 0 |

2.3 Use the master list of administrative divisions (Annex 4) to enter the information for fields 2c, 2d, 2e and 2f.

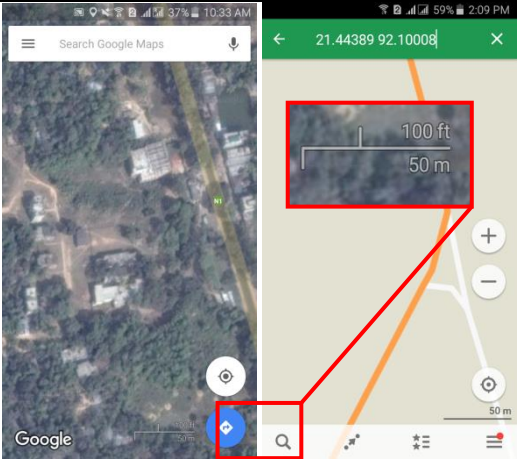
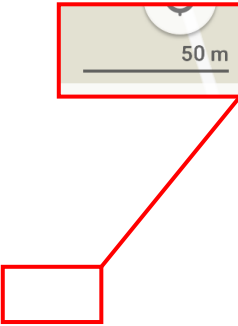
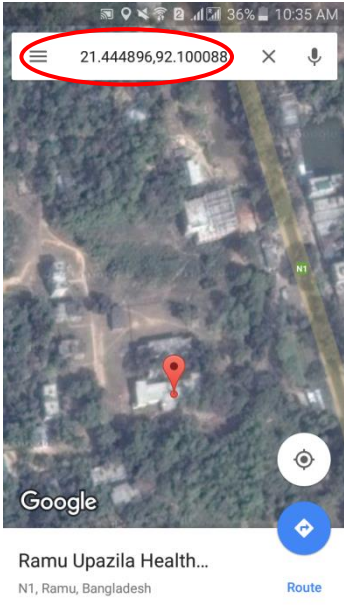
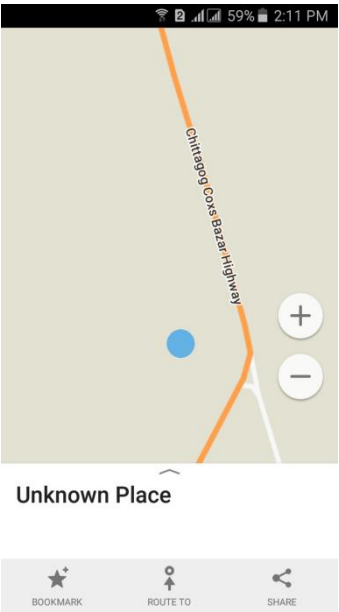

Ensure that the correct spelling and code are used (including the “0” at the front of the code in some cases).

Example: The figure below illustrates how the information should be entered for Ramu Upazila Health Complex in these fields:

| | |
|---|-------------|
| 2c. Name of the Division as per the official master list (Annex 4): | Chittagong |
| 2d. Name of the Zila as per the official master list (Annex 4): | Cox's Bazar |
| 2e. Name of the Upazila as per the official master list (Annex 4): | Ramu |
| 2f. Code of the Upazila as per the official master list (Annex 4): | 2 0 2 2 6 6 |

3. Section 3 - Geographic coordinates of the geographic object:

| Step | Action |
|------|---|
| 3.1 | Open Google Maps or Maps.Me and, using the geographic objects on the map as well as the background satellite image as reference, pan and zoom until the study site where you are located. |
| 3.2 | <p>Indicate in field 3a if the location of the geographic object can be identified on the map or not because of clouds for example.</p> <p>The figure below illustrates how the information should be entered when the geographic object is visible on the map:</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <div style="display: flex; align-items: center;"> <div style="background-color: #f0f0f0; padding: 5px; margin-right: 10px;">3a. Location of the infrastructure visible on the map</div> <div style="display: flex; align-items: center;"> Yes <div style="border: 1px solid black; padding: 2px 10px; margin: 0 10px;">X</div> <div style="margin: 0 10px;">No (clouds, blurry image, no features in the area..)</div> <div style="border: 1px solid black; width: 30px; height: 30px; margin-left: 10px;"></div> </div> </div> </div> |
| 3.3 | Zoom to the geographic object until the scale bar on the bottom right of the screen shows a value equal to 50 meters or lower |

| | |
|-----|---|
| | <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Google Map</p> </div> <div style="text-align: center;">  <p>Maps.Me</p> </div> </div> |
| 3.4 | <p>Write the scale value in field 3b</p> <div style="border: 1px solid black; padding: 5px; display: flex; align-items: center;"> <div style="background-color: #f0f0f0; padding: 5px; margin-right: 10px;"> <p><i>3b. Scale at the moment of taking the coordinate (maximum: 50 meters)</i></p> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center; margin-right: 5px;">5</div> <div style="border: 1px solid black; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center; margin-right: 5px;">0</div> <div style="margin-left: 5px;">meters</div> </div> </div> |
| 3.5 | <p>Press and hold your finger on top of the geographic object until a pin appears. Start again in case the pin does not appear in the right place.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Google Map</p> </div> <div style="text-align: center;">  <p>Maps.Me</p> </div> </div> <p>Read the geographic coordinates:</p> <ul style="list-style-type: none"> • In Google Maps: the coordinates appear directly in the search field as circled in red in the figure above • In Maps.Me: <ul style="list-style-type: none"> ○ Click on the BOOKMARK icon () on the lower left side of the window. ○ Expand the sliding banner located at the bottom of the window. The coordinates will appear as circled in red |

below

(21.44389 92.10008) Unknown Place

My Places

EDIT BOOKMARK

21.44389, 92.10008

+ ADD A PLACE TO THE MAP

BOOKMARK

ROUTE TO

SHARE

3.6

Verify that the coordinates are within the Min-Max range of latitudes and longitudes for the Upazila in which the study site is located using the list of Min-Max Coordinates (Annex 9).

In the example used above, Ramu Upazila Health Complex located in Ramu Upazila has latitude: 21.44489° and longitude: 92.10008°. These values are correctly between the Min and Max for this Upazila in Annex 8.

| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude |
|--------------|--------------|--------------|--------------|---------------|---------------|
| 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 |

If this is the case, check the "Yes" box in field 3c.

3c. Coordinates falls within the min/max lat/long values

Yes

No

And write down the geographic coordinates of the pin that appears in the search field on top of your screen in fields 3d and 3e. Please make sure to include the 5 digits after the decimal place.

3d. Latitude (Decimal degrees):

21.44489

3e. Longitude (Decimal degrees):

92.10008

If the coordinates do not fall within the ranges reported in the Annex 9:

- Zoom out and verify that you are indeed located in the correct part of the country
- Verify that you have pointed the correct geographic object
- Take a new reading (steps 3.2 to 3.6)

If the coordinates continue to fall outside the ranges after applying the above:

- Write the coordinates in fields 3d and 3e
- Write "Coordinates fall outside of the range" in field 3f as per

| | | | |
|--|--|--|-------------------------------------|
| | <p>the following example:</p> <table> <tr> <td>3f: Comments regarding the reading on the map:</td><td>Coordinates fall outside the ranges</td></tr> </table> | 3f: Comments regarding the reading on the map: | Coordinates fall outside the ranges |
| 3f: Comments regarding the reading on the map: | Coordinates fall outside the ranges | | |
| 3.7 | Write down any other comments you might have about the reading in field 3f (Put "None" if you do not have any) | | |
| 3.8 | Write down your name as data collector and the data collection date in fields 3g and 3h | | |
| 3.9 | Check back through the form and complete any remaining fields | | |
| 3.10 | Move to the next study site and restart from section 1. | | |

Annex 11 - Standard Operating Procedure (SOP) for the Garmin eTrex GPS device series (Options 4, 5, 7, 8, 10 and 11)

Equipment (hardware and software):

- Garmin eTrex GPS device (10, 20 or 30) - Please note that the eTrex 10 model will not allow implementing options 7, 8 with the offline map application nor options 10 and 11.
- Map for the region of interest installed in the device.

Documents to be used by the data collector:

- Paper version of the geographic form A 1.3 (Annex 1)
- Administrative division master list (Example in Annex 4)
- Infrastructure master list (Example in Annex 5)
- Min/max expected geographic coordinates (Example in Annex 9)

Steps to be followed:

Please fill out the geographic form as follows once arrived on site at each study site to be surveyed:

1. Section 1 - Name and code of the geographic object as per the master list:

- 1.1 Write the official name of the study site as per the geographic object master list (Annex 5) in field 1a
- 1.2 Write the official code of the study site as per the geographic object master list (Annex 5) in field 1b

Example: The example below illustrates how the information for Ramu Upazila Health Complex (a community health facility in Bangladesh) should be entered for these two fields in the form:

| | |
|--|-----------------------------|
| 1a. Name of the study site as per the master list (Annex 5) | Ramu Upazila Health Complex |
| 1b. Code of the study site as per the master list (Annex 5): | S T S 0 2 3 |

2. Section 2 - Address and location of the geographic object:

- 2.1 Write the street name and number of the study site in field 2a. No other information (such as the name of an administrative division) should appear in this field.

If the study site is located in a place for which there is no street name or number then “NA” (standing for “Not Applicable”) should be entered here.

- 2.2 Write the official postal code (zip code) for the area in which the study site is located.

If unknown at the time of data collection, this code can be obtained from a country specific resource. In the case of Bangladesh, the Bangladesh Post Office (<http://www.bangladeshpost.gov.bd/postcode.asp>) provides this information online.

Example: The figure below illustrates how the information for Ramu Upazila Health Complex is entered in the fields 2a and 2b of the customized form:

| | |
|-------------------------------------|-----------------|
| 2a. Building number and street name | National road 1 |
| 2b. Postal code | 4 7 3 0 |

2.3 Use the master list of administrative divisions (Annex 4) to enter the information for fields 2c, 2d, 2e, and 2f.

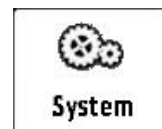
Ensure the correct spelling and code are used (including the "0" at the front of the code in some cases).




Example: The figure below illustrates how the information should be entered for Ramu Upazila Health Complex in these fields:

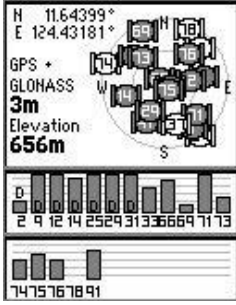
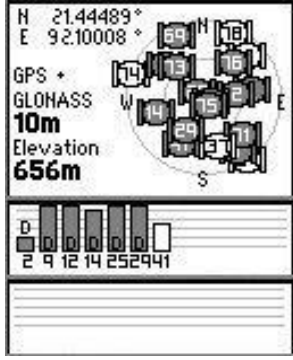
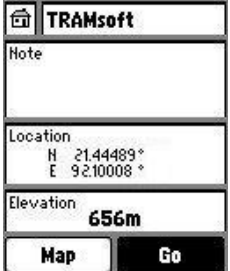
| | |
|---|-------------|
| 2c. Name of the Division as per the official master list (Annex 4): | Chittagong |
| 2d. Name of the Zila as per the official master list (Annex 4): | Cox's Bazar |
| 2e. Name of the Upazila as per the official master list (Annex 4): | Ramu |
| 2f. Code of the Upazila as per the official master list (Annex 4): | 2 0 2 2 6 6 |


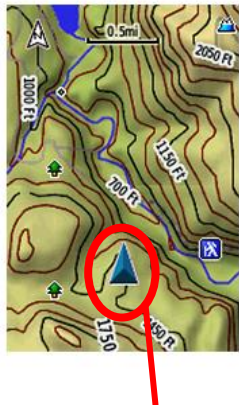
3. Section 3 - Geographic coordinates of the geographic object:

| Step | Action |
|------|---|
| 3.1 | Once you have arrived at the place to be located, find an open space and turn the GPS device on. |
| 3.2 | If you are not already on the menu page, click twice on the menu button on the left of the device to get there. |
| 3.3 | Using the thumb stick, scroll down the menu page until the "Setup" icon is highlighted. Next, press the thumb stick to access the Setup sub menu. |
| 3.4 | Using the thumb stick, scroll down the menu page until the "System" icon is highlighted. Next, press the thumb stick to access the System sub menu. |
| 3.5 | Under "Satellite System" highlight the "GPS+GLONASS" option and press the thumb stick to save the selection. |



| | | | | | | | | |
|-----------------------------|---|---|--------------------|-------------------|-----------------------------|----------------------|--------------|--------------|
| | This will allow you to use both the GPS and GLONASS constellations of satellites as shown here | | | | | | | |
| | <table><tr><td>Satellite System</td></tr><tr><td>GPS</td></tr><tr><td>GPS + GLONASS</td></tr><tr><td>Demo Mode</td></tr></table> | | Satellite System | GPS | GPS + GLONASS | Demo Mode | | |
| Satellite System | | | | | | | | |
| GPS | | | | | | | | |
| GPS + GLONASS | | | | | | | | |
| Demo Mode | | | | | | | | |
| 3.6 | Click on the back button on the right of the device to return to the Setup sub menu. | | | | | | | |
| 3.7 | Use the thumb stick again until the "Units" icon is highlighted. Next, press the thumb stick to access the Units sub menu. |  Units | | | | | | |
| 3.8 | Set both the "Distance and Speed" as well as "Elevation" items to the metric system as shown here: | | | | | | | |
| | <table><tr><td>Distance and Speed</td></tr><tr><td>Metric</td></tr><tr><td>Elevation (Vertical Speed)</td></tr><tr><td>Metric(m/min)</td></tr></table> | | Distance and Speed | Metric | Elevation (Vertical Speed) | Metric(m/min) | | |
| Distance and Speed | | | | | | | | |
| Metric | | | | | | | | |
| Elevation (Vertical Speed) | | | | | | | | |
| Metric(m/min) | | | | | | | | |
| 3.9 | Click on the back button on the right of the device to return to the Setup sub menu. | | | | | | | |
| 3.10 | Use the thumb stick again until the "Position Format" icon is highlighted. Next, press the thumb stick to access the Units sub menu. |  Position Format | | | | | | |
| 3.11 | Set the "Position Format," "Map Datum," and "Map Spheroid" as presented here: | | | | | | | |
| | <table><tr><td>Position Format</td></tr><tr><td>hddd.ddddd</td></tr><tr><td>Map Datum</td></tr><tr><td>WGS84</td></tr><tr><td>Map Spheroid</td></tr><tr><td>WGS84</td></tr></table> | | Position Format | hddd.ddddd | Map Datum | WGS84 | Map Spheroid | WGS84 |
| Position Format | | | | | | | | |
| hddd.ddddd | | | | | | | | |
| Map Datum | | | | | | | | |
| WGS84 | | | | | | | | |
| Map Spheroid | | | | | | | | |
| WGS84 | | | | | | | | |
| 3.12 | Click on the back button twice to return to the menu page | | | | | | | |
| 3.13 | Holding the GPS device horizontally in front of you, use the thumb stick to scroll down the menu page until the "Satellite" icon is highlighted. Next, press the thumb stick to access the "Satellite page" which looks as follows: |  Satellite | | | | | | |

| |  | | | | | | | | | | | | | |
|--------------|--|---|--------------|---------------|---------------|--------------|---------------|---------------|-------|------|----------|----------|----------|----------|
| 3.14 | <p>Wait for the accuracy value to become less than 15 metres with at least 4 satellite signals received (number of grey bars at the bottom of the page). Best practice would be to stay around one minute on the same spot to allow for the best reading possible.</p> <p>In the example shown here, the accuracy is 10 m with 6 satellite signals received (the transparent bar is not counted as it shows a signal that is not strong enough to be used).</p> |  | | | | | | | | | | | | |
| 3.15 | <p>Once the accuracy value is below 15 metres with at least 4 satellite signals, temporarily write down the number of satellite signals and the accuracy measure on a piece of paper.</p> | | | | | | | | | | | | | |
| 3.16 | <p>Mark the waypoint by pressing and holding the thumb stick. This will take you to the "Mark Waypoint" page as seen here:</p> |  | | | | | | | | | | | | |
| 3.17 | <p>Verify that the coordinates are within the Min-Max range of latitudes and longitudes for the Upazila in which the study site is located using the list of Min-Max Coordinates (Annex 9).</p> <p>In the example used above, Ramu Upazila Health Complex located in Ramu Upazila has latitude: 21.44489° and longitude: 92.10008°. These values are correctly between the Min and Max for this Upazila in Annex 9.</p> <table border="1" data-bbox="352 1630 1246 1688"> <thead> <tr> <th>Upazila_code</th> <th>Upazila_Name</th> <th>Min Latitude</th> <th>Max Latitude</th> <th>Min Longitude</th> <th>Max Longitude</th> </tr> </thead> <tbody> <tr> <td>22266</td> <td>Ramu</td> <td>21.27760</td> <td>21.61280</td> <td>91.98990</td> <td>92.25740</td> </tr> </tbody> </table> <p>If this is the case, check the "Yes" box in field 3c.</p> <div data-bbox="344 1756 1182 1872"> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> 3c. Coordinates falls within the min/max lat/long values </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> </div> </div> <p>If this is not the case, meaning that the coordinates falls outside the ranges:</p> <ul style="list-style-type: none"> - Verify again the units and position format of the device (steps 3.6 to 3.11) | | Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude | 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 |
| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude | | | | | | | | | |
| 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 | | | | | | | | | |

| | | | | | |
|---|--|---|---|--------------|----------------------------------|
| | <ul style="list-style-type: none"> - Take a new reading (steps 3.13 to 3.16) <p>If the coordinates continue to fall outside the ranges:</p> <ul style="list-style-type: none"> - Write “Coordinates fall outside of the range” in field 3h as per the following example and continue the process using the coordinates in question. <table border="1" data-bbox="352 356 1225 468"> <tr> <td data-bbox="352 356 719 468">3h: Comments regarding the GNSS based coordinates</td><td data-bbox="719 356 1225 468">Coordinates fall outside the ranges</td></tr> </table> | 3h: Comments regarding the GNSS based coordinates | Coordinates fall outside the ranges | | |
| 3h: Comments regarding the GNSS based coordinates | Coordinates fall outside the ranges | | | | |
| 3.18 | <p>Click twice on the menu button on the left of the device to get to the menu page and use the thumb stick until highlighting the "Map" icon.</p> <div data-bbox="1066 472 1225 600">  <p>Map</p> </div> | | | | |
| 3.19 | <p>Use the geographic objects on the map to identify if collected coordinates (appearing as a blue triangle) are falling in the right area.</p> <p>If this is the case, check the "Yes" option in field 3d as follow:</p> <table border="1" data-bbox="347 875 799 965"> <tr> <td data-bbox="347 875 644 965">3d. Coordinates falls in the right place on the offline map</td><td data-bbox="644 875 799 965"> Yes <input checked="" type="checkbox"/> </td></tr> </table> <p>If this is not the case:</p> <ul style="list-style-type: none"> - Verify again the units and position format of the device (steps 3.6 to 3.11) - Take a new reading (steps 3.13 to 3.16) <p>If the coordinates continue to fall outside the correct area:</p> <ul style="list-style-type: none"> - Write “Coordinates fall outside the correct area on the map” in field 3h as per the following example and continue the process using the coordinates in question <div data-bbox="991 703 1230 1106">  <p>Your location</p> </div> | 3d. Coordinates falls in the right place on the offline map | Yes <input checked="" type="checkbox"/> | | |
| 3d. Coordinates falls in the right place on the offline map | Yes <input checked="" type="checkbox"/> | | | | |
| 3.20 | <p>Write down the final number of satellite signals and accuracy in fields 3a and 3b of the customised form as presented here:</p> <table border="1" data-bbox="371 1576 1265 1800"> <tr> <td data-bbox="371 1576 746 1688">3a. Number of satellite signals received</td><td data-bbox="746 1576 1265 1688"> <div>0</div> <div>6</div> </td></tr> <tr> <td data-bbox="371 1688 746 1800">3b. Accuracy</td><td data-bbox="746 1688 1265 1800"> <div>1</div> <div>0</div> meters </td></tr> </table> | 3a. Number of satellite signals received | <div>0</div> <div>6</div> | 3b. Accuracy | <div>1</div> <div>0</div> meters |
| 3a. Number of satellite signals received | <div>0</div> <div>6</div> | | | | |
| 3b. Accuracy | <div>1</div> <div>0</div> meters | | | | |
| 3.21 | <p>Write the coordinates with 5 decimal digits in fields 3c and 3d of the form. Then complete field 3e with the location where you took the reading. If option 2 was checked in field 3e, write the details of the location in field 3f as per the example below:</p> | | | | |

| | | | | | | | | | |
|---|--|---------------------------------|----------|----------------------------------|-----------|----------------------------------|---|---|--|
| | <table border="1"> <tr> <td>3c. Latitude (Decimal degrees):</td><td>21.44489</td></tr> <tr> <td>3d. Longitude (Decimal degrees):</td><td>092.10008</td></tr> <tr> <td>3e. Waypoint (Circle one option)</td><td> 1 At the location 2 Near the location (for example, entrance gate, park or communal space) </td></tr> <tr> <td>3f. Comments regarding the GNSS based coordinates</td><td>Reading taken 50 meters from the entry of the study site</td></tr> </table> <p><i>Note: As much as possible, waypoints should be at the location being mapped – "1. At the location"</i></p> | 3c. Latitude (Decimal degrees): | 21.44489 | 3d. Longitude (Decimal degrees): | 092.10008 | 3e. Waypoint (Circle one option) | 1 At the location 2 Near the location (for example, entrance gate, park or communal space) | 3f. Comments regarding the GNSS based coordinates | Reading taken 50 meters from the entry of the study site |
| 3c. Latitude (Decimal degrees): | 21.44489 | | | | | | | | |
| 3d. Longitude (Decimal degrees): | 092.10008 | | | | | | | | |
| 3e. Waypoint (Circle one option) | 1 At the location 2 Near the location (for example, entrance gate, park or communal space) | | | | | | | | |
| 3f. Comments regarding the GNSS based coordinates | Reading taken 50 meters from the entry of the study site | | | | | | | | |
| 3.22 | Write down any other comments you might have about the reading in field 3f (Put "None" if you do not have any) | | | | | | | | |
| 3.23 | Complete fields 3g to 3j of the form (the serial number can be found inside the battery compartment) | | | | | | | | |
| 3.24 | Check back through the form and complete any remaining fields | | | | | | | | |
| 3.25 | Move to the next study site and restart from section 1 IMPORTANT: Turn off the GPS device by holding down the on/off button until you are at the next point to be collected. | | | | | | | | |

Annex 12 - Standard Operating Procedure (SOP) when using an Android-based device equipped with an in-built GNSS receiver, the GPS Essentials and the Google Maps or Maps.Me applications (Options 7 to 12)

Equipment (hardware and software):

- GNSS-enabled Android device
- GPS Essentials application installed on the device
- Google Maps or Maps.Me application installed on the device

Documents to be used by the data collector:

- Paper version of the geographic form A 1.3 (Annex 1)
- Administrative division master list (Example in Annex 4)
- Infrastructure master list (Example in Annex 5)
- Min/max expected geographic coordinates (Example in Annex 9)

Steps to be followed:

Please fill out the geographic form as follows once arrived on site of each study site to be surveyed:

1. Section 1 - Name and code of the geographic object as per the master list:

- 1.1 Write the official name of the study site as per the geographic object master list (Annex 5) in field 1a;
- 1.2 Write the official code of the study site as per the geographic object master list (Annex 5) in field 1b;

Example: The example below illustrates how the information for Ramu Upazila Health Complex (a community health facility in Bangladesh) should be entered for these two fields in the form:

| | |
|--|-----------------------------|
| 1a. Name of the study site as per the master list (Annex 5) | Ramu Upazila Health Complex |
| 1b. Code of the study site as per the master list (Annex 5): | S T S 0 2 3 |

2. Section 2 - Address and location of the geographic object:

- 2.1 Write the street name and number of the study site in field 2a. No other information (such as the name of an administrative division) should appear in this field.

If the study site is located in a place for which there is no street name or/ number then “NA” (standing for “Not Applicable”) should be entered here.

- 2.2 Write the official postal code (zip code) for the area in which the study site is located.

If unknown at the time of data collection, this code can be obtained from a country specific resource. In the case of Bangladesh, the Bangladesh Post Office A(<http://www.bangladeshpost.gov.bd/postcode.asp>) provides this information online.

Example: The figure below illustrates how the information for Ramu Upazila Health Complex is entered in the fields 2a and 2b of the customized form:

| | |
|-------------------------------------|-----------------|
| 2a. Building number and street name | National road 1 |
| 2b. Postal code | 4 7 3 0 |


2.3 Use the master list of administrative divisions (Annex 4) to enter the information for fields 2c, 2d, 2e and 2f.


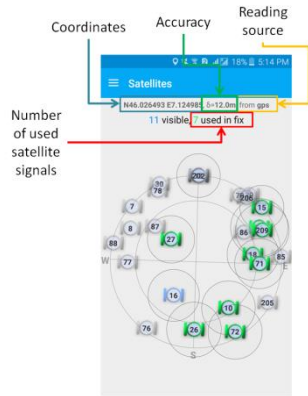
Ensure that the correct spelling and code are used (including the “0” at the front of the code in some cases).

Example: The figure below illustrates how the information should be entered for Ramu Upazila Health Complex in these fields:

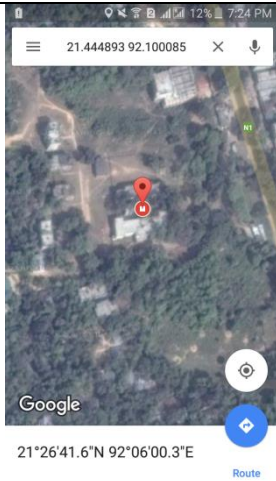
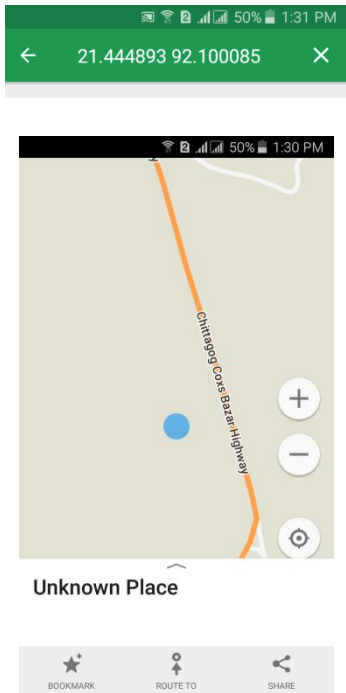
| | |
|---|-------------|
| 2c. Name of the Division as per the official master list (Annex 4): | Chittagong |
| 2d. Name of the Zila as per the official master list (Annex 4): | Cox's Bazar |
| 2e. Name of the Upazila as per the official master list (Annex 4): | Ramu |
| 2f. Code of the Upazila as per the official master list (Annex 4): | 2 0 2 2 6 6 |

3. Section 3 - Geographic coordinates of the geographic object:

| Step | Action |
|------|---|
| 3.1 | Once you have arrived at the place to be located, find an open space, turn the GPS option of your Android device on and open the GPS Essentials application. |
| 3.2 | <div> Go to the “Settings” page using the icon presented on the right and fix the settings for the following 3 components as presented in the figures below: Units => Meters (SI) Position datum => World Geodetic System 1984 Position format => Decimal </div> <div>  Settings </div> |

| | | |
|-----|---|---|
| | <div> <div> Units <ul style="list-style-type: none"> <input type="radio"/> Kilometers, Meters <input type="radio"/> Miles, Yards, Feet <input type="radio"/> Miles, Feet <input type="radio"/> Nautical Miles, Feet <input type="radio"/> Nautical Miles, Meters <input checked="" type="radio"/> Meters (SI) </div> <div> Position Format <ul style="list-style-type: none"> <input type="radio"/> Degrees, Minutes, Seconds <input type="radio"/> Degrees, Minutes, Fractions <input checked="" type="radio"/> Decimal <input type="radio"/> UTM <input type="radio"/> MGRS <input type="radio"/> OSGB36 </div> </div> <div> <p>CANCEL</p> <p>CANCEL</p> </div> <div> Position Datum <ul style="list-style-type: none"> <input type="radio"/> YACARE, Uruguay <input type="radio"/> ZANDERIJ, Suriname <input type="radio"/> KOREAN GEO DATUM 1995, S Korea <input type="radio"/> SIRGAS, South America <input type="radio"/> EUROPEAN 1950, Mean (7 Param) <input type="radio"/> ORDNANCE GB 1936, Mean (7 Para) <input type="radio"/> Petroleum Development Oman 1993 <input checked="" type="radio"/> World Geodetic System 1984 <input type="radio"/> World Geodetic System 1972 <input type="radio"/> NORTH AMERICAN 1983, CONUS <p>CANCEL</p> </div> | |
| 3.3 | Go to the “Main menu” page and click on the “Satellites” Icon presented on the side here. |  <p>Satellites</p> |
| 3.4 | Move to the point to be located and stay on the same spot for at least 1 minute (depending on the hardware of your Android phone/tablet) to allow for the best reading possible. | |
| 3.5 | <p>Make sure the reading is taken by the GPS receiver and not a nearby wifi connection (element in orange in the example on the right) and then wait for GPS Essentials to take a reading with:</p> <ul style="list-style-type: none"> - At least 4 satellite signals to be used in the fix (element in red in the side figure) - The accuracy reading to be below 15 meters (green element in the side figure) |  <p>The screenshot shows the GPS Essentials interface. At the top, it displays 'Coordinates' (N46.926493 E7.123400), 'Accuracy' (12.3m), and 'Reading source' (GPS). Below this, it says '11 visible' and 'used in fix'. A red box highlights the 'used in fix' text. A green box highlights the '12.3m' accuracy. The bottom part of the screen shows a map with several satellite signals represented by green circles, each with a number inside. A red box highlights one of these signals.</p> |

| | <p>In the example shown below, the accuracy is 12 meters with 11 visible satellite and 7 used for the coordinates</p> <div style="border: 1px solid black; padding: 10px; text-align: center;"> <p>N21.444893 E92.100085, δ=12.0m, from gps</p> <p>11 visible, 7 used in fix</p> </div> | | | | | | | | | | | | |
|--------------|---|--------------|--------------|---------------|---------------|---------------|---------------|-------|------|----------|----------|----------|----------|
| 3.6 | <p>Once the accuracy value is below 15 meters with at least 4 satellite signals, temporarily write down:</p> <ul style="list-style-type: none"> - the number of satellite signals and accuracy measure - the latitude and longitude shown on the screen | | | | | | | | | | | | |
| 3.7 | <p>Verify that the coordinates are within the Min-Max range of latitudes and longitudes for the Upazila in which the study site is located using the list of Min-Max Coordinates (Annex 9).</p> <p>In the example used above, Ramu Upazila Health Complex, located in Ramu Upazila, has latitude: 21.44489° and longitude: 92.10008°.</p> <p>These values are correctly between the Min and Max for this Upazila in Annex 9.</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>Upazila_code</th><th>Upazila_Name</th><th>Min Latitude</th><th>Max Latitude</th><th>Min Longitude</th><th>Max Longitude</th></tr> </thead> <tbody> <tr> <td>22266</td><td>Ramu</td><td>21.27760</td><td>21.61280</td><td>91.98990</td><td>92.25740</td></tr> </tbody> </table> <p>If this is the case, put a cross in the "Yes" box in field 3c.</p> <div style="border: 1px solid black; padding: 5px;"> <div style="display: flex; align-items: center;"> <div style="background-color: #d3d3d3; padding: 5px; flex: 1;"> <p>3c. Coordinates falls within the min/max lat/long values</p> </div> <div style="flex: 1; text-align: center;"> <p>Yes <input checked="" type="checkbox"/></p> </div> <div style="flex: 1; text-align: center;"> <p>No <input type="checkbox"/></p> </div> </div> </div> <p>If this is not the case, meaning that the coordinates falls outside the ranges:</p> <ul style="list-style-type: none"> - Verify again the units of the device (steps 3.2) - Take a new reading (steps 3.3 to 3.8) <p>If the coordinates continue to fall outside the ranges:</p> <ul style="list-style-type: none"> - Write "Coordinates fall outside of the range" in field 3h as per the following example and continue the process using the coordinates collected: <div style="border: 1px solid black; padding: 5px;"> <div style="display: flex; align-items: center;"> <div style="background-color: #d3d3d3; padding: 5px; flex: 1;"> <p>3h: Comments regarding the GNSS based coordinates</p> </div> <div style="flex: 1; text-align: center;"> <p>Coordinates fall outside the ranges</p> </div> </div> </div> | Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude | 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 |
| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude | | | | | | | | |
| 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 | | | | | | | | |
| 3.8 | Switch from GPS essentials to Google Maps or Maps.Me | | | | | | | | | | | | |
| 3.9 | Enter the coordinates written down under step 3.6 in the search window and tap the search button () | | | | | | | | | | | | |

| | | | | | | |
|---|---|---|---|--|--|--|
| 3.10 | <p>Verify that the resulting pin falls in the right place on the map.</p> <p>If it is not possible to make the verification because the image is blurry or cloudy, check the "Not sure" option in field 3d.</p> <p>If this is the case, check the "Yes" option in field 3d as follow:</p> <table><tr><td>3d. Coordinates falls in the right place on the offline map</td><td>Yes <input checked="" type="checkbox"/></td></tr></table> <p>If this is not the case:</p> <ul style="list-style-type: none">- Make sure that there is no typo in the coordinates you have entered in the search field- Verify again the units of the device (steps 3.2)- Take a new reading (steps 3.3 to 3.8) <p>If the coordinates continue to fall outside the correct area: Write “Coordinates fall outside the correct area on the map” in field 3h as per the following example and continue the process using the coordinates in question</p> | 3d. Coordinates falls in the right place on the offline map | Yes <input checked="" type="checkbox"/> |  <p>In Google Map</p>  <p>In Maps.me</p> | | |
| 3d. Coordinates falls in the right place on the offline map | Yes <input checked="" type="checkbox"/> | | | | | |
| 3.11 | <p>Write down the final number of satellites and accuracy measure in fields 3a and 3b as presented here:</p> <table><tr><td>3a. Number of satellite signals received</td><td><input type="text" value="0"/><input type="text" value="7"/></td></tr><tr><td>3b. Accuracy</td><td><input type="text" value="1"/><input type="text" value="2"/> metres</td></tr></table> | 3a. Number of satellite signals received | <input type="text" value="0"/> <input type="text" value="7"/> | 3b. Accuracy | <input type="text" value="1"/> <input type="text" value="2"/> metres | |
| 3a. Number of satellite signals received | <input type="text" value="0"/> <input type="text" value="7"/> | | | | | |
| 3b. Accuracy | <input type="text" value="1"/> <input type="text" value="2"/> metres | | | | | |
| 3.12 | <p>Write the coordinates with 5 decimal digits in fields 3e and 3f of the form. Then complete field 3g with the location where you took the reading. If option 2 was checked in field 3g, write the details of the location in field 3h as per the example below:</p> | | | | | |

| | | | | | | | | | |
|---|---|---------------------------------|----------|----------------------------------|-----------|----------------------------------|--|---|--|
| | <table border="1"> <tr> <td>3e. Latitude (Decimal degrees):</td><td>21.44489</td></tr> <tr> <td>3f. Longitude (Decimal degrees):</td><td>092.10008</td></tr> <tr> <td>3g. Waypoint (Circle one option)</td><td> 1 At the location <input checked="" type="radio"/> 2 At a nearby location (for example, at the gate, in a park or communal space) </td></tr> <tr> <td>3h: Comments regarding the GNSS based coordinates</td><td>Coordinates collected in a parking lot 50 m away from the study site</td></tr> </table> <p><i>Note: Wherever possible, waypoints should be at the location being mapped – “1. At the location”</i></p> | 3e. Latitude (Decimal degrees): | 21.44489 | 3f. Longitude (Decimal degrees): | 092.10008 | 3g. Waypoint (Circle one option) | 1 At the location <input checked="" type="radio"/> 2 At a nearby location (for example, at the gate, in a park or communal space) | 3h: Comments regarding the GNSS based coordinates | Coordinates collected in a parking lot 50 m away from the study site |
| 3e. Latitude (Decimal degrees): | 21.44489 | | | | | | | | |
| 3f. Longitude (Decimal degrees): | 092.10008 | | | | | | | | |
| 3g. Waypoint (Circle one option) | 1 At the location <input checked="" type="radio"/> 2 At a nearby location (for example, at the gate, in a park or communal space) | | | | | | | | |
| 3h: Comments regarding the GNSS based coordinates | Coordinates collected in a parking lot 50 m away from the study site | | | | | | | | |
| 3.13 | Write down any other comments you might have about the reading in field 3f (Put "None" if you do not have any) | | | | | | | | |
| 3.14 | Complete fields 3g to 3j of the form | | | | | | | | |
| 3.15 | Check back through the form and complete any remaining fields | | | | | | | | |
| 3.16 | Move to the next study site and restart from section 1 | | | | | | | | |

Annex 13 - Standard Operating Procedure (SOP) when using Survey123 with built in GNSS receiver on Android or iOS device (Option 9)

Equipment (hardware and software):

- Computer with Survey123 Connect installed in it
- GNSS-enabled Android device or iOS device
- Survey123 installed on the device

Documents to be used by the data collector:

- Administrative division master list (Example in Annex 4)
- Infrastructure master list (Example in Annex 5)
- Min/max expected geographic coordinates (Example in Annex 9)

Prior to Survey123 data collection

The survey will be created on a computer with Survey123 Connect installed in it. To find out more about Survey123, refer to the HGL Starter Kit for Survey123 for ArcGIS²⁹. This starter kit also includes information on downloading/installing Survey123 Connect and the Survey123 field app, creating a survey, and collecting data. The steps to create this particular survey are listed specifically in the section below (“Steps to be followed for Survey123 form creation”). Figure 2 details the Excel worksheet (XLSForm) used to create the Survey123 form.

The Administrative Master List and the Infrastructure Master List can be embedded in the survey itself as a choice list for their respective fields (as is done in this survey). For the name of the administrative division or infrastructure, the autocomplete feature will supply the name as it is typed in based on this embedded choice list while the administrative division or infrastructure code will be automatically supplied using the pulldata function based on the administrative division or infrastructure name. Using existing data such Administrative Master List and the Infrastructure Master List in Survey123 can be done by following the steps in section 7.2.3 *Using existing data in your survey* of the Starter kit - Survey123 for ArcGIS²⁸.

Once the survey is created and before collecting data with the Survey123 form, it is necessary to download and install Survey123 from the available download page for [Apple](#) or [Google Play](#) stores. Specific references for how to download/install Survey123 are available from the Survey123 starter kit.

Following the creation of the Survey123 form, it should be tested with a small number of users. In this case, the survey should be published and shared with a smaller group within the organization. After initial testing, if satisfied with the questions and user experience, share the survey with the entire organization or other personnel who need access.

²⁹ https://www.healthgeolab.net/DOCUMENTS/HGL_Survey123_starter_kit.pdf

Steps to be followed for Survey123 form creation:

| Question | Survey123 Question Type Used | Additional Settings | Reason/Comments |
|----------------|------------------------------|---|--|
| Section 1 | Begin group | | Organizes content into related section |
| 1a | Select One (list) | Autocomplete | Allows user to filter list as they type |
| 1b | Text | Pull data from table | Automatically populates info based on name given in 1a |
| N/A | End group | | Must complete the first section |
| Section 2 | Begin group | | Organizes content into related section |
| 2a | Text | | Allows user to enter text address including numbers |
| 2b | Integer | pull data from table; input mask (9999) ³⁰ | Automatically populates info based on name given in 1a; numbers used for postal code ³¹ |
| 2c | Text | pull data from table | Automatically populates info based on name given in 1a |
| 2d | Text | pull data from table | Automatically populates info based on name given in 1a |
| 2e | Text | pull data from table | Automatically populates info based on name given in 1a |
| 2f | Integer | pull data from table | Automatically populates info based on name given in 1a; numbers used for admin code |
| N/A | End group | | Must complete the second section |
| Section 3 | Begin group | | Organizes content into related section |
| 3a | Select One (list) | | Choose yes or no based on map visibility |
| Point location | Geopoint | Accuracy threshold - 50 meters | Need Geopoint field to get point location |
| 3b | Decimal | Pull data from point location/GPS | Number for estimated scale/accuracy ³² |
| 3c | Select One (list) | | Choose yes or no if coordinates fall into acceptable range ³³ |
| 3d | Decimal | Pull data from point location/GPS | Decimal numbers for latitude |
| 3e | Decimal | Pull data from point location/GPS | Decimal numbers for longitude |
| 3f | Text | Multiline appearance, 1000 character limit | Additional blank space and characters for writing related comments |
| 3g | Text | | Text field for entering name ³⁴ |
| 3h | DateTime | Defaults to the formatted for mm/dd/yyyy hh:mm | Date and Time entered in for collection, defaults to the minute the survey is opened. |

³⁰ Input masks force a particular format for the data. More information on input masks here: [Input Masks - Survey123](#)

³¹ This assumes that there are no postal codes with leading zeros (0). Otherwise Question type should be text

³² Depending on accuracy of GPS, this could be integer, but decimal gives better resolution beyond integer

³³ In the future this question would be automatically determined based on a table of acceptable max/min lat and long pairs for each admin code (similar to Annex 9)

³⁴ Survey123 also has the ability to capture email and/or username used to sign into the survey if needed.

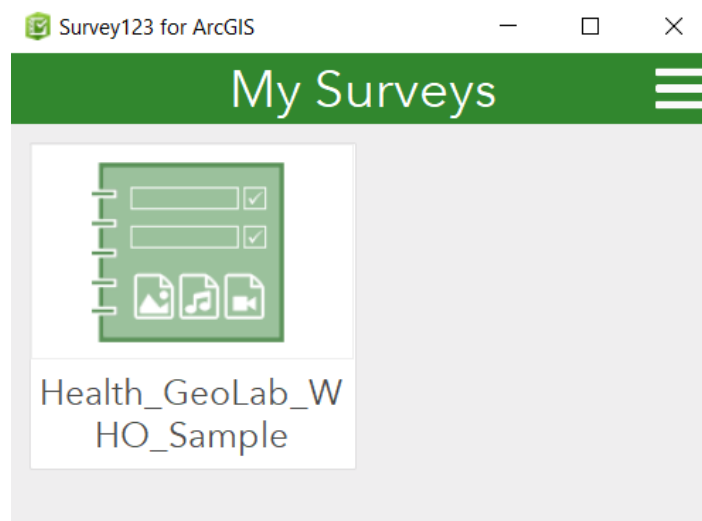
| type | name | label |
|-----------------------|-----------------------------|--|
| begin group | section_1_study_site | Section 1 Name and Code of Study Site |
| select_one study_site | study_site_name | 1a. Name of the geographic object as per the master list |
| text | study_site_code | 1b. Code of the geographic object as per the master list |
| end group | | |
| begin group | section_2_address | Section 2 Address and Location of the Geographic object |
| text | site_address | 2a. Street name and number |
| integer | site_zip_code | 2b. Postal Code |
| text | site_first_admin | 2c. Name of the 1st level administrative division as per the official master list: |
| text | site_second_admin | 2d. Name of the 2nd level administrative division as per the official master list: |
| text | site_third_admin | 2e. Name of the 3rd level administrative division as per the official master list: |
| integer | site_third_admin_code | 2f. Code of the upazila as per the official master list: |
| end group | | |
| begin group | section_3_geo_coordinates | Section 3 Geographic coordinates of the geographic object |
| select_one yes_no_geo | site_visible | 3a. Location of the geographic object visible on the map |
| geopoint | site_geographic_coordinates | Site Coordinates |
| decimal | site_scale | 3b. Scale at the time of taking the coordinates (maximum: 50 meters) |
| select_one yes_no | site_coordinates_minmax | 3c. Coordinates fall within the min/max lat/long values? |
| decimal | site_coordinates_lat | 3d. Latitude (Decimal Degrees) |
| decimal | site_coordinates_long | 3e. Longitude (Decimal Degrees) |
| text | site_comment | 3f. Comments regarding the reading on the map: |
| text | site_name_operator | 3g. Name of the operator: |
| dateTime | site_collection_date | 3h. Collection Date |

| | | |
|-----------|--|--|
| end group | | |
|-----------|--|--|

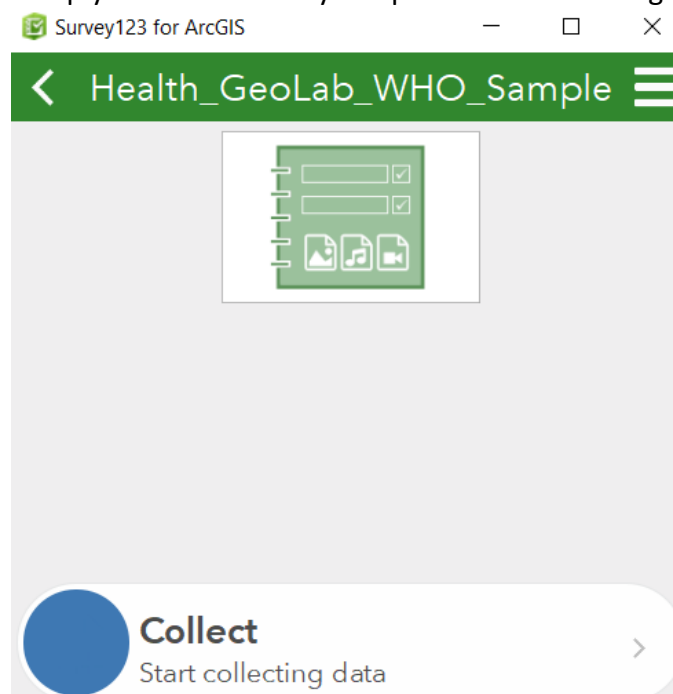
Figure 2. Excel worksheet to create the Survey123 form.

Steps to be followed for data collection:

To begin data collection, open the Survey123 application from your mobile device. This will open the main page – “My Surveys” as indicated below:



If you have already downloaded the Survey (“Health_GeoLab_WHO_Sample”), this will appear in this menu. Simply select the survey to open the menu to begin survey collection:



Selecting “Collect” at the bottom of the menu will open the survey.

Please fill out the geographic form as follows once arrived on site of each study site to be surveyed:

1. Section 1 - Name and code of the geographic object as per the master list:
 - 1.1. Write the official name of the study site as per the geographic object master list (Annex 5) in field 1a. As you type, the list of available study sites should filter to those that contain those characters. Select the site that is appropriate;
 - 1.2. Once the official name of the study site is entered, field 1b will automatically populate with the correct official code of the study site. If desired, check that the code corresponds to the code listed per the geographic object master list (Annex 5)

Example: The examples below illustrate how the information for Ramu Upazila Health Complex (a community health facility in Bangladesh) should be entered for the first question (1a). Notice as Ramu is entered in the textbox that all the sites containing “Ramu” filter and then you can choose “Ramu Upazila Health Complex.” Upon completing 1a, 1b should default to correct study site code.

1a Name of the object as per the master list

☐ Ramu Upazila Health Complex (Chakaria)

☐ Ramu Cantonment

☒ Ramu Upazila Health Complex

☐ Ramu Mokti Office

1a Name of the object as per the master list

1b Code of the object as per the master list

2. Section 2 - Address and location of the geographic object:
 - 2.1 Write the street name and number of the study site in field 2a. No other information (such as the name of an administrative division) should appear in this field.

If the study site is located in a place for which there is no street name or/ number then “NA” (standing for “Not Applicable”) should be entered here.
 - 2.2 If there is an existing official postal code (zip code) associated with the area, this information will automatically populate based on the site name (from 1a).

If unknown at the time of data collection, this code can be obtained from a country specific resource. In the case of Bangladesh, the Bangladesh Post Office (<http://www.bangladeshpost.gov.bd/postcode.asp>) provides this information online.

Example: The examples below illustrate how the information for Ramu Upazila Health Complex (a community health facility in Bangladesh) should be entered questions 2a, 2b. (2b can be automatically populated based on the

information entered in the administrative division where the study site is located.)

2a. Street name and number

National Road 1

2b. Postal Code

2022

2.3 The information for 2c, 2d, 2e, 2f should be populated automatically after entering site name (question 1a).

Use the master list (Annex 4) to ensure that the correct spelling and code are used (including the “0” at the front of the code in some cases).

Example: The figure below illustrates how the information should be entered for Ramu Upazila Health Complex in these fields:

2c. Name of the 1st level administrative division as per the official master list:

Chittagong

2d. Name of the 2nd level administrative division as per the official master list:

Cox's Bazar


2e. Name of the 3rd level administrative division as per the official master list:

Ramu

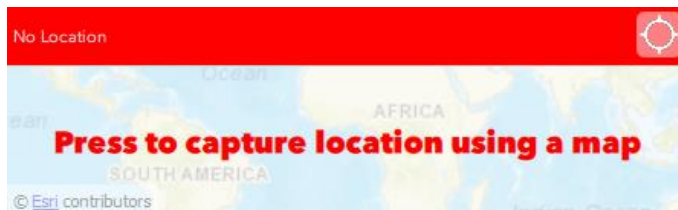
2f. Code of the upazila as per the official master list:

202266

3. Section 3 - Geographic coordinates of the geographic object:

| Step | Action |
|------|---|
| 3.1 | <p>When you get to this section in Survey123, please take a minute to ensure the map looks similar to the following:</p> <div data-bbox="229 1836 1420 2049"> <p>Site Coordinates</p> <p>42.598°N 70.972°W ± 75 m</p>  </div> |

If there is no location (as seen in the graphic below) or the location is not accurate, let Survey123 access your location by pressing the target button in the upper left corner (as highlighted by the red box).



If there remains no ability to collect location, you need to allow Survey123 to have access to your device's GPS location. In the iOS or Android settings, go to Survey123 and allow for the application to use the device location while using the app. In the iPhone it should be similar to Figure 3. Figure 4 details the similar settings for Android devices.

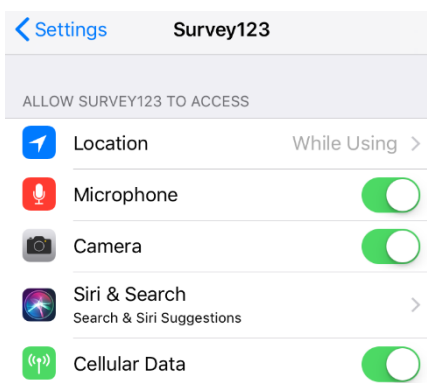


Figure 3. iPhone Survey123 settings

It is also important to allow Survey123 to use cellular data if you have no external GNSS receiver, as this will be the ability for Survey123 to get better locations and to submit data while in the field.

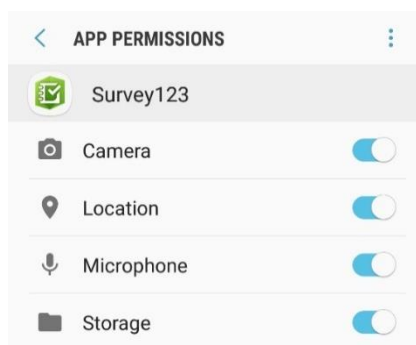
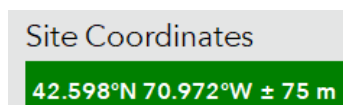


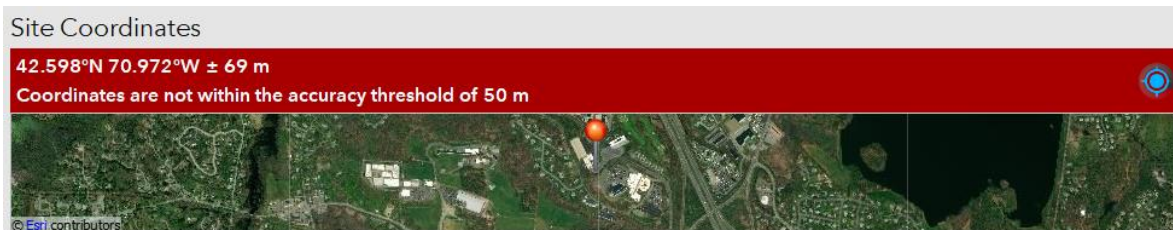
Figure 4. Android. Survey123 settings

- 3.2 Move to the point to be located and press the target button for Survey123 to acquire your collection. To collect multiple positions, hold this target button down for several seconds. To stop collection, simply tap the target button once. The estimated accuracy is indicated in the map below where the \pm is:



In this instance, the estimated accuracy is 75 meters. If this number is greater than 50

meters, then you will not be able to collect the point location and instead the map will look will like the following:



Allow Survey123 additional time to collect your location. Or you can use the target button to reestablish the location within Survey123. Once your accuracy is better than 50 meters, you will be allowed to collect a point location for the site.

3.3 After the position of the point has been collected, the associated accuracy (question 3b) will automatically populate from the information provided by your mobile device GPS that is used within Survey123. The associated latitude and longitude (3d and 3e) will also automatically populate for the site point coordinates.

3.4 Compare the latitude and longitude, which are automatically completed for you in 3d and 3e to the minimum and maximum lat/long pairs for the appropriate administrative region. For instance, with Ramu, coordinates should range from 21.27760 and 21.61280 for Latitude and 91.98990 and 92.25740 for Longitude. Data for associated max and min latitudes and longitudes is available in Annex 9. Example of Ramu min and max below:

| Upazila_code | Upazila_Name | Min Latitude | Max Latitude | Min Longitude | Max Longitude |
|--------------|--------------|--------------|--------------|---------------|---------------|
| 22266 | Ramu | 21.27760 | 21.61280 | 91.98990 | 92.25740 |

If the coordinates are between the min and max for both latitude and longitude, select “yes” for question 3c as indicated below:

3c. Coordinates fall within the min/max lat/long values?

☒ Yes ☐ No

If this is not the case, meaning that the coordinates falls outside the ranges:

- Review step 3.2 to reacquire the site location coordinates

If the coordinates continue to fall outside the ranges:

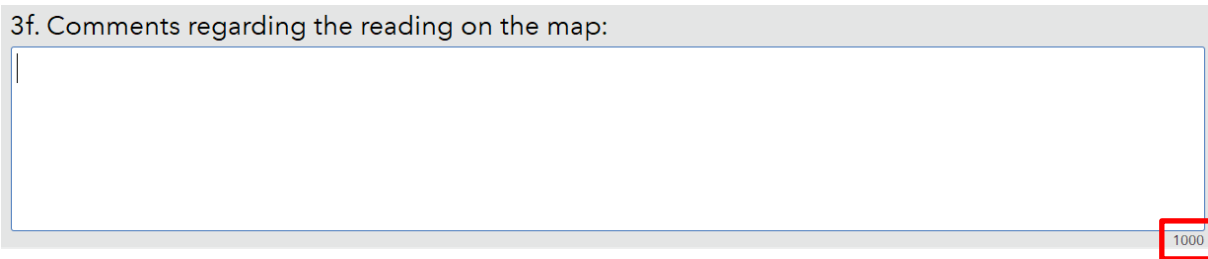

- Write “Coordinates fall outside of the range” in field 3f as per the following example and continue the process using the coordinates collected:

3f. Comments regarding the reading on the map:

Coordinates fall outside the ranges

In the case, select ‘No’ as the coordinates are not between the minimum and maximum (3c)

3.5 For question 3f, enter any comments into the textbox, such as if the coordinates are outside the min/max latitude and longitude threshold or the estimated accuracy of the site

| | |
|-----|--|
| | <p>coordinates. In the textbox you will see a small number in the lower right-hand corner as indicated in the picture below (outlined by the red box):</p> <p>3f. Comments regarding the reading on the map:</p>  <p>This number shows the remaining number characters accepted in the textbox. You have a maximum of 1000 characters and as you type this number will decrease accordingly to how many you enter. This includes spaces between words. You will not be able to enter more text after this number reaches zero (0).</p> <p>If you do not have any comments enter "None" if you do not have any.</p> |
| 3.6 | Enter your name in the space indicated for 'Name of the operator' for question 3g |
| 3.7 | Question 3h will automatically populate with the current date that the survey is opened. There is no need to change this date. |
| 3.8 | <p>Once you have entered in the information for all questions, select the checkmark as indicated below:</p>  <p>This checkmark should be in the lower right-hand corner. If your device is online, you will be able to submit your survey.</p> <p>Full details on how to properly submit your survey can be found in the Survey123 starter kit, section for 7.3.2 Collecting data in the field using the Survey123 Field App.</p> |
| 3.9 | Move to the next study site and restart from section 1 |

Annex 14 – Example of structured database- Health facilities in the Philippines

| HF_Name | HF_Code | Address | Pos_Code | Reg_name | Prov_name | Mun_name | Bgy_name | Bgy_code | Nbr_Sat | Accuracy | Wtin_box | Wtin_map | Latitude | Longitude | Waypoint | Comments | Op_Name | Dev_brand | Dev_ser | Coll_date |
|----------------------------------|---------|------------------|----------|------------|-----------|--------------|----------------------|-------------|---------|----------|----------|----------|----------|-----------|----------|--|-----------------|-----------------|----------|-----------|
| SANTANDER RURAL HEALTH UNIT | 903 | NATIONAL ROAD | 6026 | REGION VII | CEBU | SANTANDER | POBLACION | PH072245008 | 10 | 9.3 | Yes | Yes | 9.41705 | 123.3349 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| ALCANTARA RURAL HEALTH UNIT | 1399 | NA | 6033 | REGION VII | CEBU | ALCANTARA | POBLACION | PH072201007 | 10 | 10.5 | Yes | Yes | 9.97036 | 123.4024 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| ALCOY RURAL HEALTH UNIT | 1437 | NATIONAL HIGHWAY | 6023 | REGION VII | CEBU | ALCOY | POBLACION | PH072202006 | 11 | 10.1 | Yes | Yes | 9.70925 | 123.50729 | 2 | Reading taken 10 meters away from the facility | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| BALIRI RURAL HEALTH UNIT | 1454 | NA | 6036 | REGION VII | CEBU | BARILI | POBLACION | PH072210038 | 9 | 10.0 | Yes | Yes | 10.11565 | 123.50997 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| BORBON RURAL HEALTH UNIT | 1458 | NA | 6008 | REGION VII | CEBU | BORBON | POBLACION | PH072213015 | 10 | 10.3 | Yes | Yes | 10.88766 | 124.02753 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| MINGLANILLA RURAL HEALTH UNIT I | 1465 | NA | 6046 | REGION VII | CEBU | MINGLANILLA | POBLACION WARD IV | PH072232013 | 10 | 10.1 | Yes | Yes | 10.24579 | 123.79552 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| MINGLANILLA RURAL HEALTH UNIT II | 1897 | LIPATA STREET | 6046 | REGION VII | CEBU | MINGLANILLA | LINAO | PH072232007 | 10 | 10.3 | Yes | Yes | 10.25576 | 123.80998 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| RONDA RURAL HEALTH UNIT | 1983 | NA | 6034 | REGION VII | CEBU | RONDA | POBLACION | PH072239011 | 10 | 10.4 | Yes | Yes | 10.00051 | 123.40961 | 2 | Reading taken on the nearby parking | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| SAMBOAN RURAL HEALTH UNIT | 2032 | NA | 6027 | REGION VII | CEBU | SAMBOAN | POBLACION | PH072240011 | 11 | 10.0 | Yes | Yes | 9.52916 | 123.30664 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| CONSOLACION RURAL HEALTH UNIT | 2890 | NA | 6001 | REGION VII | CEBU | CONSOLACION | POBLACION OCCIDENTAL | PH072219013 | 10 | 10.2 | Yes | Yes | 10.37651 | 123.95548 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| BADIAN RURAL HEALTH UNIT | 2971 | NA | 6031 | REGION VII | CEBU | BADIAN | POBLACION | PH072207020 | 10 | 10.4 | Yes | Yes | 9.86547 | 123.39327 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| MENDELIN RURAL HEALTH UNIT | 3245 | NA | 6012 | REGION VII | CEBU | MEDELLIN | POBLACION | PH072231014 | 10 | 9.7 | Yes | Yes | 11.13814 | 123.96175 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| SAN REMEGIO RURAL HEALTH UNIT | 3830 | NA | 6011 | REGION VII | CEBU | SAN REMIGIO | POBLACION | PH072243020 | 9 | 9.5 | Yes | Yes | 11.0844 | 123.93526 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| SOGOD RURAL HEALTH UNIT | 3846 | NA | 6007 | REGION VII | CEBU | SOGOD | POBLACION | PH072247016 | 10 | 8.0 | Yes | Yes | 10.74711 | 124.00234 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| MALABUYOC RURAL HEALTH UNIT | 4618 | NA | 6029 | REGION VII | CEBU | MALABUYOC | BARANGAY I (POB.) | PH072229015 | 9 | 10.2 | Yes | Yes | 9.65667 | 123.32608 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| TABOGON RURAL HEALTH UNIT | 4662 | NA | 6009 | REGION VII | CEBU | TABOGON | POBLACION | PH072248018 | 7 | 7.9 | Yes | Yes | 10.93972 | 124.02554 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| OSLOB RURAL HEALTH UNIT | 4734 | SAN JOSE STREET | 6025 | REGION VII | CEBU | OSLOB | POBLACION | PH072235020 | 10 | 9.7 | Yes | Yes | 9.52043 | 123.43307 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| TABUELAN RURAL HEALTH UNIT | 4902 | NA | 6044 | REGION VII | CEBU | TABUELAN | POBLACION | PH072249016 | 9 | 10.6 | Yes | Yes | 10.82051 | 123.86578 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| SIBONGA RURAL HEALTH UNIT | 4953 | NA | 6020 | REGION VII | CEBU | SIBONGA | POBLACION | PH072246021 | 10 | 10.3 | Yes | Yes | 10.0168 | 123.62104 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| DAANBANTAYAN RURAL HEALTH UNIT I | 5321 | NA | 6013 | REGION VII | CEBU | DAANBANTAYAN | POBLACION | PH072221016 | 11 | 9.9 | Yes | Yes | 11.25073 | 123.99672 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| CATMON RURAL HEALTH UNIT | 5776 | NA | 6006 | REGION VII | CEBU | CATMON | POBLACION | PH072216019 | 11 | 9.9 | Yes | Yes | 10.72265 | 124.01185 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| DUMANJUG RURAL HEALTH UNIT | 6660 | NA | 6035 | REGION VII | CEBU | DUMANJUG | POBLACION | PH072224039 | 11 | 10.4 | Yes | Yes | 10.05895 | 123.43551 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| BOLJOON RURAL HEALTH UNIT | 7249 | NATIONAL HIGHWAY | 6024 | REGION VII | CEBU | BOLJOON | POBLACION | PH072212005 | 10 | 10.3 | Yes | Yes | 9.62875 | 123.47986 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| CARMEN RURAL HEALTH UNIT | 7262 | NA | 6005 | REGION VII | CEBU | CARMEN | POBLACION | PH072215016 | 9 | 9.9 | Yes | Yes | 10.58881 | 124.0162 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| GINATILAN RURAL HEALTH UNIT | 7668 | NA | 6028 | REGION VII | CEBU | GINATILAN | POBLACION | PH072225012 | 10 | 10.2 | Yes | Yes | 9.56988 | 123.312 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| MOALBOAL RURAL HEALTH UNIT | 7669 | NA | 6032 | REGION VII | CEBU | MOALBOAL | POBLACION EAST | PH072223010 | 11 | 10.5 | Yes | Yes | 9.9364 | 123.39281 | 1 | None | Josephine Baker | Garmin eTrex 20 | 30E00615 | 10-12-12 |
| ALEGRIA RURAL HEALTH UNIT | 7670 | NA | 6030 | REGION VII | CEBU | ALEGRIA | POBLACION | PH072203007 | 9 | 10.0 | Yes | Yes | 9.72951 | 123.33949 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |
| MALINGIN BARANGAY HEALTH STATION | 15099 | NA | 6013 | REGION VII | CEBU | DAANBANTAYAN | MALINGIN | PH072221012 | 11 | 9.9 | Yes | Yes | 11.219 | 124.01289 | 1 | None | Daniel Durand | Garmin eTrex 30 | 30E00828 | 10-12-12 |

Annex 15 – Process to test if the GNSS receiver of a GNSS-enabled device is functioning properly

This Annex presents the steps to be followed to test if the GNSS receiver of a GNSS-enabled device is functioning properly. This test helps determine which devices should be used for field data collection.

Equipment (hardware and software):

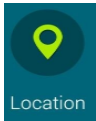


- Android device with built-in GNSS receiver with GPS Essentials application installed in the device (See section 4.2.5) or dedicated navigation devices like Garmin eTrex GPS device (10, 20, or 30)
- Pen and paper
- Computer with internet connection
- Google account


If you are testing multiple devices, assign a unique ID to each device to help you identify which readings are coming from which device (e.g., Device001 or D001, D002, D003,...). You may attach a tape or sticker with the unique ID to each device to help you identify them particularly if the devices are of the same model/look the same.

If testing the GNSS-receiver of Android devices, go to Part 1.a of this Annex. If testing Garmin eTrex GPS devices, start at Part 1.b.

Steps to be followed:

Part 1.a – Collecting geographic coordinates using Android device with built-in GNSS receiver with GPS Essentials application installed in the device

| Step | Action |
|------|---|
| 1 | Go outside and find an open space near a landmark that is easily recognizable on satellite images (monument surrounded by open space for example). Stand in the same location for the rest of the steps. |
| 2 | Turn on the location option of your Android device.  |
| 3 | Open the GPS Essentials app.  |
| 4 | Go to the <i>Settings</i> page through the icon presented on the figure on the right and fix the settings for the following 3 components as presented in the figures below: <ul style="list-style-type: none">• Units: Meters (SI)• Position format: Decimal  |

| | |
|---|---|
| | <ul style="list-style-type: none"> Position datum: World Geodetic System 1984 <div> <div> <p>Units</p> <p><input type="radio"/> Kilometers, Meters</p> <p><input type="radio"/> Miles, Yards, Feet</p> <p><input type="radio"/> Miles, Feet</p> <p><input type="radio"/> Nautical Miles, Feet</p> <p><input type="radio"/> Nautical Miles, Meters</p> <p><input checked="" type="radio"/> Meters (SI)</p> <p>CANCEL</p> </div> <div> <p>Position Format</p> <p><input type="radio"/> Degrees, Minutes, Seconds</p> <p><input type="radio"/> Degrees, Minutes, Fractions</p> <p><input checked="" type="radio"/> Decimal</p> <p><input type="radio"/> UTM</p> <p><input type="radio"/> MGRS</p> <p><input type="radio"/> OSGB36</p> <p>CANCEL</p> </div> <div> <p>Position Datum</p> <p><input type="radio"/> YACARE, Uruguay</p> <p><input type="radio"/> ZANDERIJ, Suriname</p> <p><input type="radio"/> KOREAN GEO DATUM 1995, S Korea</p> <p><input type="radio"/> SIRGAS, South America</p> <p><input type="radio"/> EUROPEAN 1950, Mean (7 Param)</p> <p><input type="radio"/> ORDNANCE GB 1936, Mean (7 Para)</p> <p><input type="radio"/> Petroleum Development Oman 1993</p> <p><input checked="" type="radio"/> World Geodetic System 1984</p> <p><input type="radio"/> World Geodetic System 1972</p> <p><input type="radio"/> NORTH AMERICAN 1983, CONUS</p> <p>CANCEL</p> </div> </div> |
| 5 | <p>Still in the <i>Settings</i> page, turn on the <i>Track only GPS locations</i> setting.</p> <div> <p>Settings</p> <p>GPS Readout</p> <p>GPS Update Interval Chooses the frequency of GPS fixes (faster updates consume more battery)</p> <p>Tracking Update Interval Chooses the frequency of track fixes (faster updates consume more storage)</p> <p>Drop stationary locations Enable to drop locations when you are not moving (preserves storage space) <input checked="" type="checkbox"/></p> <p>Track only GPS locations Enable to not use Wifi or other locations for tracking <input checked="" type="checkbox"/></p> <p>Use Fused Provider Use the Google Play Service Fused location provider <input type="checkbox"/></p> <p>Altitude Mode Select the altitude data source</p> </div> |
| 6 | <p>Go back to the main menu page of GPS Essentials and tap on the <i>Satellites</i> icon as shown on the right.</p> <div>  <p>Satellites</p> </div> |

-
- The diagram illustrates the process of satellite selection for GPS. At the top, a mobile phone screen displays the following information:
- Coordinates:** N46.026493 E7.124985
 - Accuracy:** 12.0m
 - Reading source:** from gps
 - Satellites:** A list of 11 visible satellites, with 7 highlighted in green and labeled "used in fix".
- Below the phone screen, a constellation of 12 satellites is shown, each with a number and a status indicator (green or grey). The satellites are arranged in a circular pattern around a central point labeled "S". The satellites are numbered as follows:
- 202 (grey)
 - 7 (green)
 - 8 (green)
 - 88 (grey)
 - 77 (grey)
 - 16 (blue)
 - 76 (grey)
 - 26 (green)
 - 72 (green)
 - 10 (green)
 - 205 (grey)
 - 85 (grey)
 - 71 (green)
 - 19 (green)
 - 209 (green)
 - 86 (green)
 - 15 (green)
 - 7208 (green)
 - 90 (grey)
 - 78 (grey)
 - 87 (green)
- Arrows indicate the flow of information from the phone screen to the constellation of satellites, highlighting the selection of 7 satellites for use in the fix.

- The coordinates will themselves appear in the upper left corner of the window (framed in blue)

In the example shown below, the reading is taken by GPS, 7 satellites are used in the fix, and the accuracy is 12 meters => this is a good reading!

11 visible, 7 used in fix

- 8 Once the reading shows the accuracy value is below 15 meters with at least 4 satellite signals, take a screenshot of your device screen.

- 9 Record on a paper the device number, reading number (1st, 2nd, or 3rd), and the reading from the GPS Essentials app from the screenshot (number of satellite signals received, accuracy (in meters), latitude, and longitude) as in the example shown below:

| Device no. | Reading no. | Nbr sat signals | Accuracy | Latitude | Longitude |
|------------|-------------|-----------------|----------|----------|-----------|
| D001 | 1 | 7 | 12 | 14.61549 | 120.98218 |


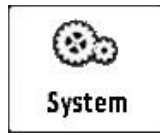
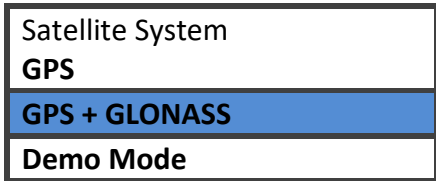
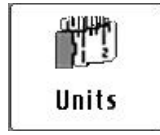
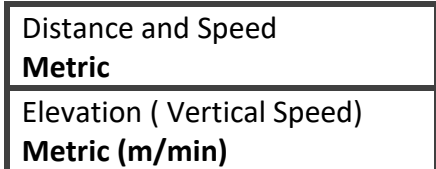
- | | |
|----|---|
| 10 | Using the same Android device, repeat steps 6-9 two more times to capture 3 sets of reading for each device being tested. |
|----|---|



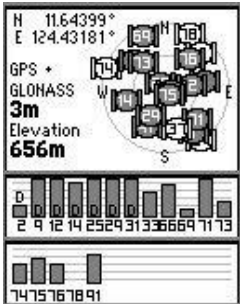
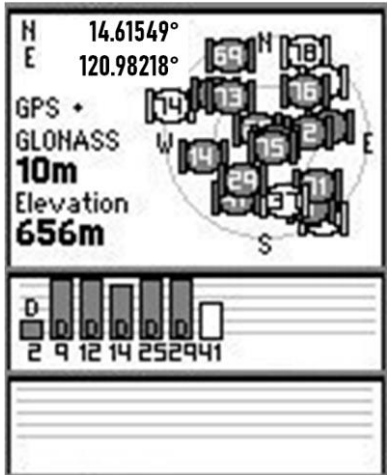
- 11 If testing more than one device, remain at the same location where you took the readings for the first device then do steps 2 to 10 for the remaining devices.

| Device no. | Reading no. | Nbr sat signals | Accuracy | Latitude | Longitude |
|------------|-------------|-----------------|----------|----------|-----------|
| D001 | 1 | 7 | 12 | 14.61549 | 120.98218 |
| D001 | 2 | 9 | 13 | 14.61550 | 120.98219 |
| D001 | 3 | 14 | 8 | 14.61549 | 120.98219 |

- | | |
|----|----------------------------------|
| 12 | Proceed to Part 2 of this Annex. |
|----|----------------------------------|

Part 1.b – Collecting geographic coordinates using dedicated navigation devices like Garmin eTrex GPS device (10, 20, or 30)

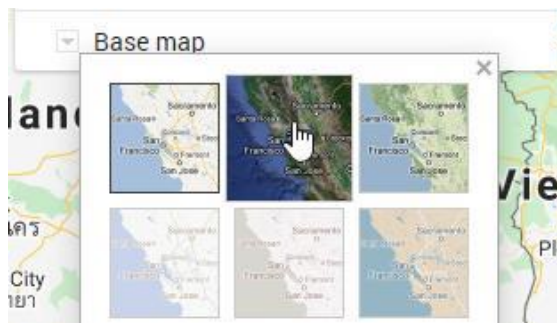
| Step | Action |
|------|--|
| 1 | Go outside and find an open space near a landmark that is easily recognizable on satellite images (monument surrounded by open space for example). Stand in the same location for the rest of the steps. |
| 2 | Turn the GPS device on. |
| 3 | If you are not already on the menu page, click twice on the menu button on the left of the device to get there. |
| 4 | Using the thumb stick, scroll down the menu page until the "Setup" icon is highlighted. Next, press the thumb stick to access the Setup sub menu. |
| |  |
| 5 | Using the thumb stick, scroll down the menu page until the "System" icon is highlighted. Next, press the thumb stick to access the System sub menu. |
| |  |
| 6 | Under "Satellite System" highlight the "GPS+GLONASS" option and press the thumb stick to save the selection. This will allow you to use both the GPS and GLONASS constellations of satellites as shown here |
| |  |
| 7 | Click on the back button on the right of the device to return to the Setup sub menu. |
| 8 | Use the thumb stick again until the "Units" icon is highlighted. Next, press the thumb stick to access the Units sub menu. |
| |  |
| 9 | Set both the "Distance and Speed" as well as "Elevation" items to the metric system as shown here: |
| |  |
| 10 | Click on the back button on the right of the device to return to the Setup sub menu. |

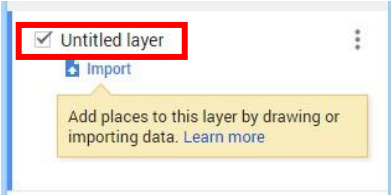
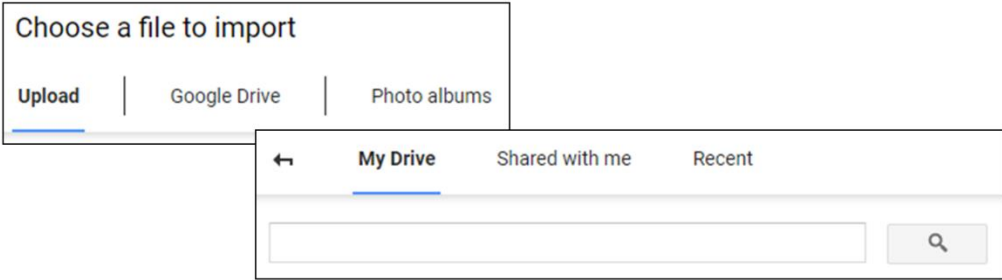
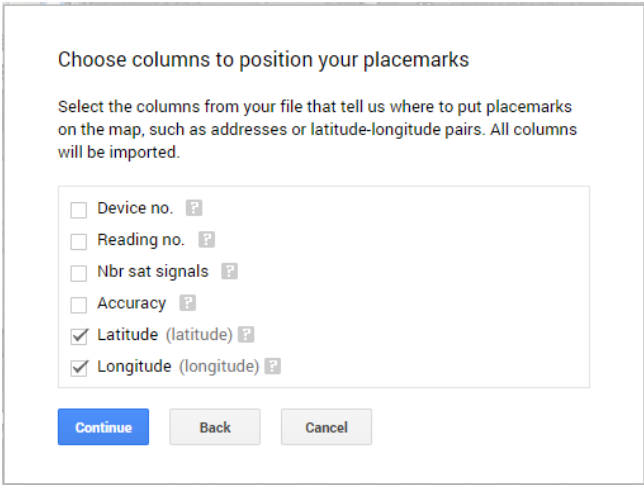
| | | |
|----|--|---|
| 11 | Use the thumb stick again until the "Position Format" icon is highlighted. Next, press the thumb stick to access the Units sub menu. |  |
| 12 | Set the "Position Format," "Map Datum," and "Map Spheroid" as presented here: | <div data-bbox="470 383 911 640"> <div>Position Format hddd.ddddd</div> <div>Map Datum WGS84</div> <div>Map Spheroid WGS84</div> </div> |
| 13 | Click on the back button twice to return to the menu page | |
| 14 | Holding the GPS device horizontally in front of you, use the thumb stick to scroll down the menu page until the "Satellite" icon is highlighted. Next, press the thumb stick to access the "Satellite page" which looks as follows: |   |
| 15 | Wait for the accuracy value to become less than 15 meters with at least 4 satellite signals received (number of grey bars at the bottom of the page). Best practice would be to stay around one minute on the same spot to allow for the best reading possible. In the example shown here, the accuracy is 10 m with 6 satellite signals received (the transparent bar is not counted as it shows a signal that is not strong enough to be used). |  |
| 16 | Once the accuracy value is below 15 meters with at least 4 satellite signals, record on a paper the device number, reading number (1 st , 2 nd , or 3 rd), and the reading from the Garmin eTrex GPS device (number of satellite signals received, accuracy (in meters), latitude, and longitude) as shown below: | |

| | | | | | | | |
|----|--|-------------------|--------------------|------------------------|-----------------|-----------------|------------------|
| | | Device no. | Reading no. | Nbr sat signals | Accuracy | Latitude | Longitude |
| | | D001 | 1 | 6 | 10 | 14.61549 | 120.98218 |
| 17 | Using the same Garmin eTrex GPS device, repeat steps 14 to 16 two more times to capture 3 sets of reading for each device being tested. | | | | | | |
| 18 | If testing more than one device, remain at the same location where you took the readings for the first device then do steps 2 to 10 for the remaining devices. | | | | | | |
| | | Device no. | Reading no. | Nbr sat signals | Accuracy | Latitude | Longitude |
| | | D001 | 1 | 6 | 10 | 14.61549 | 120.98218 |
| | | D001 | 2 | 9 | 13 | 14.61550 | 120.98219 |
| | | D001 | 3 | 14 | 8 | 14.61549 | 120.98219 |
| 19 | Proceed to Part 2 of this Annex. | | | | | | |

Part 2 – Checking the location of the collected geographic coordinates on Google My Maps

| Step | Action |
|------|--|
| 1 | On your computer and ensuring you have internet connection, open a browser and go to the Google Drive: https://drive.google.com |
| 2 | Log in to your Google account. |
| 3 | In the Google Drive page, click the <i>New</i> button in the upper left corner. Then click <i>Google Sheets > Blank Spreadsheet</i> |
| 4 | Give a title to the blank spreadsheet that opens (e.g., GNSS receiver test) |
| 5 | Encode the readings you took earlier from the paper form (Part 1) including the field/column names. |
| 6 | Go back to the Google Drive page. Click the <i>New</i> button > <i>More > Google My Maps</i> . |
| 7 | Give a title to the Google My Maps that opens (e.g., GNSS receiver test) |
| 8 | In the bottom of the left side bar, click on the arrow/triangle before Base map then choose the image labelled “Satellite”. |



| | | |
|----|---|--|
| 9 | Click <i>Untitled layer</i> and give it a name (e.g., Android devices or Garmin e Trex) |  |
| 10 | Click <i>Import</i> under the layer name. | |
| 11 | In the window that pops up, click <i>Google Drive</i> then select the Google Sheet you created in steps 4 & 5. (You can also search for the Google Sheet via the search field.) Click the <i>Select</i> button. |  |
| 12 | In the <i>Choose columns to position your placemarks</i> window that pops up, make sure that <i>Latitude</i> and <i>Longitude</i> boxes are checked. Click <i>Continue</i> . |  |
| 13 | In the <i>Choose a column to title you markers</i> window that pops up, choose <i>Device no.</i> . Click <i>Finish</i> . | |

| | |
|----|---|
| | <div data-bbox="550 141 1197 602" data-label="Form"> <p>Choose a column to title your markers</p> <p>Pick a column to use as the title for the placemarks, such as the name of the location or person.</p> <div> <input checked="" type="radio"/> Device no. ⓘ <input type="radio"/> Reading no. ⓘ <input type="radio"/> Nbr sat signals ⓘ <input type="radio"/> Accuracy ⓘ <input type="radio"/> Latitude ⓘ <input type="radio"/> Longitude ⓘ </div> <div> Finish Back Cancel </div> </div> <p>The collected geographic coordinates will now show up on the map as markers.</p> |
| 14 | <p>Click on <i>Individual</i> styles under the layer name. In the <i>Group places by</i> dropdown menu, choose <i>Style data by column: Device no.</i></p> <p>This will color the different markers according to the device the readings were taken with.</p> |
| 15 | <p>On the map, check if there are any markers that fall far (more than 50 meters) from the landmark where the readings were taken at.</p> <p>If all the markers fall at/near the landmark, then all the devices are fit to be used for field data collection.</p> <p>If there are markers that fall far from the landmark, proceed to step 16.</p> |
| 16 | <p>Identify the device/s used to take the readings of the markers falling far from the landmark using their unique ID.</p> |
| 17 | <p>Once the device/s has/have been identified, re-test them by doing Part 1.a or Part 1.b of this annex (depending on the type of device) and check the collected geographic coordinates using Part 2.</p> |
| 18 | <p>If after the re-test, all the markers fall at/near the landmark, then the device/s is/are fit for use for field data collection.</p> <p>If a device fails repeatedly with this test then it should not be used for field data collection.</p> |