

GLOBAL POSITIONING SYSTEMS

SURVEY COORDINATORS:

GIVE A COPY OF THIS CHAPTER TO EVERY SUPERVISOR TOGETHER WITH THE OTHER MANUALS.
TRANSLATE THIS CHAPTER INTO THE LOCAL LANGUAGE, IF NECESSARY. ENSURE THAT THE INFORMATION
IN THIS CHAPTER IS APPROPRIATE TO YOUR SURVEY. SOME COUNTRIES MAY NEED TO GIVE SLIGHTLY
DIFFERENT INSTRUCTIONS, DEPENDING ON THEIR CUSTOMIZED QUESTIONNAIRES.

GLOBAL POSITIONING SYSTEMS

UNICEF recommends the use of *Global Positioning System* (GPS) units during fieldwork to record information on the exact geographic location of the sample cluster. The *Global Positioning System* (GPS) is a satellite-based navigation system. A GPS unit determines its position using satellites that orbit the earth. Each satellite's position, as well as the current time, is transmitted via radio signals. The GPS unit receives these signals and uses them to calculate its position in terms of latitude, longitude, and altitude.

The benefits of GPS waypoint¹ collection are substantial. This will make it possible after the survey to link MICS4 data with other data sets containing similar geographic information. Typical examples would be to use databases that include geographic location information on health facilities, schools, climate, altitude or many other geographically located attributes. With the use of GPS, it becomes possible to carry out further analyses of MICS4 data sets by expanding them with information available from other databases. GPS units may also be used to update the sample frame, meaning that listing teams may have used GPS units to record information on the geographic location of the clusters in the sample. In such cases, using GPS during the main fieldwork may facilitate locating the clusters, since information on longitude and latitude will be available to supervisors during fieldwork.

Table 1
Why use GPS to collect cluster locations?

- Permits linking of additional data to MICS data through geographic links
 - E.g. Census data, facility data, other geo-located data
- Permits geographic grouping of data beyond region
 - E.g. Climactic zones, agricultural zones, etc.
- Permits mapping of sample clusters
 - E.g. with DevInfo

¹ A set of coordinates that identify a point in physical space; in this case to identify the location of a surveyed site using longitude and latitude and attitude.

COLLECTING AND PROCESSING GPS DATA

GPS DATA COLLECTION TEAM

GPS data collection can almost always be done without hiring additional personnel. The size and structure of GPS Data Collection team may vary according to the survey or the particular phase the collection of GPS data is performed; however there should be a field team which collects the GPS points and a field GPS Coordinator.

Since the collection of GPS waypoints occurs while survey staff are already in the field, roles may be doubled up. The interview teams may collect GPS data and the GPS Coordinator will likely be one of the Field Supervisors, while the GPS data collector will be one member of the interviews' team. On the other hand, if the GPS data collection is performed during the mapping and listing activities, then Mapping and Listing Coordinator will also be a GPS Coordinator, while the Mapper will be the in charge for the collection of GPS waypoints.

These responsibilities belong to the GPS Coordinator:

1. Obtain and prepare materials for GPS training and field work:
 - Find base maps for all areas that will be visited in the survey.
 - Provide copies of this Chapter (*Global Positioning System*) for each training participant.
 - Provide copies of GPS data collection form – enough so that all survey sites can be recorded.
2. Train GPS data collection teams to:
 - Complete the GPS data collection forms
3. Use a GPS unit to collect GPS waypoints
4. Prepare the GPS units before field work:
 - a. Ensure each unit has appropriate settings
 - b. Tag each GPS unit with a number. This number should be recorded by the GPS data collection teams on the GPS data collection form
5. Organize field work:
 - a. Assign survey sites to each GPS data collection team
 - b. Obtain travel allowances for each GPS data collection team
 - c. Arrange transportation for the GPS data collection teams to the field
6. Quality Check the GPS Data:
 - a. Use GPS TrackMaker to verify the accuracy of GPS points (see GPS TrackMaker Manual below)
 - b. Arrange for the recollection of any incorrect GPS waypoints

- c. Type the hand-recorded GPS coordinates from the GPS data collection form into an excel spreadsheet

The responsibilities of the GPS data collector(s) are as follows:

1. Contact local officials at each survey site to inform them about the survey and obtain their cooperation.
2. Capture and record the GPS waypoint at the centre of the survey site.
3. Complete the GPS data collection form, including the GPS waypoint name/number, latitude, longitude, altitude, and GPS-unit number.
4. Communicate with the GPS Coordinator about any problems encountered in the field and follow his or her instructions.

TRAINING

The GPS data collectors must be trained in the basics of the GPS units, point collection protocols, and simple troubleshooting techniques. The training of GPS data collectors should take a half- to a full-day. It is extremely important to give GPS field staff time during the training to practice GPS waypoint collection in a field or park where there is a clear view of the sky. This training should be conducted by the GPS Coordinator.

The GPS Coordinator will need additional training beyond that which is provided to the GPS data collection teams. The Coordinator needs to know how to transfer points from the GPS receivers to a computer, operate a GPS unit, and how to modify the GPS unit settings (e.g. coordinate system, datum, measurement units). Training of the GPS Coordinator should occur early on so he/she can take a lead role in the training of field staff, data collection, and data processing.

If the GPS units are used to update the sample frame, then the Listing Team must be trained on both how complete the Mapping and Listing forms, and operate and troubleshoot the GPS units. In this case training on the Listing and GPS data collection may be combined in one training course. The Listing and GPS Data Collection trainings should each take one half- to a full-day, and they can be combined into one long-day.

MATERIALS

1. Hardware:
 - One GPS receiver per GPS data collection team, plus two (2) extra GPS units.
 - Eight (8) AA batteries per GPS unit.

- Two (2) PC cables for downloading data from receivers.
2. Software:
- One (1) copy of GPS TrackMaker so the GPS Coordinator can visualize and troubleshoot GPS waypoints.

Each GPS data collection team should have these materials when they enter the field:

- One copy of this Appendix: Global Positioning System
- GPS data collection form – one form for each survey site
- Base maps for the areas in which survey sites are located
- One GPS unit with eight AA batteries

DATA COLLECTION PROTOCOLS

As part of planning for the survey, determine at which point the GPS points will be collected, where (household clusters, health facilities, etc), and by whom (mapping and listing teams, a GPS data collection team, interviewers who are also trained to collect GPS points, etc). During the planning process, a list of survey sample locations will be generated. The GPS Coordinator should be provided detailed place names such as province, district, city, and census block number of a location. In other cases, the GPS Coordinator may be provided a facility name and address where the GPS point should be taken. The GPS Coordinator helps obtain base maps of the areas to be surveyed to give to the GPS data collection teams.

DATA ELEMENTS COLLECTED

A minimum of five data elements should be collected from each GPS location. The GPS units collect three of these elements (latitude, longitude, and altitude), and users are trained to enter the other two pieces of data (waypoint name, GPS unit number). During this process, each coordinate is also recorded on a paper back-up (GPS data collection form).

- **Waypoint name** – examples include household cluster ID and health facility number.
- **GPS unit number** – a number assigned to each unit by the GPS coordinator before fieldwork.
- **Latitude** - A North/South coordinate measured from the equator. Combined with a Longitude coordinate, it identifies an exact location on the earth's surface.
- **Longitude** - An East/West coordinate measured from the Prime Meridian that runs through West Africa and Western Europe. Combined with a Latitude coordinate, it identifies an exact location on the earth's surface.
- **Elevation** – A measurement of height above sea level.

A “GOOD” GPS LOCATION

A “good” GPS location is outside in an open area far away from tall buildings and tree canopy. GPS waypoints should not be collected from indoor locations. If the GPS point represents multiple households or buildings, a “good” GPS point is located near the center of the structures.

It is sometime difficult to get an open view of the sky in urban areas due to tall buildings. If you are unable to make sufficient contact with satellites from the center of the survey site, identify the closest large intersection or park and try to move near the center of that open area. Similarly, survey sites surrounded by tall trees may not gain sufficient contact with satellites to take a GPS point. Move to the closest road, clearing, or other area with an open view of the sky.

Heavy clouds can also obstruct the ability of a GPS unit to receive satellite signals. While it is not impossible, it will be more difficult to collect GPS waypoints under heavy cloud cover or while it is raining. You may have to wait for the cloud cover to dissipate if it is preventing your GPS unit from receiving satellite signals.

HOW TO USE GPS – FIELD GUIDE FOR GPS WAYPOINT COLLECTION

Summary of procedures for collecting cluster locations using GPS:

1. Set up the GPS Unit:

Insert two AA batteries:

1. Remove the battery panel on the rear of the unit.
2. Flip the small metal handle and rotate counter-clockwise to open the battery compartment.
3. Insert two AA batteries
4. Replace the battery panel.

Turn GPS Unit On:

1. Press the PWR (power) button.
2. The first screen says “Wait... Tracking Satellites.”
3. After 1-3 minutes, the GPS unit should acquire a number of satellite signals and display the message “Ready to Navigate Accuracy: XX m.”

Set position format, datum, and distance unit

1. Press PAGE until you arrive at the MENU screen.
2. Using the DOWN button, scroll to SETUP and press ENTER.

3. In the SETUP sub-menu, scroll to UNITS. Select ENTER.
4. A screen appears called UNITS. Set these units:
POSITION FRMT: hddd.dddd - Decimal Degrees
MAP DATUM: WGS 84
UNITS: METRIC
NORTH REF and **VARIANCE:** do not change
 - a. Using UP/DOWN, highlight the unit (ex. POSITION FRMT) you wish to change. Press ENTER.
 - b. Scroll to the correct unit using UP/DOWN. Press ENTER.
 - c. Repeat for each unit.



2. How to Collect and Edit GPS Waypoints:

Collect a GPS waypoint

1. Turn the GPS unit on by holding the POWER button.
2. The first screen says "Wait... Locating Satellites."
3. After 1-3 minutes, the GPS unit should say "Ready to Navigate Accuracy: X meters."
4. Press PAGE until you reach the MENU screen. Press ENTER.
5. Highlight MARK on the MENU screen. Press ENTER.
6. Using the UP/DOWN buttons, highlight the GPS point number in the flag then press ENTER.
7. A screen appears called EDIT WAYPOINT NAME. Using the UP, DOWN, and ENTER buttons, change the waypoint name to a 6-digit Identification Number. Press ENTER.
8. A screen appears called MARK WAYPOINT. Using UP/DOWN, scroll to "OK?" and press ENTER.
9. Record the waypoint name, latitude, longitude, and altitude on a GPS Data Collection Form.

Edit a GPS waypoint name

1. From the MENU page, use the UP/DOWN buttons to highlight WAYPOINT. Then select ENTER.

2. Using UP/DOWN, highlight “0-9” and press ENTER.
3. Navigate to the point you would like to edit using the UP/DOWN buttons, and select ENTER.
4. A screen appears called REVIEW WAYPOINT. To edit a previously stored GPS point, use UP/DOWN to highlight the waypoint name in the flag and select ENTER.
5. A screen appears called EDIT WAYPOINT NAME. Edit the name, then use the UP/DOWN button to highlight OK and select ENTER.

Review the location of a GPS waypoint

1. From the MENU page, use the UP/DOWN buttons to highlight WAYPOINT and select ENTER.
2. Using UP/DOWN, highlight “0-9” and press ENTER.
3. Navigate to the point you would like to edit using UP/DOWN, and select ENTER.
4. A screen appears called REVIEW WAYPOINT. To view the location of a stored GPS point, use UP/DOWN to highlight the MAP sub-menu and select ENTER.
5. This will display a rough map of the points collected.

Managing duplicate waypoint locations

If the GPS data collector realizes that waypoints are incorrectly paired, (s)he should delete, then recollect the incorrect waypoints.

1. From the MENU page, use the UP/DOWN buttons to highlight WAYPOINT and select ENTER.
2. Using UP/DOWN, highlight “0-9” and press ENTER.
3. Navigate to the point you would like to edit using UP/DOWN, and select ENTER.
4. Use UP/DOWN to highlight DELETE and select ENTER.
5. The message “Delete waypoint XXXXXX?” appears. Press ENTER to select “yes.”

POST FIELD GPS DATA CHECKING AND CLEANING

When Listing Teams return from field work, the GPS Coordinator checks that the GPS data are correct. He/she uses GPS TrackMaker, a free geographic information system, to plot the GPS points and check for common errors. Detailed instructions for use of GPS TrackMaker are provided in the Appendix x: GPS TrackMaker Manual. Common GPS errors are described below.

COMMON GPS ERRORS

Duplicate or Paired Points

Duplicate and paired points describes when two or more waypoints are given the same latitude/longitude coordinate, or coordinates that are located only meters from each other. This is

considered an error unless otherwise documented. For example, if GPS waypoints are collected from a hospital and an adjoining health facility and they are located only meters apart, this is not an error.

Pairing and duplication usually occurs when the GPS unit has not made contact with enough satellites to calculate a new position, and it uses its last known location (the GPS coordinate of the last survey site). Therefore, when pairing occurs, one waypoint - the first of the two - is often correct. Paired and duplicate waypoints need to be recollected, but the first of each duplicated waypoint may be kept if it is correct.

Missing Data

Missing waypoint data is easy to avoid but occurs often. This happens when the GPS data collection team either forgets to collect the point, or gave it the wrong waypoint name in the GPS unit. The GPS Coordinator can easily identify missing way points in GPS TrackMaker by comparing the number of waypoints collected in the GPS unit with the list of survey sites that should have been visited. If waypoints are missing, the GPS Coordinator should check the hand recorded coordinates on the GPS data collection form. If the GPS data are missing from both the GPS unit and the GPS data collection form, the coordinate needs to be recollected.

Administrative Mismatches

When reviewing the waypoints in GPS TrackMaker, the GPS Coordinator ensures that the waypoints fall in the administrative areas that are indicated in the sample file (used to plan which sites will be surveyed). If the sample data and the GPS locations do not match, then there is a need to investigate the origin and significance of these discrepancies.

If the local boundaries have changed recently, the waypoint location may be correct but the administrative boundary file in GPS TrackMaker may be outdated. Sometimes, too, the administrative boundary files shows simple, generalized boundary lines which diverge by a number of meters or kilometers from reality. Waypoints located near administrative borders may appear incorrect on the map, but in reality they are located in the correct position. Waypoints with administrative mismatches between the sample file and the GPS waypoints that have no clear explanation should be recollected.

Hand-Entry Typos

GPS coordinates are recorded in two places – the GPS unit and the GPS data collection form. The hand-recorded data is typed into an Excel spreadsheet and sent to Macro International's Calverton office along with the final GPS download files. The hand-recorded data are used to verify and correct and bad GPS data. Since it is common for data entry errors to occur especially when working with multi-digit numbers, it is imperative that the GPS data collection teams and the GPS coordinator check for hand-entry typos when they are copying the data.

PROVISION OF FINAL GPS DATA

Once the GPS data has been finalized, the GPS Coordinator needs to produce two files. The first file contains waypoints downloaded from the GPS units in GPS TrackMaker. This file should be a GPS TrackMaker file (*.gtm) (preferred) and/or excel file (*.xls). Instructions for exporting GPS data from GPS TrackMaker are provided in the Appendix x: GPS TrackMaker Manual.

The second file is an excel spreadsheet listing all of the coordinates hand-recorded on the GPS data collection form. The data processing team shall perform a final detailed cleaning of the GPS datasets (See Appendix x. Processing the Data).

GPS DATA COLLECTION FORM		GP
GP1. Cluster number: _____		
GP2. Area:	GP3. Region:	
Urban..... 1	Region 1..... 1	
Rural..... 2	Region 2..... 2	
	Region 3..... 3	
	Region 4..... 4	
GP4. Operator name and number:		
Name _____		
GP5. Day/Month/Year of measurement: _____ / _____ / _____		

CLUSTER POSITION CHECKLIST

- CHECKED ESTIMATED ACCURACY (AFTER “READY TO NAVIGATE”)
- MARKED WAYPOINT
- RENAMED WAYPOINT TO CLUSTER NUMBER
- RECORDED WAYPOINT’S POSITION
- SAVED WAYPOINT

GP6. Waypoint name: _____			
	N/S/E/W	Degrees	Decimal degrees
GP7. Elevation:		_____	
GP8. Latitude:	N S	_____ . _____	
GP9. Longitude:	E W	_____ . _____	

GPS TRACKMAKER MANUAL

INTRODUCTION

This manual describes how to use GPS TrackMaker to manage GPS data collected for MICS4 survey. This guide should be used by the GPS Coordinator to collate, check, save, and export GPS data.

This manual provides a step-by-step guide to:

- Installing GPS TrackMaker
- Downloading GPS data
- Checking GPS data
- Exporting GPS data

USING GPS TRACKMAKER

Common errors in GPS data can be identified when GPS data are simply displayed in GPS TrackMaker or other geographic information system (GIS).

Materials and equipment needed

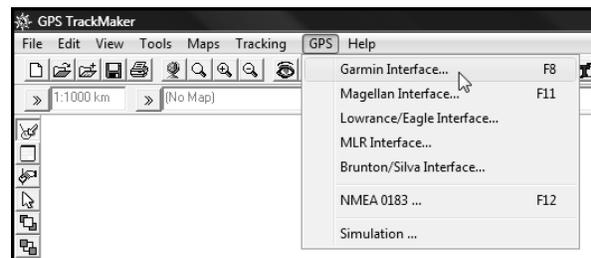
- GPS units (being used by the GPS data collectors)
- The serial cable or USB cable specific to the GPS unit
- A computer with a serial or USB port
- The disk provided by Macro International Inc. which includes:
 - GPS TrackMaker program (also free at www.gpstm.com)
 - Customized maps
 - Region map
 - Continent map

Install GPS TrackMaker

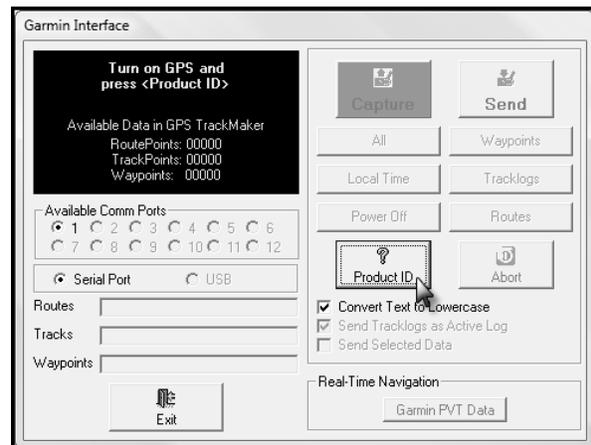
1. Refer to the manual that came with the GPS unit(s) to determine if there are any drivers that must be installed before the unit is plugged into the computer.
2. Insert the disk that was provided by the country manager and install the GPS TrackMaker software by double-clicking the file “gtm134.exe.”
3. Follow the prompts to complete the installation.

Download waypoints from GPS unit

1. Plug the first GPS unit into the computer using the serial or USB cable.
2. Turn the GPS unit on.
3. Open GPS TrackMaker and click on the GPS tab.
4. Select Garmin Interface. A box will pop up on the screen. Select a different interface if using a different type of GPS unit.

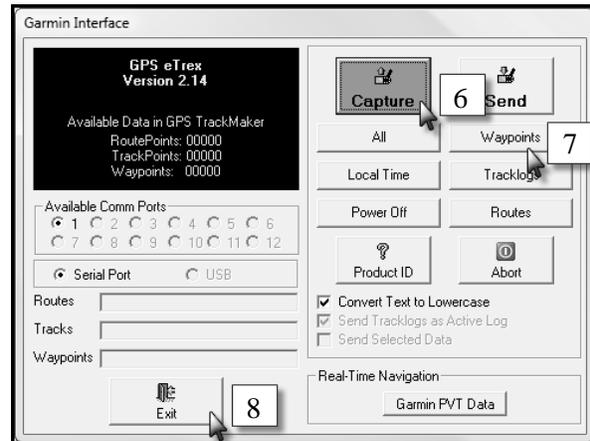


5. Click on the Product ID button. The black box will update showing the specifications of the GPS unit being use

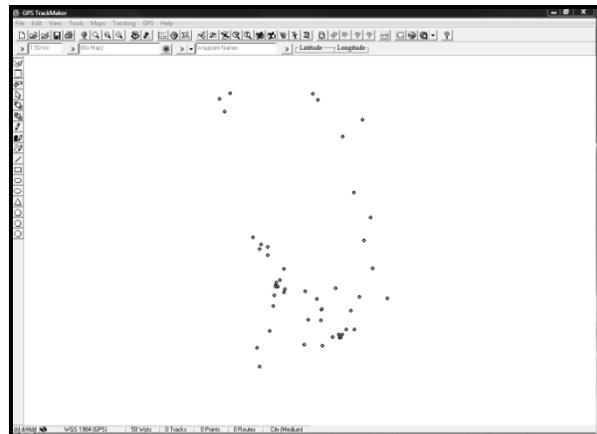


6. Click the Capture button (If you receive a no data message make sure your GPS unit is turned on).

- Click the Waypoints button. The waypoints will download from the GPS unit.



- Click the Exit button.
- The waypoints should appear on your screen. (If they do not appear click on the view tab and check the waypoints selection).



- Repeat for each GPS unit that contains waypoints.

Add map layers to GPS TrackMaker

By overlaying GPS points on national and regional borders in GPS TrackMaker, the GPS Coordinator can check the GPS datasets for errors such as points located outside of the country or region, or duplicate and paired points. Whenever possible, Macro International will provide the GPS Coordinator with layers of national and regional borders. To use these layers for quality checks:

- Click File in the menu bar, and select Merge File.
- Navigate to the disk provided by Macro International.
- Open the Map folder for the correct country.
- Select WinAPRS Map File 1.0 (.map) from the drop down menu at the bottom right of the Window.

5. Select the region map and click Open. The region layer appears on the map.

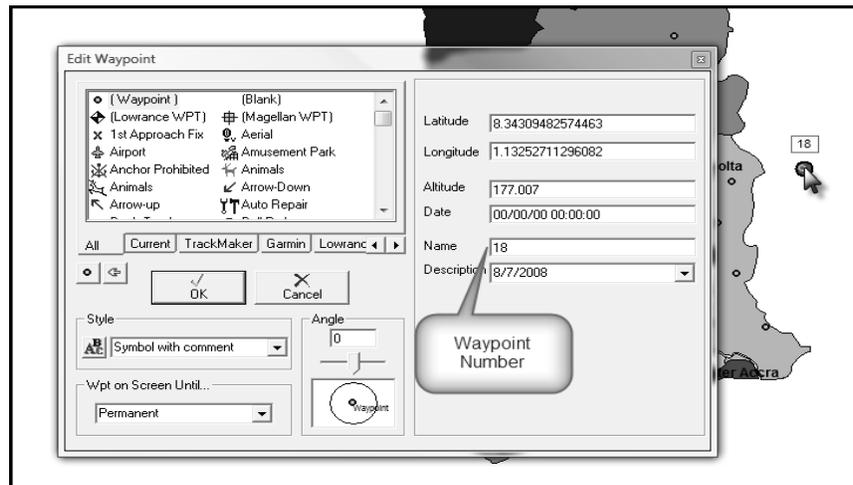
QUALITY CHECK OF GPS WAYPOINTS

Answer the following questions about the GPS data

1. Do all of the points fall within the national boundary?
2. Do all of the points fall within the correct regions?
3. Does the distribution of the points match areas visited by field teams?
4. Does the number of points located in each region in GPS TrackMaker match the number of points collected from each region according to the GPS Collection (back up) sheets?

Make a list of GPS points that are missing or are not located in the correct place so they can be recollected. Identify the point name by right-clicking the point.

Recollect missing or incorrect waypoints. Be sure to update the paper GPS Data Collection form with any changes.



EXPORT GPS WAYPOINTS FROM GPS TRACKMAKER

The GPS Coordinator should export GPS waypoints. The waypoints should be exported in one of the following formats: GPS TrackMaker (gtm) or text (txt) file.

1. Go to File in the menu bar, and select Save File As.
2. Navigate to the proper file location.
 - a. Include the survey country, year, and starting and ending waypoint numbers in the file name (i.e. Ghana_2005_1_50.gtm)
 - b. Select the file type. Either: GPS TrackMaker File (*.gtm) or GPS TrackMaker

Text Format (*.txt).

3. Click Save.

