

Humanitarian Field Guide to GPS Technology

Prepared by MapToGround

maptoground.cartography.id.au

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Abstract

This guide provides advice on the hands-on application of GPS units, computer-based technology and georeferenced maps (digital and hardcopy) in the humanitarian field. It includes a list of web resources that provide maps and related software.

References

Items marked [A1] or [A2] are listed in the appendices.

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1.0 GPS basics

A Global Positioning System, GPS (also termed Global Navigation Satellite System, GNSS) is a set of satellites that transmit data to permit a GPS receiver to determine its geographical position. Currently there are three operating or pending systems – GPS (USA), GLONASS and Galileo. Provided a GPS receiver has a clear view of the sky it is effective anywhere on the earth's surface at any time.

Handheld GPS units have the facilities to manage waypoints and tracks. Some GPS units have the ability to display maps. Smart phones and like devices commonly have GPS capability and can run software to enable user interaction.

1.1 Waypoints:

A waypoint (also known as point of interest, POI) is a recorded location. A waypoint can be recorded in a GPS unit by

- marking the current location,
- keying in a location reference or
- downloading a location reference from a computer.

The GPS unit can be used to find the way to a waypoint location. A waypoint can be uploaded to a computer.

1.2 Tracks:

A track is a recorded path. A track can be recorded in a GPS unit by

- moving with the GPS unit active or
- downloading the track from a computer.

The GPS unit can be used to guide the user along a track. A track can be uploaded to a computer.

2.0 Scale

In the case of a hard copy map, the scale, when expressed as a ratio, "1 : 100,000" for example, is unambiguous – 1 cm on the map represents 1cm X 100,000 = 1.000 km on the ground. In the case of an electronic map image, the situation is not as straightforward. On a laptop, a map image file with a ground extent of 25 km may be displayed as 250 mm wide (a scale of 1 : 100,000), while the same file presented on a video projector screen may be ten times the size (a scale of 1 : 10,000). Similarly a map file printed on an A4 sheet will be at a different scale to the same file printed on an A3 sheet. A scale bar, however, remains valid at any degree of enlargement.

Larger scale maps, for example a UNOSAT [A2] map of an IDP camp, show more detail of a smaller area; smaller scale maps, for example a Logistics Cluster [A2] transport routes map, show less detail over a larger area.

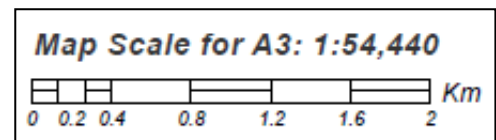


Fig. 1 Scale bar on UNOSAT map

3.0 Coordinate systems

A geographic location is specified by a reference within a coordinate system. The two common coordinate systems are latitude and longitude (also known as geographic) and UTM/UPS (often known simply as UTM).

3.1 Latitude and Longitude coordinate system:

The geographical coordinate system is useful on small and medium scale maps; it is not as convenient as the UTM system on large scale maps. The parallels of latitude run east-west, the meridians of longitude run true north-south from pole to pole. A location is given by the latitude north or south of the equator and the longitude east or west of the zero meridian. The units are generally degrees, minutes and seconds though there are format variations. There are 60 seconds in a minute and 60 minutes in a degree. A negative sign on latitude can be used to indicate south, a negative sign on longitude can be used to indicate west.

A location in Sydney	A location in Dublin	Format
– 33.8700°, 151.2183°	53.3345°, – 6.2508°	D.dddd
– 33° 52.20', 151° 13.10'	53° 20.07' N, 6° 15.05' W	D M.mm
33° 52' 12" S, 151° 13' 6" E	53° 20' 4", – 6° 15' 3"	D M S.s

Fig. 2 Some examples of latitude, longitude formats.

A degree of latitude or a degree of longitude at the equator is approximately 110 kilometres; a minute of latitude or a minute of longitude at the equator is approximately 1.9 kilometres – a nautical mile.

3.2 UTM/UPS:

The Universal Transverse Mercator/Universal Polar Stereographic, UTM/UPS, or UTM coordinate system is convenient for medium or large scale maps. The world is divided into 60 longitudinal zones (notated by a *zone number*, 0 – 59) by meridians spaced at 6 degree intervals (0°, 6°, 12°, ...). On each of these zones a square grid is projected. In addition there are 20 lateral zones (notated by an alphabetical *zone characters*). A location reference on this grid is specified by a *zone number*, a *zone character*, an *easting* (6 digits) and a *northing* (7 digits).

The UTM system uses the alphabetic characters **C** through to **X** excluding **I** and **O** but including **N** and **S** as lateral zone indicators. However in some UTM system applications the symbols **N** and **S** serve as hemisphere designators as an alternative for zone indicators. A general rule is – do not substitute **N** and **S** for zone indicators unless explicitly required.

The UTM system can be useful on medium and large scale maps

because the coordinates are metre based and a grid overlay is square and regular – commonly 1 kilometre.

If a map is marked with a 1 kilometre grid it may be the practice in a radio net to give local locations as a *6 digit grid reference*. The appropriate numerals are underlined in Fig. 3.

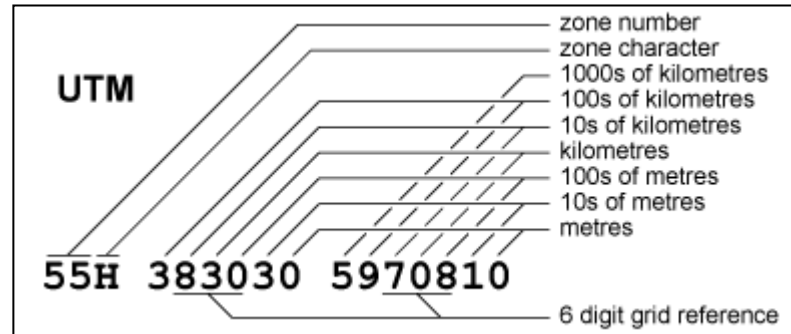


Fig. 3 Allocation of characters in UTM reference

3.3 Coordinate Conversion:

Computer programs that are intended for GPS unit interfacing (for example, GPS Utility [A1] and OziExplorer [A1]) can be used to convert between coordinate systems. Earth Point [A1] provides a versatile online coordinate converter.

4.0 Datum

The zero meridian of longitude passes through a brass marker at Greenwich (actually the precise location is approximately 100 m to the east) – the marker is the reference for the traditional geographic coordinate system. In an analogous fashion there is a reference – a datum – for global positioning systems – in fact for historical and other reasons there are many references. Fortunately the World Geodetic System 1984, **WGS 84**, is dominant internationally. Wherever a datum choice is presented choose WGS 84.

5.0 KMZ and KML files

KML (Keyhole Markup Language) files can carry global position data and references to other files (typically graphics files) in a markup language format (for example as HTML is) and as a result they are text based. Thus a KML file on its own could contain a set of waypoints but not an associated map image. Any map image would be on a separate file.

A KMZ (Keyhole Markup Zip) file is a zipped compilation of a KML file and any associated files. The zipping and unzipping processes are generally performed by the application programs and are transparent to the user.

KMZ files can be displayed in Google Earth and loaded into some map-capable GPS units. User generated Google Earth data can be saved as a KMZ file.

6.0 GPX files

GPX files carry GPS data (waypoints, routes, and tracks) in a text based markup language. The GPX format provides a standard that allows the exchange of GPS data across platforms and devices.

GPX files can be displayed in Google Earth and loaded into GPS units.

7.0 KMZ and GPX files on handheld GPS devices

Some Garmin GPS units including the Oregon, Dakota, Colorado, eTrex 20 and eTrex 30 models (check the device specifications to see if it is 'custom maps compatible') will load and display KMZ files containing map graphics. KMZ files can be loaded into the *Garmin\CustomMaps* folder in the same manner as files can be manipulated on a USB memory stick. Note, typically only the graphical data (a map), not any global position related data (waypoints, tracks or routes) that the KMZ file might contain are loaded by this process. Global position data generally must be loaded separately as a GPX file. For Garmin units GPX files carrying waypoint data can be loaded into the *Garmin\GPX* folder. After a Garmin unit is restarted the KMZ files will appear on the map list and may be enabled or disabled by the user. Some GPS units have a map display quality option; this item should be set to maximum.

KMZ files with map images intended for handheld devices are usually tiled. The map image is comprised of sections, or tiles (Garmin sometimes calls them 'images'). GPS units may have a constraint on the maximum number of tiles they can load. Garmin map-capable units produce a message *too many custom map images, they will not be displayed* on start-up if the total tile complement exceeds the limit.

The number of tiles in a KMZ file can be determined by expanding the file into its descendants in the places section of the Google Earth sidebar. Large KMZ map files may have a tile count in excess of the limitations of the GPS unit. It is possible in Google Earth to delete individual tiles to bring the tile count within the bounds of the GPS unit. The modified file must be saved before loading into the GPS unit.

Fig. 4 is a screen shot from a Garmin GPS unit loaded with a KMZ map file. The waypoints (ID-6, ID-11, ID-13) were loaded with a GPX file.

A user may generate position data on Google Earth (tracks, routes, waypoints) and then wish to load these data into a GPS unit. It may be necessary to convert a KMZ file (saved from Google Earth) to a GPX format. GPS Utility [A1] will convert KMZ and KML files to GPX files, OziExplorer [A1] will convert KML files. GPS Visualizer [A1] is a versatile online file format converter.

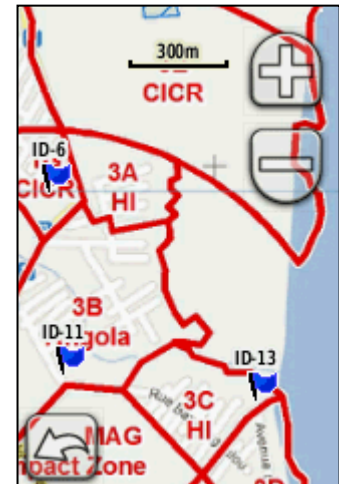


Fig. 4 GPS screenshot

8.0 KMZ files, GPX files, GPS data and Google Earth

8.1 Opacity Control

A KMZ file will open in Google Earth as an overlay. The transparency (or its complement, opacity) of a map image can be controlled with the slider at the base of the "Places" box in the side bar. Many KMZ maps are tiled. Map tiling can be exposed by expanding the map reference in the side bar and the tile transparency individually managed. KMZ maps may be overlaid one on another and alignment of features checked by use of the transparency slider.

8.2 Loading GPS data

GPS data (waypoints, tracks, route) may be directly loaded into Google Earth from the GPX unit but a more secure method is to first save the GPS data as GPX files and then load those files into Google Earth through the "File → Open" menu (select files of type "Gps"). If there are data missing, try adjusting the history bar which may have appeared in the top left corner of the Google Earth image screen.

Google Earth provides documentation capacity. Areas can be outlined, placemarks and images inserted. It is an effective process once the user becomes familiar with it. Support material is available on the web.

The total data displayed in the Google Earth window (say – UNOSAT map, waypoints imported from GPS unit, placemarks) can be saved as a single KMZ file for record keeping and distribution.

A1: Map and GPS software resources

ArcGIS Explorer, www.esri.com/software/arcgis/explorer

ArcGIS Explorer is a free GIS Viewer that enables the user to explore, visualize, and share GIS information. The user can create custom maps, include local data and perform spatial analysis.

Earth Point, www.earthpoint.us/

Earth Point provides useful online tools, in particular a versatile coordinate converter and an area calculator for Google Earth.

GPS Utility, www.gpsu.co.uk

GPS Utility is a commercial program for GPS receiver interaction. It manages, manipulates and maps waypoint, route and track information. It handles (and hence can convert) an extensive range of file formats.

GPS Visualizer, www.gpsvisualizer.com

GPS Visualizer provides online file conversions and displays uploaded GPS data.

Mapwel, www.mapwel.eu

Mapwel provides MapUpload, a free program to load IMG files into Garmin GPS receivers and MapWel 2015, a moderate cost program for constructing IMG and KMZ files and for interacting with Garmin GPS receivers.

MotionX, gps.motionx.com/iphone/overview/

MotionX provides a comprehensive GPS application for the iPhone and iPad. Check the manual to see if the application has the features you require.

OziExplorer, www.ozieplorer.com

OziExplorer provides commercial software for interaction between map images and an extensive range of GPS receivers.

Quantum GIS, qgis.org/en/site/

QGIS is a free Geographic Information System that enables the user to create, edit, visualise, analyse and publish geospatial information on Windows, Mac, Linux and BSD platforms (Android pending).

A2: Map resources

CIA World Factbook, www.cia.gov/library/publications/the-world-factbook/

The CIA World Factbook provides country maps, regional maps and physical and political world maps.

GDACS, vosocc.unocha.org/

GDACS, “virtual OSOCC”, is a cooperation framework between the United Nations, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters.

iMMAP, immap.org/mirror1/?page_id=1368

The map catalogue of iMMAP, an international NGO that provides targeted information management support to partners responding to complex humanitarian and development challenges.

Logistics Cluster, www.logcluster.org/

The WFP Logistics Cluster provides an extensive range of maps in PDF and/or PNG format. The maps are intended for humanitarian logistics application. The *General Logistics Planning Maps* provide country wide coverage – effectively ‘road maps’ – excellent for transport considerations.

MapAction, www.mapaction.org

MapAction's range of maps is extensive; the maps are generally directed towards operational issues such as logistics and population movement. MapAction also provides PowerPoint map templates and map symbol sets to enable the production of PowerPoint material for report presentation.

MapToGround, maptoground.cartography.id.au

MapToGround provides maps from recognized humanitarian sources as KMZ files and OziExplorer support files.

OpenStreetMap, www.openstreetmap.org/

OpenStreetMap is a free map of the whole world. Users may edit the map to maintain currency.

OSOCC, <http://www.unocha.org/what-we-do/our-work>

The On-Site Operations Coordination Centre (OSOCC) concept was developed by OCHA and the International Search and Rescue Advisory Group network. OSOCC's emergency management techniques are valuable in a sudden-onset disaster that requires international relief resources.

ReliefWeb, reliefweb.int/maps/

The map directory of ReliefWeb. ReliefWeb is a digital service of the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). It provides disaster and crisis updates and analysis.

UN Cartographic Section, www.un.org/Depts/Cartographic/english/htmain.htm

United Nations Cartographic Section, Department of Field Support, provides general country or region maps, mission maps, latest deployment maps and political operation maps in PDF format. It also provides a world map structured by country in PDF format.

UNOSAT, www.unitar.org/unosat/maps

UNOSAT provides humanitarian aid maps in PDF format indexed by country. Each UNOSAT map is annotated and carries additional text relevant to the situation covered by the map. UNOSAT also produces multi page reports in PDF format on explicit disaster situations.

WFP Map Centre, www.wfp.org/aid-professionals/map-centre

WFP provides maps relating to WFP operations around the world. The maps provide time-sensitive information on rainfall, flooding, transport links, earthquake effects and storm damage. Reasonably there is some overlap with the maps presented by the WFP Logistics Cluster, GLCSC.

ZKI, www.zki.dlr.de/activations/list

ZKI disaster situation maps are indexed with search options. Maps are generated from satellite imagery and carry additional text relevant to the situation covered by the map. ZKI maps are available in JPEG and KMZ formats.