THE REPUBLIC OF UGANDA

District Road Works

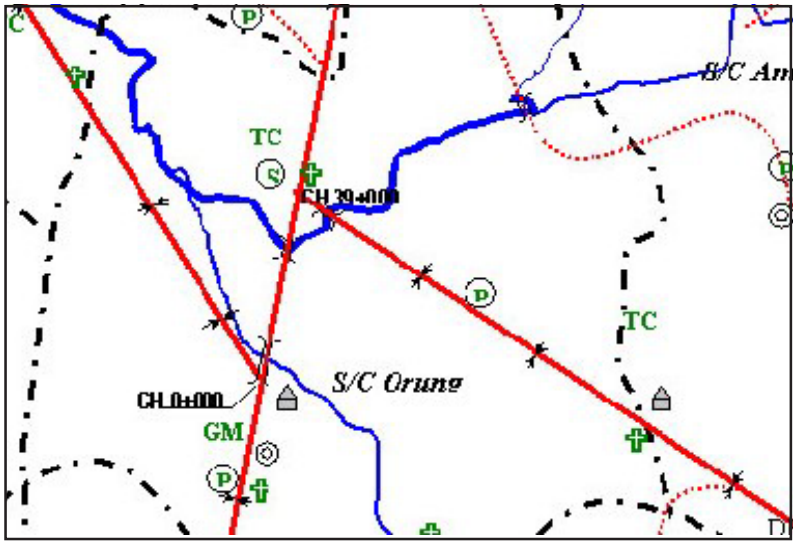
VOLUME

1

Planning Manuals

Manual E:

GPS Mapping Manual for RAMPS Module



Ministry of Works, Housing and Communications

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These manuals have been prepared by the Ministry of Works, Housing and Communications, Uganda.

The aim of the manuals is to complement the Ministry's effort in providing guidance and building capacity of Local Governments to enable them handle their mandated roles in planning and management of the road sector development.

This manual is part of a set titled District Road Works. The set consists of 5 Volumes, each volume comprising a series of manuals covering varying aspects under the following headings:

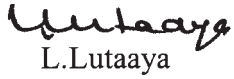
Volume 1	Planning Manuals
Volume 2	Contract Management Manuals
Volume 3	Implementation and Monitoring Manuals
Volume 4	Technical Manuals
Volume 5	District Administrative and Operational Guidelines

The Manuals describe in detail the organization and techniques for planning, implementation and administration of a district road network. The manuals support Government strategies on sustainable maintenance of district roads; they encourage community participation, promote use of labour based methods and gender balance, ensure protection of the environment, foster work place safety and health in implementation of road works by adopting appropriate contracting practices and support the local construction industry.

They are primarily aimed at Road Engineers, Planners and Managers involved in the planning and management of district road works.
In line with the topics covered in these manuals, related training modules have been designed and are incorporated in the curriculum of the Mount Elgon Labour Based Training Centre.

The manuals are the property of the Ministry of Works, Housing and Communications, but copying and local distribution is not restricted.

We wish to acknowledge the efforts of COWI Consulting Engineers and Planners AS who assisted in the compilation of the Drafts and the invaluable support of the Danish International Development Agency for the financial assistance extended to the Ministry in preparing the manuals.



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1. Introduction

The final output from RAMPS Mapping Module is basically a number of road network maps in digital format containing at least two layers of geographical feature namely a) Roads and b) Socio-economic centers. As the final map is produced in ArcView GIS software, some other geographic layers based on the availability can also be incorporated with the road network map. Preparation of maps in the RAMPS mapping module involves all the steps of making a digital map starting from scratch such as capturing of data, processing the data and finally making the map. Capturing of data involves registering data in GPS receiver and downloading the same; processing data involves linking GPS data to RAMPS tables; and finally making map involves symbolizing the features as per customized templates, defining layout of the map etc. As there are three different activities involved with the complete process of making map, software required to perform those activities are also three in number, which are as follows:

a) Mapsource – To download GPS data and to do preliminary editing of the data;
b) RAMPS Mapping Utility – To process GPS data, to enter socio-economic and other landmark point name, to enter road-code, tracking direction ete., to convert the data to ArcView shape file and to link arcView shape file to different RAMPS tables;
c) ArcView 8.x (or 3.x) – To symbolize features, overlaying features obtained from other sources (if any) and making final map;

GPS method for data capturing is very simple and straight forward – which can be compared to use of any sophisticated mobile phone; however it is important that each and every steps is followed correctly, failing to which may result absolutely unpredictable output. For instance, the data calculated and recorded in GPS receiver is based on WGS84 (World Geodetic System) datum, whereas because of the topographical variation, the national datum for Tanzania is Arc1960. So while drawing maps, if the datum of the map is not changed to Arc1960, the location of the same point in say Dodoma may vary for over 300 meters (almost 1/3rd of a Km).

This manual describes the all the steps involved to produce road network map, starting from doing the GPS survey to printing final map in ArcView. There is a brief description about ArcView software related to how to open the map, organizing layers, designing layout etc. Once the map is put in ArcView, there are so many ways how the data can be played with. However, providing detail instruction on ArcView software outside the scope of this manual.

2. Surveying road tracks and waypoints

2.1. Settings in GPS receiver: The Garmin GPS receiver requires a number of operational and system settings, which can be done through simple menu-based commands in the receiver. Most of the settings are done once for all, however as it is obvious that the equipment would be handle more than one person, so it is always good to check some of the essential settings everyday before starting the survey. The settings in the receiver are very important as both the accuracy in doing the survey and the accuracy in data captured in the receiver depend on the settings on the receiver. The following settings need to check before performing the survey:

i) Trackpoint registration method (by distance or by time);
ii) Trackpoint registration interval;
iii) "Tracklog full" event action;
iv) Whether previously recorded waypoint is empty;
v) Whether previously recorded track-log is empty;
vi) Whether trip computer has been reset;
vi) Reference datum (for Tanzania/ Uganda/ Kenya it is **ARC1960**);
vii) WAAS enabled/ **disabled**;
ix) Whether distance unit has been set to metric (Km, meter etc.);

Figure-1: GPS interface keys

The Garmin GPS receiver come with only few interface keys and a "rocker" (equivalent to mouse) as shown in figure-1, which are used to operate the machine and do the settings. The main menu of the receiver is accessed by pressing the "menu" button twice. There are 9 items under the main menu (see figure-2). Out of these 9 menus, only 3 menus (Tracks, Points and Setup and occasionally Trip Computer) are basically required to do road-network mapping. The functions of the main-menu commands have been described briefly in table-1.

Figure-2: GPS Main Menu

Table-1: Brief description of main menu commands

Menu Name	**Function**
i) Trip Computer	Used to calculate average speed, distance traveled etc during a particular session of survey;
ii) Tracks	Used to save/ delete tracklogs, to setup tracklog registration method etc;
iii) Points	Used to manage waypoint (i.e. landmarks locations) such a registration of waypoint, deletion of waypoint etc.;
iv) Routes	Used to define "route" of traveling (origin to destination), provided that the all the tracks and waypoints related to the routes are previously registered in the receiver. For example, if you want to travel from Dodoma to Mwanza, you can define the routes as "Dodoma-Arusha-Sherengati-Mwanza" etc. Although this is a very useful feature for the drivers to travel to any unknown location, it is not useful for the road-network mapping;
v) Proximity	Whether GPS receiver alarm should beep when you are near to any known location on the route. This function is not useful for the present purpose;
vi) Celestial	Related to tidal information etc.
vii) Mapsource Info	If Mapsource world-data (the world map coming with the Mapsource CD) is uploaded to the receiver, then the tile of the map can be selected to put on or off;
viii) System Info	Provides GPS receiver unit ID, software version etc;
ix) Setup	Used to do a number of system settings;

Apart from the main menu commands, there are also some "context menus", which are obtained by pressing menu button *once* any time on a particular "page" of the receiver. Before going to the details about the context menu, let us first discuss about the "page" of the receiver. There are 5 pages with a Garmin GPS72 or GPSMAP76 model receiver, which are as follows (see figure-3):

i) GPS information page
ii) Map page
iii) Pointer page
iv) Highway page
v) Active route page

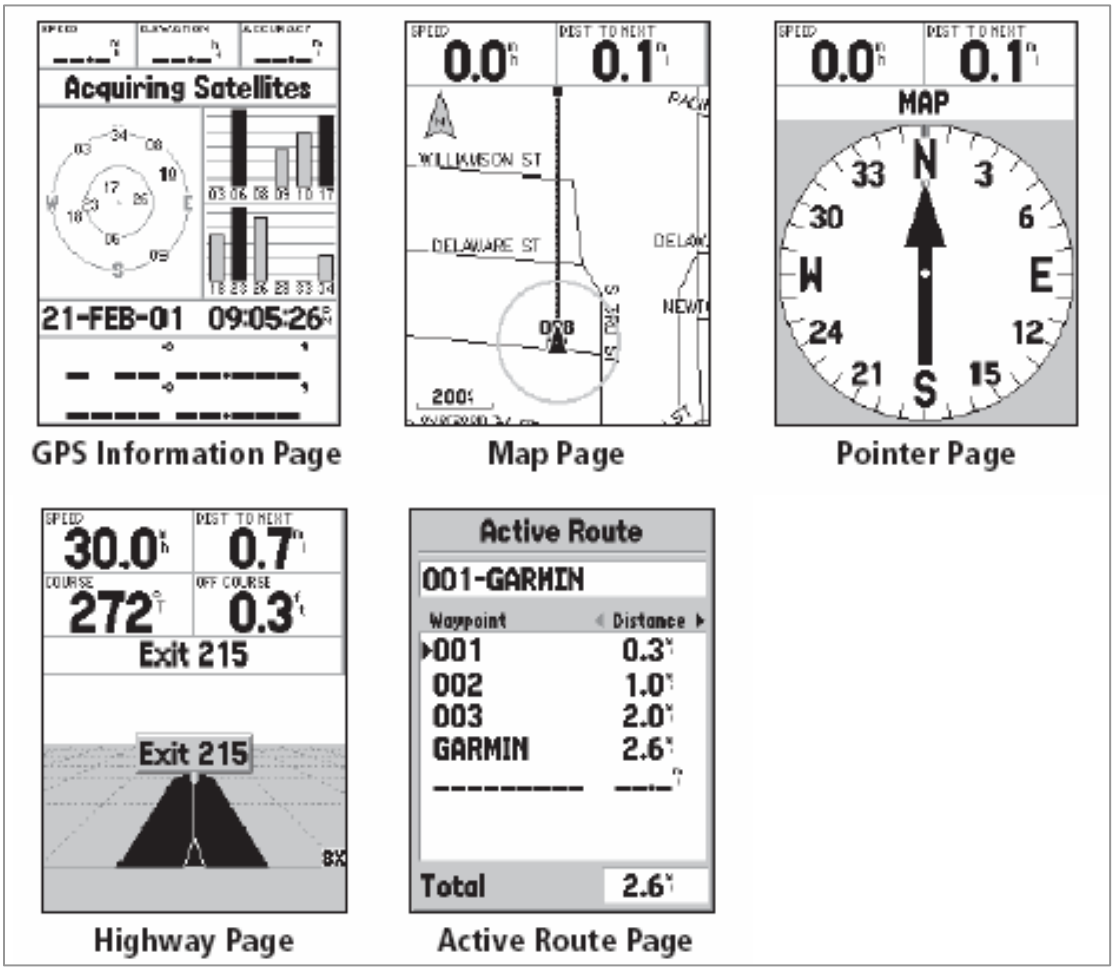


Figure-3: Pages of GPS receiver

The above pages can be accessed any time by pressing page button of the receiver. These pages are used to display different type of information, and you will select any particular page based on what type of information you want to see any particular time while doing the GPS survey. For instance, to see the satellite signal strength (similar to mobile phone signal

reception), you have to select 1st page called "GPS information page". Remember that there is no effect on accuracy of capturing data from which page you display on the screen while doing the survey – the purpose of different pages is to give you the information about the data (such as latitude, longitude, elevation, speed etc.). There are a number of setups with individual pages, which enables you to set "what details" or "how" you want to see various display. For instance, on the map page, you can put the North direction upward to the screen, so that as you change the direction along the road you can see the change in with tracklog arrow as well. The alternate way to put the direction of movement always upward so that the north arrow icon on the screen keeps moving as you change the direction of the movement. Similarly you can change field name, number of header rows to used for displaying fields etc. Figure-4 shows the context menu obtained by pressing menu button once while displaying "map page" on screen.

Figure-4: "Map page" context menu

Table-2: Brief description of "map page" context menu

Menu name	Function
i) Full Screen Map	To cover full screen with map without any fields on the top;
ii) Measure Distance	Measure distance between points on map drawn by "rocker" key;
iii) Setup Page Layout	How many rows (on the top of map) should be used to display attribute information (such as speed, elevation etc.) ;
iv) Change Data Fields	In figure-4, on the top of the screen there are two fields namely "Speed" and "Distance to Next". If you want to change the right filed to say "elevation", then use this command;
v)Setup Map	Selecting this command bring another set of options about changing the layout of the "Map Page". The sub-menus of the map page context menu have been shown in figure-5;

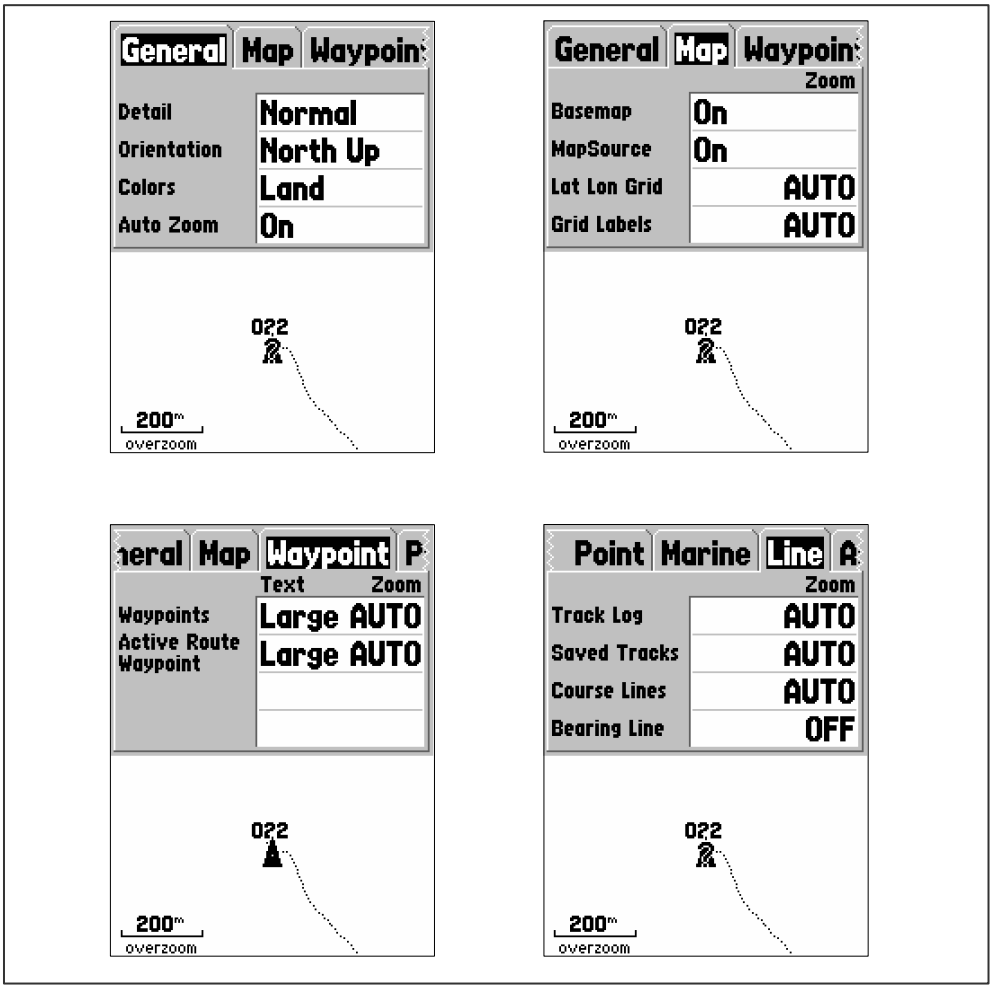


Figure-5: Options of the command "Map page context menu" →"Setup Map sub-menu"

It is advisable not to do any changes to the default settings of the map-page context menus, otherwise it may result ambiguous displays. For example, the default setting for "Auto Zoom" (see general button in box-1 in figure-5) is set to "on". If it is set to "off", the location in the map will be fixed to one place and the display it will not be changing as you change your geographical location while tracking road; thus the present location of the track-log header (the triangular arrow) will not be focused on the display screen automatically and you will be confused whether GPS is capturing data or not.

2.2. Registering waypoints: In any map, the geographical features are represented using one of the three types of shapes namely i) Point, ii) Line and iii) Polygon and the example of these features are i)school, church, trading center, ii) roads, narrow rivers etc. and iii) lakes, wide rivers etc. The point type geographical features, which are permanent landmarks on the earth, are registered as waypoints in GPS receiver. To capture the waypoint, the user has to visit the location of the landmark and then has to mark it using "Enter" button of the

receiver. Now there is a trick in marking the waypoint – *otherwise, simply pressing the "Enter" button does not create the waypoint in the receiver*. Keep pressing the enter key for at least 3 seconds until you get the "mark waypoint box" as shown in figure-6. This screen shows the co-ordinates and elevation of the waypoint. *Although the "mark waypoint box" is*

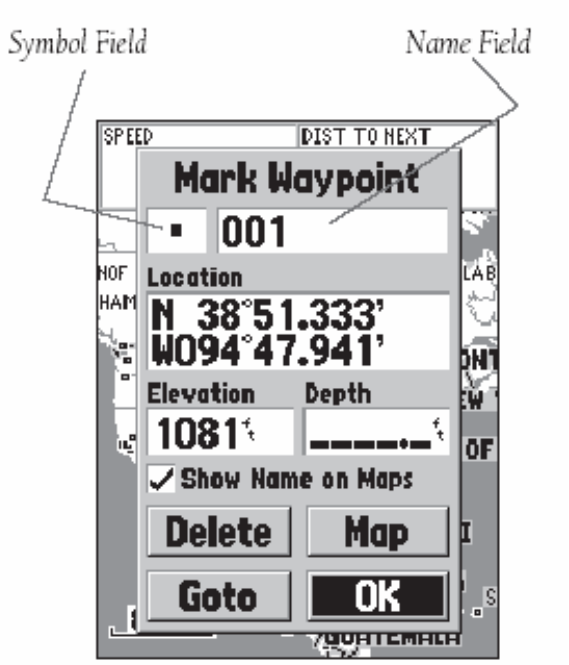


Figure-6: "Mark Waypoint box" to register waypoints

displayed and the waypoint data is locked there, the waypoint has not been yet recorded to the receiver until the "OK" button is pressed (move the cursor to the "OK" button using the rocker key and then press the "Enter" key).

By default, each time you register a waypoint, the receiver produces a sequential number for the waypoint starting from "001" (001, 002, 003….) as its name (see figure-6). You can replace the automatically generated number to actual name of the feature; the name can by typed in the receiver using the rocker key (use up-down to pick alphabet from the list of alphabets and left-right to move cursor). However, typing in the name using the rocker key is very inconvenient and so the names of the waypoints are to enter in computer after downloading data. So a waypoint survey sheet is used (see Appendix-C) to list down all the waypoints registered in the GPS receiver along with the sequential number and the names, so that after downloading the data, actual names of the waypoints can be entered corresponding to the sequential number listed down in the survey sheet. It is very important to write the name of the waypoints in the survey sheet very carefully so that the name goes to the EXACT sequential number and it is very much advisable to check the waypoint number in the "Mark waypoint box" before listing the number in the survey sheet, so that if

any waypoint is missed to register by mistake, only that waypoint would be affected, but not the whole list. For example, say at a location called 'X' the waypoint was locked in the "mark waypoint box" against the waypoint number 15 (i.e. the enter button was kept pressing for more than 3 second and the "waypoint mark box" was obtained), however by mistake, "OK" button was not pressed (see figure-6) and finally the waypoint was not registered in the receiver. So, as you register the next waypoint (say at a location "Y"), the waypoint number 15 would appear again in the "mark waypoint box" and the "Y" location would be registered against the waypoint 15. The resulting map will such that, location name "X" will be displayed at the location of "Y" and all the onward location names will be shifted to the next location and the survey data will be absolutely unusable.

Garmin GPS receiver model GPS 72 and GPSMAP76 can store 500 and 1,000 waypoints respectively. So you can register upto 500 (or 1,000) waypoints in a day so that after downloading the data in computer, you can free up the waypoint memory by deleting the waypoints from the receiver. Even if in a day only few waypoints have been received (say 60 nos) and there is enough memory available for next day survey, still the it is required to delete all the previously registered (and downloaded) waypoints from the receiver everyday before doing survey. Because whenever you download data from the receiver, all the waypoint available in the receiver are copied in the computer; thus if you do not delete previously downloaded data, the same waypoints will be duplicated in the map. To delete all the waypoints, follow the key sequence shown in figure-7. That is, first press "Menu" key twice to get main menu and then select "Points" menu; after entering "Points" menu command, press again menu key to get the options as shown in figure-7.

Figure-7: Deleting waypoint – "Menu" Key twice →"Points" menu→"Menu key" →"Delete All" command

It is always advisable to mark the waypoint by visiting the exact location of the landmark waypoint. However, if the waypoint is registered simultaneously while doing the road tracks, possibly the user will mark the waypoint while remaining on the road track. This will however result a map where the point features are shown on the roads (e.g. schools on the road!), which is very faulty. However, if the waypoint is marked away from the original position, there is a way to move the location to approximately true location in Mapsource software. In such case, the waypoint location is needed to draw with a short description in the "Waypoint Survey Form" as shown in figure-8. The waypoint must not be marked from such distant location where it is difficult to approximate the position of the waypoint in relation to the road track.

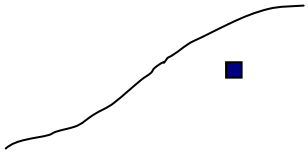
Seq.No	Name	Description
15	X	 The point is 50m away from the road on the right side.

Figure-8: Illustrating waypoint location in the "Waypoint survey form"

If there are more than one geographical features clustered in the same location (for instance school, church, trading center etc.), each and every feature has to be registered with individual sequence number; later on such clustered waypoints have to be separated manually using the Mapsource software. Registering individual points for individual features is very important as location of each and every feature under different category needed for various data analysis or queries; for example, you my want to get the map of only educational centers at certain time and other time you may want a map of only the trading centers. Road structures (bridges/culverts etc.) do not need to capture as waypoints for two reasons. First, two many structures may spoil the readability of the map and secondly, the structure locations can be determined from the chainage positions from the road inventory. However, large bridges or drifts can be considered as exceptions and can be marked as waypoints.

2.3 Tracking Roads: The Garmin GPS receiver recognizes the change of its geographical location and it captures its positional data (i.e. latitude, longitude, elevation of the particular point on earth) automatically as you move with the GPS receiver. The interval for capturing the points is either in equal distance unit or in equal time unit as per the track-log interval set in the in the track-log interval. The stream of such automatically captured points is called

track-log. The track-log is displayed as dotted line with a leading arrow as shown in figure-5. Remember that to see the track-log on screen, you have to set the map scale to visible scale range using "zoom-in" and "zoom-out" buttons. For instance the map scale in figure-5 is in large scale of 200m and if you set the map scale to small scale such as 500Km, you will not be able to see the track on the display as the whole track will appear as a small dot on the map with very small scale. However, after each day survey, these track-logs are downloaded to computer and the code numbers of the corresponding road are also entered.

AS the GPS receiver records the every position automatically, it is important that the GPS receiver should not be allowed to capture locations off the road; otherwise, the track-logs captured outside actual road would become the part of the road, and the result will be a misleading map as shown in figure-9.

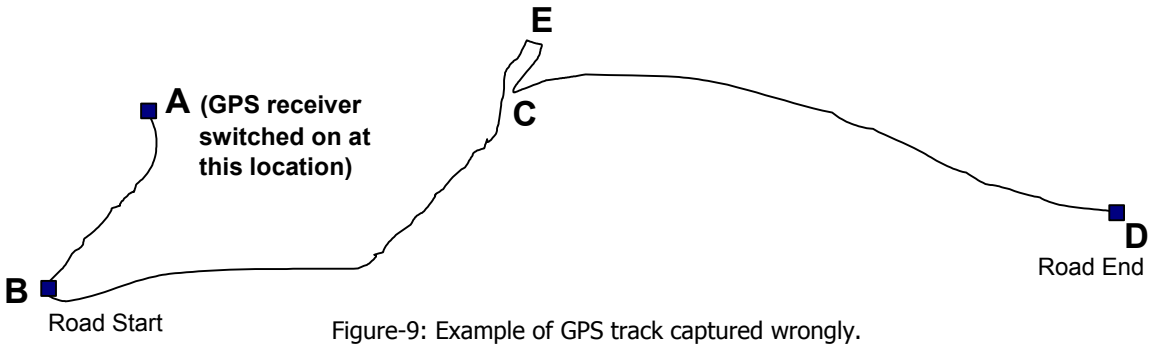


Figure-9: Example of GPS track captured wrongly.

In the above figure, the actual road track is **B-C-D**. As GPS receiver was switched on at location A, the segment A-B was automatically captured and became the part of the road. Moreover, at point C, there was an off-road movement (went to a shop or captured a waypoint at point E) and an extra segment has been added to actual road track.

In order to record the track correctly, following steps are required to follow precisely.

i. Move to the exact start position of the road and park the car there;
ii. Switch on the GPS receiver with clear view to sky and (the receiver should have at least 45° clear-view to the satellites). Now **CLEAR** all the previously recorded waypoints and track-logs. Wait for few minutes until enough satellite signal is obtained;
iii. Then mark a waypoint so that you can recognize the location after downloading the data in Mapsource software. If the location is also any landmark (such as trading center), *then register another waypoint against the particular landmark type*. Remember that the start and end point of road are used only to check later in

Mapsource software whether the track has been captured accurately; otherwise waypoint of type "road start" and "road end" do not appear on the final version of the map in ArcView. So if you want to show the start (or end) of the road with name of the place, you should mark the location under appropriate socio-economic center type (such as Trading Center).

iv. Now start driving and do the tracking. Limit the speed of the car within 40Km per hour (that 11m per second). Over speeding may increase the interval of the consecutive track-points as the receiver would miss to register track-points.

v. As you drive, if there is any landmark falls beside the road, then mark the location as waypoint. Remember that you need 3 to 4 seconds to mark the waypoint. Once the location is "**locked**" in the receiver (see figure-6), you can continue driving and if you confirm the registration (i.e. press "OK" button) away from the actual location, still you will record the actual location which has been "locked" in the receiver display;

vi. If you need to mark any waypoint a bit off the road, then park the car beside the road and then **switch-off the receiver**. Then walk to the landmark location and **switch-on** the receiver again there. Wait for enough satellite signals and then mark the waypoint. After marking the waypoint, **switch-off** the receiver again. Make sure that you follow the switch-on-off sequence while registering waypoint off the road, otherwise you will get incorrect track-log as shown in figure-9. After recording off-road waypoint, be sure that you come back to the same location where you switched off the receiver, and at that location, you switch-on the receiver. Now wait for few minutes for the satellite signal and then continue driving;

vii. As you reach at the end of the road, you need to mark the location (so that later on when you download data in Mapsource software, you can recognize the location). If there is any socio-economic center at the location, then mark the point as the specific socio-economic center ***as well*** so that the location will appear with name in the final version of the map (in ArcView); see the instruction in the above "step-iii" regarding how to mark the start and end positions of a road.

3. Downloading and processing data in Mapsource

3.1 Setting-up Preferences: Mapsource is a proprietary software of Garmin Ltd. and it is basically used to download GPS data from the receiver to computer and to do some basic and preliminary editing of data. The Mapsource software come with world-map with basic information such as name and location of the major cities or towns, major roads, lakes,

rivers etc. which put at the background of the GPS surveyed features, and thus helps you to edit data. The world map come Mapsource software is not very accurate in large scale display, as it has not been done from physical survey of the features; rather it has been produced from compiling data from a number of secondary sources such as World Atlas etc.

Data saved in Mapsource software are stored in a file with *.mps extension, which is also a proprietary data structure of Garmin Ltd. Although the GPS data can be displayed in different units and co-ordinate system in the Mapsource software, the actual data saved in the file is as per following format:

i) Location (latitude/ longitude) : Radian
ii) Datum: World Geodetic System-84 (WGS84)
iii) Elevation and depth: meters

The "Mapping Utility" software reads data directly from the Mapsource (*.mps) file and it does not really matter much what units are set in the software to display data. However, if the location is displayed in radians or even decimal degrees, the users are not able to measure distance between two points in radians under WCS (World Coordinate System). Thus there are certain settings which need to set before using the Mapsource software. Although such settings are set only once after installation of the software, the "setup-section" is put under the main text of this manual so that the user do not forget to do the settings.

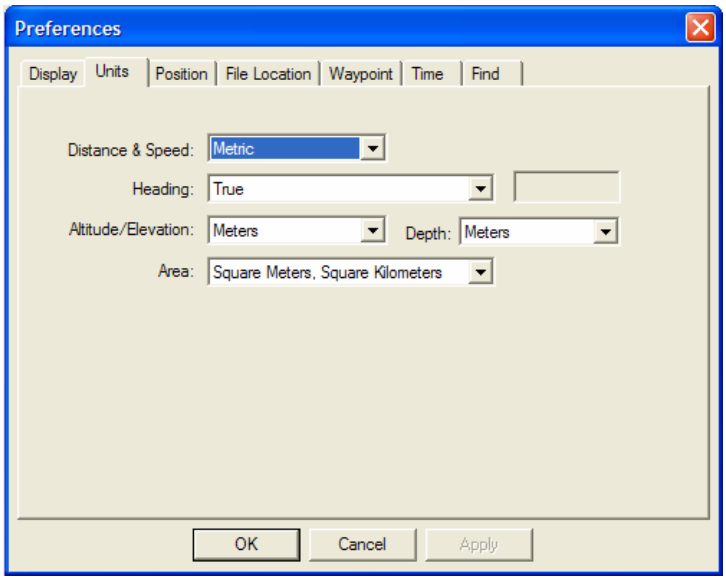


Figure-10: "Preferences" dialogue box in Mapsource software

The "Preferences" dialogue box (figure-10) can be found under "Edit" menu command of the MapSource software or by pressing "Ctrl+Shift+P" keys. There are 7 tabs or pages in the "Preferences" dialogue box namely i) "Display", ii) "Units", iii) 'Positions", iv) 'File location" v) "Waypoint", vi) "Time", and vii) "Find". Basically 3 out of these 7 buttons are used for road-network mapping as discussed follows:

i) **Units**: Units are related to distance, area, speed, altitude and depth. It is relevant to mention here that ***altitude*** is the height above mean-sea-level (MSL), whereas ***depth*** is the height above the imaginary regular shaped ellipsoid (used to define datum). For further clarification on datum, see Appendix-B. Anyway, set the values for "Unit" fields exactly same as shown in figure-10.

ii) **Positions**: The position data of any location is expressed with respect to at least two references namely datum and grid. Explanation about datum and grid has been given in Appendix-B. In brief, a datum defines the size of an ellipsoid, which is equivalent the earth with regular shape. For different part of the world, different definition (size) of the ellipsoid is chosen, so that the actual earth surface is very close to the imaginary ellipsoid. For Tanzania, the best fit ellipsoid is called Arc1960. So enter values for "Positions" fields exactly same as shown in figure-11.

iii) **File Locations: "**File Locations" is the folder name where all the map source files are stored. Enter the values as follows: **C:\Mapping**.

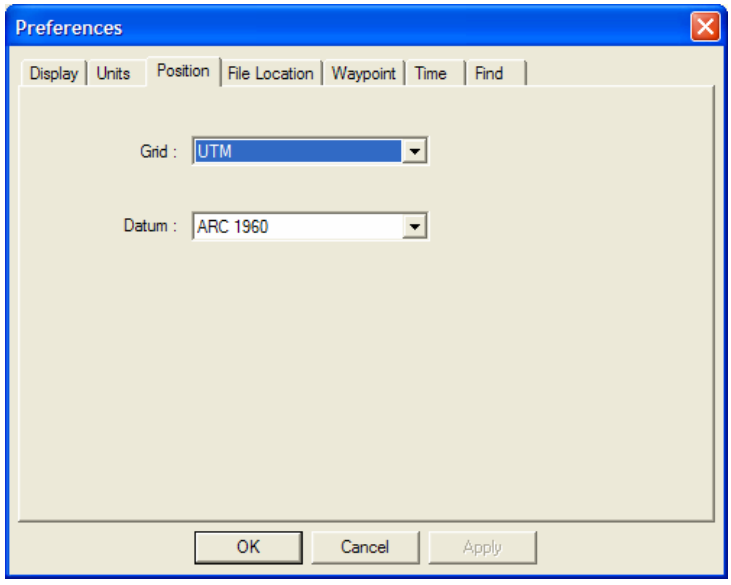


Figure-11: "Positions Preferences" dialogue box in Mapsource software

3.2. Downloading data: Mapsource software deals with the 4 types of data, which are as follows:

Table-3: Types of data handled by Mapsource software

Data Type	Description
i) Waypoints	Used to denote point-type features such as landmark locations on earth (e.g. school);
ii) Tracks	Used to denote linear features such as road network, narrow rivers etc.;
iii) Routes	A set of predefined tracks and waypoints, which defines the traveling path from one location to another. Route is not used for the road network mapping;
iv) Maps	Mapsource software come with a basic location map covering all over the world. The data is locked and can not be edited. The positional accuracy of the data is not very good as it has not been done through physical survey. For the road-network mapping, "map" type data is not used;

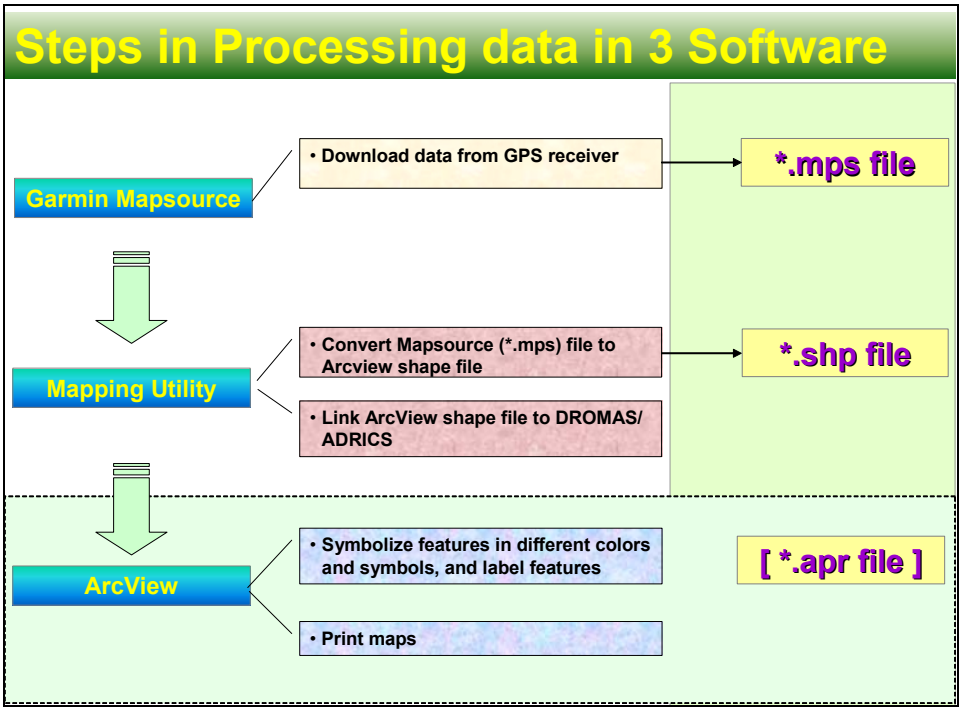


Figure-12: Steps in processing data in 3 different software

To download data from the GPS receiver, connect the receiver to the computer at either serial or USB port and enter the following command sequences: File→Open from→Serial

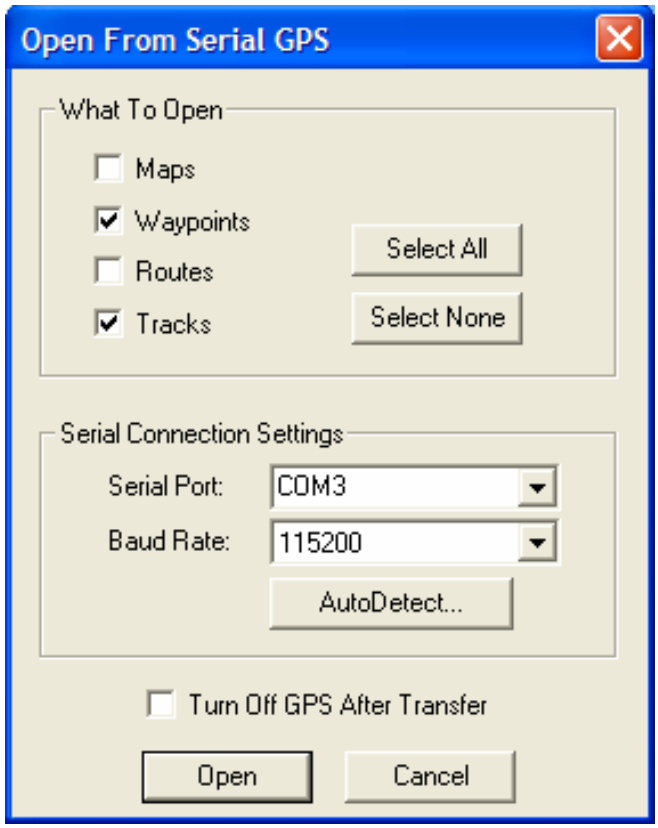


Figure-13: Dialogue box for downloading data from GPS receiver

GPS. Then you get a dialogue box as shown in figure-13. Select only Waypoints and Tracks in the dialogue box and unselect the remaining data types. Now press "**Auto Detect…**" button, which will then detect the communication port and will set the baud rate. If the auto-detection is successful, press "**Open**" button to start downloading data. If auto-detection fails, then check the cable connections first. Sometimes, some third party software (for example Nokia phone communicator software) occupies the communication port and does not allow free-up port for other software. In such case, uninstall or disable the third party software. After successful downloading, a new file is opened in the Mapsource document and the downloaded data are displayed there. Set proper zoom scale to see the details of the data. Save the file with a name in combination of the district name and the day number suffix, for example "Mbale-Day1.mps".

3.3 Editing Waypoints: The following editing operation can be done in Mapsource software with the Waypoint type data:

i) Entering "Name" and "Type Code" of the waypoints;

ii) Moving location of the waypoints;

i) Entering "Name" and "Type Code" of the waypoints: Waypoint name and type code can be entered both in the Mapsource software and in the Mapping Utility software. To enter the name and type code, first open the "Waypoint tab" in the Mapsource document (click on the Waypoints tab) and then highlight the waypoint (see figure-14).

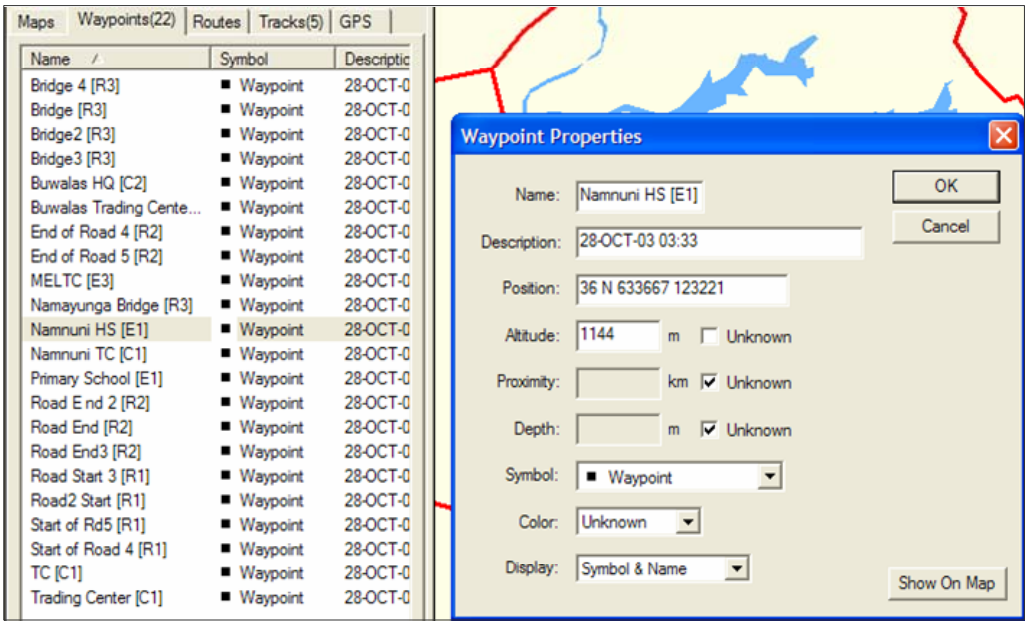


Figure-14: Editing waypoint name and type code

Then double click on the waypoint row (left box of figure-14) to open the "Waypoint Properties" dialogue box (see the right window in figure-14). Under the name field, enter the name of the feature followed by the type code of the waypoint enclosed by square brackets. For the name, use short name of the socio-economic features, for example HS for high school, PS for Primary School, TC for trading center. The short name and type code of various socio-economic features has been listed in Appendix-C. If you have several waypoints with the same name, for example "Bridge", use suffix with them, such as Bridge-1, Bridge-2 etc.; otherwise use different name. Because, the waypoint names have to be unique in the whole list. While editing the waypoints, you may also want to see the waypoint in the map; to do so, press "Show On Map" button (see figure-14). After finishing the entry of all the waypoint name and codes, save the file by pressing the save button .

ii) Moving location of the waypoints: To move a waypoint in a map, first zoom in the waypoint location to a detail level. For zooming in, you can use the "**zoom tool**" (the left most tool in the Mapsource tool menu, with magnifying glass and plus sign icon) so

that you can see the details around the specific waypoint. After selecting the zoom tool, draw a rectangle centering the waypoint (click at the top bottom left corner and keep the mouse button clicked as you move the cursor to the bottom right corner of the rectangle and then release the mouse button there; see figure-15). After the waypoint is clearly visible in a detail zoom level, then select the "**selection tool**" by clicking on it. The selection tool is the white arrow in the Mapsource tool menu. If you did not select the selection tool and instead you selected the waypoint tool will start

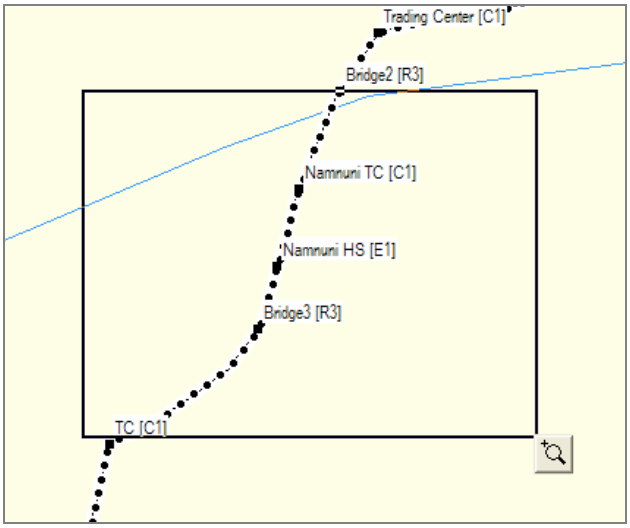


Figure-15: Zooming in a rectangular area using **Zoom tool**

creating new waypoints in the map as every time you click on the map after clicking on the **waypoint tool**. *So be sure about clicking on the selection tool and **never** click on the waypoint tool (the green flag)*. As you have selected the **selection tool**, click on

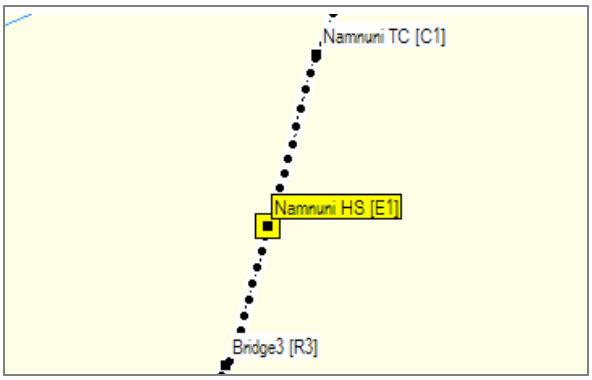


Figure-16: Selecting the waypoint by clicking on it **just once**

the waypoint on the map just once (**do not double click** the waypoint). As you click on the waypoint, the waypoint is selected, and it is encircled by a yellow rectangle as shown in figure-16. Next click on the selected waypoint **once again**. As you do so, the waypoint move tool is activated as shown in figure-17. With the waypoint **"move**

tool" activated, cursor is changed to white arrow with black waypoint flag and you are ready to move the waypoint. Move cursor to the desired location, and then click on mouse to complete the moving. As you move cursor, you can also see the distance of displacement at the status bar of the window (see figure-17, where distance of displacement is shown as 150 m). As you do moving of the waypoint, it is very likely that there will be some mistakes, specially at the beginning. If there is any mistake in editing, just press undo key (**Ctrl+Z**), or press undo button.

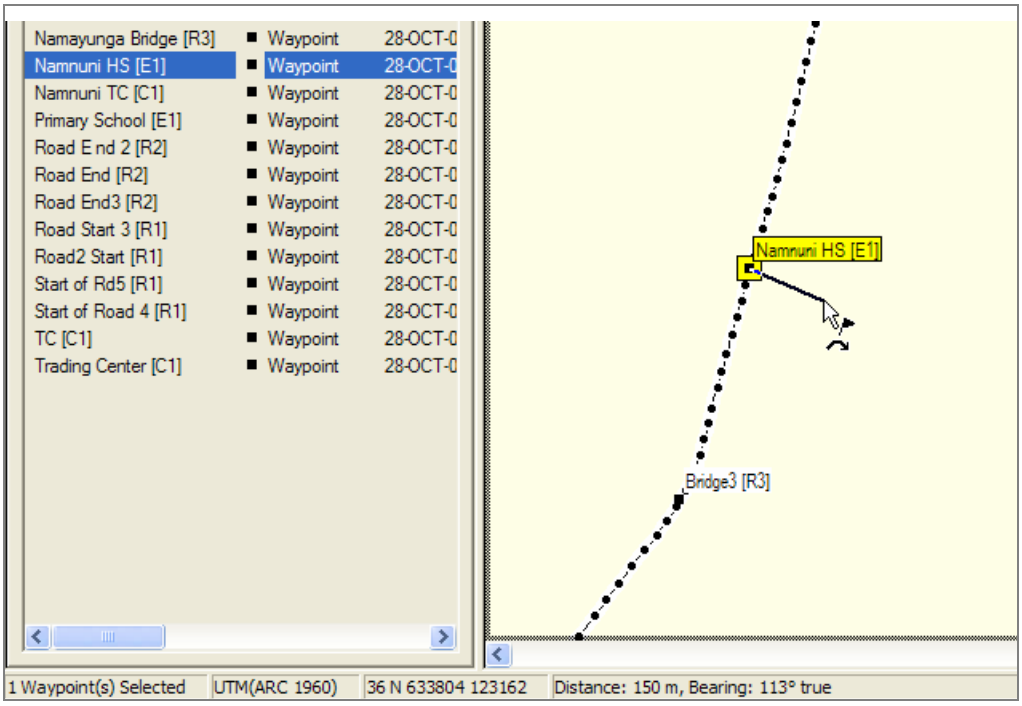


Figure-17: Moving the waypoint **using move tool** at a distance 150m from original location

After finishing all the editing works, press save buttons to save the changes. In fact it is always good keep saving the file quite often so that any loss in data editing can be avoided.

3.4. Editing Tracks: The following editing operations can be done in Mapsource software with the Track type data:

i) Entering "Road Number";

ii) Deleting duplicate or extra part of a track;

The purpose of editing road tracks in Mapsource software is to make sure that all the roads are perfectly captured and there is no extra lines tailed to the road track (because of off-road movement or because of poor satellite connection). In order to verify the correctness in

track data, you need to zoom in the track and then scroll through the track-points. For instance the track number "19101" has been highlighted in the figure-18 and the track is shown in yellow lines with black dots. To show any particular track on screen, highlight the track on the "tab-list" box and then press right button of the mouse (see figure-18). The zoom level of the map is 500m (see the bottom right corner of the screen). To zoom-in, either use the zoom tool from the (the left most button in the tool menu) or use zoom-in and zoom-out buttons. Remember that the zoom tool allow you to zoom-in a particular area through drawing rectangle of the area, whereas zoom-in and zoom-out buttons allow you to zoom to the center of the map. You can also select the desired zoom level in the zoom scale pick list (for instance, 700m, 500m, 300 m etc.). You can also drag the map window using the hand tool.

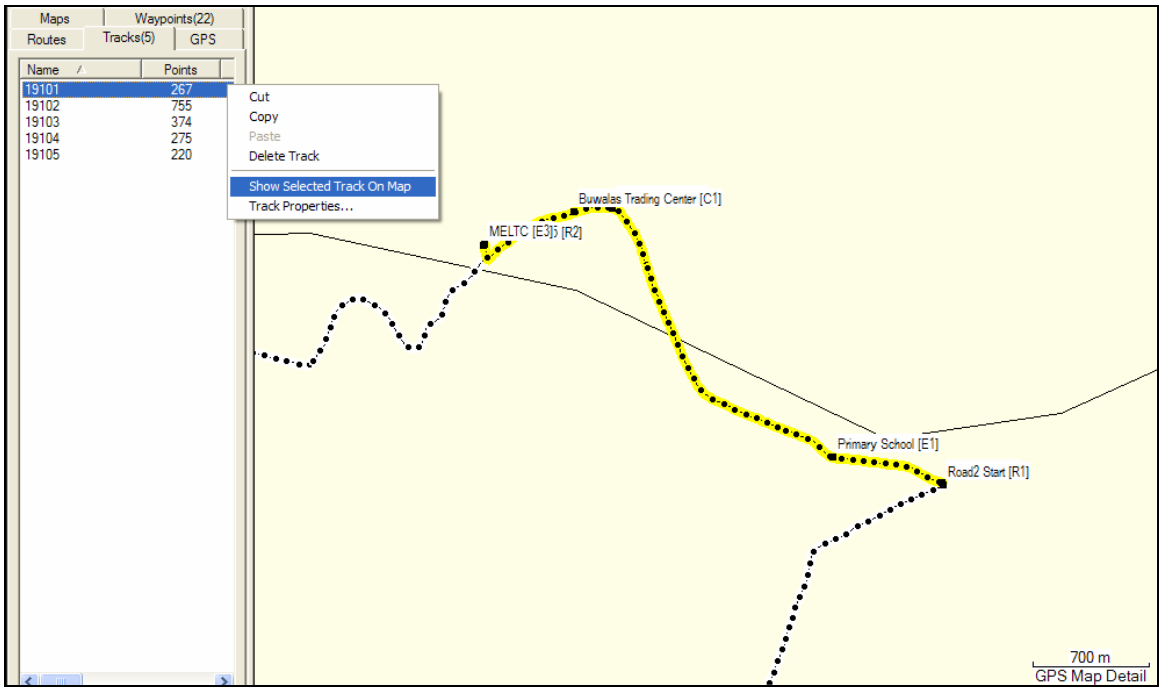


Figure-18: Showing a track at the center of the screen

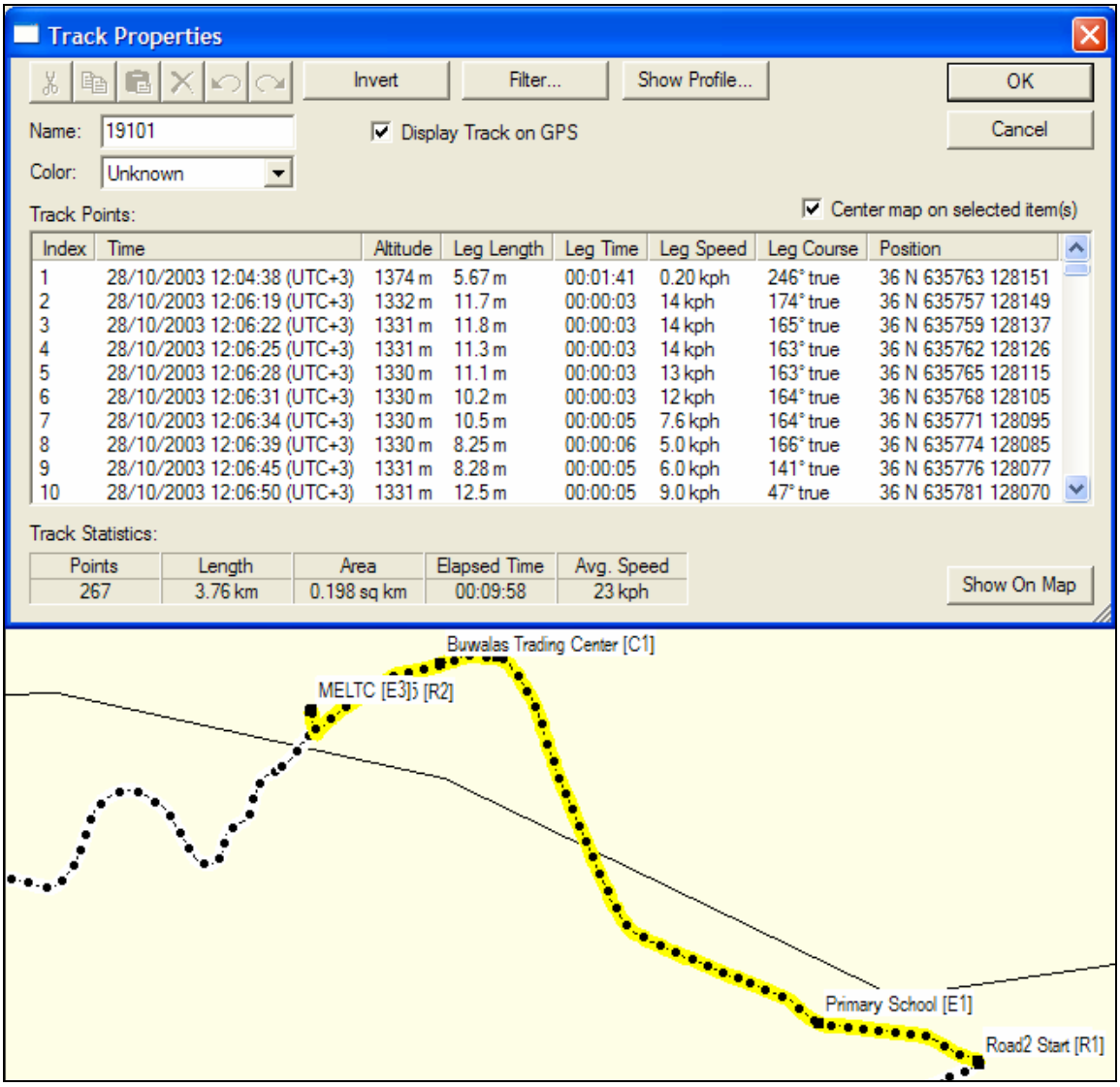
"Roller Skating" through the track-points from the starting to the end is another way to check the correctness of the track. To "roller skate" a track, click on the track on the tab-list and then right click to open the "**track properties window**" (see figure-19). In the track-properties window, you can see the list of all the legs, which constitutes the track. Now follow the following steps to do "roller skating":

i) Check the tick-box named "Center on the selected item(s);

ii) Select the first row of the "Track Points" list;

iii) Use up and down arrow to scroll through the "Track Points" list which makes the

"roller skating" along the track. If the track is hidden behind the "Track Properties" window, you can move the window by holding the top blue bar of the window (click on the window and then move mouse holding the mouse clicked). To see detail level of the track-points, you need to zoom to an appropriate scale (say 70m zoom level).



Index	Time	Altitude	Leg Length	Leg Time	Leg Speed	Leg Course	Position
1	28/10/2003 12:04:38 (UTC+3)	1374 m	5.67 m	00:01:41	0.20 kph	246° true	36 N 635763 128151
2	28/10/2003 12:06:19 (UTC+3)	1332 m	11.7 m	00:00:03	14 kph	174° true	36 N 635757 128149
3	28/10/2003 12:06:22 (UTC+3)	1331 m	11.8 m	00:00:03	14 kph	165° true	36 N 635759 128137
4	28/10/2003 12:06:25 (UTC+3)	1331 m	11.3 m	00:00:03	14 kph	163° true	36 N 635762 128126
5	28/10/2003 12:06:28 (UTC+3)	1330 m	11.1 m	00:00:03	13 kph	163° true	36 N 635765 128115
6	28/10/2003 12:06:31 (UTC+3)	1330 m	10.2 m	00:00:03	12 kph	164° true	36 N 635768 128105
7	28/10/2003 12:06:34 (UTC+3)	1330 m	10.5 m	00:00:05	7.6 kph	164° true	36 N 635771 128095
8	28/10/2003 12:06:39 (UTC+3)	1330 m	8.25 m	00:00:06	5.0 kph	166° true	36 N 635774 128085
9	28/10/2003 12:06:45 (UTC+3)	1331 m	8.28 m	00:00:05	6.0 kph	141° true	36 N 635776 128077
10	28/10/2003 12:06:50 (UTC+3)	1331 m	12.5 m	00:00:05	9.0 kph	47° true	36 N 635781 128070

Points	Length	Area	Elapsed Time	Avg. Speed
267	3.76 km	0.198 sq km	00:09:58	23 kph

Figure-19: Track properties

As you scroll through the track-points in the track-properties window, you can delete one or more track-points by selecting the point(s) and then pressing the "X" button in the track-properties window (see figure-19). To select multiple points, first highlight the first point, then press shift button and then click on the last point. If you have deleted any track-point  by mistake, you can use "**Undo**" button or press "Ctrl+Z" to reverse the change. When you delete track-points, make sure that you do not make the **track-leg** length (distance between two consecutive track-points) too long. If one or more track-legs are over say 125m length, it is advisable to redo the survey.

In addition to delete the track-points, you can also delete the whole track. To do so, just click on the track in the track-tab and then press the "X" button of the map window. Do this deletion and edition operation carefully, other-wise it is very easy to mess up the data through this kind of manual editing. It is wise to do the survey very carefully and accurately, so that you have clean track-log data and each track corresponds to a whole road in the road network.

Once a clean set of tracks are obtained, it is just very simple to enter the road number. Usually one road consists of one track; however if there is any split of track at one or more intermediate points (because of say interruption of satellite signal reception), a road can consist of multiple tracks. Opposite to this (i.e. one track for multiple roads) is not possible as it does not allow to enter road code and the track-data can not be used for mapping. Anyway, to enter road-code, select the track from the track-tab and then open the track-properties, either by double-clicking on the track or by right-clicking on the tract (see figure-18, 19).

If you have multiple tracks for a road, you need to assign same road-code to all those tracks. But, in Mapsource, you can not enter same code for multiple tracks. In such case you need to use suffixes with the road-code; for example if you have 3 tracks for "19101" road, you need to enter the track-code as "19101a", "19101b", "19101c". *While entering the road-code suffix, make sure that the suffixes must follow the order of road tracks, the way they were surveyed*.

3.5 Saving files: The files should be saved immediately after downloading the data from the GPS receiver. Moreover, after every operation (like editing waypoint code/ names, editing tracks etc.) the file should be saved to make sure that the no changes are lost. The location of the data directory is "**C:\Mapping**" folder; so save the Mapsource files under that directory. Each day after the survey, the data are downloaded in computer and a new Mapsource file is generated. Thus, the file name string should consist of the name of the district followed by survey day number suffix. For example, if the district is Mbale, then name of the Mapsource file should be Mbale-day1.mps, Mbale-day2.mps, Mbale-day3.mps (for the survey data of day 1, day 2 and day 3 respectively) and so on. Do not make several files for one survey session; otherwise those file will later make confusion. If you had to create any scrap Mapsource file under "C:\Mapping" folder, then delete such scrap files later.

4.1 Making Shape-files: This button enables you to convert the Mapsource *.mps format file to ArcView shape file. As you press the button, a screen as shown in figure-22 is opened. At the upper part of the screen, a box displays a list of all the Mapsource *.mps files under C:\Mapping folder. Each file in the box is attached to a small tick-box next to the filename

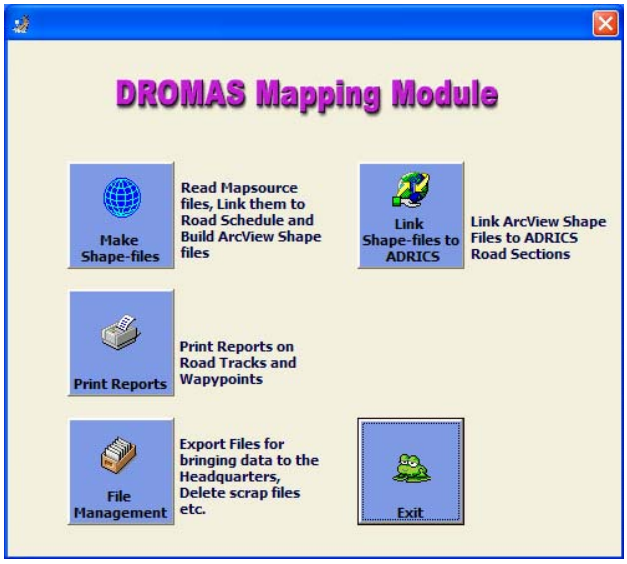


Figure-21: Startup screen of RAMPS Mapping Utility

on the left. You can select the files you want to convert by putting a tick before the corresponding filenames. The lower part of the screen contains tabular display. There are two "pages" or "tabs" on this screen called "Tracks" and "Waypoints". The page can be accessed by pressing the tab-button (i.e. the page-name button) of the respective page.

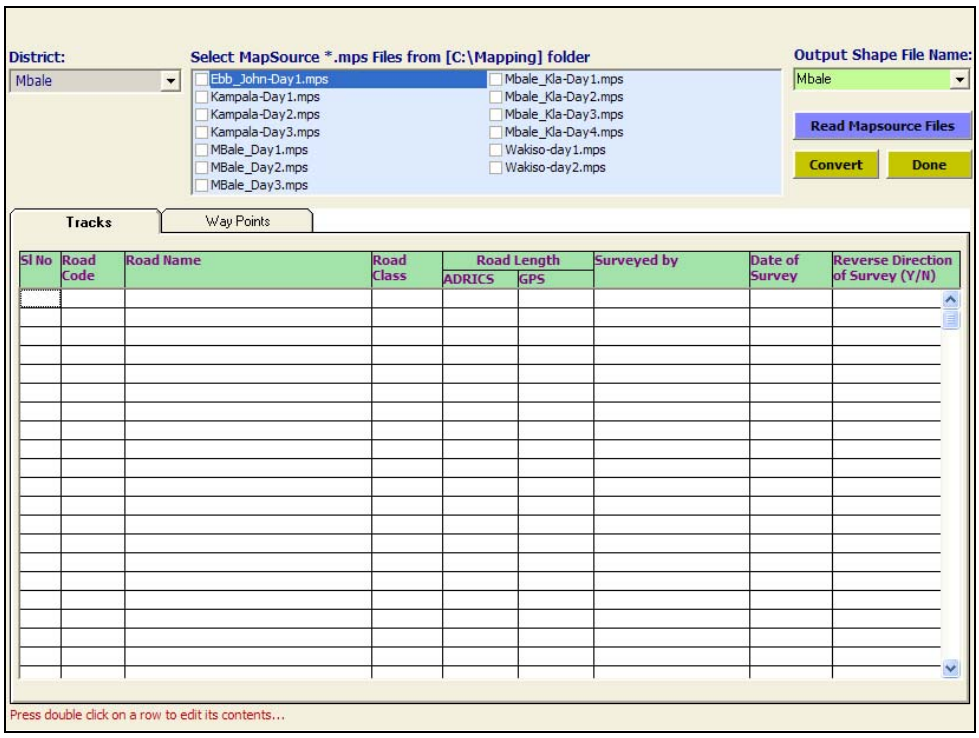


Figure-22: Mapsource to Shape file conversion window

To convert Mapsource files, first select the files by putting tick-marks next to the filenames. Remember that every time you download data from GPS receiver to computer, you create one Mapsource file which corresponds to survey data of the day and filenames of those Mapsource files are suffixed with day number (i.e. MBale-day1.mps). You can create one ArcView shape file per Mapsource file, or you can combine a number of Mapsource files and edit them together. Press "Read Mapsource Files" button to read the GPS data from Mapsource file(s) into memory. It may take couple of minutes to complete the reading; wait until data reading is done and do not press any key. When the file reading is complete, a

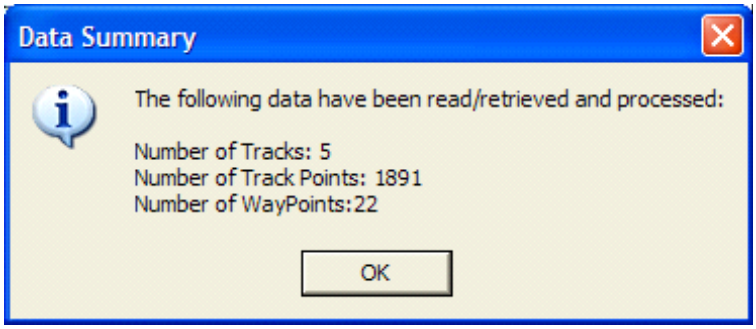
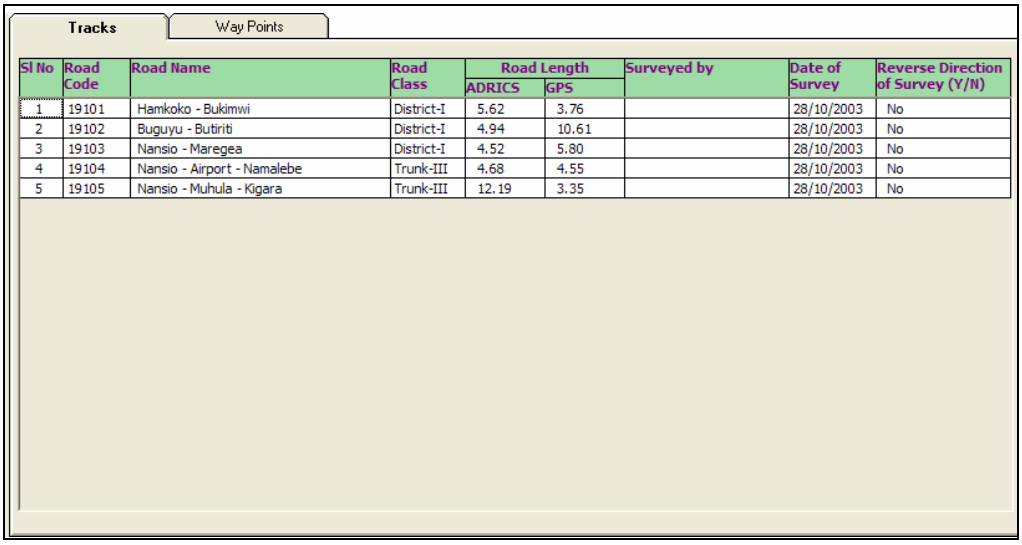


Figure-23: Dialogue box showing data reading summary

dialogue window pops up which displays summary of Mapsource data read viz. number of tracks, number of waypoints etc.; at the same time the "Tracks" table is filled in with track-headers and "Waypoints" tables is filled in with all the waypoint data read from the Mapsource files(s). Apart from the track-header, also all the track-point data are read and put in computer memory in the sequence of tracking direction. You can edit any row in the track-header or waypoint table by double-clicking on the respective row.


Tracks | Way Points

Sl No	Road Code	Road Name	Road Class	Road Length		Surveyed by	Date of Survey	Reverse Direction of Survey (Y/N)
				ADRICS	GPS			
1	19101	Hamkoko - Bukimwi	District-I	5.62	3.76		28/10/2003	No
2	19102	Buguyu - Butiriti	District-I	4.94	10.61		28/10/2003	No
3	19103	Nansio - Maregea	District-I	4.52	5.80		28/10/2003	No
4	19104	Nansio - Airport - Namalebe	Trunk-III	4.68	4.55		28/10/2003	No
5	19105	Nansio - Muhula - Kigara	Trunk-III	12.19	3.35		28/10/2003	No

Figure-24: Track-header table in "Tracks" tab

The track-header dialogue box has been shown in figure-23. In this box, you can enter the following data:

i) Road code;

ii) Road type;

iii) Road class;

iv) Surveyed by;

v) Reverse direction of survey (True/ False)

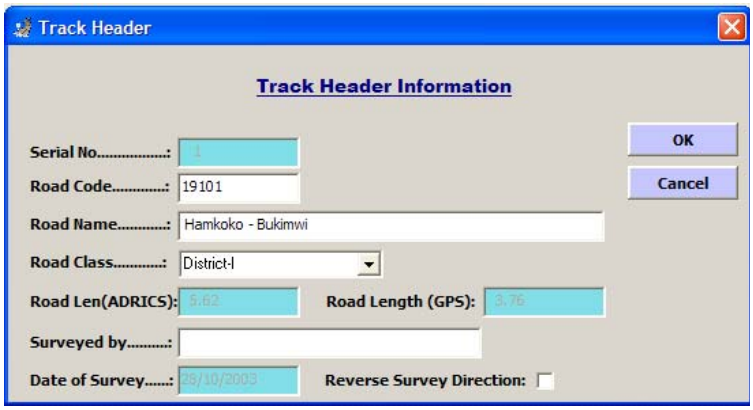


Figure-25: Track-header data entering screen

As you enter correct road number, the program picks corresponding road name, road length, road class etc data from RAMPS database and put it in the form. If the road code is not found in the database, road-name, road class etc. fields in the form remains blank and you can enter those data manually. While entering road code, you must remove any suffix from the road code (if any). Remember that in Mapsource software, you need to enter unique number for the road tracks. Thus if one road (say 19105) comprise of multiple tracks, you had to add a, b, c etc. suffix with the road code (for example 19105a, 19105b, 19105c etc.). However, when you edit data in track-header screen, you must edit all the road code of above example to "19105".

The "**Reverse Survey Direction**" is a very important information and you need to enter correct value for this field very carefully. Remember that it is one of the important functions of the Mapping Utility software to do "dynamic segmentation" of road tracks. With the dynamic segmentation, the whole road is divided into a number of parts (or segments) and each segment in the resulting shape file corresponds to a section in the RAMPS database. The segmentation is done on the basis of chainage value of the road sections (and proportionately to RAMPS road-length and GPS road length); the segmentation is started from the '0' chainage and progressed along the direction of track-point sequence. The track-point sequence is built as per direction of survey. If the survey is done at the same direction

of road (i.e. from '0' chainage to end-chainage), the track-point sequences are in right order. *However, if the road is surveyed in reverse direction starting from the end-chainage, the track-point sequences need to be reversed and a tick-mark has to put in the "Reverse Survey Direction" field*. Failing to enter this field correctly (i.e. putting a tick mark in case of forward direction survey or no tick-mark in case of reverse direction survey) will result entirely wrong segments from dynamic segmentation.

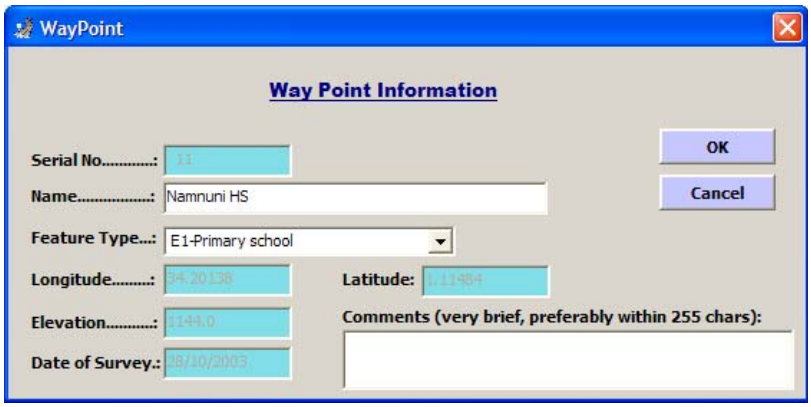


Figure-26: Waypoint data entering screen

After completion of editing the track-header and waypoint data, enter the name of the output shape-file in the "Output Shape File Name" field. If the output shape file already exists, you will be prompted whether you want to overwrite the file. If you do not want to overwrite the existing file, respond "No" and change the filename. You must give a meaningful name to the output shape file, which should comprise of name of the district. For example, if you convert 5 days Mapsource files (day 1 to day 5) for the district MBale, the name of the output shape file should be "Mbale_1-5". If you press "Convert" button now, the following two sets of ArcView shape files will be generated.

a) Trk_OutputFileName.shp

b) Wpt_OutputFileName.shp

The first one is "Line" type shape file containing the road data and the second one is of "Point" type shape file containing socio-economic location data.

Apart from reading data from the Mapsource files, you can also read data from existing shape files. The "Output Shape File Name" drop-down list contain list of all the shape files under "C:\Mapping" folder. If you select any file from the list, you will be prompted whether you want to retriever data from the selected shape files. Remember that, if you read data from existing shape file, all previously read data from memory (if any) will be replaced by the latest read data.

4.3 Printing Reports: You can generate one of the following reports through this button:

i) Blank GPS Survey Sheet for Tracks;
ii) Blank GPS Survey Sheet for Waypoint;
iii) List of Tracks surveyed;
iv) List of Waypoints surveyed;

With the present version of the software, you can get only the track-header and waypoint information of the latest shape file. In future with the next version, you will be able to select the shape files, for which you would like to generate the reports.

4.4 File Management: Using this button, you can do one of the following operations on shape file and/ or Mapsource files.

i) Deleting files;
ii) Exporting selected file to a compact format file;

Every time you download files from GPS machine, you generate a new Mapsource file. It may happen that you have downloaded same data multiple times and created different Mapsource files with the same data. Any redundant scrap files in the hard disk under **C:\Mapping** folder may create unnecessary confusions. So whenever you recognize that a Mapsource file has become redundant, just delete the file immediately. However, important thing to remember that NEVER DELETE ANY good Mapsource file, even if you have converted its content to ArcView shape file.

Similarly, every time you combine multiple shape files, the constituent shape files become redundant. So after checking the correctness of the resulting combined shape file in ArcView, delete the constituent shape files immediately. The key point to remember that do not keep any scrap file in the hard disk. At the same time, do not delete any good file. When you press delete button, you are asked to enter the name of your district. You can enter the district name in either capital letters, or small letters or mixed; but if you enter the name incorrectly, the shape files will not be deleted. This is just a security so that you do not delete good files by mistake.

"Export" button creates a "RAR" format compact file out of all the selected Mapsource files and shape files. The name of the RAR file is same as of the district name. Usually one compact file should fit in one diskette (of size 1.44 MB). However, if the size of all the

selected files is too large to fit in one diskette, the resulting RAR file is split into parts and the name of the files are suffixed by part01, part02 etc. For example, if the compact RAR file size is say 2 MB size, then there will be two RAR files and the file names will be DistrictName.part1.rar, DistrictName.part2.rar. The compact file is saved under C:\Mapping\ExpoImpo folder. The purposes of creating compact files are i) you can backup your data in a safe location in another folder of hard disk or in a CD and ii) you can bring the data to the headquarters to build nationwide road network database.

5. Preparing Map in ArcView

Once the shape files are ready, you need to do at least the following things to get a printable map:

i) Add data layers (theme);

ii) Symbolize the layers;

iii) Label layers;

iv) Project data from spherical coordinate system to planer (Cartesian) coordinate system;

v) Create layouts;

5.1 Add a data layer: The first step is to create a new View in a new ArcView Project, where you can assemble the shape files as layers. Start ArcView (using the menu command under startup Switchboard of RAMPS, see figure-20). While we talk about ArcView Project, one important thing to mention here that ArcView does not store any data within it's Project file. ArcView Project file is a text type file, where only references to the actual data files are stored. So if you create a map in ArcView and want to copy the map to another computer, you must copy all the data files (used in that ArcView Project) to the second computer at the same folder location of the first computer. Even if you copy the data (shape files) from the first computer to the second under a different folder location than the original locations in first computer the Project file will not work in the second computer.

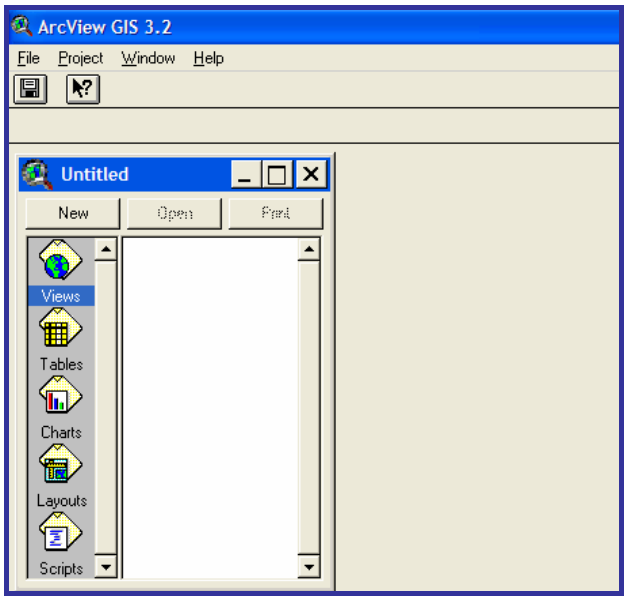


Figure-28: ArcView Project window

As you open a ArcView project, as shown in figure-28 you will get the following icons in the Project window: i)**Views**, ii)Tables, iii)Charts, iv)**Layouts** and v)Scripts. Out of these 5 different type documents, we need to deal with only Views and Layouts. A View is a

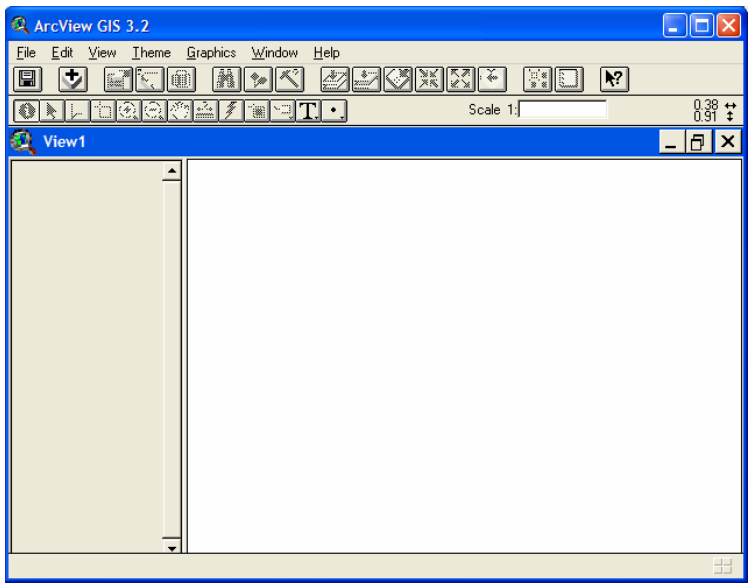


Figure-29: ArcView **View** window

workspace, where you can assemble your data files in layers. To create a new View, first highlight the View icon in Project window (see figure-28) and then press "New" button.

A blank View window has been shown in figure-29. In the View window, there is a gray color vertical box on the left side and there is a white color map area on the right hand side. The left side gray-box (see figure-29) is called Table of Contents (ToC), where you can assemble the data layers. To add a layer, press the Add Theme ("**+**") button from the toolbar (see figure-29, there are two toolbar rows in View window below the menu bar and "Add Theme" belongs to the top toolbar). The "Add theme" button brings a "Add Theme" dialogue box, where you can find the list of the shape or other data set. Select "**C:\Mapping**" folder (see right box in figure-30) and then pick one of the shape file from

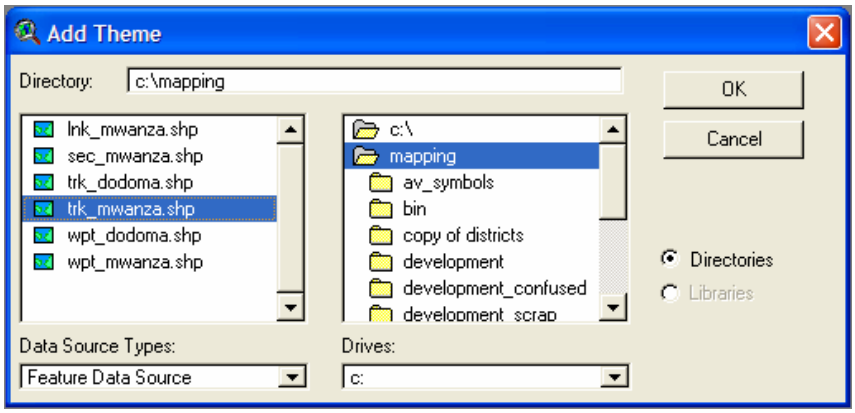


Figure-30: Adding a Theme (data layer) to ArcView **View** ToC

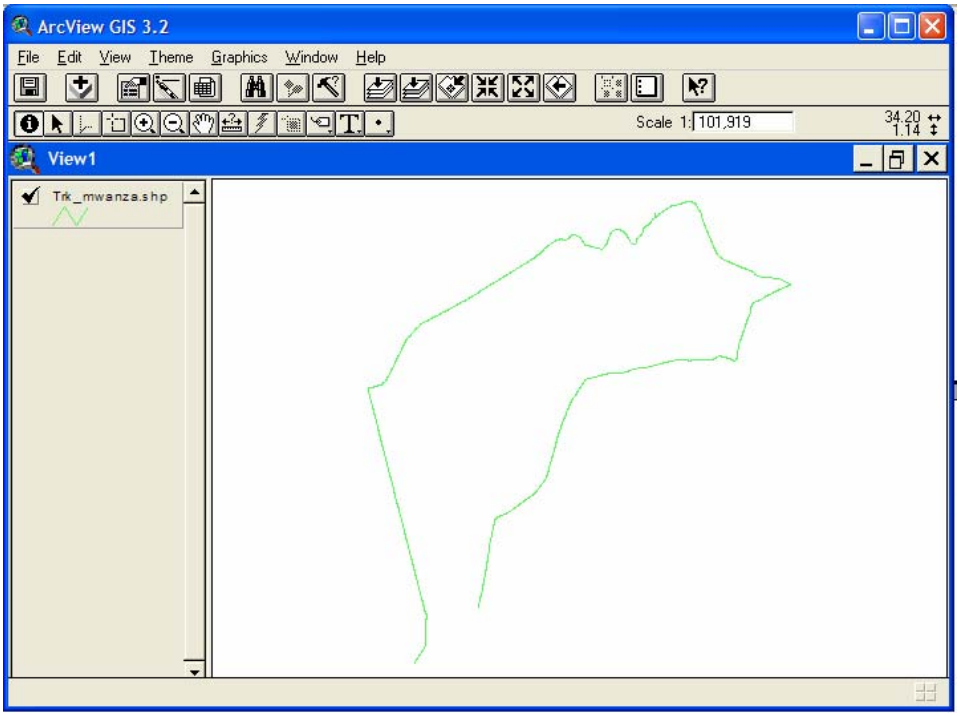


Figure-31: Displaying a layer in ArcView **View**

the left box (say trk_mwanza.shp).

As you add the layer, it is not yet displayed in the View area. To display a layer, set on its display on/off property by putting a tic mark in the ToC (see figure-31). Once the layer is set in the ToC, you can symbolize it by one of the attribute values of the shapes. To see the attribute values, press on the "Open Theme Table" tool (5th icon on the top toolbar, see figure-31). The Theme table (attribute table) of the trk_mwanza.shp shape file has been shown in figure-32.

Attributes of Trk_mwanza.shp

Shape	Id	Roadcode	Roadname	Roadclass	Dist_code	Rdlen_gps	Rdlen_im	Classcode	Surveyby	Surveydate	Reversedi
PolyLineZ	1	19101	Hamkoko - Bukimwi	Feeder	26	4	6	4		20031028	False
PolyLineZ	2	19102	Buguyu - Butiriti	Feeder	26	11	5	4		20031028	False
PolyLineZ	3	19103	Nansio - Maregea	Feeder	26	6	5	4		20031028	False
PolyLineZ	4	19104	Nansio - Airport - Namalebe	District	26	5	5	3		20031028	False
PolyLineZ	5	19105	Nansio - Muhula - Kigara	District	26	3	12	3		20031028	False

Figure-32: Attributes of a data layer (shape file), using "Theme Table" tool 

In figure-32, you can see there are 5 Polylines (or shapes) with trk_mwanza.shp. Each of such shape corresponds to a road of the road network. Similarly, each shape in sec_mwanza.shp corresponds to one section in the road network. You can also check attributes of individual shapes by clicking on the shape after activating the "**Identify**" tool

(the first icon on the bottom toolbar, see figure-31, 33). In this context please remember that you can check name of any tool by simply putting the cursor on it (without clicking).

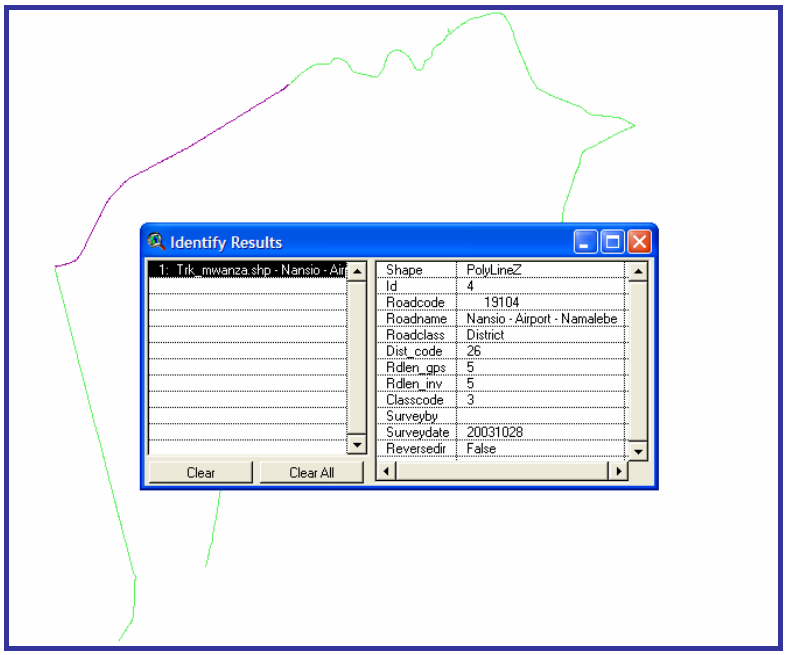


Figure-33: Identifying a shape using the identify tool

5.2 Symbolizing Layer: In order to symbolize a layer, first double click on the layer and open the legend editor (figure-34). You can define your own symbol set, however, there are a number of predefined **symbol templates**, under **C:\Mapping** folder and you can just load one of them to symbolize your layer. To load a predefined symbol set, press "**Load...**" button in Legend Editor Dialogue box (see figure-34). Then pick "**Road_by_Class.avl**" from the *.avl file list under **C:\Mapping** folder, and then press "**Apply**" button in the Legend Editor box.

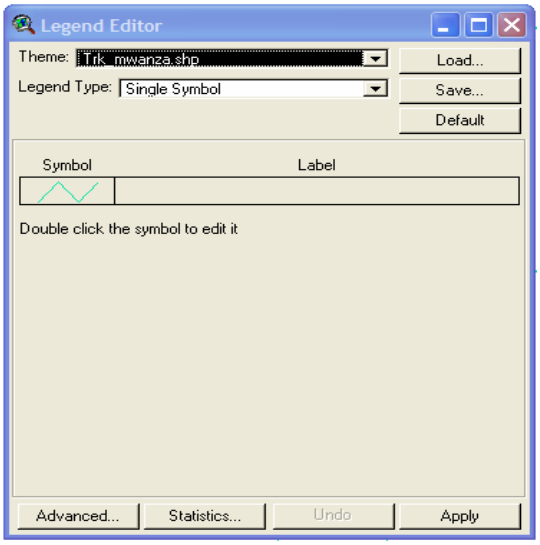


Figure-34: ArcView Legend Editor

5.3 Naming Layers: As you add a data layer to your ToC, the name of the layer remains the same as the name of the data file with full path name. It is then sensible to rename the layer to a meaningful name which can appear on the printed map. To rename a layer (i.e. Theme), first highlight the layer, then use the menu command "Theme→Properties" and thus open the "**Theme Properties**" dialogue box (see figure-35). In the dialogue box, rename the theme in the "Theme Name" box (see figure-35).

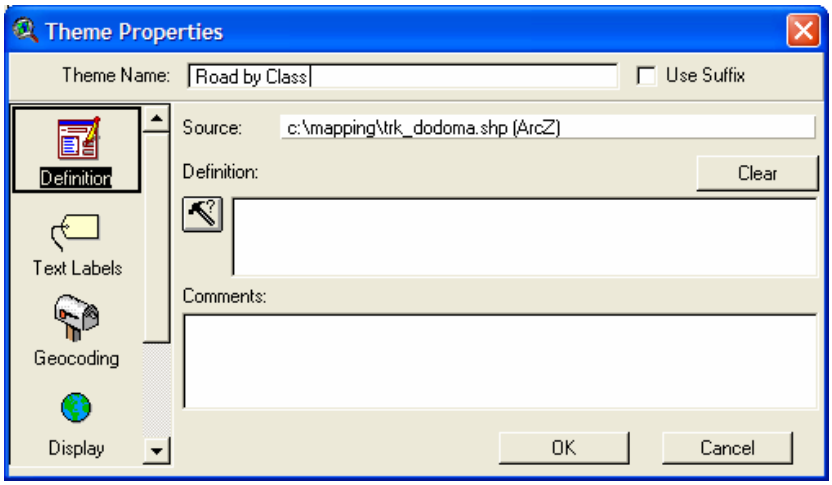


Figure-35: Theme Properties dialogue box

In a similar way to above, you can add some other layers, such as "Socio Economic Center" layer to your ToC and then symbolize it accordingly using the predefined symbol set. Table-5 describes list of the layers and their corresponding symbol set names as follows:

Table-5: Layer name and corresponding data files and symbol set

Layer Name	Data File Name	Symbol set name
1. Socio Economic Centers	C:\Mapping\Wpt_ DistrictName.shp	Socio_Economic_Centers.avl
2. Core Road Network	C:\Mapping\Lnk_DistrictName.shp	Core_RoadNetwork.avl
3. Road by Class	C:\Mapping\Trk_DistrictName.shp	Road_By_Class.avl
4. Road by Surface Type	C:\Mapping\Sec_DistrictName.shp	Road_By_SurfaceType.avl
5. Road by Surface Condition	C:\Mapping\Sec_DistrictName.shp	Road_By_SurfaceCondition.avl
6. Road Intervention Needed	C:\Mapping\Sec_DistrictName.shp	Road_Intervention_Needed.avl
7. Road Intervention Planned	C:\Mapping\Sec_DistrictName.shp	Road_Intervention_Planned.avl

5.4. Order of Layers: As a View consists of a number of layers, it is obvious that elements of one layer overlap with another layer at the same geographical space. The order of drawing map features is thus an important issue to look into so that you can decide which layers to get more preference to the other when they overlap themselves. The order of drawing map features is bottom to top; that means, the bottom most layer is drawn first,

then the second last and so on. Thus if any element of a layer is overlapped by another layer on its top, the element of the top layer will be drawn and that of bottom layer will be hidden. In case of "Core Road Network", you will like to also put the "Road by Class" layer. So the combination of these two layers will display the road network, where first all different roads are drawn with respective symbol of "Road by Class", and the core-roads hides the overlapping roads with "Core Road Network" symbol set.

5.5. Changing ToC Style: The default ToC style for line feature is "Strong Zigzag". We need to change the line feature ToC style to "**Flat**" (see figure-36). ToC style of a View can be changed from the menu command "**View → ToC Style**". After changing the style, press "**Apply**" button and then close the dialogue box.

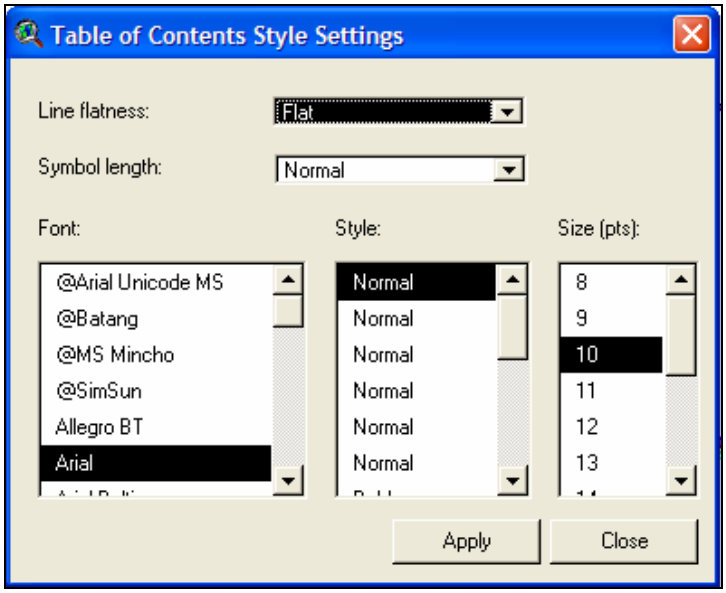


Figure-36: Dialogue box for Table of Contents (ToC) Style Settings

5.6. Labeling Layers: You can label (text annotation or marking) any layer using any of its associated attribute field values. For instance, the attributes of "Trk_Mwanza.shp" has been shown in figure-32, and obviously you may want to label the roads with "RoadCode" filed. The first step in labeling the layers is to adjust the settings (size and font) of the text to be used for labeling; the settings you can change in "**Symbol Window**" (see figure-37). To open the "Symbol Window", use the menu command "**Window→Show Symbol Window**". There are six tabs (or pages) with the Symbol Window as follows:

Fill Palette	Pen Palette	Marker Palette
Font Palette	Color Palette	Palette Manager

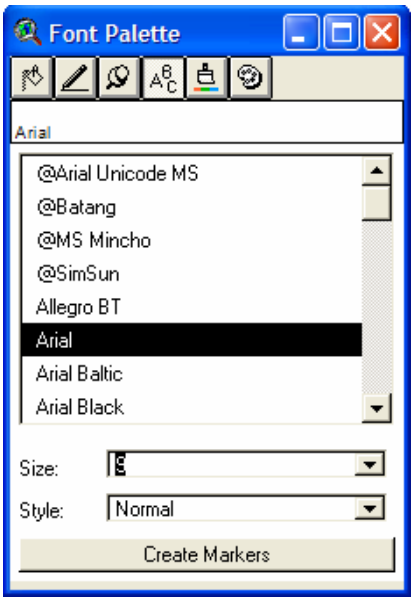


Figure-37: Font Palette in Symbol Window

To open any tab of symbol, just click on the respective icon of the symbol window. For example, press on the fourth icon (Font Palette icon) to open the "Font Palette" tab. From the "Font Palette" tab, change the font and size of the symbol to "Arial" and "9" respectively (see figure-37).

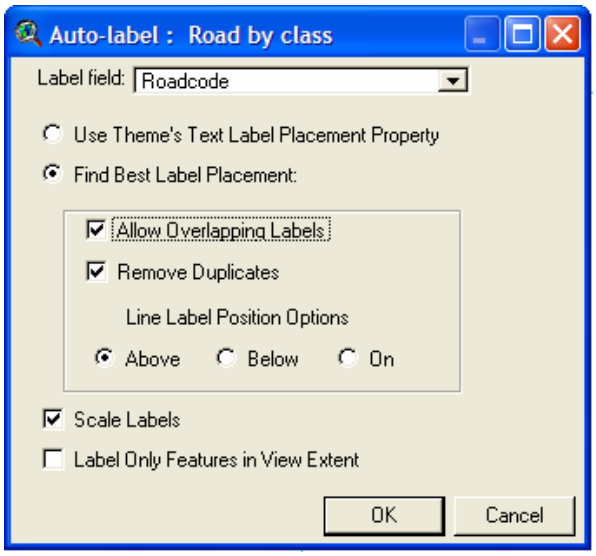


Figure-38: Auto-label dialogue box

Next highlight the layer, you want to label (in this case "Road by class") and then enter the menu command "Theme→Auto-label". The Auto-label window is opened as shown in figure-38. By default, the label field is "RoadName"; change this filed to "RoadCode". Also set "Allow Overlapping Labels" to on (put a tick beside this field). Then press "Ok" button.

While doing auto-label, if you have done any mistake, select all graphics by the menu command "**Edit→Select All Graphics**" and then press delete key.

In a similar way as above, you can also label "Socio Economic Centers" layer. In this case, the label field name is "FeatureName".

5.7. Applying Projection on a View: The shape file data you have is in curvilinear (spherical) coordinate system, i.e. in degree decimal with respective to Arc1960 datum, where origin of the center of the ellipsoid is somewhere at the center of the earth. However,

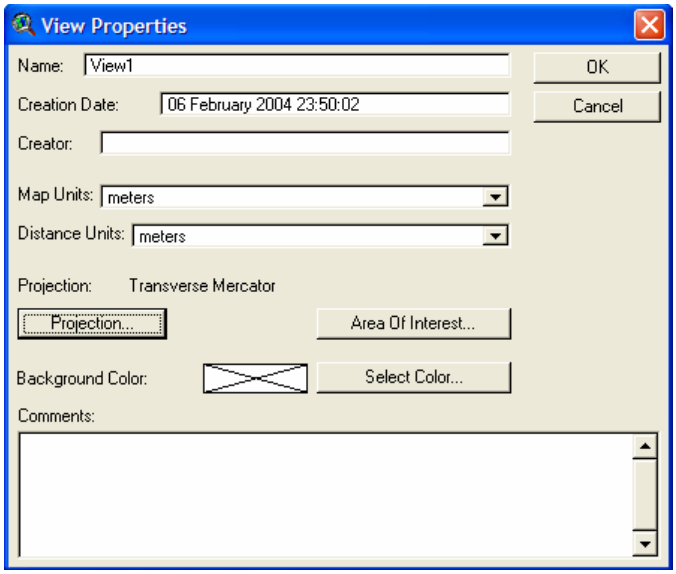


Figure-39: View Properties dialogue box

when you need to plot map on plane paper, you need to convert the curvilinear coordinates to planner (Cartesian) coordinate system. Loosely speaking, the process of such transformation is called "Map Projection". The resulting coordinates are in linear measurement (such as meter) and the origin of such planer axes is somewhere on the earth

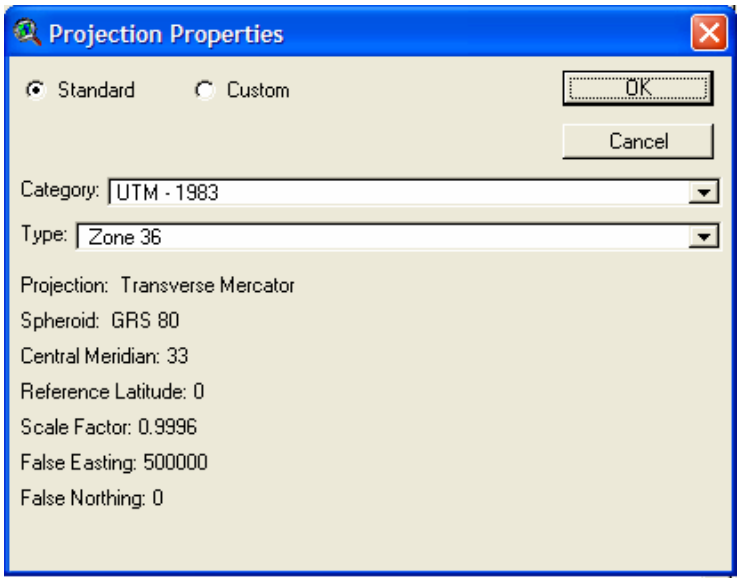


Figure-40: Projection Properties

surface, usually at the lower bottom corner of the country. For further elaboration on Projection, see Appendix-B.

To apply projection on a view, open the View Properties using the menu command "**View→Properties**". Then press the "**Projection**" button (see figure-39). The Projection Properties is popped up, see figure-40. In the category field, select "UTM – 1983" and under type field select "Zone 36". Remember that under UTM (Universal Transverse Mercator) projection, Tanzania fall within 3 grid zones namely zone 35, 36, 37. Based on the location of your district, select the grid zone, which is one of above zones. After pressing OK, you will go back to the "View Properties" window (see figure-39). In this window, select "Map Units" field to "Meters" and "Distance Units" to also "meters". The settings of units must be set correctly after setting the "Projection Properties"

5.8. Creating Layout: Layout is a document where you can compose one or more "View", "Legend", "Scale bar", "North arrow" etc. element, which you can see on a standard paper map. To create a layout, use the menu command: "View→Layout", while the view is open. Depending on the shape of your map, you need select either "Landscape" or "Portrait" type

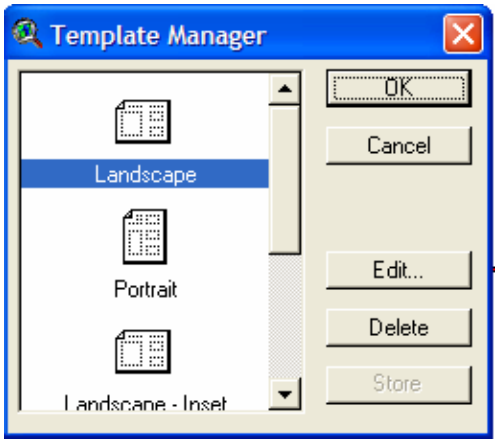


Figure-41: Layout Template Manager

layout from the "Template Manager" (see figure-41). After getting the "Layout" window, the first thing you need to do is to take out "Snap to Grid" properties. The "Snap to Grid" properties can be set from the menu command "**Layout→Properties**", see figure-42.

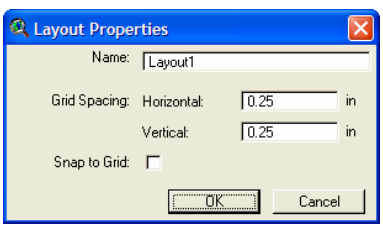


Figure-42: Layout Properties

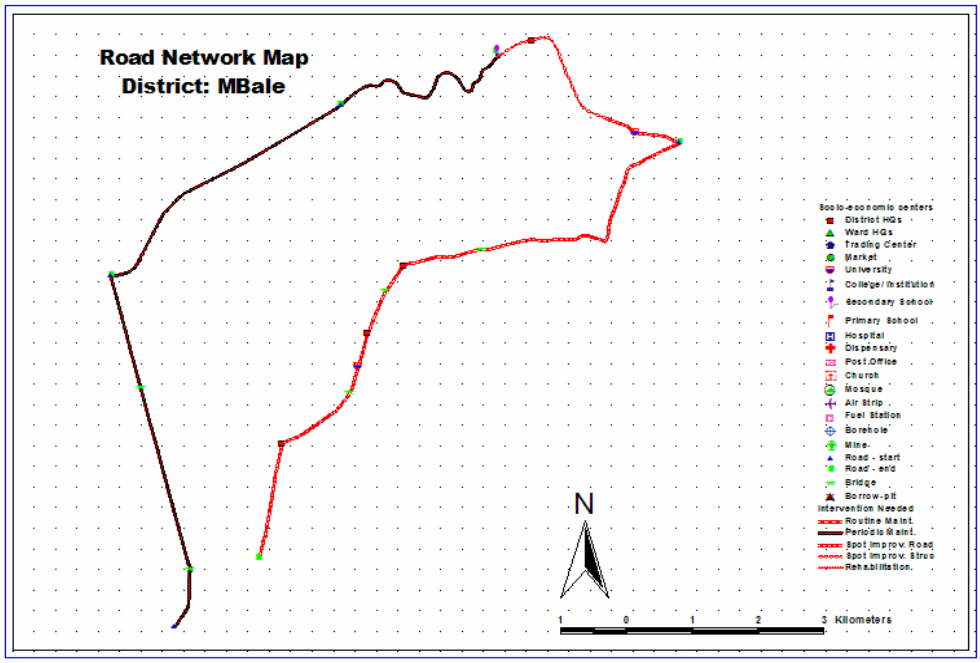
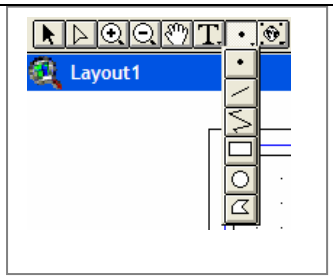


Figure-43: A typical Layout

In the layout page, you usually do the following things viz. adjust size of the legend box, adjust size of the view, edit title, adjust size of the north arrow, adjust scale bar etc. the following table describes different command sequences you need to do in order to do editing on the "Layout".

Table-6: Task involved in adjusting Layout

To do the Task	**Do this**
1. Adjust size of the "Legend box"	Click on the legend box (once) and get the handle of the box. Drag the corner of the handle to adjust the size of the box;
2. Adjust the "Scale Bar"	Double click on the scale bar. Edit the "Scale Bar Properties" as follows: **Unit**: Kilometer **Interval**: 1 (i.e. 1 Km interval) **Intervals**: 3 (number of intervals with 1 Km length, see figure-43) **Left Division**: 2
3. Change "North Arrow" logo	Double click on the "North Arrow" icon and select a icon from the list
4. Change "Title" of the layout	Double click on the "Title" text and then edit the text, what you want to use. To make a line break, just press enter.

5. Add a "Rectangular" border around the map	 First click on the graphics icon (the second icon on the right side, see the figure). As you get a drop down list of different shapes, select the "Rectangular" shape and then draw the rectangle by mouse (pressing mouse at the top left corner and while keeping the mouse pressed, drag it to the bottom right corner, then release the mouse.

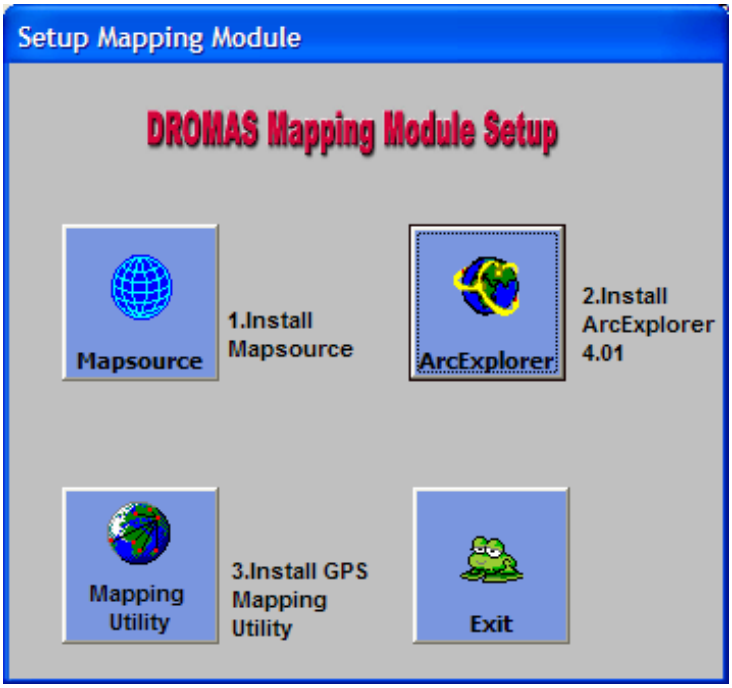


Figure-44: Mapping Software Setup window

Installation of RAMPS Mapping Module involves installation of three software namely i) Mapsource, ii) ArcExplorer (or ArcView) and finally iii) Mapping Utility. Install these software in the order they listed above. When you insert the CD, the software setup window pops up (as shown in figure-44). If the setup window does not pop up, browse the CD drive and then click on "SetupBatch.exe" file.

After installation of ArcView, you need to restart the computer. While restarting the computer, take out the installation CD and insert the CD when the restarting is done.

The ArcView installation should be prompted as follows:

Installation Type: Local Installation

Setup Type: Typical

Destination folder : C:\ESRI

MapSource software should be installed under the default directory,
i.e. under **C:\Program Files\Garmin\Mapsource**

Appendix-B

A. Datum: Explanation about datum projection needs quite elaborative discussions. Here only a brief discussion has been presented, so that the parameters used in the mapping module can be understood properly and that correct use of those parameters can be ensured.

Although the earth is of irregular shaped and the shape is close to ellipsoid, it is possible to give a regular geometric definition of the shape of earth for all different technical purposes such as referencing points on the surface of the earth with relation to the centroid of the regular ellipsoid. While defining such ellipsoid, it is always the intention that the actual earth surface (or topography) matches exactly with the imaginary ellipsoid. Unfortunately, because of non-uniformity, different part of the world fits with different definition of earth ellipsoids and there is no single definition of earth ellipsoid, which can fit everywhere. To define an ellipsoid, we need to know the dimension of semi-major axis and semi-minor axis. However, the definition of earth (which fits the topography) is not only the about the semi-major axis and semi-minor axes, but also the location of centroid of the ellipsoid in the earth and the orientation of the axes. That means, even if the same imaginary ellipsoid is suitable for Tanzania, Uganda and Kenya, the locations of the origin of the ellipsoid in the earth center place have to be different, so that the ellipsoidal fits to the surface of the earth (see figure-22).

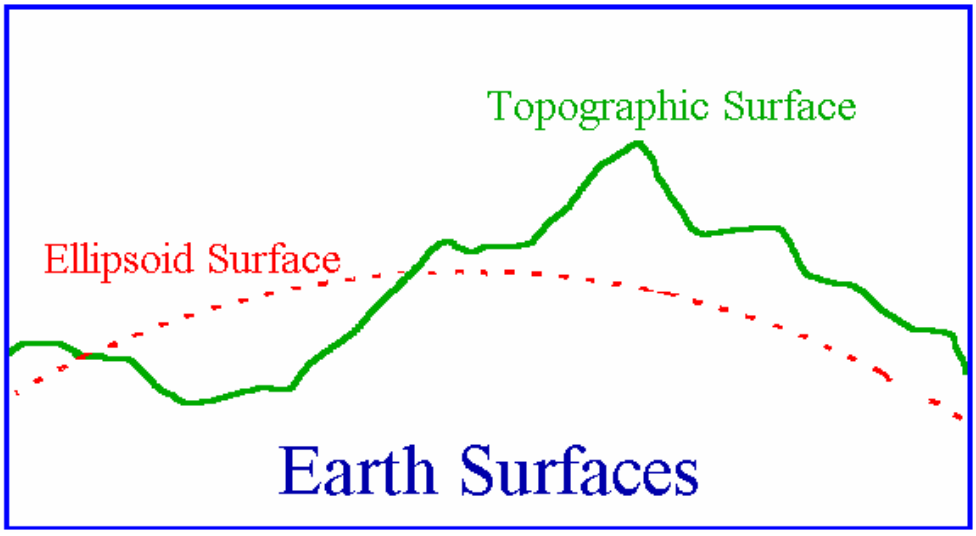


Figure-21: Actual earth surface and the imaginary Ellipsoidal surface

Usually every country has its own ellipsoid, which is used to do the mapping of the country.

The Ellipsoid used for the East African countries country is called **Clarke 1880** which has semi-major axis and semi-minor axis of 6,378,249.145 meter and 6,356,514.870 respectively. Remember that the **semi-major** axis is the radius of the ellipsoid along the long direction of the axis and **semi-minor** axis is the radius of the ellipsoid along the short direction of the ellipsoid.

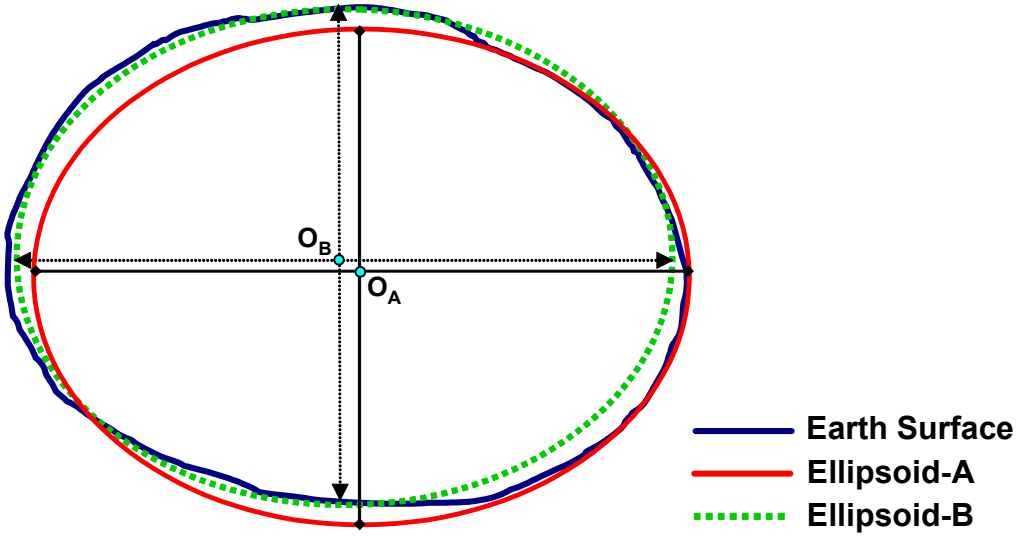


Figure-22: Two different ellipsoids are used to fit different parts of the world

As mentioned before, in order to fit an ellipsoidal surface to the earth surface, we need three types of parameters as follows:

i) Definition of the **Ellipsoid** (semi-major axes and semi-minor axis);

ii) Location of the **centroid** of the ellipsoid;

iii) **Orientation** of the axes (for example, in the figure-22, not necessarily the orientation of the semi-minor axis is vertical, but it can be a little inclined to define the best fit ellipsoidal model). There are three rotational parameters to define orientation viz. rotation along x-axis, rotation along y-axis and rotation along z-axis;

The above three type parameters comprise the "**Datum**" of a geographic co-ordinate system. So if we mention the co-ordinate of place (latitude, longitude and elevation), we need to know reference system of the co-ordinate (i.e. the datum) as well. Obviously the same location has different set of co-ordinates values for different datum or co-ordinate system. Ellipsoid is a part of a "datum" and different countries uses different "datum"s for

their own country mapping; the datum used for East African countries is called "**Arc 1960**" and as mentioned before, the ellipsoid for this datum is "Clarke 1880".

The important thing to mention here is that the GPS receiver always produces co-ordinate with respect a datum called **WGS84** (World Geodetic System 84). WGS84 is a global datum and all other datum definitions are usually expressed with respect to this datum. So as we use the GPS data in different countries, we need to convert the datum for the respective countries' datum. If the datum definition is known, there are mathematical procedures how co-ordinate can be transferred from one datum to other. The definition and datum transformation parameters for Tanzanian datum (Arc1960) with respect to WGS84 are as follows:

Datum Name	Ellipsoid	Location of Ellipsoid with respect to WGS84	Orientations of axes with respect to WGS84
Arc 1960	Clarke 1880	Δx = +175 meter Δy = +23 meter Δz = +303 meter	$r_x = 0$ $r_y = 0$ $r_z = 0$

B. Projection: The earth surface is spherical while we do mapping on plane paper. So we need to convert the spherical surface to flat plane and the technique is called projection. As a result of projection, there is always some distortion of the map on the flat plane and the nature and extent of distortion depends on the type of projection. For example, in the figure-23, the distortion of causing from the conic projection is the length of the arc between two standard parallels at the top of the cone is less than the length at the bottom. The distortion from the projection is one of the following types: area distortion, shape distortion, length distortion and direction distortion.

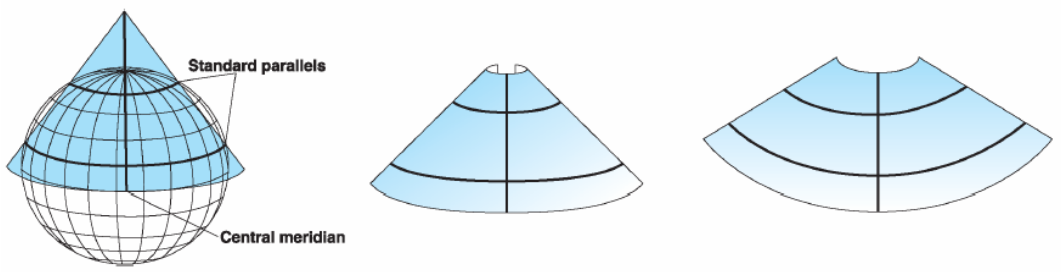


Figure-23: Converting spherical earth surface to flat plane using conic-projection

After projecting the spherical surface for the specific area, a local planer co-ordinate system (i.e. Cartesian co-ordinate) is established, with a local origin and the co-ordinates are expressed in linear distance instead of curvilinear co-ordinates (i.e. degree, minutes).

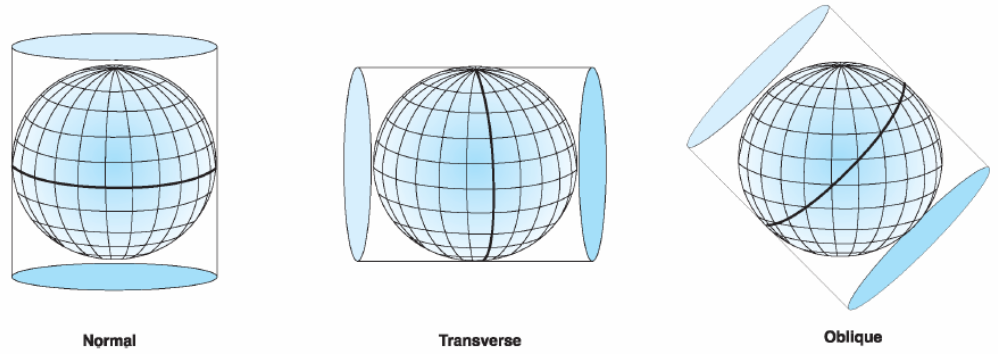


Figure-24: Cylindrical projections to convert spherical surface