Landscape Explorer

USER MANUAL

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X,Y,Z Format

Chapter 1: Overview

Landscape Explorer is an application for all those who need to understand the way the world's surface looks. It enables the user to create a three dimensional model of a landscape using data imported from digital data files or obtained directly from scanned map images.

Once created the model can be viewed from any position with a considerable degree of control over how it is presented. Drawings schemes available range from the realistic to the abstract, making Landscape Explorer applicable to a wide range of topographical problems.

Although in itself a specialised program, Landscape Explorer provides a considerable number of links to other applications such as graphics packages, GIS systems, CAD programs and other 3D viewing programs such as Vistapro.

Landscape Explorer uses the MDI (Multiple Document Interface) model, and consists of two sub-applications, the Landscape Viewer module, which is used to examine a landscape surface, and the Map Definition module, used to define the characteristics of the surface to be explored.

Using This Manual

This manual covers the following topics:

Using the View Module

This chapter describes the Landscape Viewer module, including loading and viewing maps, setting viewing parameters, colour schemes, and creating animation sequences.

Using the Map Definition Module

Describes the basic features of the Map Definition Module, and the techniques involved in creating new maps from digital data files and scanned map images.

Map Definition Tools

This chapter describes in detail the tools available to define a map, including contour tracing, spot heights, interpolation, and terrain types.

Advanced Map Definition Features

Describes advanced features including USGS DEM file analysis, Export, and using Colour Settings.

Appendices

These cover information about file formats and memory issues.

Chapter 2: Using the View Module

Introduction

This View Module displays a view of a previously defined map. The map may be viewed from any direction using a variety of different drawing schemes ranging from the abstract, such as simple grid, to realistic such as summer or winter colours.

Many other parameters may be altered by the user to tailor the image to specific requirements. Examples include the light source position, magnification, perspective, background, and terrain colours. You will probably wish to try varying some or all of these features to obtain the best results for your purposes.

Multiple copies of the Landscape Viewer module may be opened, subject to system resource constraints.

Getting Started

Start Landscape Explorer Pro. When you run the software for the first time a preliminary dialog will appear. You can prevent this from appearing again by checking the box marked *Do not display again*. Press on the continue button, and when the main menu appears proceed as follows:

From the View Map menu select the View Projection item or press F2. A dialog box appears prompting for a *.lem file to open. Select a file such as *lomond.lem*. A dialog box appears showing progress as the map is loaded.

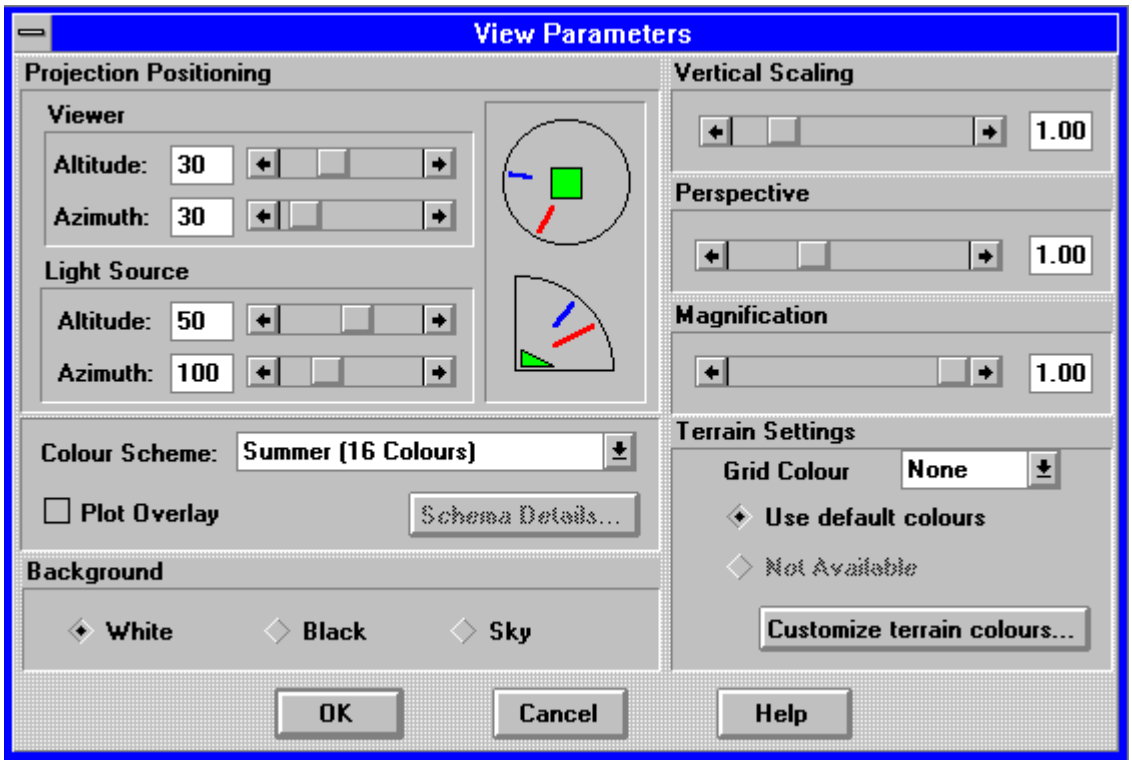
1. The View Parameters dialog box appears. This is where the parameters which determine how the view will be drawn are set. In particular note the controls setting viewer and light source position, and the drop down list with available colour schemas. For now however just press OK. A dialog box appears showing progress as the map is drawn.
2. When complete a window is opened displaying the view. If you want to change any of the parameters used select the View Parameters... item from the View Map menu, or press Ctrl-F1.

The following section describes the parameters available in more detail.

View Parameters

The following parameters may be set from the View Parameters dialog. If your .lem files are on your hard drive the parameters set will be saved with the file. No data is saved when if the files are on cdrom.

Fig 1. The View Parameters dialog.



Positioning Parameters

Projection Viewpoint

This describes the viewer's position in terms of altitude and azimuth. Altitude may range from 0 to 90 degrees where 0 is horizontal with and 90 vertically above the map. Azimuth ranges from 0 to 359, corresponding to the compass bearing. The red lines in the feedback controls to the right of the slide bars indicate the viewer position.

Light Source Position

This describes the position of the light source in terms of altitude and azimuth in a similar manner to that described for the Projection Viewpoint above. The blue lines in the feedback controls to the right of the slide bars indicate the viewer position.

Colour Scheme Parameters - Colour Schemes

Contour (gradual)

Draws the projection coloured according to altitude using a graduated colour scheme which ranges from blue (for low areas) though green to red.

Contour (stepped)

Draws the projection coloured in steps according to altitude. The scheme used is the same as that in the Map Definition Module.

Desert

Draws the projection to give an impression of a hot desert landscape. Includes light source and terrain information.

Framework

Draws the projection with grid squares coloured according to terrain, but with no shading. Will be of particular interest to professional users who wish to show the distribution of geological features, soil types, etc. Colours are drawn using the standard windows palette, so this scheme functions best in true colour mode.

Mono

Draws the projection in greyscale. This is particularly suitable for producing images for printing on mono printers.

Summer

Draws the projection to give an impression of a temperate climate landscape in summer. This and the following winter colour version are probably the best options for presentation-quality work where an overlay is not available, and give excellent results with colour printers. Includes light source and terrain information.

Winter

Draws the projection to give an impression of a temperate climate landscape in winter with snow covering the higher ground. The degree of snow cover may be set by selecting the 'schema details' button, which is activated when this scheme is selected. Includes light source and terrain information.

Summer 16

Similar to the summer scheme, but uses the standard windows palette. May give better results than summer when running windows in true colour.

Winter 16

Similar to the winter scheme, but uses the standard windows palette. May give better results than winter when running windows in true colour.

Polar
Draws the projection to give an impression of a polar landscape. Includes light source and terrain information.

Wireframe
Draws the grid squares as simple open quadrangles. Light source and terrain are ignored.

Colour Scheme Parameters - Other Items

Schema Details
This button is used to specify additional details for colour schemes. It is activated with the bitmap colour scheme where it is used to select a .bmp file to overlay, and the Winter schemes, where it is used to set the degree of snow cover.

Miscellaneous Parameters

Background
A set of three radio buttons that allow either a white, black or graduate sky blue background to be used.

Perspective
Allows the user to exaggerate or relax the perspective. A value of 1.0 gives a 'Natural' looking perspective.

Vertical Scaling
The default setting (left of the slider) draws the projection completely to scale. However with flat landscapes it may be useful to exaggerate changes in height. Moving the slider to the right increases the vertical scaling by a factor of up to five times.

Magnification
The default setting (centre of the slider) sizes the projection to fit comfortably within the window. This can be changed to give a smaller drawing by suitable positioning of the slider bar. A range of 20% to 100% of default size is available. This feature is useful when using the BMP overlay scheme as the time required to draw the image is proportional to the size of the image.

Terrain Settings
A grid may be superimposed on the landscape: select black, grey or white from the drop down box to include. This feature is particularly useful with the Framework and BMP overlay schemes. Leave as the default (none) to omit the grid. Note that this is not effective with the Wireframe scheme, which always draws the grid in black.

The radio buttons allow the user to choose between using the current default colour settings schema, or that previously associated with this map (if any). See Colour Settings for details.

Customise Terrain Colours

The button accesses the Colour Settings dialog. This is described in the System Options chapter.

Printing, Copying and Saving your Picture

Once you have produced an image you may wish to take a copy of the image for use elsewhere. Landscape Explorer provides the usual options of printing, copying to the clipboard, or saving as a .bmp file. These are accessed as follows.

File Menu

Print

Prints the current view of the map.

Printer Setup

Sets printer options for Landscape Explorer before printing. The available options depend on the printer you have selected.

Edit Menu

Copy (as Bitmap)

Click and drag using the left mouse button to define a rectangular area of the landscape viewer window that will be copied to the clipboard.

The picture will be copied as a bitmap; better printing quality can usually be obtained using the Copy (as Metafile) function.

Copy (as Metafile)

Copies the current view to the clipboard as a re-sizable metafile. You can paste this into any product that accepts a metafile format.

View Map

Save Picture

Saves the current image as a .lem (map), .bmp (bitmap) or .wmf (metafile) file.

Save Picture As

Saves a new or existing picture as a .lem (map), .bmp (bitmap) or .wmf (metafile) file.

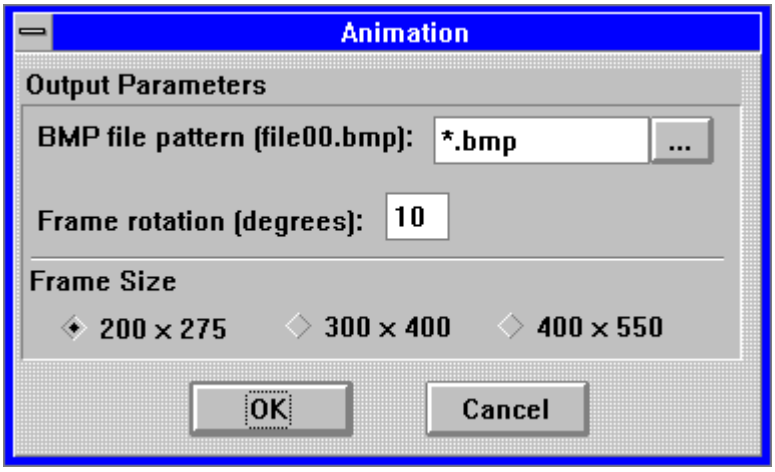
Animation

Although Landscape Explorer Pro cannot create an animation file directly, it can generate a series of .bmp files for use by a program that can create these.

Animation is accessed from the animation item in the View Map menu. It is only available when a landscape is displayed. A series of .bmp files are produced that show the current view of the landscape rotating.

On selection of the menu item, a dialog box is shown and the following items may be entered

Fig 2. The animation dialog.



BMP file pattern

The name pattern used for the series of bmp files created. Enter a filename directly or click the ellipsis box (...) to show a File Save As dialog. The last two characters in the first part of the file name will be substituted with the sequence number of the file, thus entering testxx.bmp will generate a series of files named test00.bmp, test01.bmp etc.

Frame rotation (degrees)

The rotation in degrees between frames, so for instance, a 10 degree rotation will require 36 frames. Reasonably smooth images may be obtained with 10 degree rotation or less, and up to about 30 gives acceptable sequences. The minimum value is 4 degrees.

Frame Size

A set of three radio-buttons used to select the size of the bmp files to be generated.

After entering appropriate values click on OK. A progress dialog will be shown as the DIB file is created.

Chapter 3: Using the Map Definition Module

Introduction

Before viewing a landscape you must define the shape and contents of the surface that you wish to examine. Landscape Explorer holds surface information in the form of a rectangular grid. The grid (sample) points hold the heights, whilst the grid (terrain) squares the type of terrain.

The grid dimensions may be defined in kilometres, miles, or metres, with grid point spacing in metres, feet, or tenths of a metre respectively. Maps must be defined with between 400 and 63,000 sample points. Realistic looking landscapes usually require 10,000 sample points or more. However, very large maps are slower to manipulate and draw, and for most purposes between 10,000 and 30,000 points is probably the best trade-off. Data is stored in *.lem files, usually referred to as maps.

To create a map for a landscape surface each sample point must have its height set. There are two main ways of doing this: data may be imported directly from digital files, such as Ordnance Survey NTFs, or alternatively the information may be captured from a scanned image of a topographic map.

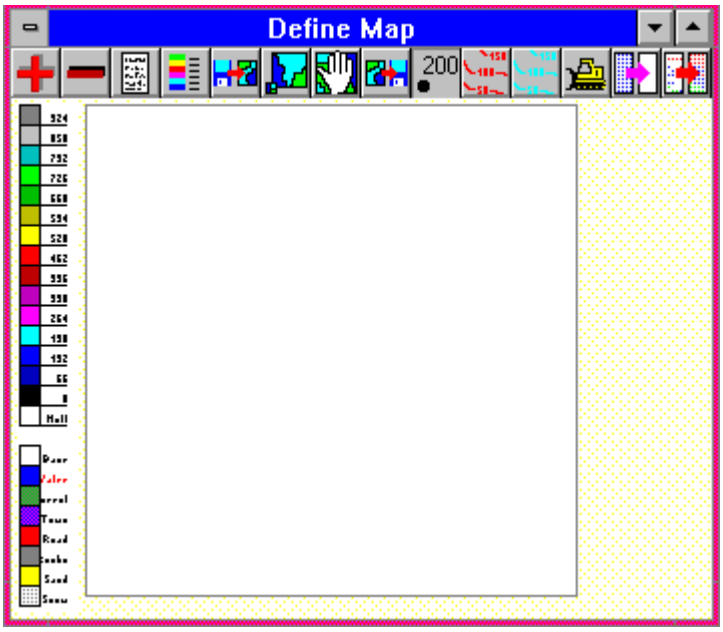
Both methods use the Map Definition Module to enter and display data. This is described in more detail in the next section.

Layout of the Map Definition Module

The Map Definition Module is activated by choosing Define Map from the Options menu. Only one copy of this window may be open at any one time.

The displayed window has three main parts: a Toolbar that gives access to the tools you will require to define the map; a Parameter Display area down the left hand side of the window which shows the current colour coding for heights and terrain types; and an initially blank area representing the 'Canvas' used to define the map.

Fig 3. The Define Map module.



The Canvas

The Canvas can display four types of information: sample point heights, terrain types, overlay objects, and a background bitmap. It is possible to disable the display of any of these items using the Map Status dialog.

Sample points

These are displayed as small solid squares. The precise size of the square will vary depending on the display size of the map canvas area but should be optimised to display a large enough square for the colour to be apparent whilst remaining small enough so as not to obscure any background bitmap, although this may not be possible with very large maps. Normally no squares are usually shown for undefined heights, and sample points at sea level (zero metres or feet) are always shown as single points.

Landscape Explorer Pro uses a range of 15 solid colours to indicate into what range the height of a sample point falls. The current ranges and associated colours are shown in the Parameter Display area to the left of the map canvas. You may adjust the total displayed range using the Display Parameters tool. The scale self-adjusts when loading, importing, or interpolating data.

Terrains

These are displayed by outlining the squares of any particular terrain in the corresponding colour. There are eight different pre-defined types of terrain, default or base, water, wood, town, road, rock, sand and snow/ice. A further 16 terrains types are available for definition by the user.

Unless explicitly defined otherwise, all grid squares are assumed to have the default terrain (in most colour schemes used by the Landscape Viewer this corresponds to low level vegetation) which is not displayed on the canvas. Any group of grid squares that does not have the default terrain is shown outlined with the appropriate colour.

Background Bitmaps

A background bitmap is used when creating a map from a scanned image. A windows bitmap (.bmp) file is placed 'behind' the canvas and used as a guide for designating heights and terrains.

The Parameter Display Area

The Parameter Display area, drawn to the left hand side of the canvas, shows the current colour coding for heights and terrain types.

The sequence of colours for **heights** is fixed but the effective range may be changed using the Set Parameters tool from the toolbar. Landscape Explorer will automatically adjust the effective range when loading old maps, importing data, or after interpolating heights.

The eight standard **terrains** are displayed below the heights. The colours used for all of these apart from the base type may altered with the Colour Settings dialog, available from the Options menu. The description of the active terrain type is written in red. This may be altered by clicking on an alternative, or by using the Set Parameters tool. This second method also gives access to the user defined terrain types.

The ToolBar

The toolbar gives access to the various functions required to define a map. These can be divided into fours groups: Map display functions, Heights definition tools and Terrain definition tools. A complete description of all tools and functions is given in the Map Definition Tools section below.

Defining a Map from Imported Data

Overview

This is probably the easiest and most accurate method of generating a map although, with the exception of the xyz file import, only height data can be imported.

The procedure for importing data differs in detail according to the source file being used. However, in general the steps are:

1. Start the Map Definition module by selecting Define Map from the Define Map menu.
2. Select Import... from the Define Map menu. This displays a File Open dialog.
3. Select the type of data source you wish to use from the File Type drop down list box.
4. Select the import file.
5. Depending on the type of data source to be used an Import Parameters dialog box may be displayed. This is described in more detail in the sections on specific import source types below. Set any required parameters and click on OK. The data is then imported and displayed on the map canvas.

Once displayed imported data is handled in exactly the same way as directly enter data. You will probably want to add terrain information or possibly edit the imported heights data. The facilities available for doing this are described in the Map Definition Tools section.

In most cases you will let Landscape Explorer create a map of the correct size and grid point spacing using the data from the import file. Sometimes however it is necessary to import into a previously defined map (particularly with USGS DEM files). See the Create New Map topic later in this chapter for details.

ASCII Text Files

This function imports a set of heights data from a text file. This should be in ASCII/ANSI space delimited text format - that is a text file which you can view using Notepad or Write (with no conversion) and consists of numbers separated by spaces or newlines. This type of file is, for instance, created by the Lotus 1-2-3 extract function. Similar files in comma delimited format can be converted to space delimited using the global find/replace function in any word processor.

The Import Parameters dialog is not displayed. Instead the Landscape Explorer imports data in a linear fashion starting at the top left corner of the map progressing left to right within top to bottom through all grid points. The program expects an exact match between the total number of grid points in the map and data values in the file and will report an error if an incorrect number of heights is encountered.

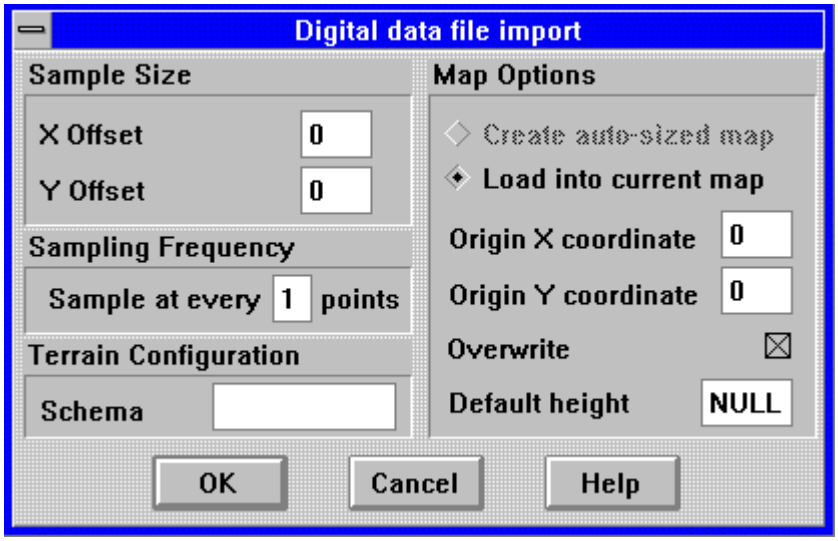
ASCII import is fairly basic in nature, and if you are developing a program or macros to export data from another application you are recommended to use the X,Y,Z,Attribute Import.

US Geological Society DEM files

This tool allows the user to import a set of heights data from a US Geological Survey digital elevation model (DEM) file. For further information about DEM file formats see the Analyse DEM file topic. Note that USGS DEMs are not in the same format as Vista/Pro DEMs.

A typical DEM file will contain many more grid points than Landscape Explorer can handle directly, and a dialog box is displayed to allow the user to specify how the data from the import file will be mapped on a Landscape Explorer map. The options are as follows.

Fig 4. USGS DEM import



Sample Size

Specify X and Y offsets from the origin used by the imported data. For DEM files this is the south west corner (bottom left on the map display canvas). Hence if you specified an X,Y offset of 50,80 the point at 50,80 in the imported data is mapped onto the bottom left corner of the map display canvas (0,0). Similarly the point 60,100 from the import data would be mapped onto 10,20.

Note that 7.5-minute DEMs may have differing numbers of elevations per profile, particularly for the first and last few profiles. In this case it is advisable to apply offsets that will not import data from these profiles.

Sampling Frequency

Specifies the frequency at which points from the imported data will be mapped onto the map display canvas. A value of 1 implies all points will be mapped, 2 implies every second point etc.

Terrain Configuration - Use Schema

The default colour settings schema to be used by the map. This should be entered as a single word of up to 8 characters - for example 'standard' would be an acceptable schema name. You will probably wish to set up a number of standard colour settings schemes to cover sets of maps showing common types of data, for example you may have a set called 'glacial' to cover maps showing glacial soil types, 'alluvial' for alluvial soil types, etc. Your schema name should correspond to that of a .CFG file set up using the Colour Settings dialog. For further details see the explanation about 'Saving and Using Colour Settings Schemas' under the Colour Settings topic.

New Map/Load into Current Map

Choose between automatically creating a new map with the correct dimensions for the imported data, or importing into the current map. With DEM files only import into the current map is available.

Origin X/Y Coordinates

Only activated when the import into the current map option is selected, these two values set the position of the map origin that the import will use. This facility enables data from multiple import files to be tiled together, hence creating maps spanning the edges of import files.

Overwrite

Only activated when the import into the current map option is selected. When checked all existing values in the map will be overwritten by imported values or set to the default height.

Default Height

Some import files may not contain data for all points on the map definition canvas. You can therefore provide a default height.

File Loading Errors

If an error is encountered while attempting to load the DEM file the process will abort and an error message is display. DEMs may fail to load for a variety of reasons, some of the more common ones are listed below.

- **Invalid Offsets:** You have chosen import offsets such that the DEM contains no data for the area to be imported. Change the offsets and try again (an offset of X=0,Y=0 and a sampling factor of 1 will never produce an error from this cause).

- **Invalid DEM type:** You are attempting to import a DEM file of a type not recognized by Landscape Explorer. This is most likely to be a 1 degree USGS DEM - which can often be recognized by their very large file size (typically about 10Mb), or Vistapro DEMs - which have a completely different format.

- **DEM file does not contain end-of-line markers:** Some DEMs available on the internet were loaded without end-of-line markers being present. Landscape Explorer cannot process these correctly.

- **DEM file is corrupt.** Some DEMs available on the internet are simply corrupt - for example containing null lines or with end-of-line characters in inappropriate places.

UK Ordnance Survey NTF files

This facility is used to import data from files produced by the UK Ordnance Survey.

Support is currently limited to the Land-Form PANORAMA Digital Terrain Model Data (DTM) files produced from the Landranger series of maps. This data can be obtained from the Ordnance Survey (Tel. 01 703 792773). A free sample can be obtained covering the Port Talbot area of Wales and, if you are an educational user Gower, Peak District, Lake District, Bristol and Glasgow are also available under the CHEST agreement. Please note that Landscape Explorer cannot process the alternative PANORAMA vector format files.

Each DTM file covers a 20km x 20km area with height values at each intersection of a 50 metre horizontal grid.

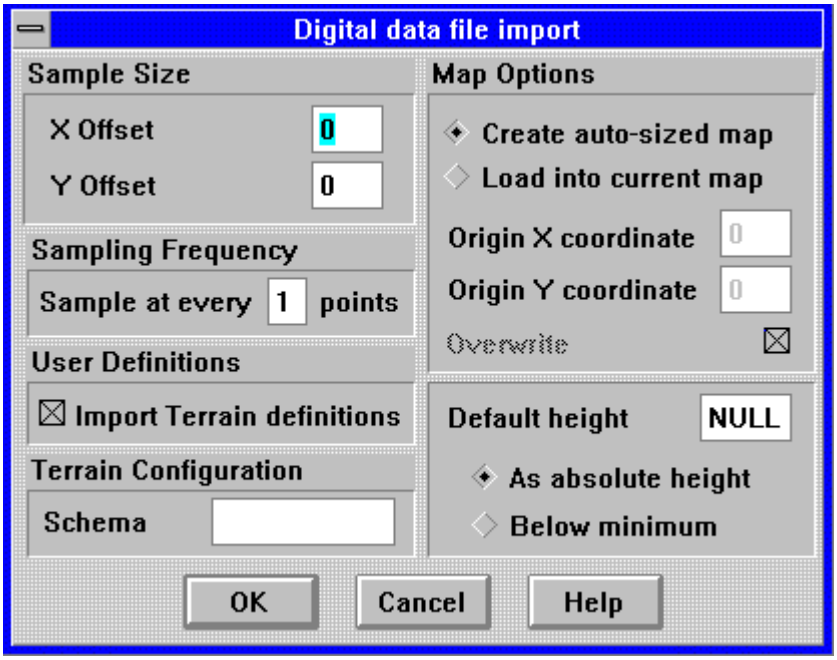
A DTM file will contain many more grid points than Landscape Explorer can handle directly, and a dialog box is displayed to allow the user to specify how the data from the import file will be mapped on a Landscape Explorer map. The options available are the same as those described for USGS DEM files.

Import X,Y,Z,Attr

This facility is designed to import data exported from commercial GIS programs, such as MapInfo, or generated by GridMaker, our utility for generating regular grid points from scattered data. It allows a complete map to be defined including size, terrain and heights information. The definition of the X,Y,Z,Attr file format is described in full in the appendix.

A dialog box is displayed to allow the user to specify how the data from the import file will be mapped on a Landscape Explorer map. The options are as described for USGS DEM import with the following additions.

Fig 5. XYZ Import dialog box.



User Terrain - Import Terrain Definitions

If checked any terrain definitions contained in the file header will be imported. This is equivalent to loading a colour settings schema using the colour settings dialog, and the imported map will be drawn on the map display canvas using the new colour settings.

Default Height

As DEM import, but additionally may be set as either an absolute value or relative to the minimum height read from the file.

Defining a Map from a Scanned Image

Overview

One of the most powerful features of Landscape Explorer is its ability to create a three dimensional model using information obtained from a topographic map (i.e. one with contour lines).

Capturing sufficient information from a map to define how a landscape surface looks is obviously a considerably more difficult problem than simply importing data from a file. As all points in the map grid must be defined, creating a typical map involves defining the heights at over 10,000 grid points.

Fortunately Landscape Explorer has been designed to address and simplify this problem. The strategy used is to define a sub-set of heights, typically along a set of contour lines, then use a set of interpolation functions to calculate the undefined heights. Remarkably good results can be achieved using this approach.

To help define the original sub-set of heights Landscape Explorer allows the use of a scanned image as a template. The quality of this scan is of crucial importance in obtaining good results and you should attempt to produce the clearest image you can. If you intend to use the auto-contour trace tool without having a colour scanner, some time spent 'cleaning up' the image using a program such as paintbrush is recommended.

A full description of the tools available is given in Chapter 5.

To define a new map the user would typically go through the following steps...

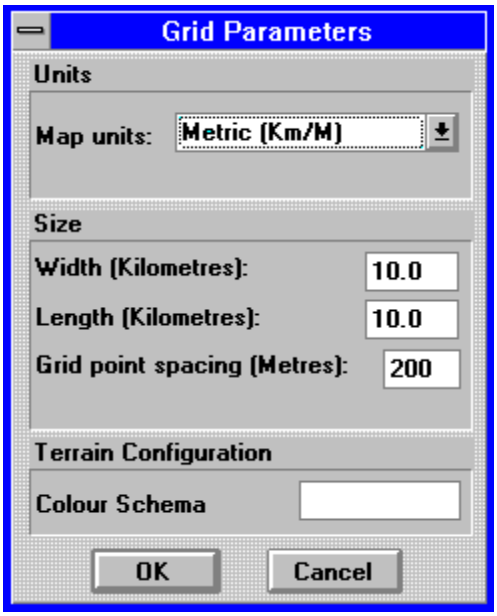
1. Enter the map definition module by choosing define map from the define map menu.
2. Create a new map of the appropriate size and grid spacing using the new map tool.
3. Use the display parameters tool to display a full range of colours for the variation in heights expected.
4. Import and size a bitmap of the original paper map using load bitmap and set bitmap magnification tools. This would typically be created as a .bmp file using a scanner.
5. Define a sufficient set of heights to give a reasonable definition of the shape of the landscape surface - typically by using the contour, spot and block height tools.
6. Use the interpolate heights tool to fill in undefined points.

7. Define any areas that do not contain the default terrain type (low vegetation) using the terrain tools
8. Save the map and view using the landscape viewer module.

Creating a New Map

You must be in the Map Definition Module. Select New Map from the Define Map menu and select the appropriate parameters from the dialog box.

Fig 6. The New Map dialog



Units

This drop-down list is used to select the measurement units that will be used. Once a map has been created these cannot be changed. The following are available:

Metric

Map side lengths in kilometres. Grid point spacing and heights in metres.

Imperial

Map side lengths in miles. Grid point spacing and heights in feet.

Size

Enter the required length and width of the map, and the distance between grid points. Note that integer values only are accepted.

Terrain Configuration

The colour settings edit box allows you to set a default colour settings to be used by the map. This should be entered as a single word of up to 8 characters - for example 'standard' would be an acceptable colour settings scheme name. You will probably wish to set up a number of standard schemes to cover sets of maps showing common types of data, for example you may have a set called 'glacial' to cover maps showing glacial soil types, 'alluvial' for alluvial soil types, etc. Your schema name should correspond to that of a .CFG file set up using the Colour Settings dialog. For further details see the explanation about 'Saving and Using Colour Settings Schemas' under the Colour Settings topic.

Opening and Saving defined Maps

When the Map Definition Module is active the following are available from the Define Map menu.

Open Map

Opens an existing map file. A dialog box prompts for a *.lem file to be selected.

Save Map

Saves changes to the map you have been working on. When you choose Save, the map remains open so you can continue working on it.

Save Map As

Saves a new or existing picture as a .lem file. When you choose Save As, the map remains open so you can continue working on it.

Chapter 4: Map Definition Tools

The Map Definition Module Toolbar

This is displayed along the top of the Map Definition Module window and simple help text is displayed in the window title bar when the mouse is moved over each button. Working from left to right the following tools are available.

Fig 7. The Toolbar

Zoom In/Zoom Out

These tools allows the user to zoom in and out of the map canvas. Clicking on the '+' button zooms in, and on the '-' zooms out. You can increase the magnification by repeated clicking of the zoom in button, which is disable when the maximum magnification is reached.

The program handles the canvas when magnified slightly differently to in its normal state. The following changes will be seen:

Display

Heights are displayed as numerical values. Terrains are displayed as coloured squares.

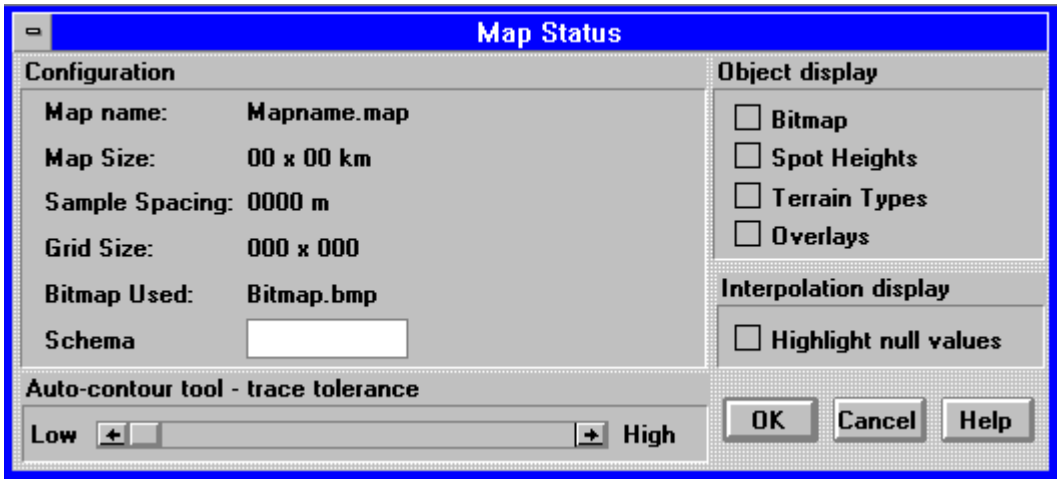
Tools

A limited selection of tools are available when the canvas is magnified. These are...Zoom in, Zoom out, Map Status, Display Parameters, Set Spot Height, Set Default Spot Height, and Set Default Terrain.

Map Function Status

Displays a dialog box showing various status parameters. These are grouped as follows:

Fig 8. Map Function Status dialog



Configuration

Shows as non-updatable values the map name, actual and grid size, sample point spacing, and background bitmap (if any).

The colour settings edit box allows you to set a default colour settings schema to be used by the map. This should be entered as a single word of up to 8 characters - for example 'standard' would be an acceptable colour settings schema name. You will probably wish to set up a number of standard schemes to cover sets of maps showing common types of data, for example you may have a set called 'glacial' to cover maps showing glacial soil types, 'alluvial' for alluvial soil types, etc. Your schema name should correspond to that of a .CFG file set up using the Colour Settings dialog. For further details see the explanation about 'Saving and Using Colour Schemas' under the Colour Settings topic.

Object Display

A set of check boxes allows the user to choose which of the background bitmap, height and terrain data to display. However as the data type manipulated by the currently selected tool must be displayed, one of these check boxes may be disabled.

Interpolation Display

Contains a single check box used to switch on null height display when using the interpolation tool. When unchecked undefined grid points are not shown, when checked they are shown in orange.

Auto-contour tool - trace tolerance

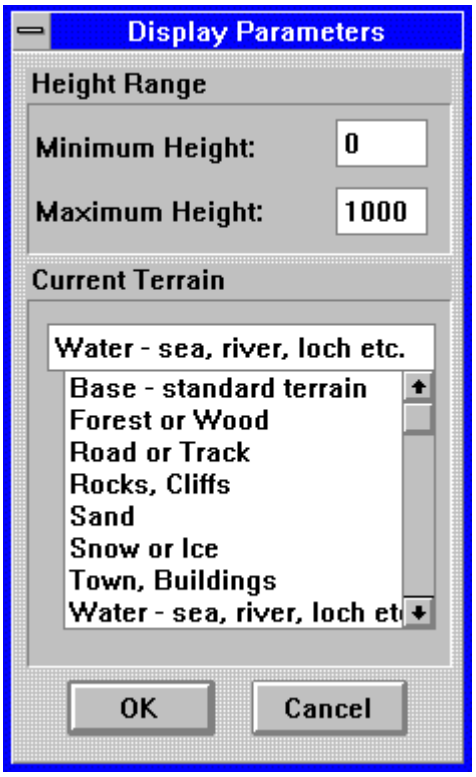
A slider used to adjust the range of colours recognized as being equivalent when using the auto contour trace tool. Mainly used with background bitmaps containing 256 colours or more, a low value for trace tolerance will only recognize a narrow range of colours, whereas a high value will recognise a wide range.

Display Parameters

Displays a dialog box that allows the user to set the height range for colour display. This default range is dependant on the map units being used.

This dialog also allows the user to set the default terrain type used by the terrain and close up tools. This can also be set directly by clicking on the chosen default terrain in the Parameter Display area of the window.

Fig. 9. The Display Parameter dialog



Load Background Bitmap

This displays a bitmap, typically a scanned image of the original paper map, as background. A .bmp file is prompted for by a standard 'open file' dialog.

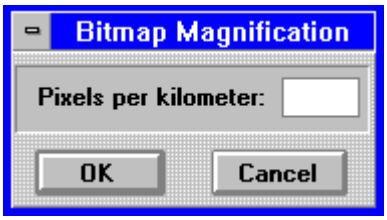
The bitmap may be moved using the Move Bitmap tool, and its magnification altered by the Set Bitmap Magnification tool.

All sample point heights and terrains are displayed (if enabled - see Map Function Status) superimposed on the background bitmap, which is typically used as a template for defining map information.

Set Bitmap Magnification

Prompts for the bitmap magnification to be used in pixels per kilometres, miles or metres (depending on the scale being used) and defaults to a value that will just fit the bitmap into the canvas. The value required to size the bitmap correctly may be calculated, but as it depends on the precise characteristics of the original scan is probably best arrived at by trial and error.

Fig 10. The Set Bitmap Magnification dialog



Move Bitmap

This enables a background bitmap to be moved under the grid. Grab the bitmap using the left mouse button and release when positioned correctly.

Set Spot Height

Prompts for the height of the sample point selected. Enter either null or a height between 0 and 9999 metres/feet. (999.9 for micro-metric maps).

Set Default Spot Height

This tool is only available when the map is displayed magnified. Set the grid point clicked on to the last height set using the spot height tool. Alternatively holding down the left mouse button and dragging sets each grid point passed over to this height.

Manual Contour Trace

Used to set a series of sample points along a line to be set to the same height. Typically this tool would be used to trace the contour lines on a bitmap loaded as background.

The tool uses a combination of the left and right mouse buttons or clicks and double clicks. To start a contour press the left mouse button. You may now either move the mouse whilst holding down the button, or release the button and click again at another position. In both cases a red line highlights where the contour will be placed. Continue defining the contour using any combination of these actions until complete, then either double click the left button or click the right button. A dialog box prompts for the height of the contour, which must be between 0 and 9999 metres/feet.

The last contour line created by both the manual and auto contour trace tools can erased by selecting the undo function from the edit menu.

Auto Contour Trace

Used to set a series of sample points along a line to be set to the same height. This tool is used to trace the contour lines on a bitmap loaded as background, and behaves in a similar manner to the Manual Contour Trace. Your background bitmap must be black or colour detail on a white background.

The auto-contour tool works by following a selected line. It is colour-sensitive, and will consequently work best on images created using a colour scanner or modified using a paint package before use. It may be used with a mono image but it is advisable to 'clean up' the image first.

To start tracing a contour press the left mouse button over a contour line. The program will now proceed to follow the line over the image, reversing the line colour as it does so. On completion a dialog box prompts for the height of the contour, which must be between 0 and 9999 metres/feet.

By default, the trace only follows pixels of exactly the same colour. However, when using the tool to trace contours from background bitmaps with 256 colours or more you will often find it useful to widen the range of colours recognised as belonging to the same contour by setting a higher tolerance. in the map status dialog.

The last contour line created by both the manual and auto contour trace tools can erased by selecting the undo function from the edit menu.

Set Heights Level

Click and drag using the left mouse button to define a rectangular area. On release a dialog box prompts for a height between 0 and 9999 metres/feet to which all sample points within the area will be set.

Set Heights to Null

Click and drag using the left mouse button to define a rectangular area. On release a dialog box prompts for confirmation that sample points in the defined area are to be set to null.

Interpolate Heights

This tool will interpolate the heights of undefined (null) grid points, and would typically be used after defining a representative sample of points. Interpolation is fully described in the following section.

Set Terrain (by square)

Allows terrain squares to be 'painted' to a particular terrain type by moving the mouse with the left button held down. Squares are set to the active terrain type, which can be set either using the Display Parameters dialog or clicking on the required terrain type in the Parameters Display area.

Set Terrain (by area)

Click and drag using the left mouse button to define a rectangular area. On release a dialog box prompts for the terrain type to which all the terrain squares in the defined area will be set.

Set Default Terrain

This tool is only available when the map is displayed magnified. Set the grid square clicked on to the currently selected terrain. Alternatively holding down the left mouse button and dragging sets each grid square passed over to this terrain.

Flood with Water

Flood fills any flat area of the map with water. After defining the shape of your landscape click on a suitable terrain square. If the four bounding sample points define a flat square a dialog will prompt for confirmation that all contiguous flat terrain squares at the same height are to be set to water.

Interpolating Heights

This tool will interpolate the heights of undefined (null) sample points. After defining a representative sample of points, for example along contour lines, this facility enables heights to be derived for the remaining undefined points. This version of Landscape Explorer offers two interpolation algorithms, an implementation of the Natural Neighbour algorithm (nngridr), which should be used to interpolate the majority of missing heights, and a trend analysis/smoothing transform, which should be used for filling in the last few points once the majority of heights have been interpolated.

By default undefined points are not displayed. Alternatively these can be drawn in orange when using the interpolation tool by checking the box in the map status dialog. Null heights are never shown when using all other tools.

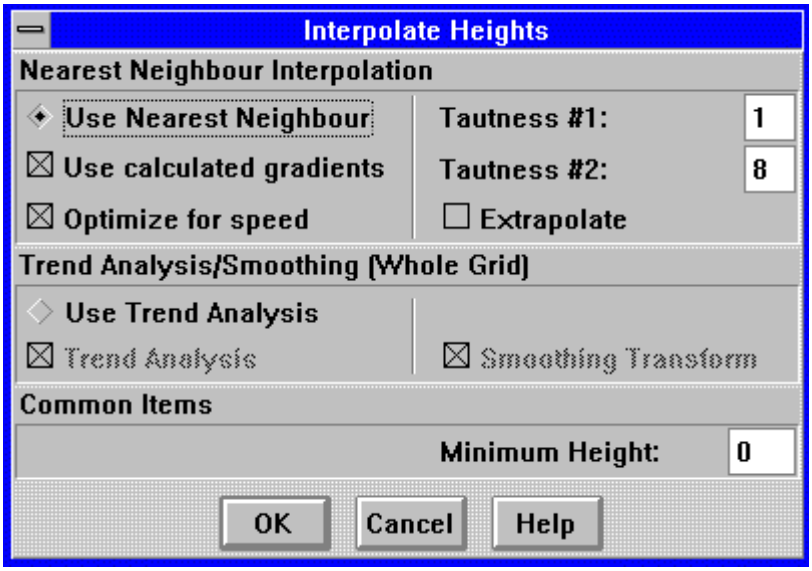
The Interpolation Process

You should broadly follow the steps outlined below:

1. Define a representative set of points, for example using the contour line tools. See the item on interpolation considerations below for more information.
2. Select the interpolation tool from the button bar and click and drag to define an area to be interpolated. After the mouse button is released a dialog box will be displayed to confirm that interpolation is to be started. Fill in the appropriate parameters for nearest neighbour interpolation (see below, but these will be the defaults when using the interpolation tool for the first time) and press OK to commence. Whilst calculating a dialog box will be displayed showing progress and allowing cancellation of the calculation.
3. Continue selecting areas for interpolation until the majority of points have been defined. You should aim at 95-98% coverage. You will probably find that the best strategy is to restrict the nearest neighbour algorithm to interpolation only first, then use extrapolation to fill in remaining areas. However, you are likely to miss a few points, and the following step is used to ensure that all heights have been defined.
4. Finally click the mouse anywhere on the canvas to start interpolation again. However this time select the Trend Analysis/Smoothing radio button, then click on OK. This will fill in any remaining undefined points and apply a smoothing transform to correct any anomalous heights.

The Interpolate Heights Dialog

Fig 12. The Interpolate Heights dialog



The following parameters may be set:

Use Nearest Neighbour/Trend Analysis

This pair of radio buttons determines which interpolation algorithm will be used. Controls not used by an algorithm will be disabled.

Use calculated gradients

Used by Nearest Neighbour interpolation. Defaults to ON. Uses gradients to estimate the trends in the data when checked. For example, a rounded hilltop will be deduced if points are available around a hill, but not on top. If turned off gradients will not be used and a flat top will be deduced.

Optimise for speed

Used by Nearest Neighbour interpolation. Defaults to ON. Calculates faster by making more generous usage of memory. When turned off requires less memory but is significantly slower.

Extrapolate

Used by Nearest Neighbour interpolation. Defaults to OFF. Enables extrapolation when checked. This is by its nature a tenuous proposition, and should be used with caution after the majority of the map heights have been defined directly or by interpolation. Note that it is advisable to define as many grid points as possible on the edges of the map, and particularly at the corners, as this reduces the amount of extrapolation required.

Tautness Parameters #1 and #2

Used by Nearest Neighbour interpolation. These two parameters control the 'taughtness' of the generated surface around the points already defined. Increasing the value of parameter 1 increases the influence of the gradient, increasing the value of parameter 2 increases the area over which the influence of the gradient is felt. Reasonable ranges are 1 to 3 for parameter #1, and 5 - 12 for parameter #2.

Minimum Height

Used by both interpolation methods. The minimum height setting is available to help when defining sea coasts and other areas of water. For example, to define an island draw the appropriate contour lines and spot heights for the island and an area of sea at zero height for two or more sample points around the coast before applying interpolation.

Trend Analysis

Used by Trend Analysis interpolation. Defaults to ON. Applies a trend analysis to the whole grid to fill in any undefined points.

Smoothing Transform

Used by Trend Analysis interpolation. Defaults to ON. Applies a smoothing algorithm to the whole grid to correct any anomalous points.

Interpolation Considerations

The proportion of defined to undefined sample points required depends on the kind of landscape being defined. For smooth, rounded hills or plains reasonable results may be obtained with 1 point in 40 or less. For more complex structures 1 in 20 or less is recommended. Interpolation is most accurate where the surface has few discontinuities - so for a valley with steep sides and a flat bottom placing two or three contour lines along the sides will be sufficient to derive the shape of the sides. However, without further information the interpolation function will assume a continuation of the sides to form an overdeep vee, so you will need to block in some of the valley floor.

In some circumstances the nearest neighbour interpolation algorithm will be unable to proceed and an error message will be displayed: for example if the height to width ration of the selected area is too extreme, or too many defined points are included in the selected area. Reselect and try again.

nngridr and Calculation Efficiency

The implementation of the nearest neighbour algoriithm used in Landscape Explorer was developed by Dave Watson (contact PO Box 734 Claremont, WA 6010, Australia). This is probably one of the most effective algorithms of it's type available.

However, although yielding excellent results, the time required to calculate interpolated values varies approximately with the square of the number of points. We found that in practice on a 486DX33 an area of up to about 8,000 points could be calculated without an unreasonable delay. Calculations on up to 20,000 points or more are certainly feasible if you are willing to allow for the time required (Landscape Explorer will issue a warning if the calculation time required is likely to be excessive). However, it is faster to interpolate a large area by selecting smaller areas in a 'piece-meal' or 'patchwork' manner. It is also a good idea to overlap patches to ensure continuity - two to three grid point depth should suffice. You should perform interpolation initially with the extrapolate option turned off, returning to extrapolate any missing points before completion. Even so, you are likely to miss a few points and the trend analysis interpolation should be used to define these last few points.

Chapter 5: Advanced Definition Features

Analyse DEM File

This function is used to analyse a DEM data file before import to facilitate correct setting of map parameters. It is accessed from the Define Map menu.

Full details of DEM file formats can be obtained from the US Geological Survey. However they basically consist of a set of parallel profiles arranged south to north, each profile being a one-dimensional array of elevations arranged west to east, thus describing a quadrilateral area. DEM files can be obtained from USGS and various anonymous ftp sites - a good selection of 7.5-minute DEM's is available from spectrum.xerox.com. Note that USGS DEMs are not the same as Vistapro/DEMs.

USGS produce the following types of DEM file.

7.5-minute DEM

7.5-minute quadrangle. Horizontal coordinate system uses UTM on North American Datum of 1927 (NAD 27) or 1983 (NAD 83). Elevations are referenced in metres or feet to the National Geodetic Vertical Datum of 1929 (NGVD 29) in the continental US, and to local mean sea level in Hawaii and Puerto Rico. Spacing of elevations along and between each profile is 30 metres and the profiles may not always have the same number of elevations because of the variable angle between true north and the grid north of the UTM coordinate system.

1 degree DEM

1- by 1-degree block. Horizontal coordinate system is Geographic (lat/long) on World Geodetic Survey (WGS) 72 or WGS 84. Elevations are referenced in metres in the continental US and Alaska and to local mean sea level in Hawaii and Puerto Rico. Spacing of elevations along each profile is 3 arc seconds. Spacing between profiles is 3 arc seconds south of 50 degrees north, and 6 or 9 arc seconds above this. DEMs north of 50 degrees are not handled correctly by Landscape Explorer.

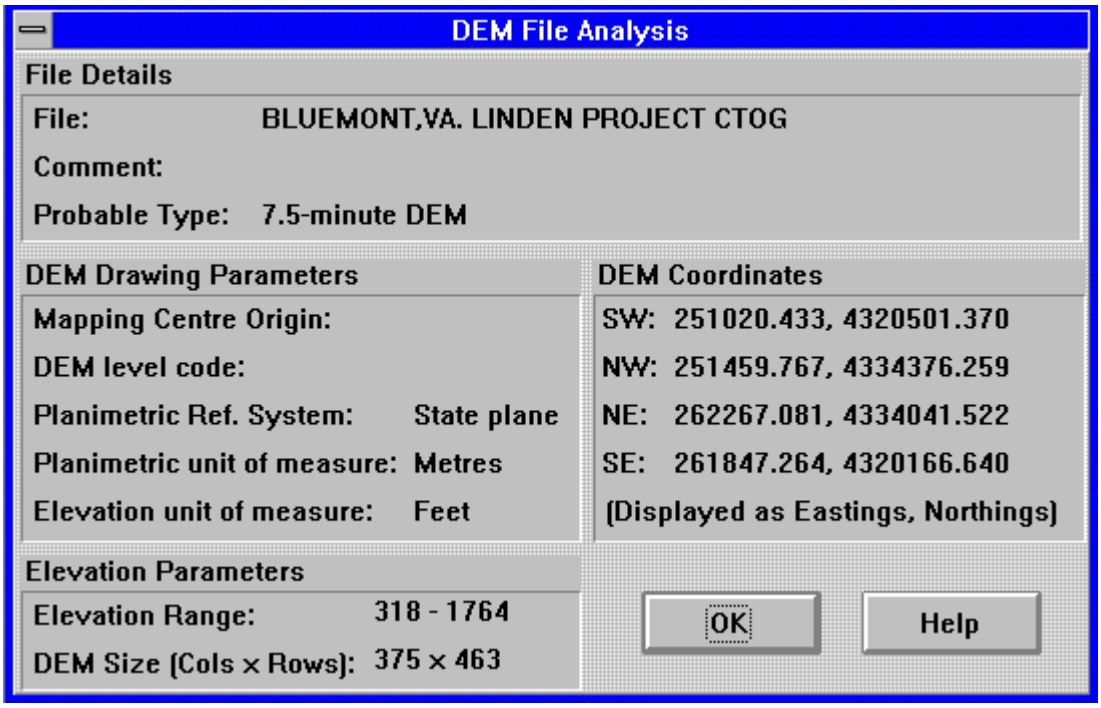
7.5-minute and 15-minute Alaska DEM

These DEMs are not handled correctly by Landscape Explorer.

File Loading Errors

If an error is encountered while attempting to load the DEM file the process will abort and an error message is display. DEMs may fail to load for a variety of reasons. Please see the section on importing USGS DEM files in chapter 3 for more details.

Fig. 13. The Analyse USGS DEM dialog



Export Functions

After you have defined a map you may wish to view it using a different viewing program, such as Vistapro or AutoCAD. Landscape Explorer can export the data constituting the map .lem file in a number of different formats.

All export functions are accessed from the map definition module. Select the Export... item from the Define Map menu. A dialog box is displayed. Select the export file type required from drop down list box, and enter the file name.

ASCII

Exports all heights in space delimited ASCII format. This is the same format as described in the Import ASCII function.

No information about terrains is exported.

X,Y,Z,Attribute

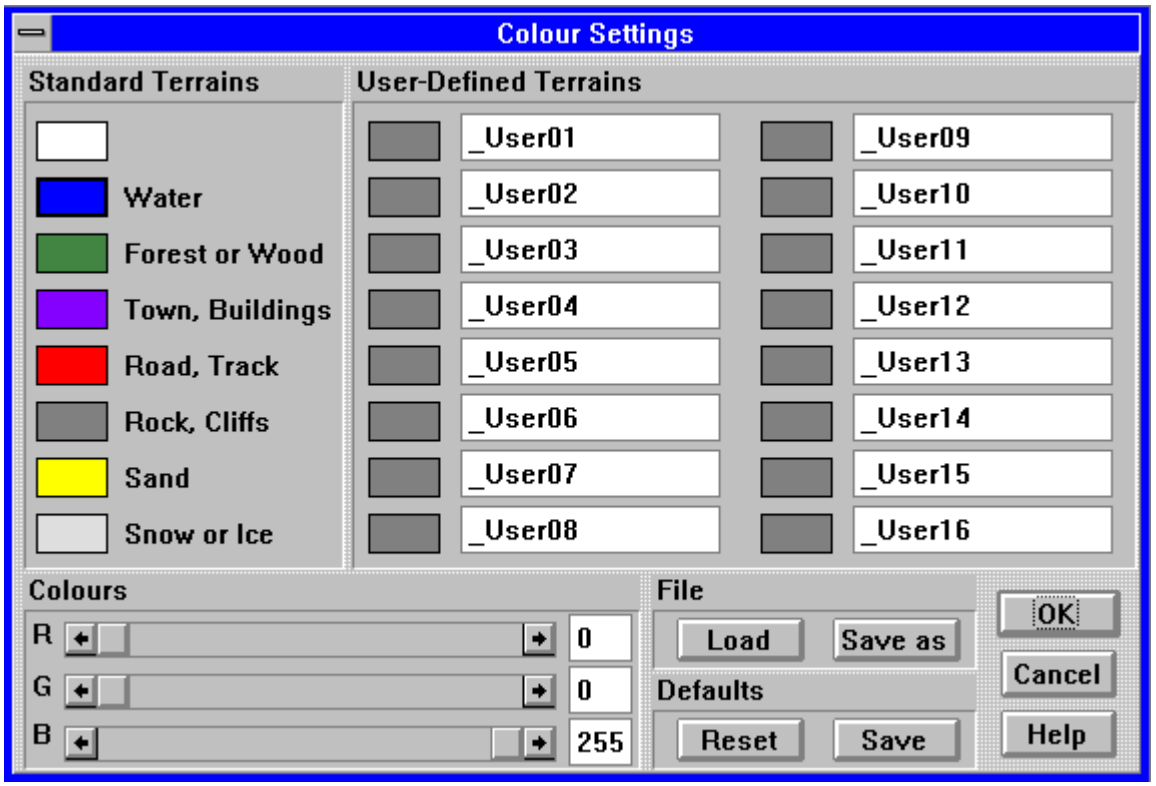
Exports all the data in the map in x,y,z,attribute format (see Import x,y,z,attr for details). This is the only format that exports details of terrains in addition to heights.

Using Colour Settings Schemas - The Options Menu

Colour Settings

Landscape Explorer offers considerable control over how terrains are be displayed. The program uses two types of terrains, standard and user-defined. Both types are controlled by the Colour Settings dialog. If this dialog is accessed from the View Parameters dialog colour changes will only apply to the view being drawn. Alternately, if you access the dialog from the Options menu changes will be applied to the global program settings - thus affecting the map definition module and the defaults for any new views drawn.

Fig 14. The Colour Settings dialog



Standard Terrains

There are currently 8 standard terrains, corresponding to pre-defined terrain types such as water and forest. You may alter the colours used for all but the base colour type, but the names are fixed.

User Terrains

Up to 16 user terrains may be defined, and unlike the standard terrains you may specify both the colour and names of these terrains. User terrains can be imported in .XYZ files - see import xyz for details.

Storing and Using Colour Setting Schemas

You can store and use colour setting schemas at several different levels. Landscape Explorer loads a default set of colours at start-up, and you can save any set of colours as these defaults using the Save button in the Defaults group box. The Reset button in the same box restores the standard program defaults.

You can also save colour settings schemas in a .CFG file. Use the Save As button in the File group box to do this. You can load a previously saved schema using the Load button in the same group box.

As described above, changes made in the Colour Settings dialog are applied globally if the dialog is accessed from the menu, but only locally to the current view if accessed from the View Parameters dialog.

You can also associate a colour setting schema with a map file - this can either be done on creation using the New Map or one of the import dialogs, or for an existing map using the map status dialog. The schema name corresponds to that of a .CFG file, and the program looks for this file in either the current directory or that specified by the Directories dialog.

Directories and Paths

This displays a dialog prompting for the path to the directory containing the colour schema (.CFC) files. If this is left blank it will use the directory from which the program was run.

Appendix A: Memory Issues

Landscape Explorer requires fairly large amounts of memory to run efficiently. If you have less than 8Mb of RAM you should have a windows swapfile installed. If you do not , and this is a good idea generally for all windows systems, you can add one using the virtual memory option in the control panel '386 enhanced' utility. Microsoft recommend using the 'permanent' option, and 8 - 12Mb seems to be optimal on most computers.

Even so, when allocating memory it must be available in RAM (possibly making space by swapping out data to disk) and in a continuous block. To facilitate this Landscape Explorer does a memory defrag before allocation, but it is still possible for a call to fail due to fragmentation of the internal Windows selector table. In practise you are unlikely to see this unless you are running in high resolution/high colour mode (say 1024x768 in 256 colours), when Landscape Explorer may be looking for several 1Mb memory blocks. If you do experience problems consider closing other applications, removing any complex wallpaper, or running with lower resolution or number of colours.

Appendix B: The XYZ Format

X,Y,Z Format

All records are comma delimited. Coordinate system uses the SW corner as origin.

Attribute refers to the terrain square to the NE of coordinate. User defined terrain colours and descriptions import is included as this information is easily available from MapInfo and maintains consistency across applications. However, inclusion is not are obligatory.

RECORD 1

Header record. Measurement System (m|i),min x, min y, max x, max y, x spacing, y spacing, attributes included (attr|noattr)

RECORD 2

Description. Free format.

RECORD 3

Number of user-colours defined (nominally n, max 16, may be 0).

RECORDS 4 to 4+N

Terrain number, colour definition (RGB format - Red + 256 * Green + 65536 * Blue), terrain description (max 24 characters).

RECORDS 4+N+1 TO END OF FILE

Data. X coord, Y coord, Height, Terrain type.

Example

m,2262300,5617000,2267900,5628000,100,100,attrDerived from TR_STYPE31,0,BdU2,255,BnH3,65535,BnR2266400,5617000,1531.74, 92266300,5617100,1520.17,92266400,5617100,1519.89,9