# ER Mapper Professional

## Level One
## Training Workbook
## for
## Land Information Applications

www.ermapper.com

ER Mapper
Geospatial Imagery Solutions

# Summary Contents

## Part Two - Enterprise Wide Imagery 465

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# About this workbook

This workbook is intended to get you started learning and using ER Mapper release 6. It is also useful to users of previous releases of ER Mapper who want to learn the new features and interface changes. It provides simple step-by-step lessons that give you hands-on practice using the basic features of the software, and using more advanced features as well. It is designed as a “cookbook” so you can repeat the procedures using your own datasets if desired. Please read the following important information before beginning.

- Chapter contents
- Setting up practice datasets
- Typographical conventions used in this document

This workbook is a significantly enhanced and expanded version of the *ER Mapper Tutorial* manual, so it covers many concepts and product features not found in that document.

This manual is *not* intended to cover all ER Mapper functionality or remote sensing and image processing concepts in depth. Please refer to the *ER Mapper User Guide* or reference texts in Appendix B “Reference texts” for more detailed information as needed.

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**Note:** The hands-on exercises in this workbook require that the example datasets and algorithms supplied on the ER Mapper CD-ROM be installed and accessable. Refer to “Appendix A “System setup” for more information.

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## Chapter contents

This manual gives you extensive hands-on experience using ER Mapper through a series of specially designed lessons. Most lessons have two basic sections:

- an overview of key concepts
- a series of step-by-step hands-on exercises

It is recommended that you start at the beginning and proceed through the chapters in order because the later chapters build on concepts learned in earlier ones. However, each chapter is independent of the others, so you can refer to a specific chapter at any time for a quick procedural overview or refresher course.

## Setting up practice datasets

The exercises in this manual assume that ER Mapper is installed and licensed, and that you will use the default ER Mapper 'tutorial' directory to save sample algorithms and other files during the lessons. In addition, some chapters require that copies of the ER Mapper example datasets be placed into the 'tutorial' directory for use by individual students. For information on configuring your system for these exercises, please refer to Appendix A "System setup" in this workbook.

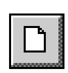
## Typographical conventions

The following typographical conventions are used throughout this document:

- ER Mapper menus, button names and dialog box names are printed in boldface Helvetica type, for example:

  "Select **Print** from the **File** menu to open the **Print** dialog box."

- Where you are asked to click the mouse on an icon button in the user interface, both the button and its formal name are indicated in the text. For example:

  "Click the **New Image Window**  button."

- Text to be typed in a dialog box text field is shown in boldface Courier typeface, for example:

  "Type **`vegetation_index`** in the text field."

# *Part One - Land Information Applications*

# 1

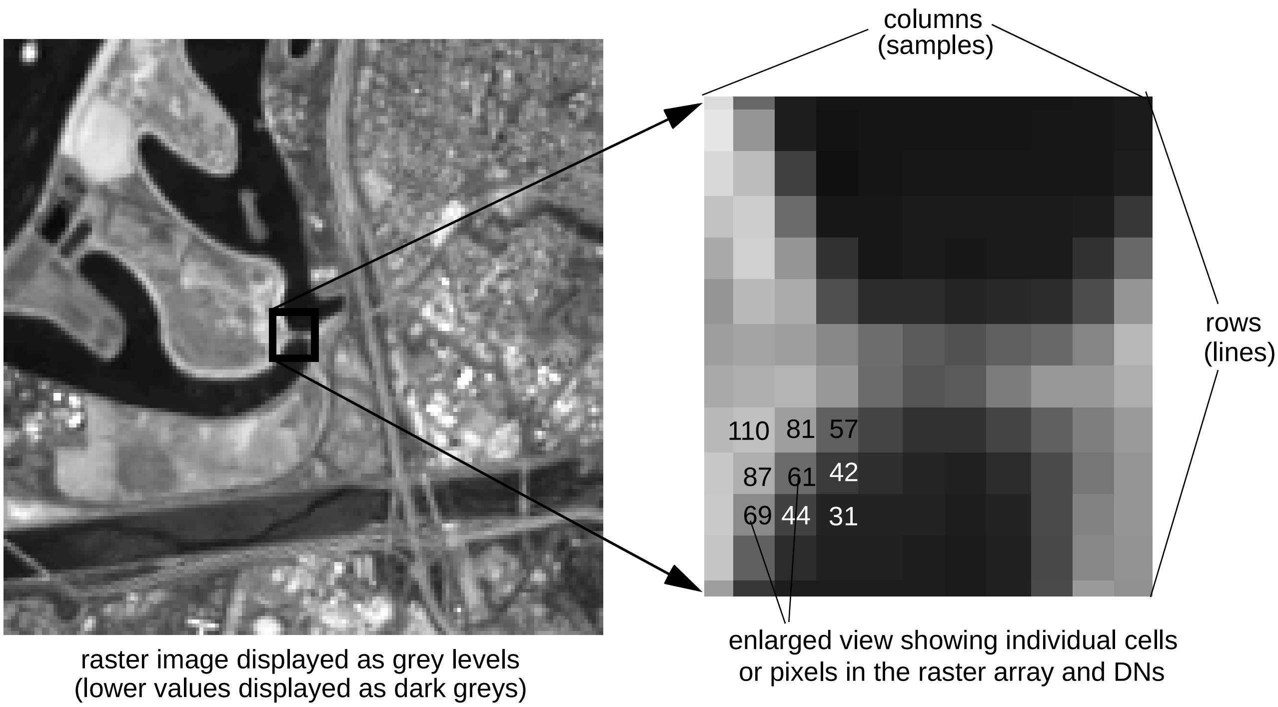
# Introduction to ER Mapper

This chapter provides a brief overview of general image processing concepts, the types data you can process, and typical ER Mapper applications in the earth sciences. It also provides an overview of how the ER Mapper software works, and advantages it provides over other image processing systems.

## Image processing concepts

The term *digital image processing* refers to the use of a computer to manipulate image data stored in a digital format. The goal of image processing for earth science applications is to enhance geographic data to make it more meaningful to the user, extract quantitative information, and solve problems.

A digital image is stored as a two-dimensional array (or grid) of small areas called *pixels* (picture elements), and each pixel corresponds spatially to an area on the earth's surface. This array or grid structure is also called a *raster*, so image data is often referred to as raster data. The raster data is arranged in horizontal rows called *lines*, and vertical columns. Each pixel in the image raster is represented by a *digital number* (or DN).




These image DNs can represent many different types of data depending on the data source. For satellite data such as Landsat and SPOT, the DNs represent the intensity of reflected light in the visible, infrared, or other wavelengths of the electro-magnetic spectrum. For imaging radar (SAR) data, the DNs represent the strength of a radar pulse returned to the antenna. For digital terrain models (DTMs), the DNs represent terrain elevation. No matter what the source, all these types of data can be stored in a raster format.

By applying mathematical transformations to the digital numbers, ER Mapper can enhance image data to highlight and extract very subtle information that would be impossible using traditional manual interpretation techniques. *This is why image processing has become such a powerful tool for all types of earth science applications.* The exercises in this manual provide many examples that illustrate how image processing is typically used to enhance image data and extract information.

Many image datasets have multiple *bands* (or layers) of data covering the same geographic area, each containing a different type of information. For example, a SPOT HRV-XS satellite image has three bands of data, each recording reflectance from the earth's surface in a different wavelength of light. Since each band records reflectance in a different part of the spectrum, this type of data is often called *multispectral* data. Many powerful image processing techniques have been developed to combine various bands from multispectral images to highlight specific types of earth science information such as vegetation abundance, water quality parameters, or the types of minerals present at the earth's surface.

# Image processing applications

Image processing has become an important tool for a wide range of earth science mapping, analysis, and modelling applications. Following are just a few of the many applications for which image processing is commonly used:

- land use/land cover mapping and change detection
- agricultural assessment and monitoring
- coastal and marine resource management
- mineral exploration
- oil & gas exploration and reconnaissance
- forest resource management
- urban planning and change detection
- telecommunications siting and planning
- physical oceanography
- geology and topographic mapping
- sea ice detection and mapping

# Traditional image processing

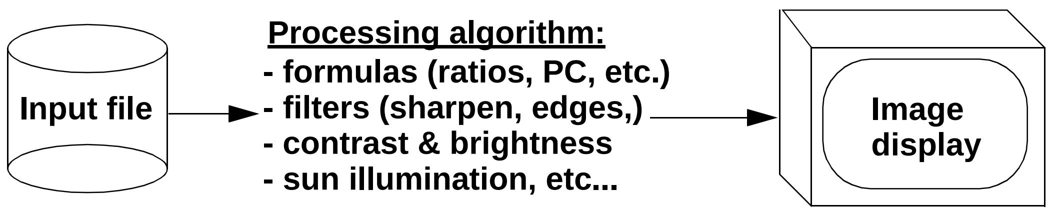
Image processing was first developed on large mainframe computers in the 1960's to process images from planetary satellites. To process an image, you specified the name of the file to process, the type of operation you wanted to perform, then waited for the system to process the data and write the results to a new image file on disk (shown in the diagram below). You then used a separate display program to view the output file and evaluate your results.


With traditional systems, the changes resulting from the image processing operation are saved in a *separate output raster file*.

Since the introduction of powerful workstations in the 1980's, processing of large images can now be performed on the desktop. Surprisingly, nearly all image processing products on the market today are still designed around this "disk-to-disk" approach from the 1960's. This means that to perform a processing operation that requires several steps, you need to write an intermediate file to disk for each step. Only when the final file is created can you view your desired results. This approach can consume tremendous amounts of time and disk space, and if the result is not what you intended, you must often start all over again.

# ER Mapper image processing

Recognizing the restrictions inherent in traditional image processing software, the creators of ER Mapper developed an entirely new approach. Instead of writing a file to disk for each processing step, ER Mapper lets you combine many processing operations into a single step, and render the results directly to your screen display in near real-time. (In most cases, no processed copies of your original data are written to disk unless you request to do so.) The set of processing steps you apply to your data is called an “algorithm” in ER Mapper.



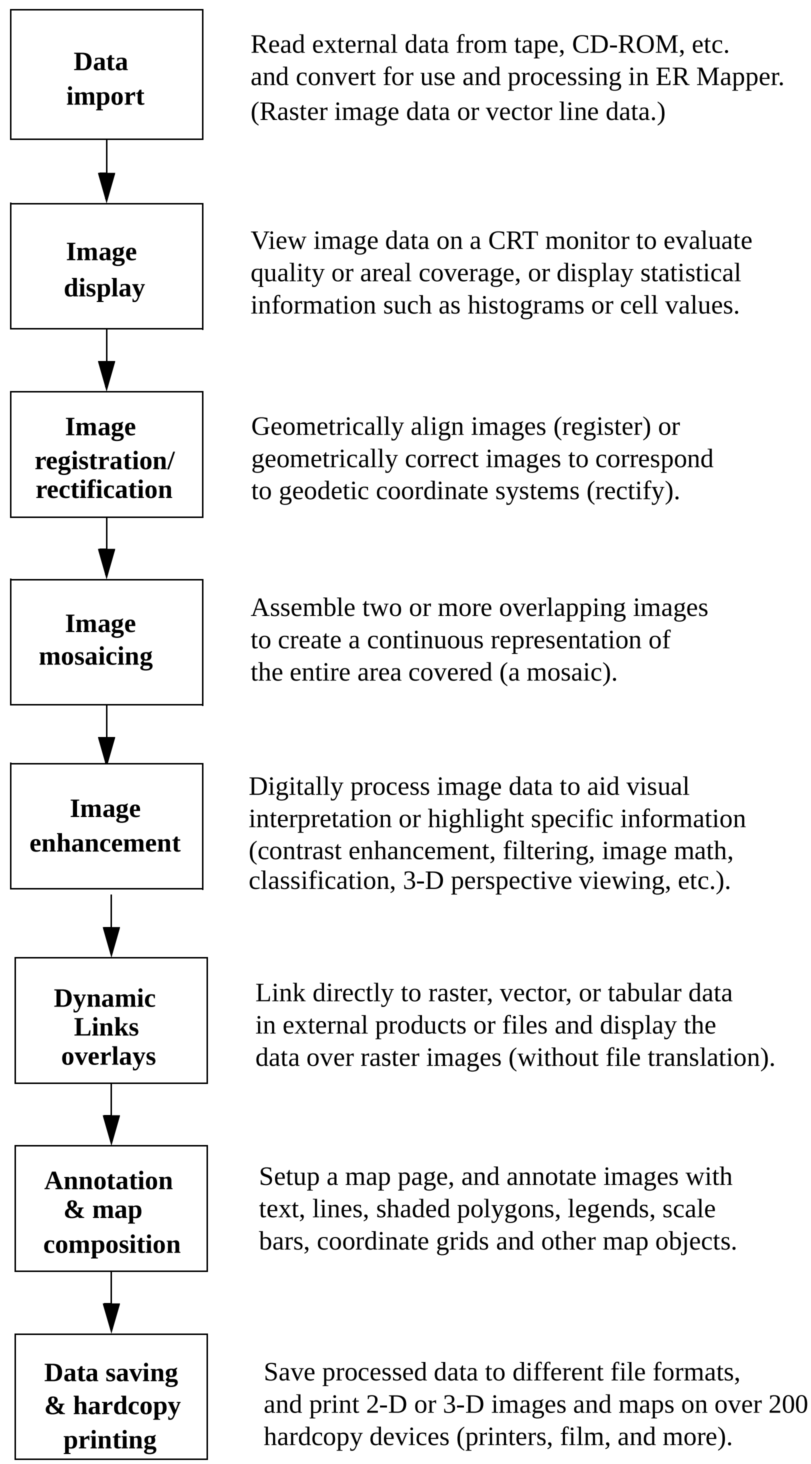

With ER Mapper, you save only a *description of the processing steps* you wish to apply to the data (the algorithm), *not* separate processed copies of the original raster data file. By storing the processing steps separately from the actual data, image processing becomes faster, easier to learn, and more interactive.

In ER Mapper, algorithms can be used for simple viewing of data such as greyscale or RGB band combinations. Algorithms are also used for complex processing and modelling operations involving many images, transformations of the data, and overlays of vector data–in both 2-D and 3-D perspective views. Examples of common image processing operations that become much easier using algorithms include image merging (data fusion), image mosaicing, and any type of image mathematical transformations such as band ratios, Principal Components Analysis, Tasseled Cap transforms, and others.

The algorithms design also allows ER Mapper to handle the next generation of very high resolution satellite and airphoto imagery much more efficiently than traditional systems. These one to three meter spatial resolution datasets have large file sizes for the area of coverage, so reducing the need to write processed copies of the data to disk is a very important consideration.

# Image processing tasks

A flowchart of typical image processing tasks is summarized in the following diagram, from data import through processing to final output.



## Data input

The first step in image processing is opening the data you want to use into ER Mapper. Typically the data might be stored on magnetic tape, CD-ROM, or other media. There are two primary types of data you may want to import into ER Mapper: raster and vector.

*Raster image data* is the type used as input to image processing operations. Typical sources include satellite images, digitized aerial photographs, digital terrain models (DTMs), and geophysical and seismic survey data.

*Vector data* is stored as lines, points, and polygons. Many geographic information system (GIS) products use vector data structures because it is more efficient for representing discrete spatial objects like roads (lines), sample locations (points), or political boundaries (polygons). In an image processing product, it is often helpful to overlay vector data on top of a raster image backdrop, for example overlay a network of known roads on a satellite image.

## Image display

After opening the data file, the next step is usually to display the image on your CRT monitor to evaluate the data quality and geographic area of coverage. If the data is of poor quality or has cloud cover over your area of interest, you might decide not to proceed any further and try to obtain better data.

There are several ways in which data can be viewed, including simple black and white or pseudocolor displays, and red-green-blue (RGB) or hue-saturation-intensity (HSI) color composite displays. The way in which you choose to display your raster data is called the “Color Mode” in ER Mapper. You can also view data in traditional two-dimensional (2-D) views, or 3-D perspective views.

In addition to displaying the data, you may want to view statistical information about it. Statistics are often good indicators of image quality. You may want to calculate statistics for the image, such as the mean value in each band, and view them in a tabular format. Or you may want to view statistical information in a graphical format using tools like histograms, scattergrams, and traverse profiles.

## Image geocoding

Many times, raster image data is supplied in a “raw” state and contains geometric errors. Whenever accurate area, direction, and distance measurements are required, raw image data must usually be processed to remove geometric errors and/or rectify the image to a real world coordinate system.

- *Registration* is the process of geometrically aligning two or more images to allow them to be superimposed or overlaid.

- *Rectification* is the process of geometrically correcting raster images so they correspond to real world map projections and coordinate systems (such as Latitude/Longitude or Eastings/Northings).
- *Orthorectification* is a more accurate form of rectification mainly used on airphotos. It takes into account properties of the camera used to take the images and fiducial marks on the image.

If your application requires that your images be registered to one another or rectified to a map projection, you will use ER Mapper's Geocoding Wizard to do this.

## Image mosaicing

A *mosaic* is an assemblage of two or more overlapping images used to create a continuous representation of the area covered by the images. ER Mapper automates the building of image mosaics because co-registered images referenced in the same processing algorithm are automatically displayed in their correct geographic positions relative to each other. This means that you are not required to write all images to one large file on disk in order to process and enhance them. The ER Mapper Image Display and Mosaic wizard automatically mosiacs images in a specified path.

## Image enhancement

Image enhancement refers to any one of many types of image processing operations used to digitally process image data to aid visual interpretation or extract quantitative information meaningful to the user. Image enhancement is what many people commonly think of as "image processing."

In ER Mapper, image enhancement operations are greatly simplified by the "algorithms" processing concept. Nearly all types of image enhancement operations can be applied and displayed in real time to provide truly interactive control without writing temporary files to disk.

Typical image enhancement operations include:

- *Image merging* (data fusion)–Combine images with different qualities to aid interpretation. For example, merge Landsat TM and SPOT Pan to combine TM spectral information with SPOT Pan spatial detail.
- *Colordraping*–Drape one type of data over another to create a combined display allowing analysis of two or three variables. For example, drape a satellite-derived vegetation map over an airborne magnetics image of the same area.
- *Contrast enhancements*–Improve image presentation by maximizing the contrast between light and dark portions (or high and low data values) in an image. Or, highlight a specific data range or spatial area in an image.

- *Filtering*–Enhance edges, smooth noise, or highlight or suppress specific linear or spatial features in images. For example, apply a gradient directional filter to highlight linear features tending north-south in an image. ER Mapper also includes Fourier Transformations for filtering in frequency domain space.
- *Formula processing*–Apply mathematical operations to combine multiple bands of image data or derive specific thematic information. Examples include thresholding, differencing, ratioing, Principal Components Analysis, and spatial modeling.
- *Classification*–Statistically group or cluster image data values into thematic categories or feature classes. For example, classify a Landsat satellite image to yield a thematic map of land cover types. (Raster representations of the spatial cover types can also be converted to vector polygons for export to GIS systems.)
- *3-D perspective visualization*–Create realistic 3-D perspective views simply by adding a "height" element to the image display, such as digital terrain/elevation data or any other type of data that may aid visualization and interpretation.
- *Color balancing*–Use the ER Mapper Color Balancing wizard to balance mosaiced images to give a seamless single image.

## Dynamic Link layers

Dynamic Links are a special ER Mapper feature that let you link to data in external products or file formats, and display the data on top of raster images without the need for importing the files. Dynamic Links can link to raster, vector, or tabular (point) datasets, so you can access and integrate *all* your geographic information. ER Mapper provides Dynamic Links to several popular products and file formats, and the procedure is fully documented so you can also create your own links to any other product or format you desire.

Types of Dynamic Links include:

- *Links to GIS products*–Extract and display vector data from GIS and desktop mapping software such as ARC/INFO®. GIS links are often used to overlay vector data such as road networks, political boundaries, or land use categories.

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**Tip:** You can display, edit, and save ARC/INFO® coverage files directly in ER Mapper. See the *ER Mapper User Guide* for details.

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- *Links to database products*–Extract and display tabular (point location) data from database products such Oracle®. Tabular links are often used to overlay georeferenced point location symbols such as cities, well locations, or ground truth sample sites.
- *Links to external file formats*–Display specialized annotation, vector data, or other data stored in PostScript®, DXF, DGN, or other standard file formats.

## Map composition

You can use ER Mapper’s built-in Annotation and Map Composition tools to create top quality image maps combining raster, vector, and tabular data. Annotation lets you draw directly on-screen using text, line, polygon, and other annotation tools, and specify fill color, shading, line styles, user-defined symbols, and group, move and resize objects. Vector annotation files created in ER Mapper can also be exported to external file formats for use in other products.

ER Mapper’s Map Composition tools let you create top quality image maps by adding coordinate grids, map collars, scale bars, legends, north arrows, and many other map objects and standard cartographic symbols. You can layout and compose maps comprised of multiple processed images, and size and scale map output as desired. All map objects are defined as full color PostScript, and you can easily add custom map objects such as company logos or special north arrows.

## Data export and hardcopy

Once you have completed processing your data, ER Mapper lets you translate raster and vector data to external standard file formats or print to over 200 different hardcopy devices. You can easily print both 2-D planimetric and 3-D perspective views.

Data export is used to export the processed version of your raster images for use in another image processing product. Or, you may want export vector annotation or vectorized thematic data to a GIS product.

Hardcopy printing is often the final goal of processing and annotating images, and ER Mapper provides unsurpassed hardcopy support and output to standard graphics file formats. ER Mapper also includes a built-in PostScript-compatible rendering engine, so you get PostScript-quality output (such as beautiful, smooth text) on any supported device, whether the device supports PostScript or not.

You can also easily print at exact sizes and map scales, and automatically print large images in strips for mosaicking large hardcopy image displays. Supported hardcopy devices include inkjet printers, laser printers, dye sublimation printers, electrostatic plotters, and film recorders. Graphics file formats include PostScript, TIFF, Targa, CGM, and CMYK and RGB color separations.

# 2

# User interface basics

This chapter introduces the basic use of the ER Mapper graphical user interface. It gives you practice using menus, toolbars, dialog boxes, and image windows, and loading and displaying image processing algorithms.

**Note:** In order to complete the exercises in this manual, you will need to access the example images and algorithms supplied with ER Mapper. If needed, ask your system manager for the location of the ER Mapper software directory at your site.

## User interface components

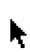
This section provides a brief introduction to the main components of ER Mapper's graphical user interface (GUI). You can perform nearly all operations by pointing and clicking with the mouse, and very little typing on the keyboard is required. The GUI is part of ER Mapper's original design, so it is well integrated and easy to learn and use.

## Using mouse buttons

When using ER Mapper, use the left button on your mouse to perform operations like selecting items from menus, manipulating image windows, and drawing annotation. In this manual, all actions are performed with the left mouse button unless otherwise indicated. The following table explains terms used in this manual to describe actions you perform with the mouse.

| Term | Meaning |
|---|---|
| Point | Position the mouse pointer on an item. |
| Click | Point to an item, then quickly push and release the left mouse button. |
| Right-click | Point to an item, then quickly push and release the right mouse button. |
| Double-click | Point to an item, then quickly click the left mouse button twice. |
| Drag | Point to an item. Then press and hold down the left mouse button as you move the pointer to a new location, then release the button. |
| Shift-click or Ctrl-click | Hold down the Shift key or Ctrl key on your keyboard, then click. |
| Shift-drag or Ctrl-drag | Hold down the Shift key or Ctrl key on your keyboard, then drag the mouse. |

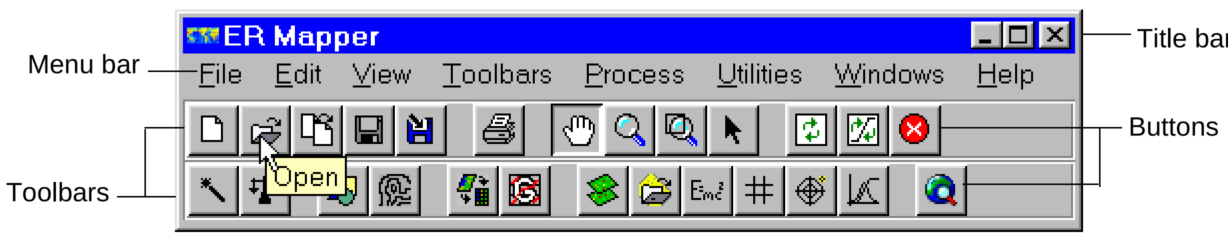
The symbol representing the mouse pointer on the screen changes shape depending on what you are pointing to and the task you are performing.

| Pointer | Location on the screen | Function |
|---|---|---|
|  | Menu bars and buttons; or inside image window | Choose menu commands and click buttons; point to the image to see data values or coordinates. |
|  | Text fields | Type or select text, or reposition the insertion point. |
|  | Inside the current image window | Zoom the image within the image window. |
|  | Inside the current image window | Drag a box over an area to fill image window. |

| | | |
|---|---|---|
|  | Inside the current image window | Pan the image within the image window. |
|  | Inside inactive image windows | Select an inactive window to become the current window. |
|  | In image windows when annotation tools are selected | Draw annotation and map composition objects. |

## The ER Mapper main menu

When you start ER Mapper, the main menu appears. The main menu has two primary components–the menu bar and rows of toolbar buttons.




| | |
|---|---|
| **Menu bar** | Lets you select commands used to carry out actions in ER Mapper. To select a command from the menu bar, click on the name of the menu to open it, then click the desired command name. |
| **Toolbar buttons** | Shows groups of buttons to let you carry out common tasks quickly. To choose a function from a toolbar, click on the desired button. |
| **Tool tips** | Place the cursor on any toolbar button and within a couple of seconds the function of that toolbar button is displayed in a small text window just below the cursor |

## Using ER Mapper toolbars

Toolbars give you quick access to many common functions, such as saving an image processing algorithm or printing a hardcopy. ER Mapper also provides optional toolbars for specific tasks and image processing applications. To hide or display various toolbars, use the **Toolbar** menu. To get short help for any toolbar function, point to the button and read the tool tips.

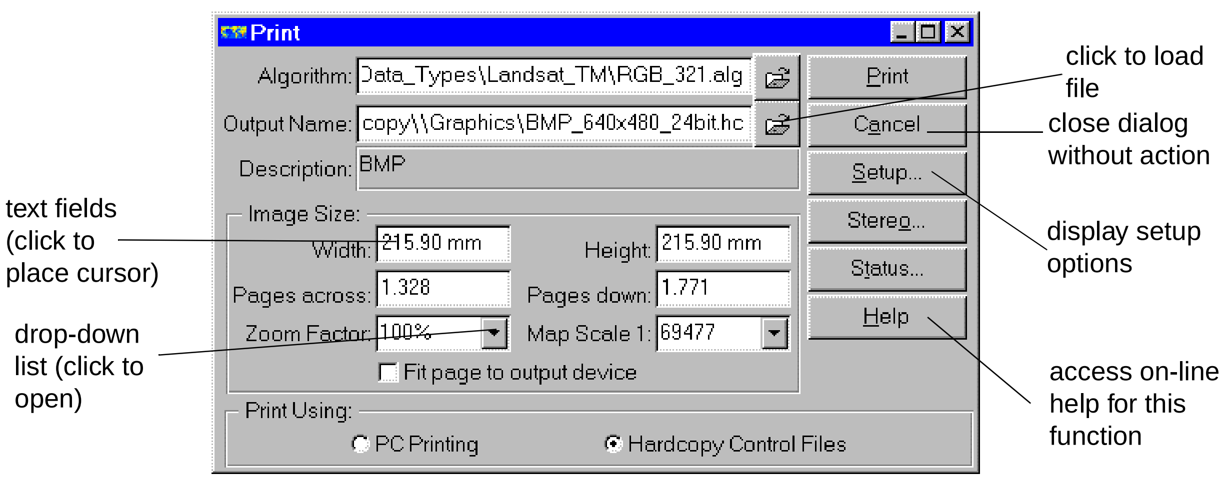
ER Mapper provides toolbars for many common tasks, and also toolbars for building processing algorithms commonly used in remote sensing applications such as forestry, geophysics, and map generation. The functions of the Standard, and Common Functions toolbars are summarized below.

| | |
|---|---|
| **Standard** | Provides quick access to standard commands for opening and saving algorithms, printing, starting and stopping algorithm processing, and changing the mouse pointer. Most functions are also available from the menu bar. |
| **Common Functions** | Provides quick access to commonly used functions, such as creating general types of algorithms, viewing and editing components of an algorithm. |

Using ER Mapper's scripting language, you can also create your own customized toolbars for specific tasks and functions. For more information on creating custom toolbars, see the *ER Mapper User Guide*.

## Using dialog boxes

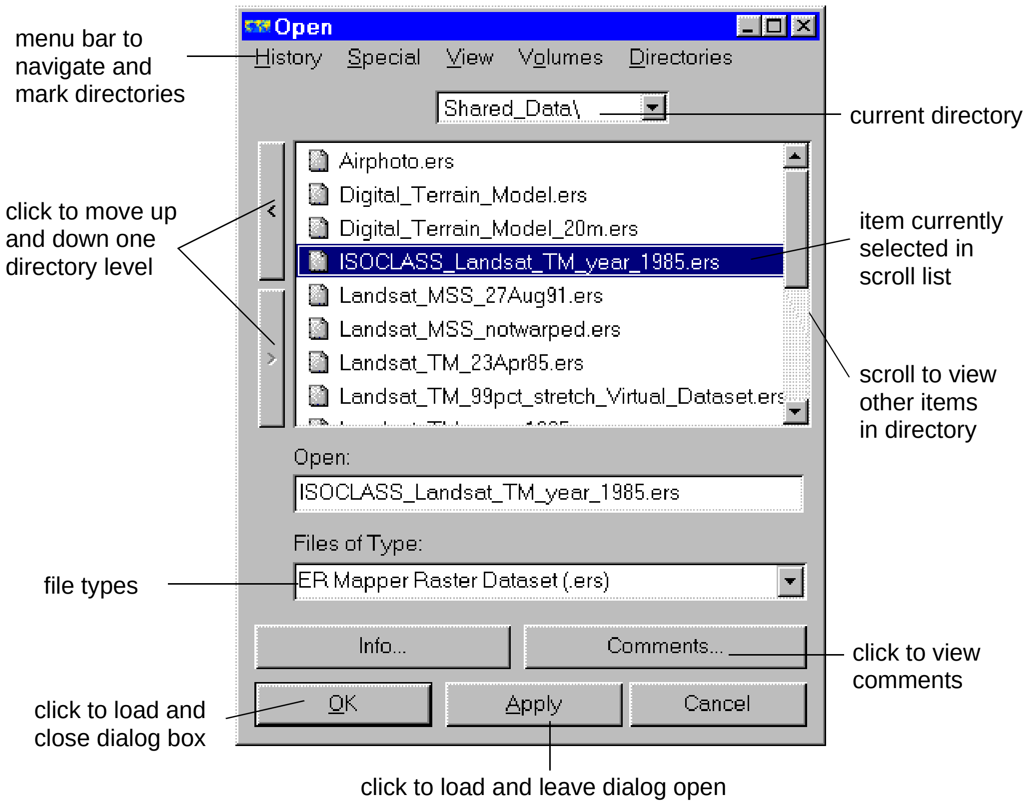
When you select menu commands or click toolbar buttons, dialog boxes often appear for you to choose options to control your image processing tasks. Some dialog boxes, such as the File Chooser, can disappear when you make your selection. Other dialogs can remain open for setting options for as long as you want to use them.




To resize a dialog box, drag one of its corners or edges to the desired size. ER Mapper automatically resizes the dialog box intelligently, so that any central display areas are enlarged, and the layout of buttons remains the same. After resizing, the dialog retains your new size for the current ER Mapper session.

## Using the File Chooser dialog boxes

When you choose to open or save a dataset, algorithm, or other file, ER Mapper displays a File Chooser dialog box. The central window contains a list of directories, or files in the current directory.




To open a file or directory displayed in the scroll list window, either double-click on it, or click once to select it and click the **OK** or **Apply** button to open it.

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**Tip:** You can see two levels of directories and/or files by widening the file chooser dialog box (drag one of the sides).

---

The File Chooser menus at the top have the following functions:

| | |
|---|---|
| **History menu** | Use to change the File Chooser's current directory. The menu has two parts: the upper portion lists most recently visited directories, and the lower portion lists marked directories. |
| **Special menu** | Use to change to your home directory, or to mark or unmark a directory (any directory may be marked for fast access using the History menu). |
| **View menu** | Use to sort the contents of the current directory by name, date modified, or date created. |
| **Volumes menu** (Windows version only) | Use to access volumes or disk drives on your network. |
| **Directories menu** | Use to change to any directory defined by your preferences settings. |

## Using the on-line help system

ER Mapper provides an extensive on-line help system with both simple overviews and detailed descriptions of all features and functions. There are two ways to access help:

| | |
|---|---|
| **Help menu** | Lets you browse all the standard ER Mapper manuals on-line, and go between manuals and topics using hypertext links. |
| **Help buttons** | The **Help** button inside dialog boxes gives you context-sensitive help. If needed, you can navigate to view more detailed information using the hypertext links. |

## Typing text in text fields

To enter text for naming files or changing values in dialog boxes, ER Mapper provides text fields. When you point to a text field, the pointer shape changes to an I-beam. To enter text, click anywhere inside the text field to place the text cursor.

To select existing text, you can drag through the desired portion, or double-click on a word or numeric value to select it. Text that is selected become reverse highlighted, and any subsequent typing replaces it.

# Hands-on exercises

The following hands-on exercises introduce you to the basic concepts of using menus and dialog boxes and managing image windows.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Choose options from menus and toolbar buttons
- Display and hide toolbars
- Open an empty image window
- Open an image processing algorithm into a window
- Move and resize an image window
- Zoom and pan the image within the window
- Manipulate multiple image windows on the screen
- Close image windows

# 1: Using menus and toolbars

***Objectives***

Learn to open and make selections from menus, use toolbars, and access on-line help.

## Move the ER Mapper main menu around the screen

1. Position the mouse pointer on the ER Mapper main menu title bar, then drag it to the lower-left part of the screen.

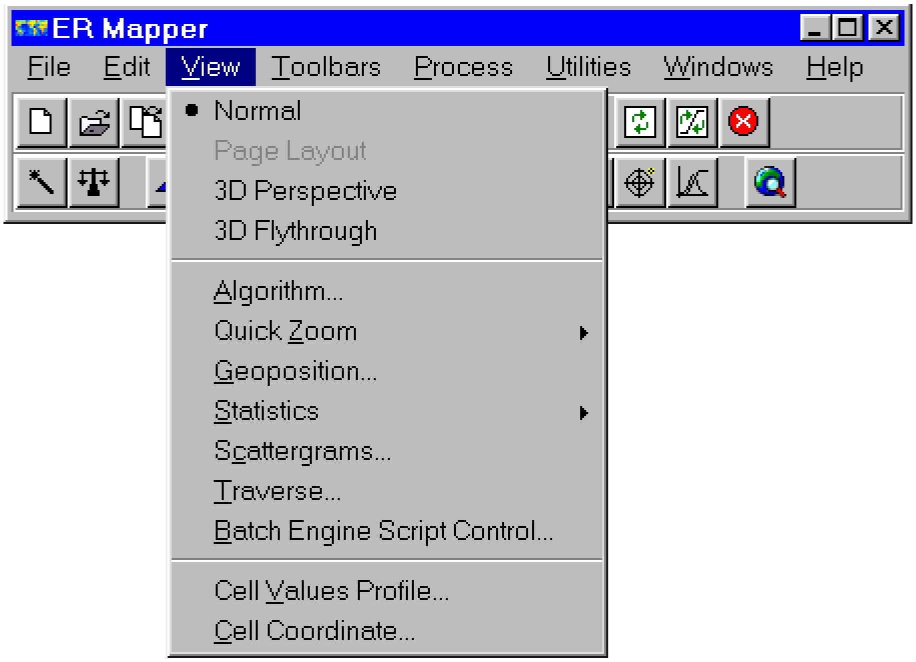
   Pointing to the title bar and dragging is how you move dialog boxes and image windows around the screen.

2. Drag the main menu to the upper-right corner of the screen.

   This is the recommended position for the main menu for the exercises in this tutorial.

## Open a menu to display its commands, then close the menu

1 Click on the **View** menu button; a list of commands under the menu displays.




The small arrows next to **Quick Zoom** and **Statistics** indicate that they have additional commands under them.

2 Click on the **Statistics** command to display its submenu.

3 Click anywhere outside the main menu to close the open menus without making a selection.

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**Note:** In the rest of this manual, selecting commands from menus is indicated as follows: “From the **Edit** menu, select **Preferences...**” (which means click on Edit in the menu bar, then click on the Preferences command).

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## Select the Print command from the menu bar

1 From the **File** menu, select **Print**.

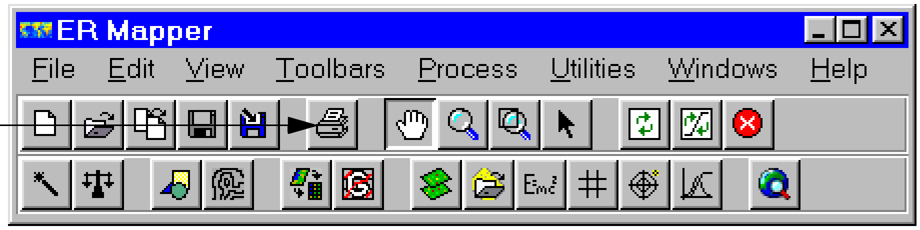
The **Print** dialog box appears with options for printing hardcopy.

2 Click the **Cancel** button to close the dialog box.

## Select the Print command from the Standard toolbar

1 On the Standard toolbar, click the **Print** button.

Click to open **Print** dialog




The same **Print** dialog box appears again. Using toolbar buttons is often a faster way to access many commands in ER Mapper.

2 Click the **Cancel** button to close the dialog box.

---

**Tip:** Many common commands on the menu bar, such as Print, are also available on the Standard toolbar. Use whichever is fastest or most comfortable.

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## Display and hide a toolbar

1 From the **Toolbar** menu, select **Forestry**.

A third row of toolbar buttons appears on the main menu below the Standard and Common Functions toolbars. This toolbar has buttons for common image processing techniques used in forestry applications.

Forestry toolbar buttons


2 Point the cursor to any button on the toolbar.

A description of the button function displays in the small text field just below the cursor.

3 From the **Toolbar** menu, select **Forestry** again.

The Forestry toolbar buttons disappear from the main menu. Use the **Toolbar** menu to display or hide any toolbar. (It is recommended that you always display the Standard and Common Functions toolbars.)

# 2: Opening windows and algorithms

To display an image in ER Mapper, you first open an empty image window, then load and display an image processing algorithm. The algorithm references a raster data file on disk, and the processing steps ER Mapper uses to enhance and render the data on the screen display. (You will learn more about algorithms later.) You can have as many different image windows open on the screen as you need.

***Objectives*** Learn to open image windows on your computer display, and open and run an image processing algorithm stored on disk.

## Open a new empty image window

1 From the **File** menu, select **New**.

An empty image window opens in the upper left corner of the screen. The window title bar reads “Algorithm Not Yet Saved” because no processing algorithm is associated with this image window yet.

## Open and display an image processing algorithm

1 From the **File** menu, select **Open...**.

The **Open** file chooser dialog box opens.

2 From the **Directories** menu, select the path ending with the text **\examples** (The portion of the path name preceding it is specific to your site.)

3 Double-click on the directory named ‘Data_Types’ to open it.

4 Double-click on the directory named ‘Landsat_TM’ to open it. (Scroll if needed to view it first.)

The list of example algorithms for processing Landsat Thematic Mapper (TM) satellite imagery displays.

5 Double-click on the algorithm named ‘RGB_321.alg.’ (Scroll down if needed to view it first.)

ER Mapper runs the algorithm and displays an enhanced Landsat TM image of San Diego, California in the image window. This algorithm displays bands 3, 2, and 1 of the Landsat image as an RGB color composite image, with band 3 in the red display channel, band 2 in the green, and band 1 in the blue. Notice also that the algorithm filename ‘RGB_321’ now appears in the title bar of the image window.

### Use the toolbar to open a different processing algorithm

1 Click the **Open** button on the Standard toolbar.

The **Open** file chooser dialog box appears. (This toolbar button has the same function as selecting **Open...** from the **File** menu.)

The algorithm named ‘RGB_321’ in the ‘Data_Types\Landsat_TM’ directory is already highlighted since it is currently loaded into the image window.

2 Double-click on the algorithm named ‘RGB_541.alg.’

ER Mapper runs the algorithm and displays a color composite of the same Landsat image, this time using bands 5, 4, and 1. Notice that the title bar also changes to show the filename of the new algorithm.

---

**Note:** By default, ER Mapper runs the algorithm automatically for you when you open it from disk. You can also reprocess the data at any time by clicking the **Refresh** button.

---

## 3: Resizing windows and zooming/panning

***Objectives*** Learn to move and resize image windows, zoom (magnify) part of an image, and pan (scroll) to other parts of an image.

### Move the image window on the screen

1 Point the mouse at the image window title bar, then drag it to another part of the screen.

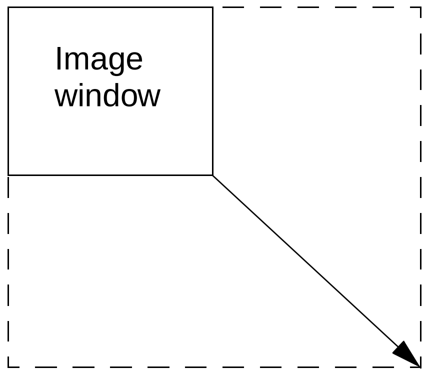
2 Drag the image back to the upper-left part of the screen.

Like dialog boxes, dragging images by the title bar is how you move them around the screen.

### Resize the image window

1 Move the mouse pointer directly over the lower-right corner of the image window–the pointer shape changes to a double ended arrow.

2 Drag the lower-right corner to make the window about twice its original size, then release.




Dragging any side or corner of an image window lets you change the default window size as you desire.

---

**Note:** When you resize a window, ER Mapper maintains the size of the image inside the window. Empty areas on the sides are filled with a cross-hatch pattern to indicate that no data is displayed there.

---

## Set the mouse pointer to Zoom mode

1 On the Common Functions toolbar, click the **Zoom Tool**  button.

This tells ER Mapper to use the mouse pointer for zooming when it is positioned inside an image window. Also notice that the **Zoom Tool** button becomes depressed to indicate that it is the active pointer mode.

2 Move the pointer inside the image window.

The mouse pointer displays as a magnifying glass icon.

## Zoom in and out of the image with the mouse

1 Position the pointer in the center of the image, and click the left mouse button.

The image zooms in by 50%.

2 Position the pointer in the center of the image, hold down the Ctrl. key while clicking the left mouse button.

The image zooms out by 50%.

3 Position the pointer in the image, and then drag it up and down.

As you drag the pointer down the image is magnified, i.e you zoom into it. When you drag the pointer upwards, the image gets smaller, i.e you zoom out.

## Set the mouse pointer to ZoomBox mode

1 On the Common Functions toolbar, click the **ZoomBox Tool**  button.

This tells ER Mapper to use the mouse pointer for creating a zoom box when it is positioned inside an image window. Also notice that the **ZoomBox Tool** button becomes depressed to indicate that it is the active pointer mode.

2 Move the pointer inside the image window.

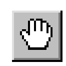
The mouse pointer displays as a magnifying glass and box icon.

## Zoom in (magnify) an area of the image with the mouse

1 Position the pointer near the upper-left center of the image, then drag to the lower-right to define a box.

When you release the mouse, ER Mapper runs the algorithm again and magnifies (or “zooms in”) on the area of the image you defined with the box. Dragging a zoom box is a fast way to magnify an area of interest. (There are other zooming functions you will learn about later.

## Set the mouse pointer to Hand mode

1 On the Common Functions toolbar, click the **Hand Tool**  button.

This tells ER Mapper to use the mouse pointer for panning when it is positioned inside an image window. Also notice that the **Hand Tool** button becomes depressed to indicate that it is the active pointer mode.

2 Move the pointer inside the image window.

The mouse pointer displays as a hand icon.

## Pan (scroll) the image within the window with the mouse

1 Click on the image. and drag it to a new position in the image window.

The hand pointer will grab the image and move it (pan) to the new location.

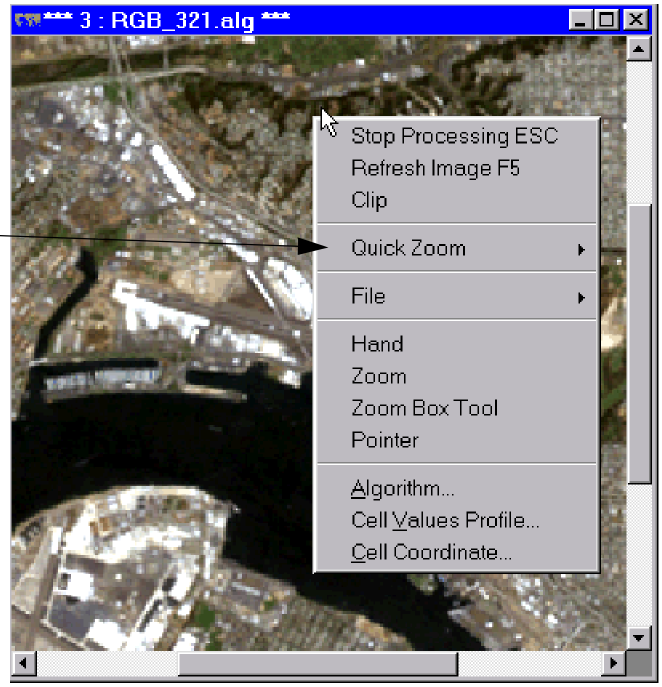
## Zoom back out to view the full image extents

1 From the **View** menu, select **Quick Zoom** and then select **Zoom to All Datasets**.

ER Mapper runs the algorithm again and zooms back out to display the full extents of the Landsat image data. The **Quick Zoom** submenu provides many options for zooming in or out to specific datasets, setting window geolinking, and other options you will learn more about later.

2 Right-click inside the image window to open the shortcut menu, then select **Quick Zoom** and then **Zoom to All Datasets**.

Right-click inside image window to open shortcut menu

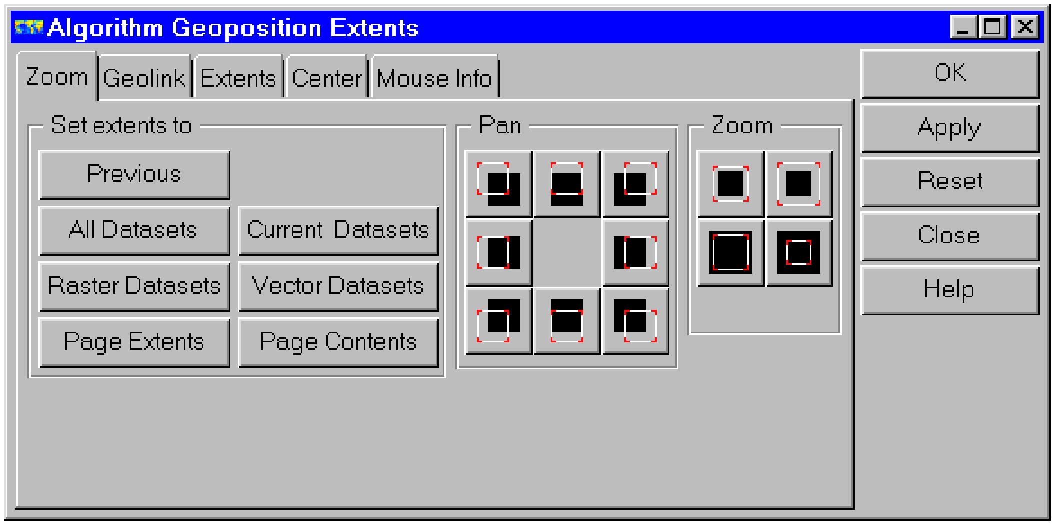



## Zoom and pan using buttons for predefined options

In addition to using the mouse, ER Mapper also lets you zoom and pan using buttons to invoke predefined zoom and pan functions.

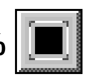
1 From the **View** menu, select **Geoposition...**.

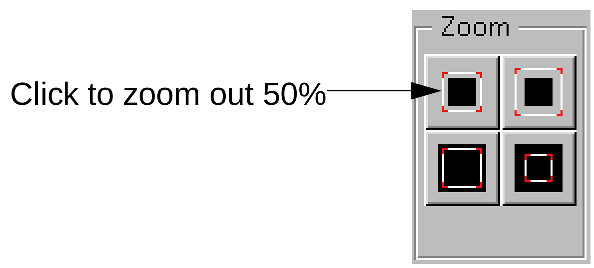
The **Algorithm Geoposition Extents** dialog box appears.




2 Click on the **Zoom** tab at the top to display zoom and pan options.

The **Zoom** tab options show sets of buttons for zooming and panning the image within the window.

3 In the buttons labelled 'Zoom,' click the **Zoom out 50%**  button.




ER Mapper runs the algorithm and zooms out to 50% of the previous display resolution.

---

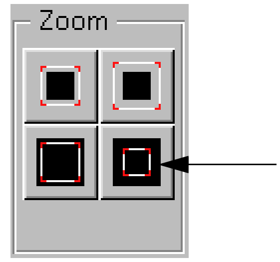
**Tip:** For all icons on buttons under 'Zoom' and 'Pan,' the black square represents the current image, and the white box represents how the size or position of the image will change after the button is clicked.

---

4 In the buttons labelled 'Set Extents To,' click **Previous**.

ER Mapper zooms out to the previous image display extents.

5 Under 'Zoom,' click on the **Zoom in 100%** button.




ER Mapper magnifies the images to two times (100%) of the previous display resolution (and keeps the image center point constant).

6 Under 'Pan,' click on the **Pan left** button.

ER Mapper pans or scrolls the image 50% to the left (the previous center point is now on the far right side of the image).

7 Under 'Pan,' click on the **Pan upper-right** button.

ER Mapper pans the image 50% to the upper-right (the previous center point is now on the lower-left corner of the image).

8 Experiment with other buttons under Zoom and Pan to see their effect.

9 Under 'Set Extents To,' click the **All Datasets** button.

ER Mapper resets the image extents to fit the entire dataset in the image window.

10 Click **Close** on the **Algorithm Geoposition Extents** dialog to close it.

# 4: Managing multiple image windows

***Objectives*** Learn to open a second image window, specify overlap priority between windows, activate an image window, and close image windows.

## Open a second image window

1 From the **File** menu, select **New**.

ER Mapper opens a new image window. As with all new image windows, it has no algorithm associated with it yet.

## Open and display a processing algorithm in the new window

1 From the **File** menu, select **Open...**.

The **Open** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the directory named ‘Data_Types’ to open it.

4 Double-click on the directory named ‘SPOT_Panchromatic’ to open it.

The list of example algorithms for processing SPOT Panchromatic satellite imagery displays.

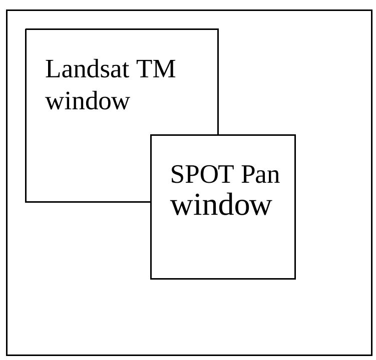
5 Double-click on the algorithm named ‘Greyscale.alg.’

ER Mapper runs the algorithm and displays a SPOT Panchromatic satellite image the San Diego (the same geographic area covered by the Landsat image in the other window). The SPOT Pan data provides greater spatial detail than the Landsat data, but has only one spectral band which is displayed in greyscale.

## Move the SPOT window to overlap with the Landsat window

1 Drag the image window titled ‘Greyscale’ to the center of the screen until it partially overlaps with the Landsat ‘RGB_541’ image window.

Your windows should be similar to the following diagram:




## Move one window in front of the other

1 Click on the title bar of the window with the algorithm description titled ‘RGB_541.’

The Landsat window moves in front of the SPOT window where there is overlap.

2 Click on the title bar of the window with the algorithm description ‘Greyscale.’

The SPOT window now moves in front of the Landsat window where there is overlap. Clicking on the title bar of a window or dialog box bar lets you choose which window or dialog box to display on top of others.

## Select a window to be the active window

The “active” image window is the one you want to currently work with, such as zooming, loading a new processing algorithm, or editing the current algorithm. (You can have many image windows open on the screen, but only one can be active.)

1 Look at the title bar of the SPOT Panchromatic window and notice the three asterisks (***) on either side of the window title.

The three asterisks indicate that this is the active (or current) window of the two.

2 Move the pointer inside the image area of the window with the algorithm description titled “RGB_541.”

The pointer shape changes to a pointing hand. (This happens whenever you move from the active window to any inactive image window.)

3 Click anywhere inside the Landsat image window or on the Title Bar.

It now becomes the active window and three asterisks appear next to the title.

4 Click inside the SPOT window or on the Title Bar again to make it active.

---

**Note:** A window can be active and still be covered by another “inactive” window. To move the active window to the front, click on its title bar.

---

## Close both image windows

1 Close one image window using the window system controls:

- For Windows, select **Close** from the window control-menu.

The window closes and disappears from the screen.

2 Close the other image window by repeating Step 1.

The window closes and disappears from the screen. Only the ER Mapper main menu is now open.

***What you learned***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Choose options from menus and toolbar buttons
- Display and hide toolbars
- Open an empty image window
- Open an image processing algorithm into a window
- Move and resize an image window

- Zoom and pan the image within the window
- Manipulate multiple image windows on the screen
- Close image windows

3

# Creating an algorithm

This chapter introduces the basic concepts involved in creating a simple image processing algorithm. You learn about the interface ER Mapper provides for creating and editing algorithms (the Algorithm window). As an application example, you learn how to create an algorithm that processes a Landsat TM satellite scene to render an image showing patterns of vegetation in the area (a "vegetation index" image).

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**Note:** This lesson is a "quick start" for creating a simple algorithm. You learn more about the concepts and procedures covered here in later chapters.

---

## About the algorithms concept

The goal of all image processing is to enhance your data to make it more meaningful and help you extract the type of information that interests you. To make this procedure faster and easier, Earth Resource Mapping developed a new image processing technique called "algorithms." Understanding how to use algorithms is the key to understanding how to use ER Mapper effectively.

## What is an algorithm?

An algorithm is a list of processing steps or instructions ER Mapper uses to transform raw data on disk into a final, enhanced image. In this sense, algorithms let you define a “view” into your data that you can save, reload, and modify at any time.

You use ER Mapper's graphical user interface to define your list of processing steps, and you can save the steps in an algorithm file on disk. An algorithm file can store any of the following information about your processing:

- Names of image dataset(s) to be displayed
- Subsets of the image dataset(s) to be processed (zoomed areas)
- Bands in the image dataset(s) to be processed
- Brightness and contrast enhancements (Transforms)
- Filtering to be applied to the data (Filters)
- Equations and combinations of bands or images used to create the output image (Formulae)
- Color mode used to display the data (Pseudocolor, Red Green Blue, or Hue Saturation Intensity)
- Any vector images, thematic color, or map composition layers to be displayed over the raster image data
- Definition of a page size and margins (used for positioning the image on a page for creating maps and printing)

By being able to apply a set of processing steps as a single entity, the complexity often associated with digital image processing is greatly reduced. In addition, you gain tremendous savings in disk space, since you do not need to store intermediate processed copies of your original data on disk.

## Building Algorithms in ER Mapper

There are two primary ways to build a processing algorithm in ER Mapper:

- Use the **Algorithm** window to add the desired types of layers, load images, and specify processing steps for each layer.
- Click a toolbar button to have ER Mapper automatically create an algorithm for you. In this case, ER Mapper adds the appropriate layers to the **Algorithm** window, prompts you to load an image, and possibly other options as well.

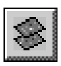
The majority of exercises in this manual ask you to build algorithms from scratch so you become familiar with and thoroughly understand the basic concepts. However, you will also use the automatic algorithm creation toolbar buttons from time to time to understand how they work.

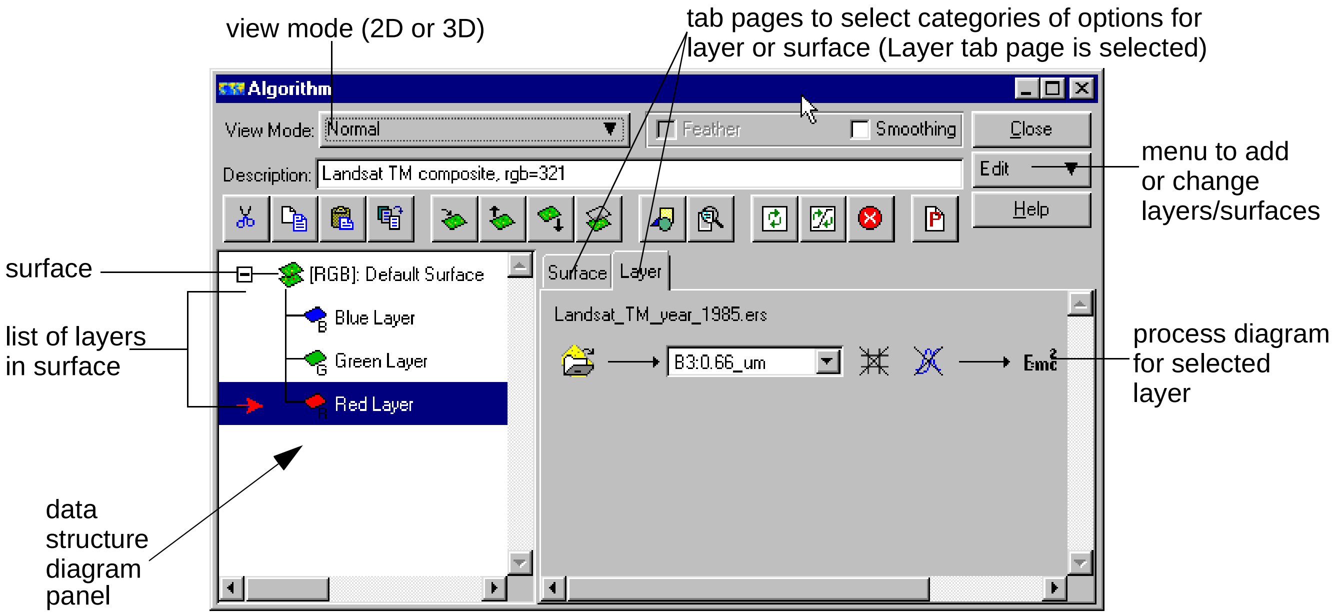
### Using Algorithms as Templates

Once you have saved your processing instructions as an algorithm file, you can use the algorithm as a “template” to easily apply the same processing to different images. Any algorithm can be used as a template, but ER Mapper also provides many template algorithms for common tasks. These include common display techniques (RGB, single band greyscale, etc.), writing processed image files to disk, and saving algorithms as “virtual datasets.” Using template algorithms saves time, and you will learn more about them in later lessons.

In addition, the toolbar buttons allow you to create various types of common algorithms very quickly. You will learn more about using toolbar buttons for these tasks later.

# The Algorithm window

The **Algorithm** dialog is a special dialog box that serves as your “command center” for creating and editing algorithms in ER Mapper. To open the **Algorithm** dialog, you can select **Algorithm...** from the **View** menu or click the **Edit Algorithm**  toolbar button. The key components of the **Algorithm** dialog are labelled below and described in the table that follows.




**Data structure diagram** Shows a list of surfaces and layers contained in the current algorithm using a hierarchy or “tree” structure. Select (click on) a surface or layer change its options using the Tab pages.

| | |
|---|---|
| **Surface** | A group of raster and/or vector data layers that combine to create a view or image. A single algorithm can have multiple surfaces that become independent entities when viewed in 3D mode. |
| **Layers** | Components of a surface that contain data used to construct an image. Different layer types can contain raster or vector data, and processing for each layer is controlled independently from the others. |
| **View Mode** | Sets the manner in which data is displayed as two dimensions (2D) normal or page layout, or three dimensions (3D). |
| **Tab pages** | Display categories of options for controlling the image display and processing techniques, such as Layer for options for the current layer, or Surface for options that apply to an entire surface. |
| **Process diagram** | Used to control the processing operations applied to image(s) in the currently selected layer (displayed when Layer tab is selected). |

## The Process Diagram

When the Layer tab is selected, the horizontal row of buttons in the right-hand panel of the **Algorithm** dialog are called the *process diagram*. They are used to define your image processing operations for the currently selected data layer. Each button in the diagram controls a specific image processing function.

As the arrows indicate, the processing stream flows from left to right. Typically, you may specify an image to be used, the bands within the image to be processed, then apply processing using formulae, filters, transforms or other options to create your desired image. ER Mapper compiles all the processing steps you specified and renders the resulting image to the screen display. The name and function of the main processing stream buttons are as follows.

| Button | Function |
|---|---|
| Dataset  | Use to load an image from disk, or edit or view information or comments about an image. |
| Band Selection  | Use to select one or more bands in the image for use in generating an image (a drop-down list). |
| Formula  | Use to enter, load, or save a formula to perform image algebra and other arithmetic operations. |

| Button | Function |
|---|---|
| Filter | Use to add or delete one or more spatial filters. (There are both pre- and post-formula Filter buttons.) |
| Transform | Use to adjust image contrast and brightness. (There are both pre- and post-formula Transform buttons.) |
| Sunshade | Use to specify artificial illumination of the image to create shaded relief effects. |

**Note:** A cross or "X" through the button indicates that the function is not active in the current data layer. In addition, there are other buttons for some layer types that you will learn about later in this manual.

# Hands-on exercises

These exercises show you how to initially display an image, and how to build, save, and reload a simple image processing algorithm. It also shows how you can easily change the image to view it in 3D perspective.

**Note:** These exercises briefly introduce concepts and procedures that are explained in more detail later in this workbook.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Load a new dataset and choose which bands to display
- Use the **Algorithm** dialog to define a processing algorithm
- Change the color lookup table for an image
- Add a formula to an algorithm
- Add text labels and comments to an algorithm
- Save the processing algorithm to disk
- Reload and view the saved algorithm
- Add a Height layer to view the image in 3D perspective

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Loading and displaying images

***Objectives*** Learn to open an image window and the **Algorithm** dialog, load an image dataset, and display the dataset on-screen. You will also learn to display different bands in the dataset, and change the lookup table ER Mapper uses to assign colors to the image.

(Part 1 shows you how to load a dataset from disk and display it on-screen for an initial look at the data. The dataset was previously imported from tape, CD-ROM or other media and now resides on the computer's hard disk. Details on importing data are discussed in the ER Mapper manuals.)

## Open an image window and the Algorithm dialog

1 From the **View** menu, select **Algorithm...**.

A new empty image window opens in the upper-left corner of the screen, and the **Algorithm** dialog opens.

The **Algorithm** dialog shows a default surface with one Pseudocolor layer in the left-hand panel (labelled "Pseudo Layer"), and a process diagram for that layer in the right-hand panel. The words "No Dataset" above the process diagram indicate that no dataset is currently loaded into the layer.

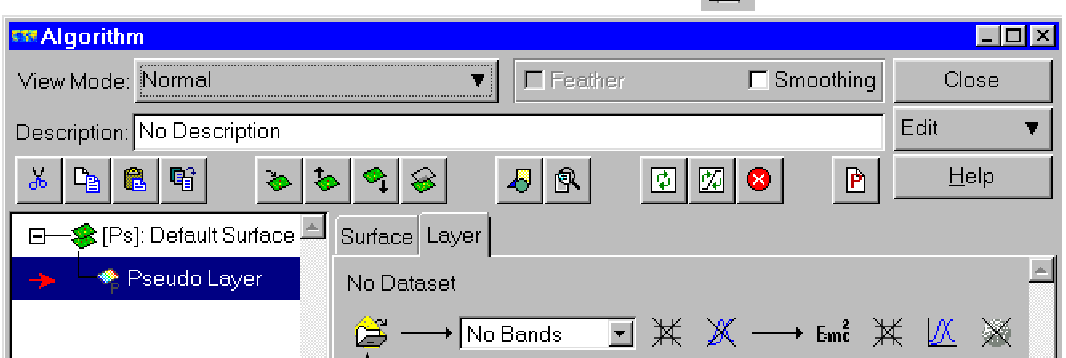
---

**Note:** If you open the **Algorithm** dialog when no image windows are currently open (as in this case), ER Mapper opens an empty image window for you automatically. This shortcut saves you the step of opening a window.

---

## Load a raster dataset into the Pseudocolor layer

1 In the **Algorithm** dialog, click the **Load Dataset** button..




**Load Dataset** button

The **Raster Dataset** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with **\examples**.

The scrolling list in the center now shows a list of directories containing example images supplied with ER Mapper (such as ‘application...’ and others).

3 Double-click on the directory named ‘Shared_Data.’

A list of raster images is displayed. Note that each has a “.ers” file extension. This is the file extension associated with raster files in ER Mapper format.

4 Scroll down to view the image named ‘Landsat_TM_year_1985.ers,’ then double-click on it to load it.

The file chooser dialog box closes, and the image is loaded into the Pseudocolor layer. Note that the layer now shows the name of the image loaded (‘Landsat_TM_year_1985’), and the button left of the name is now selected (indicating that the layer is *turned on*).

ER Mapper renders the image in the image window. The image is displayed in a range of colors because the color table named **Pseudocolor** is chosen.

---

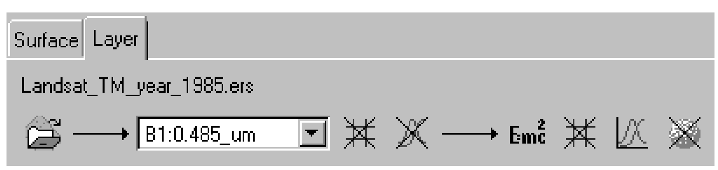
**Note:** ER Mapper remembers the last color table selected. Therefore, it might not be Pseudocolor as described above.

---

Also note that **Band Selection** drop-down shows the label ‘B1:0.485_um.’ This indicates that band 1 of the Landsat image is currently selected for the layer.

## Resize the Algorithm dialog to view all process option icons

1 If needed, drag one side of the **Algorithm** dialog to widen it until you can see all the process diagram icons below:




---

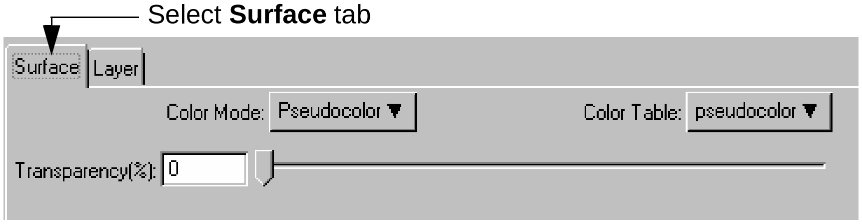
**Tip:** When you resize or reposition a dialog box, ER Mapper automatically remembers this the next time you open it. This lets you setup your work environment as you like.

---

## Change the color table used to display the image

When you are using the Color Mode named Pseudocolor (as you are in this example), the color lookup table controls the set of colors ER Mapper uses to display the image. Each lookup table contains a set of 255 colors that ER Mapper uses to display the image on-screen.

1 In the **Algorithm** dialog, select the **Surface** tab.




Options for Color Mode, Color Table, and Transparency now appear in the panel.

2 From the **Color Table** drop-down list, select **green**.

ER Mapper redisplays the image using only shades of green. Low data values are mapped to dark green, and high values to light green.

3 From the **Color Table** drop-down list, select **brown_green**.

ER Mapper redisplays the image using shades of brown for low data values transitioning into shades of green for high data values.

4 From the **Color Table** drop-down list, select **greyscale**.

ER Mapper redisplays the image using shades of grey (dark grey for low values and light grey for high values). The greyscale color table is often used to display a single band of data.

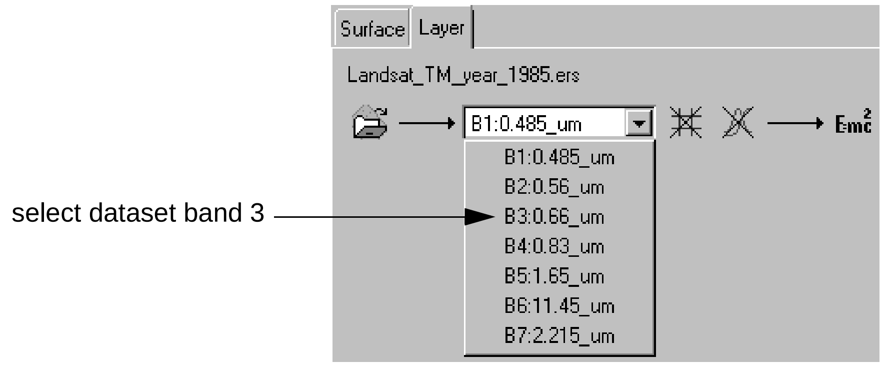
5 In the **Algorithm** dialog, select the **Layer** tab.

The process diagram displays again.

## Select and display different bands in the Landsat image

Landsat Thematic Mapper (TM) satellite images usually contain seven spectral bands. You can choose to display any band (or a combination of bands) in a raster data layer.

1 In the **Algorithm** dialog, open the **Band Selection** drop-down list and select **B3:0.66_um**.




ER Mapper renders band 3 of the Landsat image in the image window. The image brightness changes because the data range of band 3 is different than the range for band 1. (You will learn about data ranges and how to adjust image brightness and contrast later.)

2 From the **Band Selection** drop-down list, select the band labelled **B5:1.65_um**.

ER Mapper renders band 5 of the Landsat image in the image window.

3 From the **Band Selection** drop-down list, again select the band labelled **B1:0.485_um**.

ER Mapper renders band 1 of the Landsat image again.

---

**Tip:** The **Stop Processing** button or Esc key can be useful when you make a mistake, or when you want to take a quick look at the results without waiting for processing of the entire image to finish. Change the Color Table (on Surface Tab).

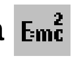
Press the **Refresh Image** button for the processing to continue.

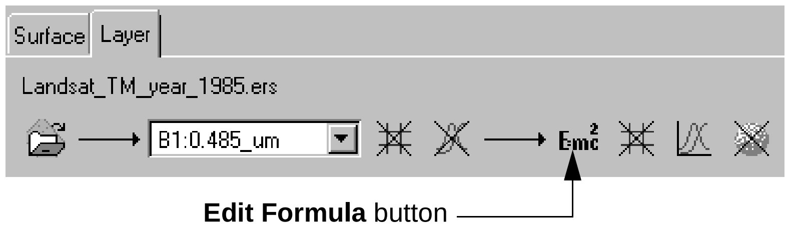
---

# 2: Processing the image

***Objectives*** Learn to develop a simple processing algorithm using a formula to highlight vegetation in the image, and to adjust the image contrast and brightness.

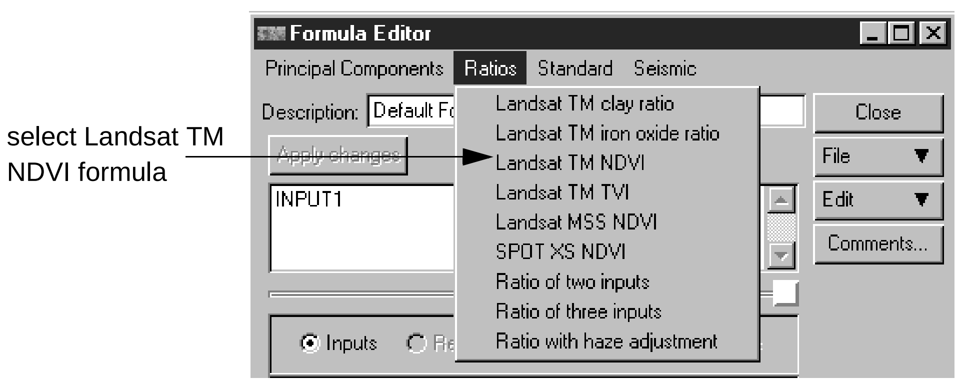
## Load a vegetation index formula into the layer

1 In the **Algorithm** dialog, click on the **Edit Formula**  button in the process diagram.




The **Formula Editor** dialog box opens to let you use standard image processing formulas or create your own formulas. The menu bar at the top gives you fast access to many formulas. Note that the current formula simply reads 'INPUT1.' (You will learn more about formulas later.)

2 From the **Ratios** menu, select **Landsat TM NDVI**.



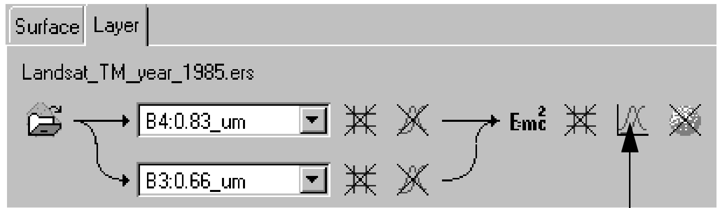

A new formula replaces the original one, and its description appears at the top. (This formula is called the Normalized Difference Vegetation Index, or NDVI. It uses information in bands 3 (red) and 4 (near infrared) of the Landsat image to highlight information on vegetation location and abundance.)

All data is initially displayed as black or dark grey because the NDVI formula processing produces a narrow range of data values (-1 to +1). You will now adjust the image contrast to account for the narrow range.

3 Click **Close** on the **Formula Editor** dialog.

## Adjust the contrast to use the entire range of grey shades

1 In the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button.




**Edit Transform Limits** button

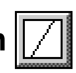
The **Transform** dialog box opens. Note that the field 'Actual Input Limits' at the bottom shows a data range of about -1.0 to +0.6. This is the range of data values produced after the raw Landsat image data was processed through the NDVI formula. You need to tell ER Mapper to map the shades of gray in the lookup table to *this* range instead of the 0-255 default data range currently shown along the X or horizontal axis under the histogram.

2 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

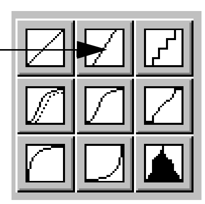
The X axis range changes to match the -1.0 to +0.6 limits of the processed data.

ER Mapper renders the image again, this time with enhanced contrast. In addition, a histogram showing the relative frequency of data values for the processed image appears in the center of the **Transform** dialog.

Areas of vegetation in the image are highlighted in light gray or white, and areas with little or no vegetation (such as water) appear very dark. You will increase the contrast between the light and dark areas even further.

3 On the **Transform** dialog, click the **Create autoclip transform**  button.

**Create autoclip transform** button



Contrast between the light and dark areas further increases. The lightest shades (densely vegetated areas) are now white and darkest shades (non-vegetated areas) are black, making the patterns of vegetation easier to interpret.

4 Click **Close** on the **Transform** dialog box.

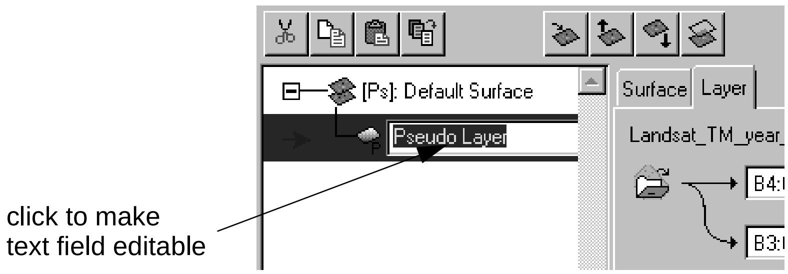
**Note:** You will learn more about histograms, contrast enhancement and the **Transform** dialog later in this workbook.

# 3: Labelling and saving the algorithm

***Objectives*** Learn to specify description labels, titles, and comments for an algorithm, and save the algorithm processing steps to a file on disk for later use.

## Enter a description for the Pseudo layer

1 In the **Algorithm** dialog, click on the text “Pseudo Layer” in the left-hand panel.




The text become reverse highlighted (shown above) indicating the text is editable.

2 Type the text label **`NDVI`** in the field. Then press the Enter or Return key on your keyboard.

This text now becomes a visual description for the layer.

## Enter a description for the surface

1 In the **Algorithm** window, on the left side of the data structure highlight the surface and click on the "[Ps]: Default Surface" description.

The pointer turns into a text cursor, indicating that the area is a text field.

2 Type the text **`Surface 1`** in the text field, then press the Enter or Return key on your keyboard.

This text now becomes a visual description for the surface. Note that the “[Ps]:” prefix remains, indicating that the surface Color Mode is Pseudocolor.

## Enter a description for the entire algorithm

1 In the **Algorithm** dialog, select the text in the **Description** text field (it currently reads ‘No Description’).

(To select the text, either drag through it, or triple-click to select the entire line.)

2 Type the following text, then press Enter or Return on your keyboard:

**`San Diego Landsat TM vegetation index`**

This text now becomes a brief description for the entire algorithm.

## Save the processing steps to an algorithm file on disk

1 From the **File** menu (on the main menu), select **Save As...**.

The **Save Algorithm** file chooser dialog box appears.

2 In the **Files of Type:** field, select ‘ER Mapper Algorithm (.alg)’.

3 From the **Directories** menu, select the path ending with the text **\examples**. (The portion of the path name preceding it is specific to your site.)

4 Double-click on the directory named ‘Miscellaneous’ to open it.

5 Double-click on the directory named ‘Tutorial’ to open it.

6 In the **Save As:** text field, click to place the cursor, then type in a name for the algorithm file. Use your initials at the beginning, followed by the text ‘Landsat_NDVI,’ and separate each word with an underscore (_). For example, if your initials are “JC,” type in the name:

**`JC_Landsat_NDVI`**

7 Click the **Apply** button to save the algorithm and leave the dialog open.

Your Landsat NDVI algorithm is now saved to an algorithm file on disk.

## Add comments to the algorithm

1 On the **Save Algorithm** dialog, Click the **Comments...** button.

A dialog box appears titled with the file name, and a text area for you to type comments about your algorithm. The cursor is already active.

2 In the comments dialog, type the following information to describe your algorithm:

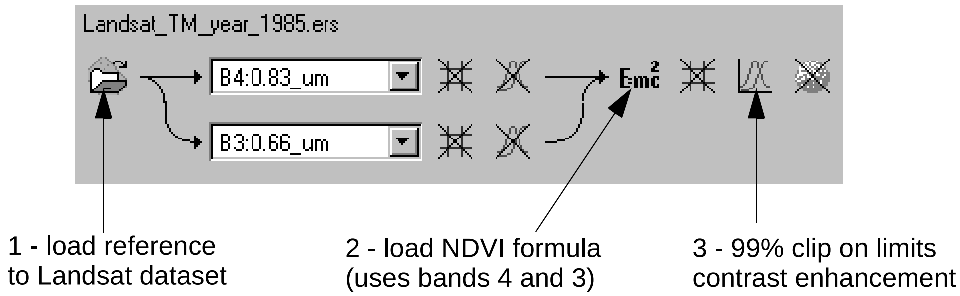
```
This algorithm uses the Normalized Difference Vegetation
Index (NDVI) formula to highlight vegetation in a Landsat
TM image of San Diego. Areas with abundant or vigorous
vegetation appear as lighter shades of grey.
```

3 Click **OK** on the comments dialog to save your comments.

4 Click **Cancel** on the **Save Algorithm** dialog to close it.

(If you accidentally click **OK**, click **Cancel** when asked to overwrite the file. Otherwise your comments will not be saved with the algorithm file.)

You have now created a simple algorithm to perform the following processing on the Landsat TM dataset:




## Close the image window

1 From the **File** menu (on the main menu), select **Close**.

The image window closes. (The **Algorithm** dialog is empty when no image windows are open.)

# 4: Opening and viewing the algorithm

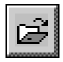
***Objectives*** Learn to display the algorithm you just created, just as you would if you wanted to view an existing algorithm at a later time.

## Open a new image window

1 On the main menu, click the **New Image Window** button.


ER Mapper opens a new image window (this is a shortcut for selecting **New** from the **File** menu). Drag the new window to the lower left part of the screen (so you can see all or part of the other image window).

## Open the algorithm data view you created earlier

1 Click the **Open**  button.

Open button


The **Open** file chooser appears. (This is a shortcut for selecting **Open...** from the **File** menu.)

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the directory named 'Miscellaneous' to open it.

4 Double-click on the directory named 'Tutorial' to open it.

Your Landsat NDVI algorithm should appear in the list.

5 Click once on your algorithm name to highlight it (do not double-click).

6 Click the **Apply** button to load and process the algorithm without closing the **Open** dialog box.

ER Mapper runs the algorithm and displays the processed Landsat image in the image window. It should look identical to the other image since they both use the same algorithm and input image.

## View the algorithm comments

1 On the **Open** dialog, click the **Comments...** button.

A dialog box opens showing the comments you entered for your algorithm. These comments can be very helpful to others who use or display your algorithm, and they are a good way to document the procedures you used to create it.

2 Click **Cancel** on the comments dialog to close it.

3 Click **Cancel** on the **Open** dialog to close it.

# 5: Viewing the image in 3D perspective

***Objectives*** Learn to create a 3D perspective view of the vegetation index image by adding a Height layer containing a digital elevation dataset.

### About 3D perspective viewing

Up until now you have viewed your images using conventional 2D planimetric views. ER Mapper makes it very easy to view images in 3D perspective by simply adding a height (or elevation) component to your algorithm. The following is a very simple introduction to the 3D viewing features, and you will learn more about them in later chapters.

## Display the vegetation image in brown and green

1 In the **Algorithm** dialog, select the **Surface** tab.

2 From the **Color Table** drop-down list, select **brown_green**.

ER Mapper redisplays the image. Areas with no or little vegetation (such as ocean) display as brown, and vegetated areas like parks and canyons are bright green.

3 In the **Algorithm** dialog, select the **Layer** tab again.

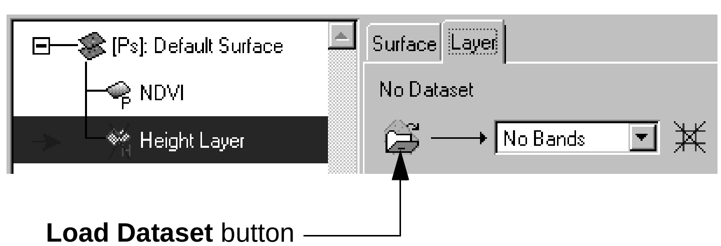
## Add a Height layer to the algorithm

1 On the **Algorithm** dialog, open the **Edit** menu, select **Add Raster Layer**, then select **Height**.

A second layer named ‘Height Layer’ is added to the algorithm. Height layers are only valid in 3D view modes, so the layer is currently inactive (crossed out).

## Load a digital elevation dataset into the Height layer

1 With the Height layer selected, click the **Load Dataset**  button in the process diagram.




**Load Dataset** button

The **Raster Dataset** dialog opens.

2 From the **Directories** menu (on the **Raster Dataset** dialog), select the path ending with **\examples**.

3 Open the 'Shared_Data' directory, then double-click on the image 'Digital_Terrain_Model.ers' to load it.

The digital elevation model (DEM) image is loaded into the Height layer.

## Select 3D perspective View Mode to view the image in 3D

1 From the **View Mode** menu (on the **Algorithm** dialog), select **3D perspective**.

ER Mapper displays a message that the image is being processed, then displays a 3D perspective view of the image. The message "Regenerating Terrain" appears in the image window as ER Mapper performs iterations to increase the resolution (detail) in the 3D image.

The right-hand panel in the **Algorithm** dialog now has two additional tabs–**3D View** and **3D Properties**. These contain controls specifically for 3D viewing of images.

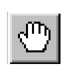
## Turn off the 3D lighting option

1 In the **Algorithm** dialog, select the **3D View** tab.

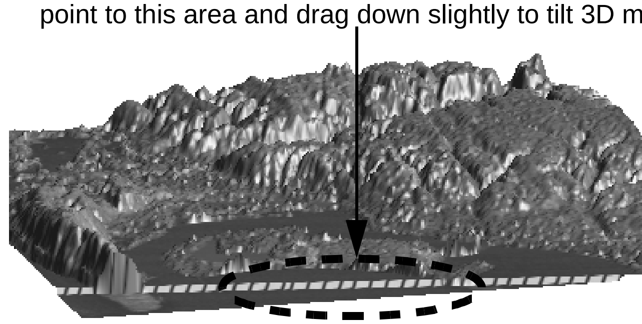
2 Turn off the **Lighting** option button.

The image redisplays without artificial lighting. (Although this is sometimes desirable, it can also obscure subtle features.)

## Change the perspective viewing angle

1 Click on the **Hand Tool**  button on the **Standard** toolbar, if it is not already selected.

2 Point to the lower part of the 3D image (the cursor changes to a hand), and drag down slightly to tilt the 3D view (see following diagram).




The 3D image tilts downward, so you are now looking more from an overhead viewpoint. You can use the mouse to manipulate the viewpoint, zoom in and out, rotate the image, and other controls (discussed in detail later).

This is a simple 3D algorithm that lets you quickly see the relationship between terrain features and vegetation in the San Diego area. You can see, for example, that natural vegetation still occurs in the many of the narrow canyons and hillsides next to developed areas.

## Select 2D View Mode to view the image in 2D again

1 From the **View Mode** menu in the Algorithm window, select **Normal**.

ER Mapper redisplays the image in a two-dimensional planimetric view again.

---

**Note:** This 3D exercise was a simple introduction to show how easy it can be to view data in 3D perspective in ER Mapper. You will learn more about the 3D capabilities and controls later.

---

## Close the image window and Algorithm dialog

1 Close the image window using the window system controls:

- For Windows, click the ☒ **Close** button in the upper-right window corner.

The window closes and disappears from the screen.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Load a new dataset and choose which bands to display
- Use the **Algorithm** dialog to define a processing algorithm
- Change the color lookup table for an image
- Add a formula to an algorithm
- Add text labels and comments to an algorithm
- Save the processing algorithm to disk
- Reload and view the saved algorithm
- Add a Height layer to view the image in 3D perspective

# 4

# Working with layers

This chapter introduces you to the concept of data layers in ER Mapper, and gives you practice using them. You will learn to load data into layers, turn layers on and off, specify layer priority during processing, and add, move, and delete data layers in an algorithm.

**Note:** This chapter focuses on the use of raster data layers for displaying and manipulating images. Use of vector layer types for displaying GIS data and annotation are covered later in this workbook.

## About data layers

In ER Mapper, you build your image display by creating one or more 'layers' of data in the **Algorithm** dialog. The various data layers combine to create a final image on your screen display or output to your hardcopy device.

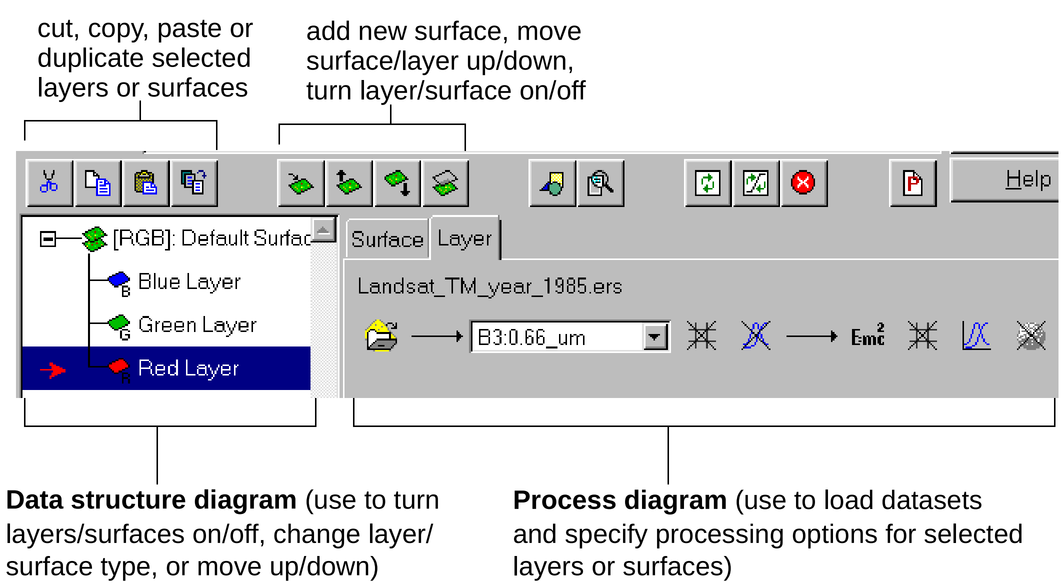
Each layer in an algorithm can have different processing and use different datasets. The simple algorithm you developed in Chapter 3 had only one layer (a Pseudocolor layer), but other types of algorithms can have several data layers. For example, an image displayed in RGB (red-green-blue) has three data layers–one for the red image component, one for the green, and one for the blue. Layers can also contain other types of data that you want to overlay on your image, such as GIS vector or tabular data, and annotation or map composition objects.

Each layer in your algorithm can be manipulated independently from the others using the process stream buttons associated with that layer. This flexibility is one of the key features in ER Mapper that makes it easy to build and fine tune complex image processing algorithms. In addition, layers can be grouped into surfaces which can be treated as separate images within the same algorithm (discussed later).

Typically, you build an algorithm by first defining one or more layers to display your raster image data, such as satellite images or digitized aerial photos. Then you can add additional layers to display vector data (such as a road network), tabular data (such as sample site locations), and layers to annotate your image with text, coordinate grids, and so on.

## Layer controls

The **Algorithm** dialog has two areas that control layers–the *data structure diagram* and the *process diagram* in Layer tab area:




# About color modes

ER Mapper uses a concept called the “Color Mode” that defines the manner in which layers containing raster data are displayed. To define a particular type of image display, you choose the appropriate types of layers and the appropriate Color Mode. Color Mode is one of the settings on the **Surface** tab in the **Algorithm** dialog.

### Color Mode options

ER Mapper provides three Color Mode options, and each is designed to display and manipulate raster image data in a different way. The Color Mode setting must correspond with the type of data layers you are using. For example, if you are working with Pseudo layers, your Color Mode must be set to Pseudocolor. The three Color Modes are:

| Color Mode | Function |
|---|---|
| **Pseudocolor** | Designed to display a single layer of raster data; image colors are controlled by the current Color Table setting. |
| **Red Green Blue** | Designed to display raster data in Red Green Blue (RGB) color space. The image colors are built using separate layers for the red, green, and blue color planes (or color guns) of the computer display. |
| **Hue Saturation Intensity** | Designed to display raster data in Hue Saturation Intensity (HSI) color space. The image colors are built using separate layers for hue (color), saturation (color purity), and intensity (color brightness). |

## About raster and vector layers

ER Mapper provides several types of data layers, each designed to display a particular format of data (raster, vector, tabular), or display raster data in a particular way. In general, there are two types of layers:

- *Raster layers* display image or grid datasets, and the displayed image is often the result of combining two or more types of raster layers (for example, red, green, and blue).
- *Vector layers* display GIS, line, tabular (point), and map composition data, and always cover raster data underneath them where there is overlap. These are discussed in detail in later chapters.

## Raster layer types

Many of the raster layer types are only valid with a certain Color Mode setting. If the layer is not valid with the current Color Mode, ER Mapper automatically crosses that layer out on the **Algorithm** dialog and does not use it during processing. The types of raster layers and the valid Color Modes associated with them are listed in the table below:

| Raster layer | Function | Valid Color Modes |
|---|---|---|
| **Pseudocolor** | Displays raster data, colors are controlled by the current Color Table | Pseudocolor |
| **Red** | Displays raster data in the display’s red color channel | Red Green Blue |
| **Green** | Displays raster data in the display’s green color channel | Red Green Blue |
| **Blue** | Displays raster data in the display’s blue color channel | Red Green Blue |
| **Hue** | Displays raster data; controls the “color” component (red, yellow, green, etc.) of the displayed image | Hue Saturation Intensity |
| **Saturation** | Displays raster data; controls the “color purity” component (pastel or pure colors) of the displayed image | Hue Saturation Intensity |
| **Intensity** | Displays raster data; controls the “brightness” component (lightness or darkness) of the displayed image | all |
| **Height** | Controls the third dimension elevation (or “z-value”) of an image viewed in 3-D perspective. | all |
| **Class Display** | Displays a raster image created with ER Mapper’s Supervised or Unsupervised Classification functions | all |
| **Classification** | Displays a solid color thematic overlay generated from raster data over other raster layers | all |

**Tip:** You can quickly change any raster layer in an algorithm from one type to another by right-clicking on the layer.

### Selecting and Modifying Data Layers

To modify a data layer, you must first select it by clicking on it. The layer becomes reverse highlighted to indicate that it is selected. You must first select a layer before you can load a new dataset into it or modify it's process stream.

Note that a layer may become inactive if you change the Color Mode to an option that is not valid for that layer. When a layer becomes inactive, a cross appears through it in the data structure diagram. For example, if you change the Color Mode to Red Green Blue, any Pseudo layers become inactive because they are only valid with a Pseudocolor Color Mode. Inactive layers are ignored during processing (similar to being turned off).

# Hands-on exercises

These exercises give you practice using and manipulating raster data layers in ER Mapper. Understanding how to work with layers is an important step in understanding how to build and use algorithms effectively.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Turn data layers on and off
- Load a dataset into one or several raster layers
- Move, add, delete, and duplicate layers
- Change a raster layer from one type to another

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Turning layers on and off

***Objectives***

Learn to turn data layers *on* to include them in processing and *off* to exclude them from processing. Also learn how the status of layers can change if the Color Mode changes.

## Open an image window and display a mosaic algorithm

1 From the **File** menu, select **Open...**.

An image window and the **Open** file chooser dialog appear.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the directory named ‘Functions_And_Features’.

4 Double-click on the directory named ‘Data_Mosaic’.

5 Double-click on the algorithm named ‘Interactive_mosaic_of_4_datasets.alg.’

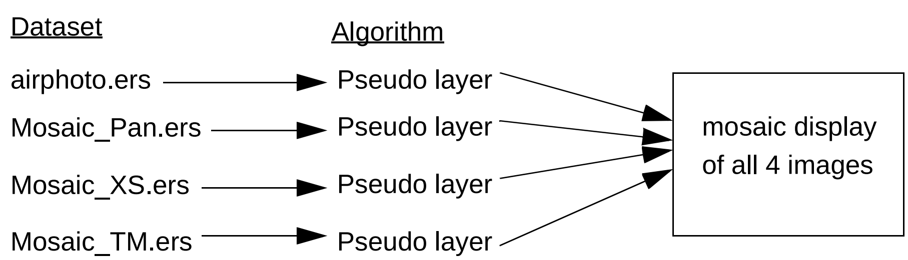
## Open the Algorithm dialog to view the data layers

1 From the **View** menu, select **Algorithm...**.

The **Algorithm** dialog appears showing four Pseudo data layers. Each dataset is loaded into its own Pseudo layer, so it can be controlled independently from the other datasets.

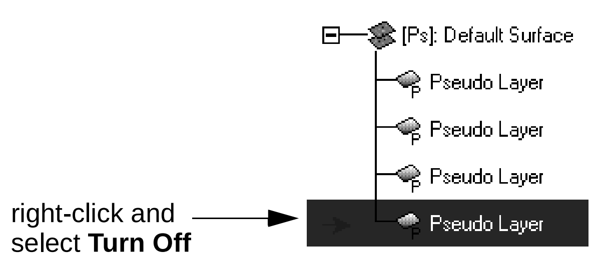
2 Click once on each layer in the data structure diagram.

The filename of the dataset loaded into that layer is shown above the process diagram on the right when the layer is selected. This algorithm works in the following way:




## Turn layers off to exclude them from processing

1 In the data structure diagram, right-click on the lowest layer and select **Turn Off** from the short-cut menu.




The layer dims slightly to indicate that it is off (you can see this more clearly if you select one of the other three layers).

The data in the upper-right portion of the image window (a Landsat TM image) does not display this time. Since the layer containing the ‘Mosaic_TM’ dataset is turned off, its data no longer appears as part of the mosaic.

2 In the **Algorithm** dialog, right-click on the third layer (containing the ‘Mosaic_XS’ dataset) and select **Turn Off** from the short-cut menu.

This time the data in the lower portion of the mosaic (a SPOT XS satellite image) does not display since its layer is turned off.

## Turn overlays on to include them in processing

1 In the **Algorithm** dialog, right-click on the lowest layer and select **Turn On**.

The Landsat TM satellite data again displays in the upper-right portion of the image window since its layer is now turned on.

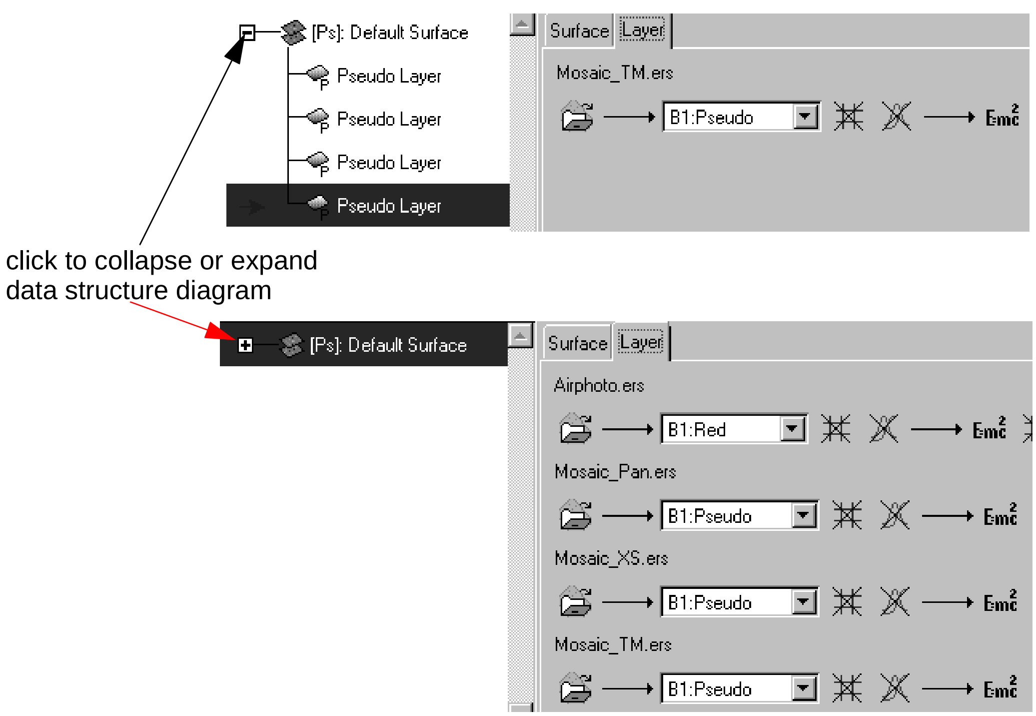
2 Right-click on the third layer and select **Turn On**.

The SPOT XS satellite image again displays in the lower portion of the mosaic.

## Collapse the data structure view of the surface

This algorithm is composed of a single surface that has four layers. Currently this surface is displayed in expanded mode so all four layers are listed in the data structure diagram in the left-hand panel.

1 In the data structure diagram, click once on the small “-” button left of the surface name ‘[Ps:]Default Surface.’



The tree structure diagram collapses to show only the surface, and process diagrams for all four layers are now displayed in the **Layer** tab page on the right. You can now easily see the filename of the dataset loaded into each layer.

2 Click once on the small “+” button left of the surface name.

The data structure diagram expands again to show all four layers.

3 Click once on the top ‘Pseudo Layer’ in the list to select it.

The **Layer** tab page in the right-hand panel changes to show only the process diagram for the selected layer.

## Choose to show process diagrams for two layers

If you have more than one layer in your surface, you can choose to display the process diagram for any combination of them.

1 Ctrl-click once on the icon for the lowest ‘Pseudo Layer’ to select it. (Hold down the Ctrl key and click on the layer icon.)

Process diagrams for both layers are now displayed.

2 Ctrl-click once on icon for the top ‘Pseudo Layer’ to de-select it.

The process diagram for that layer disappears when it is de-selected.

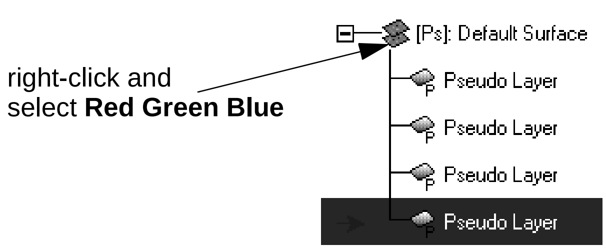
---

**Note:** Notice that one layer always has a red arrow pointing to it–this indicates that it is the *active* layer. You may select several layers and view their process diagrams, but only one layer is active at a time. For example, if you have a number of layers selected and open the **Transform** dialog, the dialog contents apply only to the active layer.

---

## Change the Color Mode to see how it affects layers

1 In the data structure diagram, right-click on the ‘[Ps]:Default Surface’ icon and select **Red Green Blue**.




All four Pseudo layers become crossed out to indicate that they are no longer valid with the current Color Mode.

ER Mapper displays an error message indicating that no layers are active. Layers that are not valid with the current **Color Mode** for the surface are treated as if they are turned off when you click **GO**.

2 Right-click on the '[RGB]:Default Surface' icon and select **Pseudocolor**.

ER Mapper again displays all four datasets in the mosaic.

---

**Tip:** You can also change the Color Mode for the selected surface by clicking the **Surface** tab in the **Algorithm** dialog.

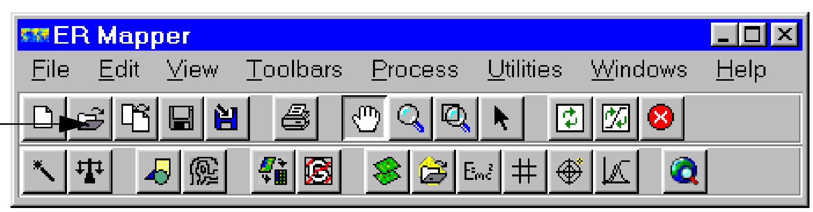
---

# 2: Loading data into layers

***Objectives*** Learn to load a dataset into a particular layer or set of layers in an algorithm. Also understand use of the **OK**, **Apply**, **OK this layer only**, and **Apply this layer only** buttons on the **Raster Dataset** file chooser dialog.

## Open a Red Green Blue (RGB) algorithm

1 On the main menu, click the **Open**  button.




click to open algorithm

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **ERMAPPER\algorithm**.

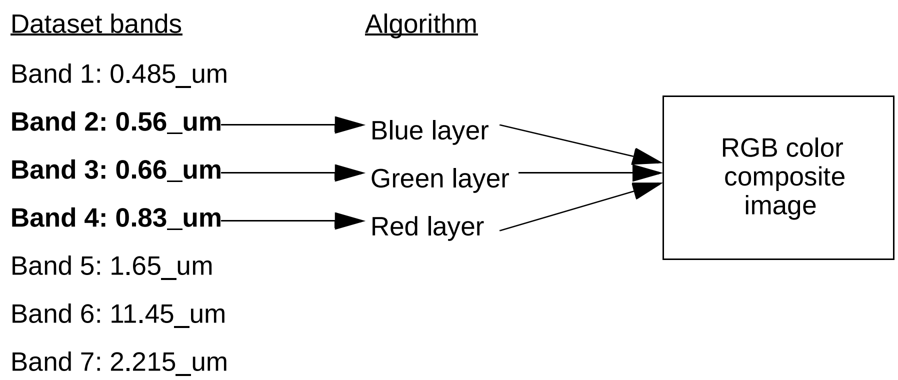
3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named 'Data_Types'

5 Double-click on the directory named 'Landsat_TM.'

6 Double-click on the algorithm named 'RGB_432.alg.'

This algorithm displays bands 4, 3, and 2 of a 1985 Landsat TM satellite image of central San Diego as an RGB color composite image. Water areas appear dark, and shades of red indicate vegetation. RGB color composite algorithms are set up as in the following diagram, in this case bands 432 are displayed as RGB:

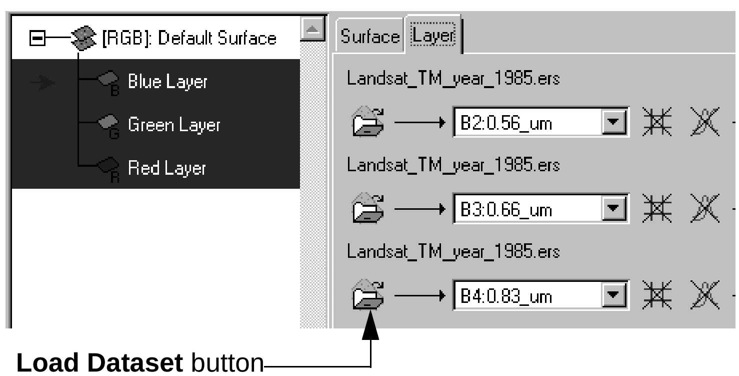



## Load a new dataset into all three layers

1 In the **Algorithm** dialog, Ctrl-click all three layers in the data structure diagram to select them.

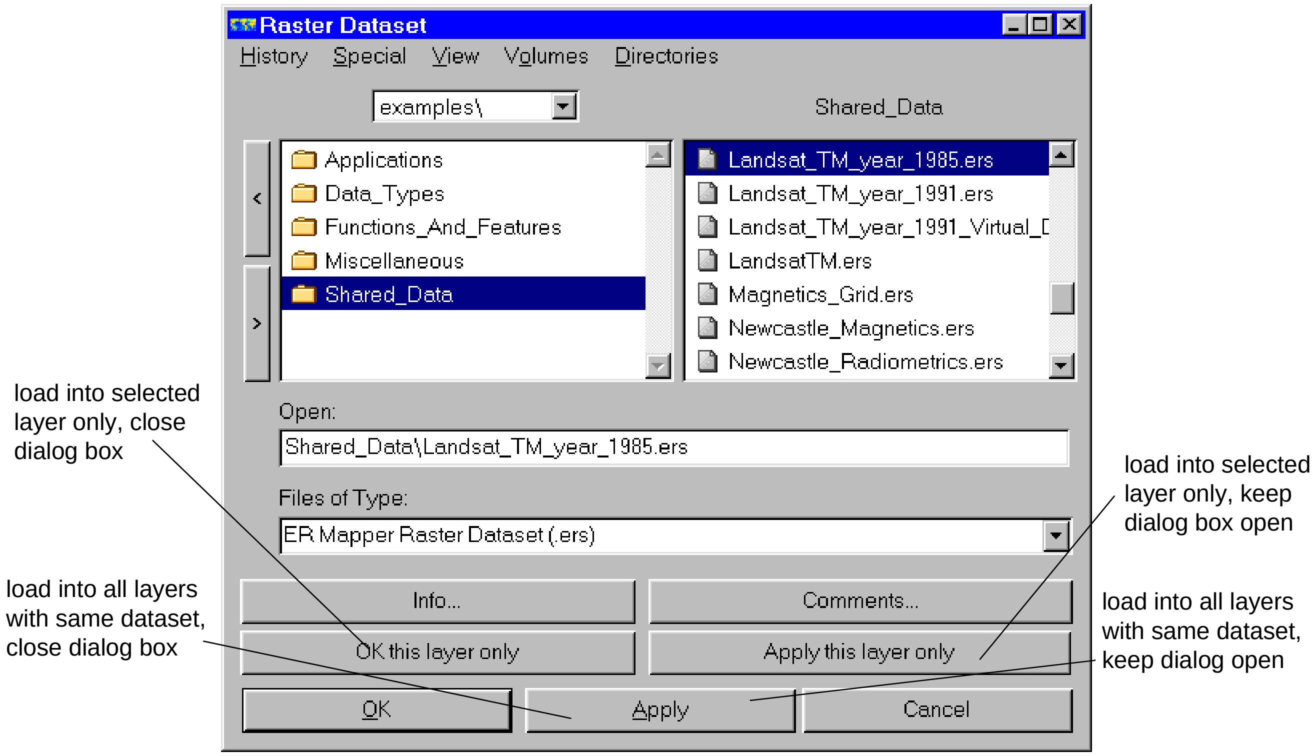
Process diagrams for all three layers are shown in the **Layer** tab page.

2 Click one of the three **Load Dataset**  buttons in the process diagram.




The **Raster Dataset** file chooser appears. Move it to the lower-left corner of the screen so you can see both the **Algorithm** dialog and image window.

Note that this dialog has **OK this layer only** and **Apply this layer only** buttons in addition to the **OK** and **Apply** buttons you see on all other file chooser dialogs.




Typically you use this dialog to load dataset header files (".ers" files). However, you can also load an algorithm (".alg" file) and use it as if it were a dataset by changing the 'Files of Type' option.

## Load a new dataset into all three layers

1 In the **Raster Dataset** dialog, click ***once*** on the dataset named 'Landsat_TM_year_1991.ers' to select it.

2 Click the **Apply** button.

ER Mapper loads the 1991 Landsat dataset into all three layers. Since all three layers previously contained the same dataset (the 1985 Landsat image), **Apply** replaced the dataset in all three layers at once.

ER Mapper displays the 1991 Landsat image, which looks similar to the 1985 image except for cloud cover on the western (left) side along the coast.

**Tip:** If a set of Red, Green and Blue layers contain the same dataset (or no dataset), the **OK** or **Apply** buttons load the selected dataset into all three layers automatically. (It does not matter which of the three layers is selected.)

## Display the 1985 dataset in Green to highlight changes

1 In the **Algorithm** dialog, click once on the ‘Green Layer’ to select it.

2 In the scroll list on the **Raster Dataset** dialog, click ***once*** on the dataset named ‘Landsat_TM_year_1985.ers’ to select it.

3 Click the **Apply this layer only** button.

ER Mapper loads the 1985 Landsat dataset into only the selected (Green) layer.

4 Ctrl-click all three layers again to select them.

The Red and Blue layers contain the 1991 image, while Green contains 1985.

Where the data values between the two images are significantly different you will see either magenta or green colors (for example cloud cover in the 1991 image). Displaying different date images of the same area in RGB is one simple way to highlight changes between dates. (Each layer could contain an image of a different date so changes between three dates can also be highlighted in RGB.)

---

**Tip:** Change detection analysis can be simplified by turning off the Blue layer to create red-green display. Areas with little change between dates will be yellow (equal amounts of red and green), and areas of change will be dominantly red (brighter in 1991) or green (brighter in 1985). For accurate analysis, the two bands displayed should be normalized to the same brightness range first to account for differences in sun angle and atmospheric effects between the two images. See the chapter “Virtual Datasets” for more information on change detection.

---

5 Click **Cancel** on the **Raster Dataset** dialog to close it without action.

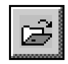
---

**Tip:** The **OK** and **OK this layer only** buttons have the same function as the **Apply** and **Apply this layer only** buttons, but they close the dialog after performing the operation (while the others leave it open). Double-clicking on a dataset or algorithm name in the scroll list has the same effect as clicking **OK**.

---

# 3: Moving, adding and changing layers

***Objectives*** Learn to move layers in an algorithm, delete layers, and add new layers. Also, learn to change a raster layer from one type to another type (green to blue for example).

1 On the main menu, click the **Load**  button.

2 From the **Directories** menu, select the path ending with the text **examples**

3 Double-click on the directory named ‘Data_Types’.

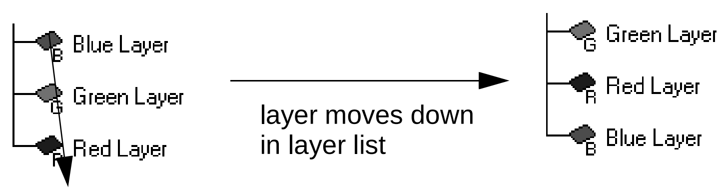
4 Double-click on the directory named ‘SPOT_XS’.

5 Double-click on the algorithm named ‘SPOT_XS_rgb_321.alg’.

This algorithm displays a SPOT XS (multispectral) satellite image of San Diego as an RGB color composite of bands 3, 2 and 1. (These bands are similar to Landsat TM’s bands 4, 3 and 2 but are imaged at higher spatial resolution.)

## Change the order of layers in the data structure diagram

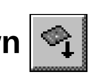
1 Point to the icon for the ‘Blue Layer’ and drag it down below the Green and Red layers.

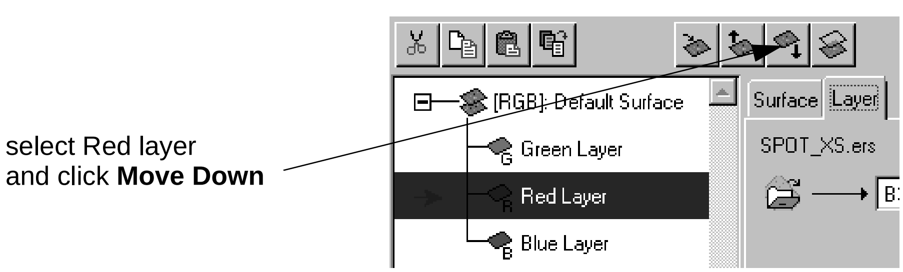



---

**Tip:** When selecting or dragging layers, always click on the layer’s icon, *not* on the label text.

---

2 Click once on the ‘Red Layer’ to select it, then click the **Move Down**  button.




The Red layer moves down one level to the bottom of the layer list.

3 Select the ‘Blue Layer,’ then click the **Move Up** button.

The Blue layer moves to the top of the layer list. You can move layers either by dragging them or selecting the layer and using using the or buttons.

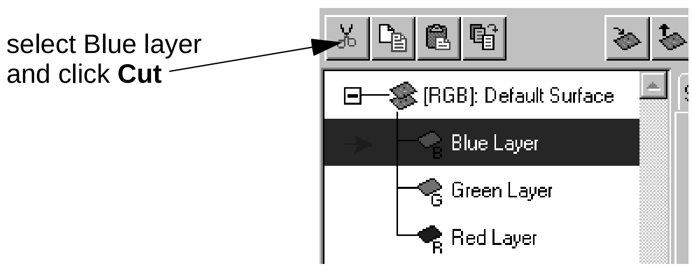
---

**Note:** The order of layers can be important when building image mosaic algorithms that display more than one dataset (it sets the display priority of images where there is overlap, those on top having the highest priority). Within a group of RGB layers containing the same dataset, changing the layer order has no effect.

---

## Delete the Blue and Green layers

1 Select the ‘Blue Layer,’ then click the **Cut** button.




The Blue layer is deleted from the layer list.

2 Select the ‘Green Layer,’ then click the **Cut** button.

ER Mapper displays only the red component of the image (SPOT band 3 in this case) because the Blue and Green layers of the algorithm were deleted.

---

**Tip:** When running ER Mapper on a PC, you can use the Ctrl-X, Ctrl-C and Ctrl-V keyboard shortcuts to cut, copy and paste layers (or surfaces) in or between algorithms.

---

## Add a new Green layer and reload the SPOT XS dataset

1 On the **Algorithm** dialog, click the **Edit** menu, select **Add Raster Layer**, then select **Green**.

A new Green layer is added to the algorithm. The new layer has no dataset loaded yet (indicated by No Dataset in the process diagram), so it is turned off.

2 Click the **Load Dataset** button in the process diagram.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named ‘Shared_Data.’

5 Click on the image named ‘SPOT_XS.ers.’ to select it, then click **OK** to load it and close the dialog.

ER Mapper loads the dataset into the new Green layer and turns it on. Also note that band 1 is selected by default in the process diagram.

6 In the process diagram, select **B2:0.645_um** from the **Band Selection** drop-down list.

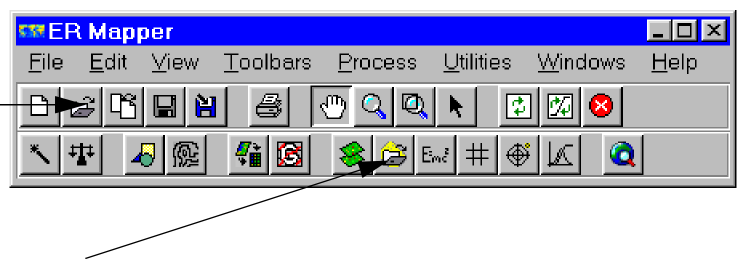
You have now created a new Green layer that contains the same dataset and band as the original green layer you deleted earlier.

---

**Tip:** You can also load a dataset into the currently selected layer using the **Load dataset** button on the main menu. (Do not confuse this with the **Open** button.)

---

**Open** - use to open *algorithms*

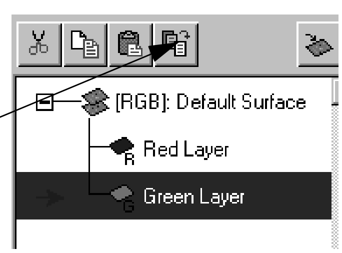



**Load dataset -** use to load a *dataset* into the current algorithm (has the same function as **Load Dataset** button on the **Algorithm** dialog)

## Create a Blue layer by duplicating the Green layer

1 With the Green layer still selected, click the **Duplicate**  button.

**Duplicate** button




A second Green layer is added below the first one. The second Green layer is an exact copy of the first one, so it already has the ‘SPOT_XS’ dataset loaded.

2 Right-click on the duplicated (lower) Green layer, and select **Blue**.

The Green layer changes to a Blue layer.

3 From the **Band Selection** drop-down list, select **B1:0.545_um**.

The new Blue layer is now correctly set to display band 1 of the SPOT dataset.

---

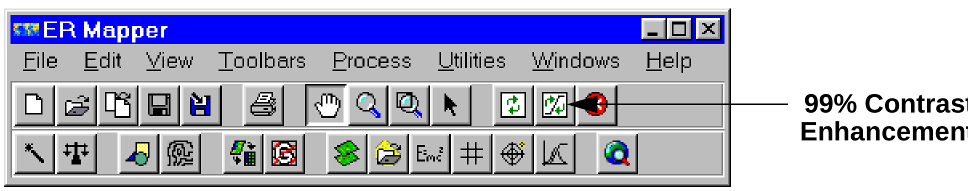
**Tip:** When manipulating multiple layers, duplicating an existing layer with the desired dataset and changing its type is usually faster than adding a new layer and loading the desired dataset.

---

ER Mapper displays the algorithm. Note that the colors look different than the original algorithm you opened at the start of this section. This is because the transforms for the new Green and Blue layers are not yet set to optimize contrast for the specific bands of data they display.

## Automatically adjust the contrast of the RGB image

1 On the main menu, click the **99% Contrast Enhancement** button.




ER Mapper automatically adjusts the transforms of the new layers to optimize the contrast and then displays the RGB image.

---

**Tip:** The **99% Contrast Enhancement** button is a quick way to adjust image contrast when viewing different datasets or combinations of dataset bands. You will learn more about how this works later.

---

## Close the image window and Algorithm dialog

1 Close the image window using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

**What you learned**

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Turn data layers on and off
- Load a dataset into one or several raster layers
- Move, add, delete, and duplicate layers
- Change a raster layer from one type to another

5

# Viewing image data values

This chapter shows you the options ER Mapper provides for viewing image data values and coordinate locations. These include cell values, neighborhoods, signatures, and traverse extraction. You also learn how to view geographic locations and measure distances between two points on an image.

**Note:** ER Mapper's histogram (transform) feature is also useful for analyzing data values, and is covered in detail in the chapter "Enhancing Image Contrast."

## About viewing data values

Viewing image data values is one of the fundamental ways to assess data quality and the particular characteristics of features in an image. Options for viewing data values and geographic locations in ER Mapper include:

| | |
|---|---|
| **Cell values** | The data value associated with each cell or pixel in the image, or the data values of that cell in each band of a multi-band dataset |
| **Neighborhoods** | An array of data values surrounding a pixel |

| | |
|---|---|
| **Signatures** | The data values of a pixel (or average of an area) in all bands shown in a line graph format |
| **Traverse extraction** | A profile of data values occurring along a line or polyline drawn on the image |
| **Scattergrams** | An X-Y plot showing the relationship between data values in two bands of an image |
| **Histograms** | A plot showing the range of data values on the X axis and their relative frequency on the Y axis |

# Hands-on exercises

These exercises show you various ways of viewing data values, coordinate locations, and geographic distances between two points on an image.

***What you will learn...*** After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- View image data values in text format
- View image data values in multiple bands as a signature
- View geographic locations and measure distances within an image
- View image data values in multiple bands along a profile line (traverse)
- View data as a scattergram, and perform analysis between it and the image

***Before you begin...*** Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Viewing values and signatures

***Objectives*** Learn to view image data values in a text format, neighborhood format, and signature (line graph) format.

## Open and display an RGB algorithm

1 From the **File** menu, select **Open...**.

An image window and the **Open** dialog appear.

2 Double-click on the directory named '\examples\Data_Types\Landsat_TM' to open it.

3 Double-click on the algorithm named ‘RGB_741.alg.’

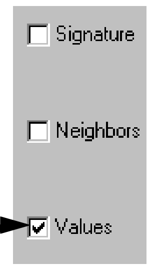
This algorithm displays bands 7, 4, and 1 of the San Diego Landsat image as an RGB color composite image.

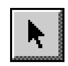
## View cell values for all dataset bands

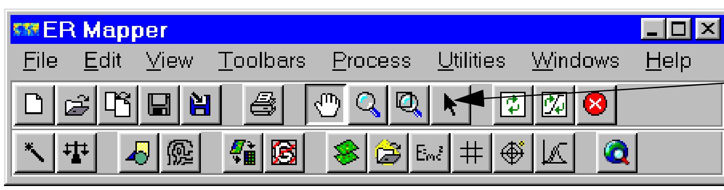
1 From the **View** menu, select **Cell Values Profile...**.

The **Cell Values Profile** dialog box opens. Move it next to the image window.

2 On the right side of the dialog, turn off the **Signature** and **Neighbors** options and turn on the **Values** option.




3 On the main menu, click the **Set Pointer mode**  button.




Set Pointer mode tells ER Mapper that you want to use the mouse pointer to view data values. (The other modes set the pointer for use as a zoom and pan tool.)

4 Point inside the image window, and drag the pointer through the image (or just click on any pixel).

The **Cell Values Profile** dialog displays the data values in all seven bands in the Landsat image for the current cell (pixel) location in the image. The data values are updated as you drag the mouse to new locations.

## View a neighborhood of cell values

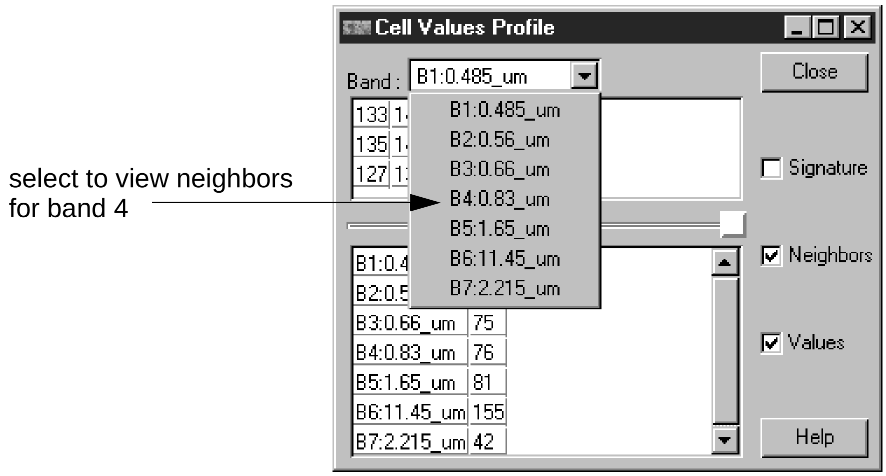
1 In the **Cell Values Profile** dialog, turn on the **Neighbors** option.

A second window is added to the dialog, with a drop-down menu to select a band.

2 Point inside the image window, and drag the pointer through the image (or just click on any pixel).

A three-by-three neighborhood of cell values displays as you drag the mouse. The center pixel in the three-by-three array is the current pixel, and the surrounding eight pixels are its neighbors on all sides. This feature is useful to viewing the local variance or texture in various parts of an image.

3 From the **Band** list, select **B4:0.83_um** then drag again in the image.




The data values for band 4 of the Landsat dataset display in the three-by-three neighborhood.

---

**Tip:** If you have more than one dataset in an algorithm (for example a mosaic or a 3D view), the cell values are shown for the dataset loaded into the *selected* layer of the algorithm. To view values for a different dataset in the algorithm, select a layer containing it, then click or drag in the image.

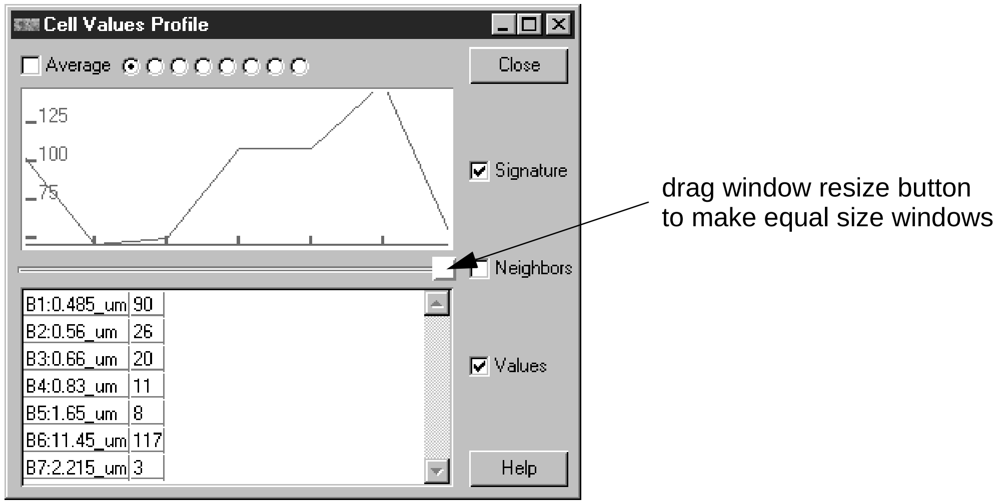
---

## View a signature of cell values for various features

1 Turn off the **Neighbors** option, and turn on the **Signature** option.

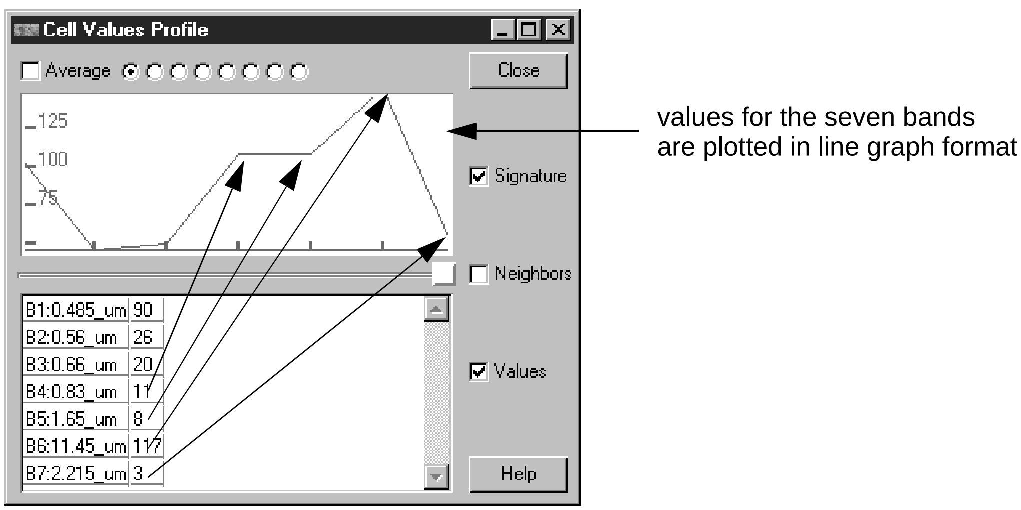
A line graph window is added with a row of option buttons on top. Each of the option buttons represents a different color you can choose for plotting a line graph, or “signature,” in the window. (On some systems the buttons appear in color.)

2 Drag the window resize button until both windows are the same size and all seven band are visible in the **Values** window:

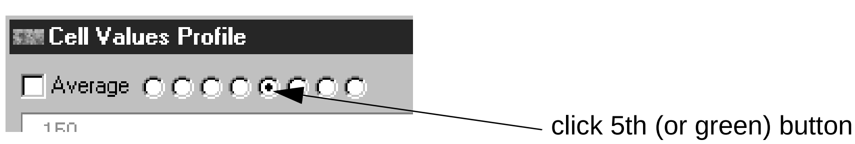



3 Point to the image window, and click on one of the magenta areas (urban and industrial areas).

The same seven data values in the Values window are plotted as a grey line (signature) in the Signature window. This lets you see the reflectance in each band compared to the others.



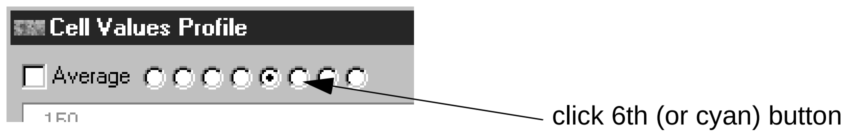

4 Click on the fifth (or green) button above the Signature field.




5 Point to the image window, and click on one of the bright green areas (mostly parks and golf courses).

A second green graph line showing the reflectance in all seven bands for the green vegetation. You can see, for example, that vegetation has lower reflectance than urban areas (the grey line) in band 1, 2 and 3 (visible wavelengths of light).

6 Click on the sixth (or cyan) button above the Signature field.




7 Point to the image window, and click in a dark ocean area near the bottom of the image.

A third blue graph line is added showing reflectance in the ocean areas. As you can see, calm ocean areas generally have lower reflectance than urban or vegetated areas, especially in the near and mid-infrared wavelength bands (bands 4, 5 and 7) that are strongly absorbed by water.

8 Click on the first (or grey) color button again to clear the signature.

The grey line representing urban reflectance clears from the Signature window. When you click on a color button a second time, the existing signature (colored line) in the window is removed.

9 Point to the image window, and click on a different magenta area display a new urban signature.

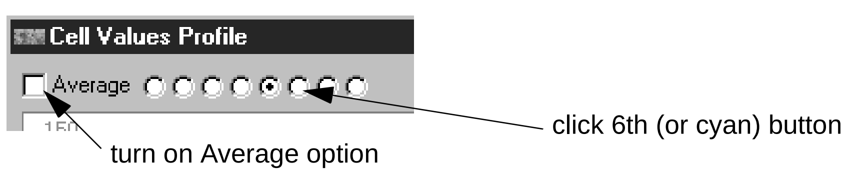
---

**Tip:** A specific image feature often has unique spectral reflectance characteristics that can be used as a "signature" to help separate it from other features. Sometimes very subtle reflectance differences in only one or two bands can help identify one feature from another (for example different species of vegetation). This analysis is simplified by looking at the data in a line graph or "signature" format.

---

## View an average signature for a feature

1 Click on the sixth (or cyan) button to clear the blue graph line, then turn on the Average option.




2 Point to the image window, and drag through one of the dark ocean areas near the bottom.

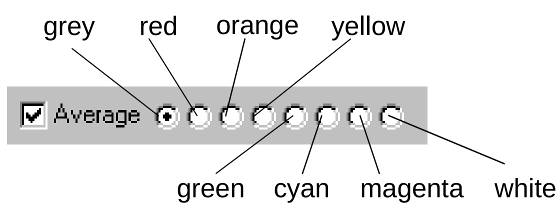
A new blue signature line appears that gets thicker as you drag.

When using **Average**, the signature is an *accumulated average* of all the data values over the area where you dragged (so the line thickens to indicate this). You can add to the average signature by continuing to drag. This allows you to view the average signature over a broad feature area, which is usually more useful than a single measurement (one pixel at a time is used when **Average** is off).

---

**Note:** The color you choose for the signature line has no relationship to the color of features in the image where you click or drag. It is therefore helpful to choose a line color that is similar to the feature color, for example choose a green line color for vegetation as shown in the previous example. If colors are not shown on the buttons, you can click on a button and the ticks and text display in that color, or use the following guide:

---




# 2: Viewing locations and distances

***Objectives*** Learn to view the geographic location of features in a dataset, and to measure the distance between two points in an image.

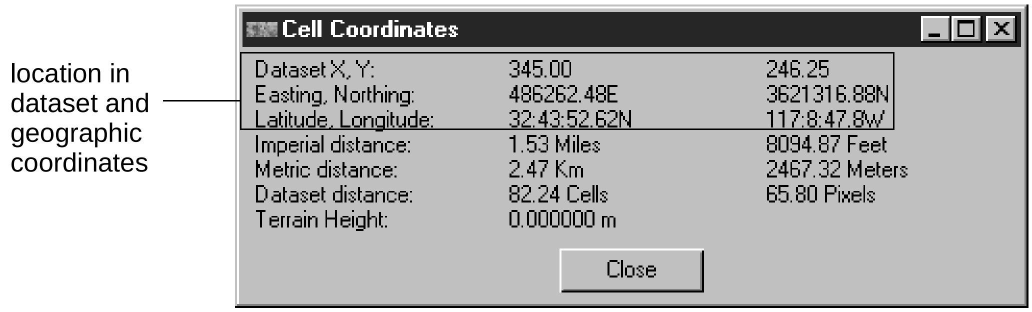
## View geographic coordinates in the image

1 From the **View** menu, select **Cell Coordinate...**.

The **Cell Coordinates** dialog appears. Drag so it does not overlap with the image window or **Cell Values Profile** dialog.

2 Point to the image window, and drag the pointer through the image.

The dataset and geographic location of the current cell appear, and are updated as you drag the mouse.




---

**Note:** The Easting Northing and Latitude Longitude fields only display values if the dataset is registered to a map projection. The dataset coordinates are in X (columns or cells) and Y (rows or lines) originating from the upper-left.

---

## View distances between points in the image

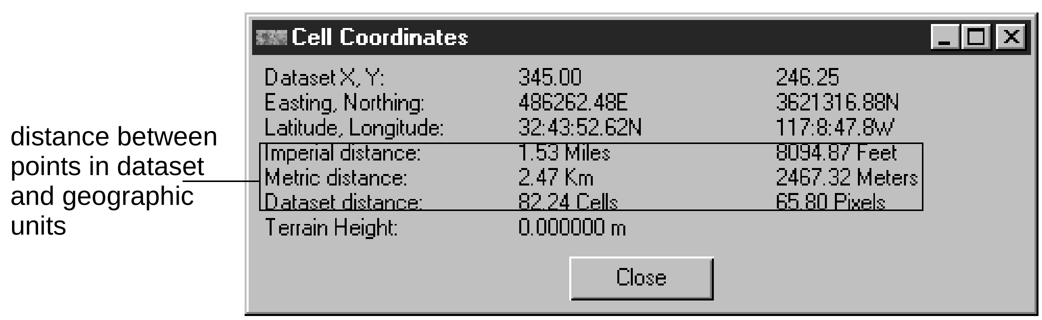
The lower three fields of the **Cell Coordinates** dialog show the distance between the point where you first depress the mouse button and the point where you release it. Distances are shown as Imperial distance (feet and miles), Metric distance (meters and kilometers), and Dataset distance (number of pixels in the X and Y directions).

1 Point to the image window, and click once on any point in the image.

The Imperial, Metric, and Dataset distance fields are cleared to zero values.

2 Pick out two features in the image, then drag the mouse between them.

This distance between those two points is displayed when you release the mouse button. Measuring the distance between two points is called *mensuration*.



## Open a 3D perspective algorithm

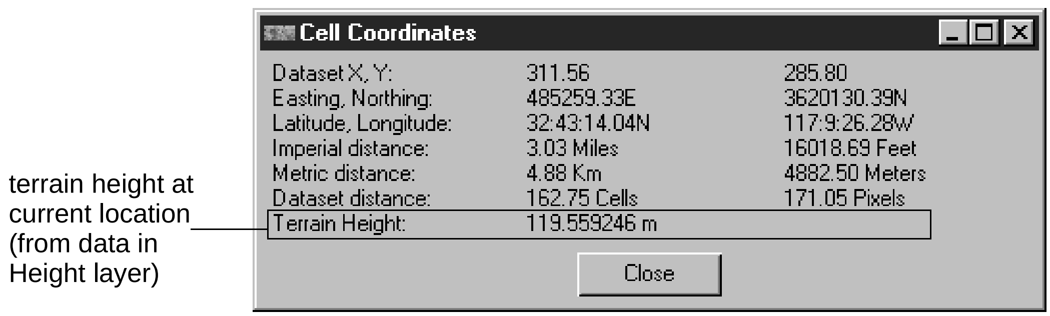
1. From the **File** menu, select **Open...**.
2. From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.
3. Open the ‘Functions_and_Features’ directory, then open the ‘3D’ directory.
4. Double-click on the algorithm named ‘Landsat_over_DTM.alg.’

   This algorithm displays a 3D perspective view of the same 741 band combination of the San Diego Landsat TM satellite image.

## Query cell values and coordinates on the 3D image

1. In the image window, drag the pointer through the 3D image.

   A cross-shaped 3D cursor appears on the image that conforms to the shape of the terrain as you drag. The cell values and locations are shown in the two dialogs, and the current terrain height is shown in the **Cell Coordinates** dialog.




   The 3D cursor also has an arrow at one end that points to north in the image.

**Tip:** You can change the color of the 3D cursor by clicking the **3D View** tab in the **Algorithm** dialog.

The terrain height values are taken from the dataset loaded into the Height layer in the algorithm (a digital terrain model in this case). The Terrain Height values only appear when viewing the image in a 3D view mode.

**Note:** You must wait for the 3D image to finish rendering before you can query cell values (the “regenerating terrain” message must disappear).

2. Click **Close** on the **Cell Coordinates** and **Cell Values Profile** dialogs.

# 3: Viewing traverse profiles

***Objectives*** Learn to view image data values for multiple bands as a profile along a line or polygon draw through the image (called *traverse extraction*)

## Open the 2D Landsat 741 algorithm again

1. From the **File** menu, select **Open...**.
2. From the **Directories** menu, select the **\examples** path.
3. Open the 'Data_Types' directory, then open the 'Landsat_TM' directory.
4. Double-click on the algorithm 'RGB_741.alg' to open it.

## Set up to draw traverse profile lines

1. From the **View** menu, select **Traverse...**.

   The **New Map Composition** and **Traverse** dialogs open.

2. On the **New Map Composition** dialog, make sure the 'Vector File' option is selected, then click **OK**.

   The **Tools** dialog and **ER Mapper** warning dialog appear.

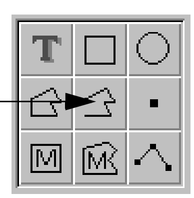
3. Click **Close** on the **ER Mapper** warning dialog to close it. (This warning relates to use of the drawing tools for composing maps, but is not meaningful for this exercise.)
4. Move the **Traverse** dialog under the image window, and move the **Tools** dialog to the right of the image window.

   You will use the vector annotation tools to draw traverse lines on the image.

## Draw a traverse line on the image

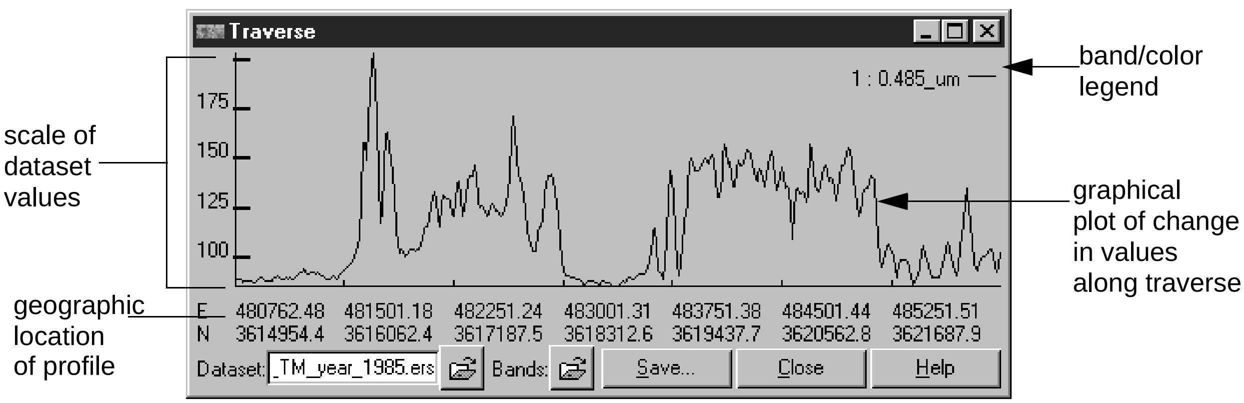
1. On the **Tools** dialog, click the **Poly Line**  button.

**Poly Line** button



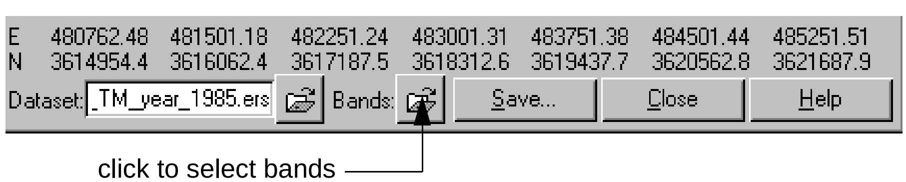
2 Define a line from the ocean at the bottom up to the land area (see below) by clicking once at the start point, clicking once at the end point, then double-clicking to end the line definition.


A profile line appears inside the **Traverse** dialog. This line displays the amplitude or change in the values of pixels underneath the traverse line. By default, values for dataset band 1 are shown as a black profile line.




## View profiles for 3 dataset bands

1 On the **Traverse** dialog, click the **Bands:**  button.




The **Traverse Band Selection** dialog appears.

2 Press the Ctrl key on your keyboard, then click on bands **1**, **4** and **7** in the list to select them.

3 Click **OK** on the **Traverse Band Selection** dialog.

Profiles for all three bands appear in the **Traverse** dialog, with a legend in the upper-right indicating the line color assigned to each band. This type of display allows you to clearly see the relationship between data values in the three bands. For example, the two dips in the profile lines are water areas that generally have lower reflectance than land areas. The two infrared bands (4 in blue and 7 in magenta) have much lower values over the water areas than the visible blue band 1 due to absorption of infrared wavelengths by water.

---

**Note:** The legend lists the band label, but not its true band number. For example, bands 2 and 3 in the legend refer to bands 4 and 7 in the Landsat image.

---

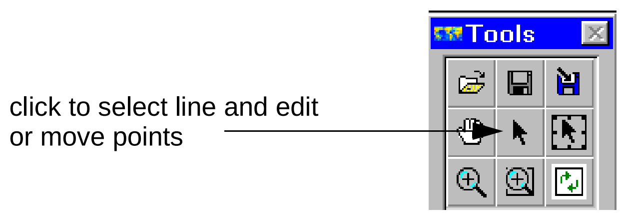
## Draw a second traverse line on the image

1 Inside the image window, define a second line in a different area by again clicking once at the start point, clicking once at the end point, then double-clicking to end the line definition.

The three profile lines appears inside the **Traverse** dialog update to show the Landsat image values under the new line. You can draw as many different traverse lines on the image as you desire, and draw polylines with multiple nodes.

## Alternate between the two traverse lines and modify them

1 On the **Tools** dialog, click the **Select /Edit Points Mode**  button.

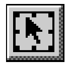



2 Inside the image window, click on the first traverse line you drew.

The line becomes selected and it's corresponding profiles again appear in the **Traverse** dialog. You can view the profiles for any traverse line by simply selecting it.

3 Inside the image window, drag one of the line end nodes to a new location.

When you release the mouse button, the revised line appears on the image and it's corresponding profiles are updated in the **Traverse** dialog. You can modify the location and length of any traverse line by following these steps.

**Tip:** To move the entire polyline at once, select it with the **Select and Move/Resize Mode**  button, then drag the selection box.

4 Click **Close** on the **Traverse** dialog to close it, then click **Close** on the **Tools** dialog to close it.

5 When asked to save the current annotation, click **No**.

**Tip:** If desired, you can save the current annotation layer and reload it later, and you can also save the traverse profiles to an XYZ format dataset on disk for export to other analysis software by clicking the **Save...** button on the **Traverse** dialog. See the *ER Mapper User Guide* for more information.

**Note:** As with the Cell Profiles, traverse profiles show the data values actually stored in the dataset on disk. Therefore algorithm formulas, transforms, and so on do not affect the data values shown in traverse profiles.

# 4: Using image scattergrams

***Objectives***

Learn to view the relationship between data values in two bands as a two-dimensional plot called a scattergram (or scatter diagram). Also learn to highlight a cluster of points in the scattergram on the image, and define polygons (regions) on the image and view the mean and spread of the data values on the scattergram.

A *scattergram* allows you to graphically see the correlation between the pixel values in two dataset bands. Values for one band are plotted on the Y axis and the other on the X axis. These two digital numbers locate each pixel in the two-dimensional measurement space of the graph.

## Open a SPOT XS RGB algorithm

1 From the **File** menu (on the main menu), select **Open...**.

2 From the **Directories** menu (on the **Open** dialog), select the **\examples** path.

3 Open the ‘Data_Types’ directory, then open the ‘SPOT_XS’ directory.

4 Double-click on the algorithm named 'SPOT_XS_rgb_321.alg.'

This algorithm displays bands 3, 2 and 1 of the San Diego SPOT XS satellite image as an RGB color composite. Vegetated areas with strong near IR reflectance (band 3) appear in red.

## Open a Scattergram dialog box

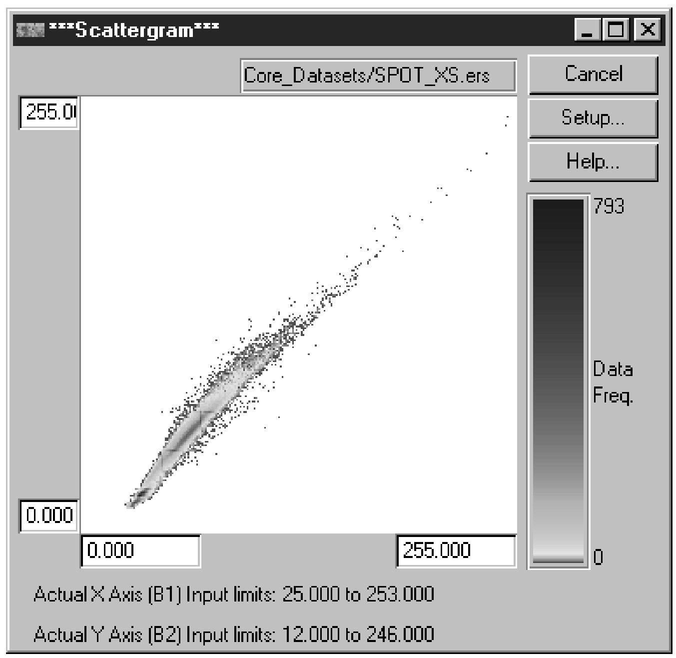
1 From the **View** menu, select **Scattergrams...**.

The **Scattergram** and **New Map Composition** dialog boxes open.

2 Make sure the 'Raster Region' option selected, then click **OK** on the **New Map Composition** dialog.

The **Tools** palette dialog opens–drag it up next to the image window.

The **Scattergram** dialog automatically references the dataset in the active image window ('SPOT_XS.ers'). You could choose to view scattergrams for any other dataset, Virtual Dataset, or algorithm as well.




By default, a new scattergram plots band 1 of the dataset on the X (horizontal) axis and band 2 on the Y (vertical) axis, and the cluster of points is shown using various colors inside the scattergram window. The colors represent the *accumulated frequency* (or "density") of data values in both bands. Areas of the scattergram with the highest densities of points are shown in colors in the upper part of the color bar (red and yellow), and low density areas in the lower colors (blue and magenta). Typically, high density areas will be a feature comprising a large number of pixels in both bands, such as a large area of water.

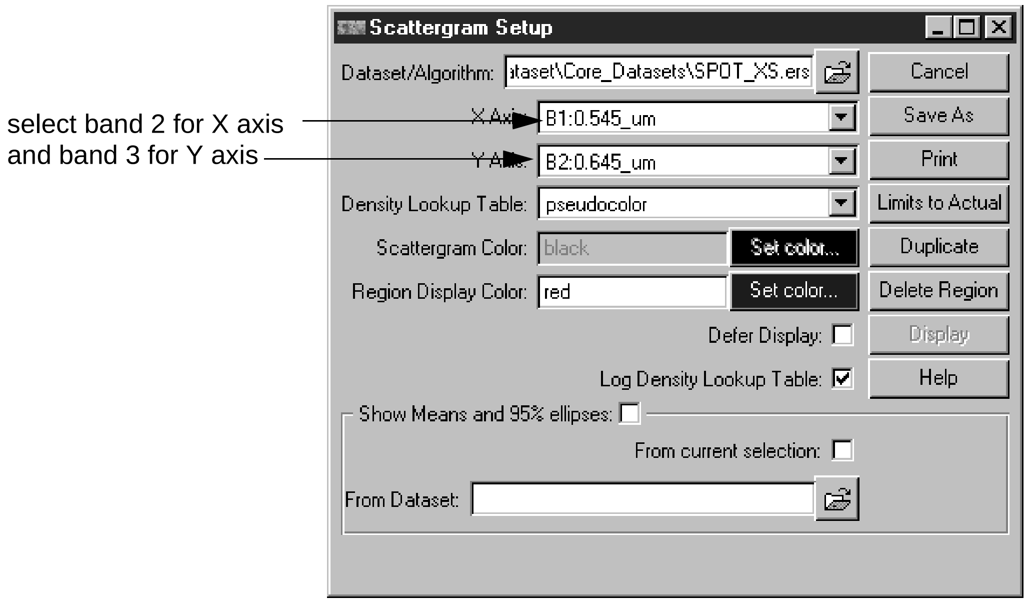
## Change the dataset band combination

In the scattergram for bands 1 and 2, notice that the data points are tightly grouped. This indicates that there is a strong correlation between the data contained in these two bands (both visible wavelength bands), so they contain common information.

1 In the **Scattergram** dialog, click the **Setup...** button.

The **Scattergram Setup** dialog opens to provide options for changing dataset bands, defining regions, and other functions. Move it so it does not cover the **Scattergram** dialog or image window.

2 From the 'X Axis' drop-down list, and select **B2:0.645_um**, and from the 'Y Axis' list select **B3:0.84_um**.




ER Mapper redraws the scattergram showing bands 2 values against band 3.

3 On the **Scattergram Setup** dialog, click the **Limits to Actual** button.

The scattergram limits are set to the actual data ranges of bands 2 and 3, so the scattergram enlarges to fill the window. The wide spread of points shows that the data in bands 2 and 3 are not as strongly correlated, so they provide different types of information. (Band 2 records visible red reflectance and band 3 records near infrared reflectance.)

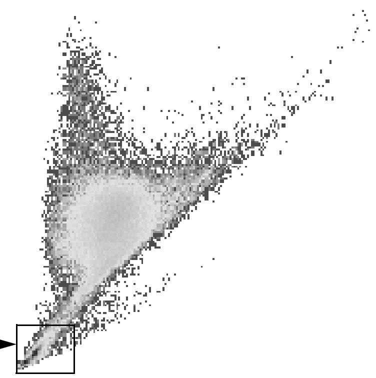
## Highlight a cluster of scatter points on the image

The distribution and clustering of points in a scattergram often shows information about features in an image. You can select an area on the scattergram, and have ER Mapper automatically highlight where those pixel values occur on the image.

1 In the **Setup Scattergram** dialog, click the **Set Color** button next to ‘Region Display Color,’ select the color yellow, then click **OK**.


click to change overlay color, select yellow, click **OK**

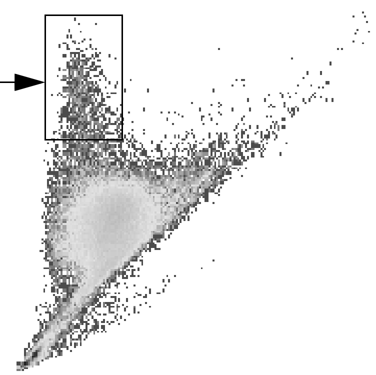
2 In the **Scattergram** dialog, drag a box to enclose the area shown below.



drag a box to enclose dense cluster of points

ER Mapper performs some calculations, then draws a yellow overlay in the image window to highlight pixels with the value range you enclosed. As you can see, this is the ocean area in the image (since it has low reflectance in both bands 2 and 3).

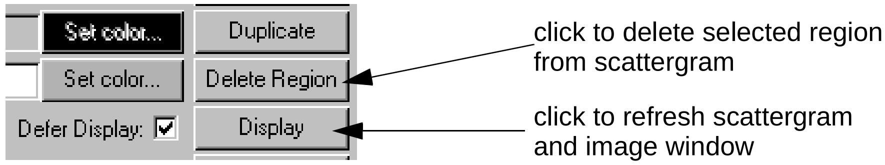
3 Revise the location of the box to enclose the area shown below. (The region box should be selected. If not, click on it to select it, then drag from the center or resize it by dragging a handle.)



revise box to enclose this area of points

Parks and golf courses in the area are highlighted on the image. These are areas with high near IR reflectance (band 3) and low red reflectance (typically vigorous green vegetation). This technique of region box highlighting lets you easily see how clusters or anomalies in the scattergram relate to features on the image.

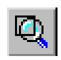
4 In the **Setup Scattergram** dialog, click the **Delete Region** button.

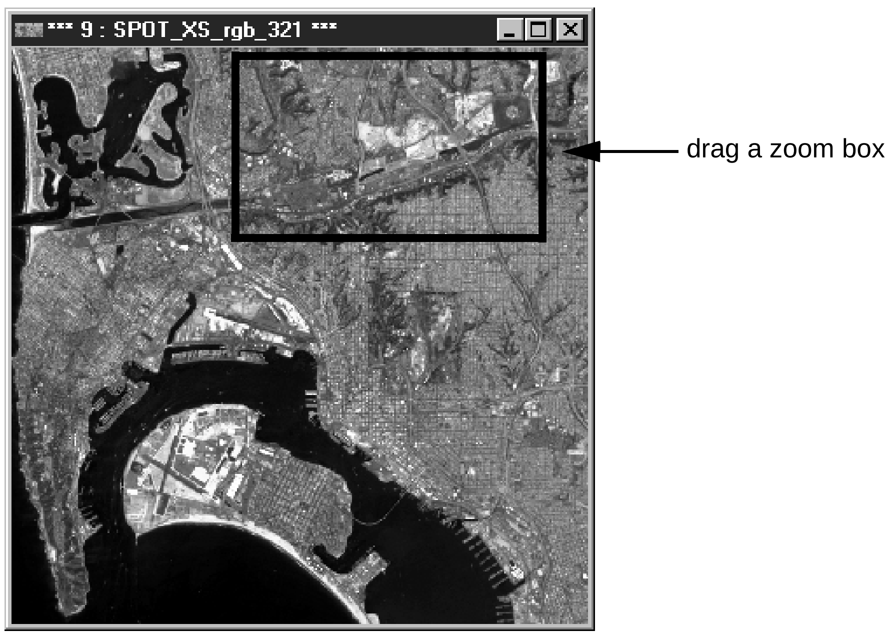



The scattergram redraws without the region box and the image redraws without the yellow overlay.

## Draw a region polygon on the image

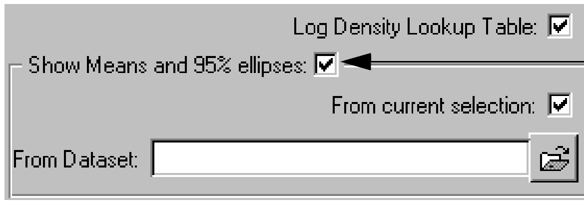
ER Mapper also lets you define a region polygon on the image, and view the mean value and 95% ellipse on the scattergram for pixels that fall inside the region.

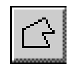
1 Click the **Zoom Box Tool**  button on the main menu, then zoom into the area of the image show below.

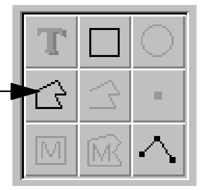



This area shows a golf course (bright red on the lower left), open pit gravel mining areas (light colored in the upper-right), and other land cover types.

2 On the **Scattergram Setup** dialog, turn on the 'Show Means and 95% ellipses' option.

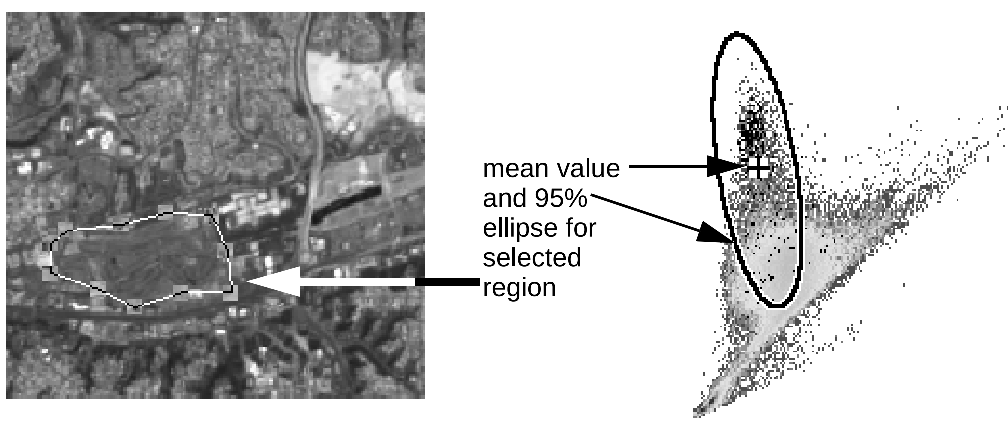



3 On the **Tools** dialog, click the **Polygon**  button.




4 Inside the image window, define a polygon around the red golf course area. (Click once at the start point, once at each node, then double-click to end the polygon definition.)

ER Mapper displays a mean and 95% confidence ellipse for the data values that fall inside the region you drew. This is a fast way to see where the region occurs in the range of possible dataset values shown on the scattergram.




The location (mean value) of the ellipse indicates that the golf course has high near IR (band 3) reflectance and low red (band 2) reflectance. The shape of the ellipse indicates that there is much higher standard deviation in the band 3 values than the band 2 values for this area.

5 Inside the image window, define a polygon around one of the two light colored gravel pit areas.

The mean and 95% ellipse for the gravel pit area appear on the scattergram.

6 With the gravel pit polygon still selected, Shift-click on the other polygon (the golf course)–both polygons should now be selected.

Mean and 95% ellipses for both areas appear on the scattergram so you can compare the two. (Means and 95% ellipses are discussed in more detail in the “Supervised Classification” chapter.)

## Close the image window

1 Click **Close** on the **Tools** dialog, then click **No** when asked to save the changes.

2 Click **Cancel** on the **Scattergram** dialog to close both dialogs.

## Close the image window

1 From the **File** menu, select **Close** to close the image window.

Only the ER Mapper main menu should be open on the screen.

***What you learned***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- View image data values in text format
- View image data values in multiple bands as a signature
- View geographic locations and measure distances within an image
- View image data values in multiple bands along a profile line (traverse)
- View data as a scattergram, and perform analysis between it and the image

6

# Enhancing image contrast

This chapter explains how to modify raster image data to enhance contrast or color to improve visual interpretation. It introduces the basic concepts associated with contrast enhancement and color mapping, and gives you practice using ER Mapper's Transform options.

## About contrast enhancement

Adjusting image contrast (often called "contrast stretching") is the most fundamental and often-used enhancement operation in digital image processing. The human eye is very good at interpreting spatial attributes in an image and picking out subtle features. However, the eye is poor at resolving such features when they are characterized by very subtle differences in color or brightness. Contrast enhancement techniques are useful for accentuating subtle differences in data values to improve visual interpretation.

Contrast enhancement is called a "point operation" in image processing because it applies a brightness or color transformation to each pixel in the dataset independent of all other pixels. By adjusting the "transform" that maps image data values to the display brightness or colors in a lookup table, you can enhance (or “stretch”) the contrast or highlight specific features to make your data easier to interpret and analyze.

image with no contrast enhancement

contrast enhanced image

## Displaying images with a color lookup table

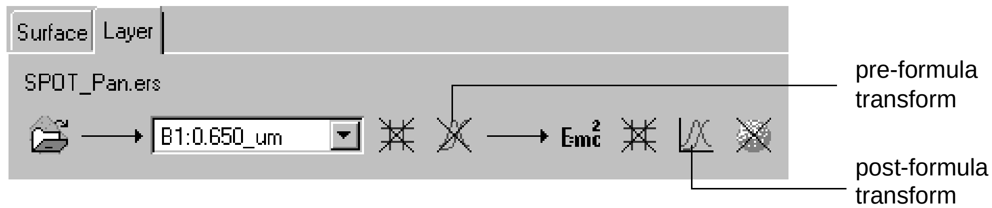
When displaying an image using a color lookup table (CLUT), image data values are mapped to specific colors or “slots” in a table. In this case, changing the transform tells ER Mapper to adjust the mapping between the image data values and the colors in the CLUT used to display them. For example, you can transform the data to be displayed using all the colors, or shift or compress the data to map it to a particular color or range of colors.

## Displaying images in RGB

A computer screen produces colors by illuminating red, green, and blue phosphors for each pixel. When you change the transform of the Red, Green or Blue layer in an RGB algorithm, ER Mapper adjusts mapping between the image data values and the brightness of the red, green, or blue phosphors of the hardware display.

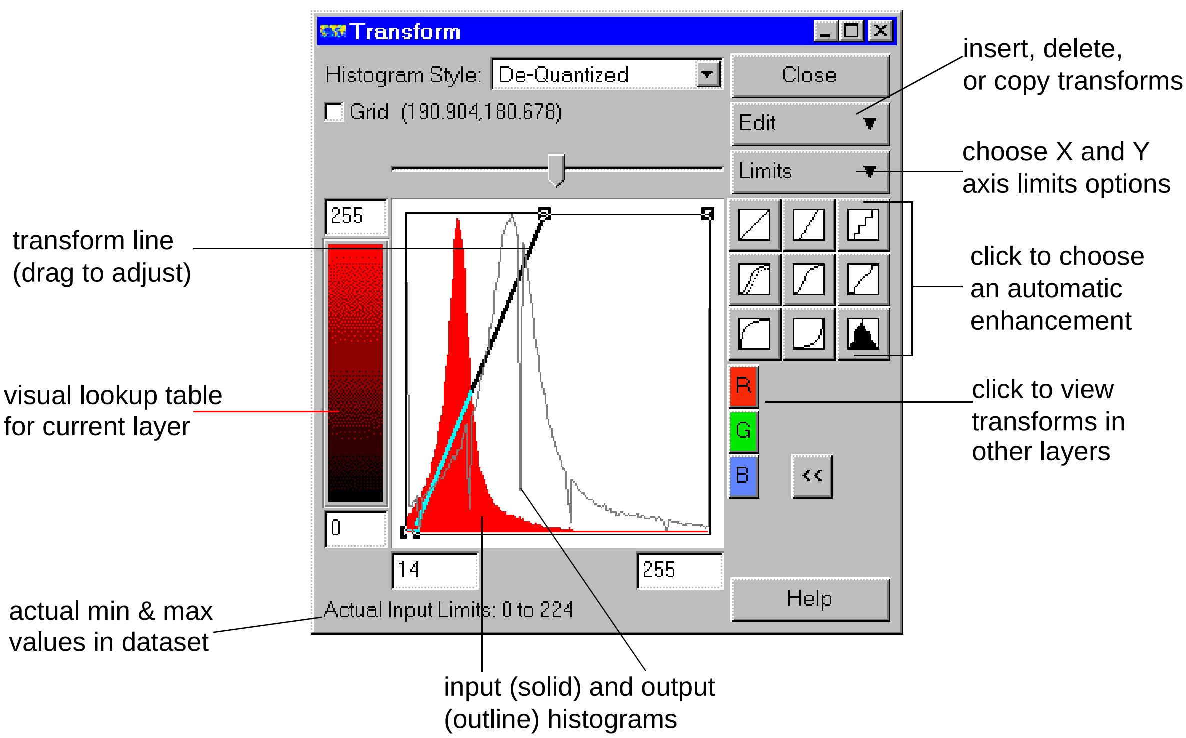
## The Transform buttons

By default, most raster data layers in ER Mapper have two Transform buttons in the algorithm process diagram. One applies a transform *before* a formula (pre-formula), and the other applies a transform *after* a formula (post-formula). You can also insert and append additional transforms in either location to create more complex contrast enhancements.




## The Transform dialog box

When you click on one of the Transform buttons in the process diagram, the **Transform** dialog box opens. This dialog provides many interactive controls for enhancing contrast and modifying color mapping.




A key concept in using the **Transform** dialog is the *transform line*, because this line controls mapping of data values to display brightness or colors. To move the line, simply drag it to a new location, or click buttons that automatically position the line for common enhancement techniques (such as histogram equalization).

# Hands-on exercises

These exercises introduce you to the basic features of the **Transform** dialog box, and how to use them to enhance image contrast and color mapping.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Edit the transform for a particular raster data layer
- Apply linear and piecewise linear transforms
- Edit the input (data) and output (display) ranges for a transform
- Use the automatic contrast enhancement options
- Apply an “area specific” contrast stretch to an image

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

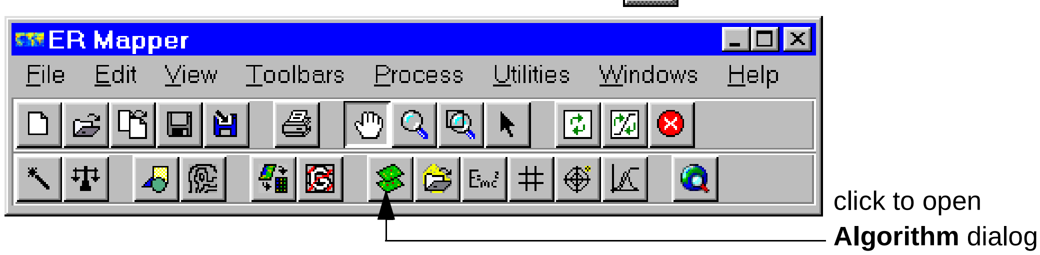
# 1: Viewing image histograms

***Objectives***

Learn to view and understand the histogram for a dataset.

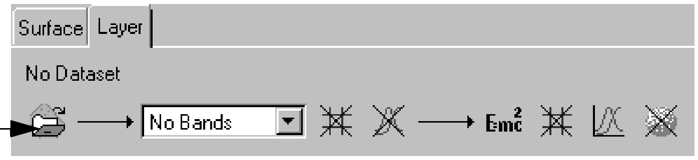
## Load and display an image in greyscale

1 On the main menu, click the **Edit Algorithm** button.




An image window and the **Algorithm** dialog box open. (This is a shortcut for choosing **Algorithm** from the **View** menu.)

2 In the **Algorithm** dialog, click the **Load Dataset**  button..




**Load Dataset** button

3 From the **Directories** menu (on the **Raster Dataset** dialog), select the path ending with **\examples**.

4 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘SPOT_Pan.ers’ to load it into the Pseudo layer.

5 Click the **Surface** tab, then select **greyscale** from the ‘Color Table’ list.

ER Mapper redisplays the image in greyscale.

6 Click the **Layer** tab again to display the process diagram.

This dataset is a SPOT Panchromatic satellite image of the San Diego, California area. (The image is initially somewhat dark, and you will improve the contrast later.)

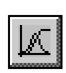
## View the histogram for the SPOT Pan dataset

1 Click on the post-formula **Edit Transform Limits**  button in the process diagram.


post-formula **Edit Transform Limits** button

The **Transform** dialog box opens. The histogram for the SPOT Pan dataset is displayed in the central portion of the dialog.

A *histogram* is graphical display of the relative frequency distribution of values in a dataset. In this case, most of the data values occur in the lower part of the 0 to 255 data range possible for SPOT Pan datasets. Peaks in the histogram show where there are many pixels with similar data values, and often indicate identifiable features in an image.

**Tip:** You can also open the **Transform** dialog for the selected algorithm layer directly from the main menu using the  button.

### View the current pointer location inside the histogram window

1 Point the mouse to any location inside the central histogram window.

The X and Y axis data values at that point are displayed in the upper-left portion of the dialog (below ‘Histogram Style’). The X location (first value) is the image data value, and the Y location (second value) is the screen brightness or LUT value.

2 Position the pointer in the lower-right portion of the histogram window.

You see a high X value because you are at the upper end of the data range, and a low Y value because you are at the lower end of the display or lookup table range.

3 Position the pointer in the upper-left portion of the histogram window.

You see a low X value because you are at the lower end of the data range, and high Y value because you are at the upper end of the display or LUT range.

### Close the Algorithm dialog

1 Click **Close** on the **Algorithm** dialog to close it.

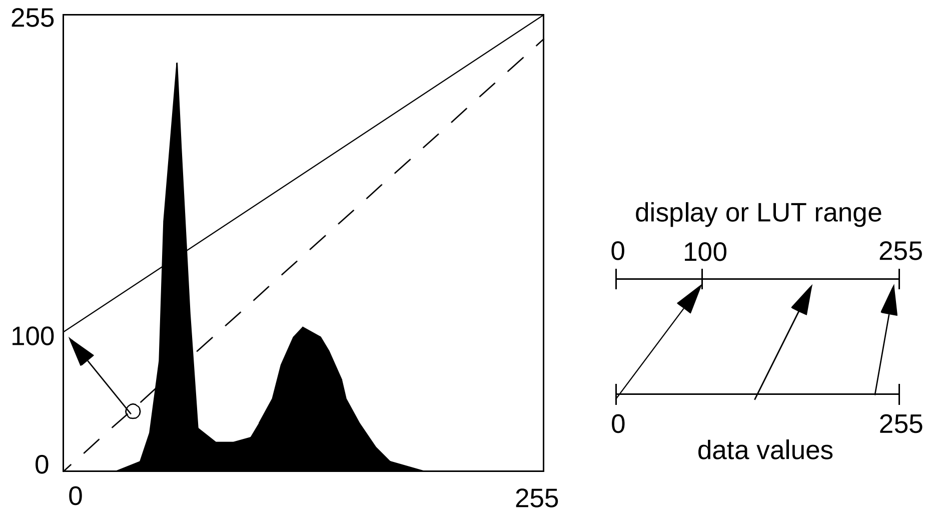
## 2: Using linear transforms

***Objectives*** Learn to use simple linear transform adjustments to perform lightening and darkening of images, and increase or decrease image contrast.

### Apply a linear lightening effect to the image

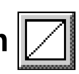
Whenever you display data in a Pseudo layer, the colors in the lookup table (greyscale in this case) are shown in a color bar along the Y axis. This lets you see how the position of the transform line affects the way the LUT colors are used to display the image.

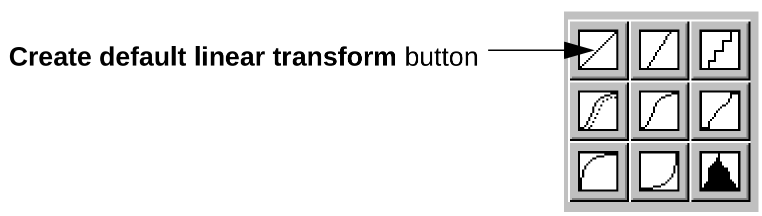
1 As shown in the diagram below, drag the circled part of the transform line up to the left along the left-hand vertical axis.




The image lightens. As shown in the right-hand diagram, you have adjusted the transform line to exclude values of about 0-100 on the display (vertical) axis, which correspond to the darker shades of grey in the greyscale lookup table. Now the entire 0-255 range of data on the X (horizontal) axis is mapped to only the lighter shades of grey in the color table, causing the image to appear lighter.

Also notice that a second outline histogram appears in the window. This is the *output histogram*, and it represents how your change affected the distribution of colors in the image. (The output histogram represents the distribution of values on the Y or display axis.)

2 On the **Transform** dialog, click the **Create default linear transform**  button.

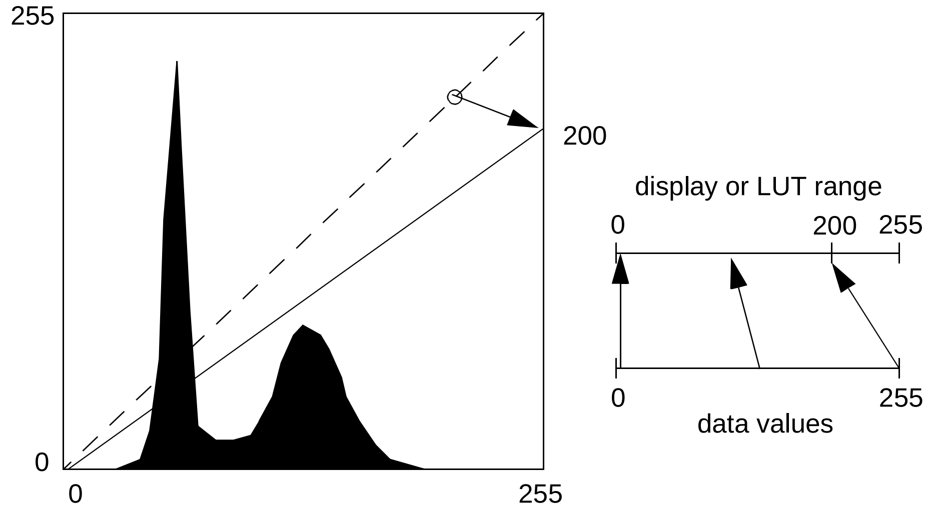



**Tip:** Pass the mouse over the button to see the button name (tooltip).

ER Mapper returns the transform line to its default position and redisplays the image. (The default position is a straight linear transform, where the line's X position is equal to its Y position. This also makes the output histogram the same as the input histogram, so it is no longer visible.)

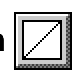
## Apply a linear darkening effect to the image

1. As shown in the diagram below, drag the circled part of the transform line down to the right along the right-hand vertical axis.




The image darkens. As shown in the right-hand diagram, you have adjusted the transform line to exclude values of about 200-255 on the display (vertical) axis, which correspond to the lighter shades of grey in the lookup table. Now the entire 0-255 range of data on the X (horizontal) axis is mapped to only the darker shades of grey, causing the image to appear darker.

Also notice that the linear darkening effect caused the output histogram to shift left of the input histogram (whereas the lightening effect it shifted it right).

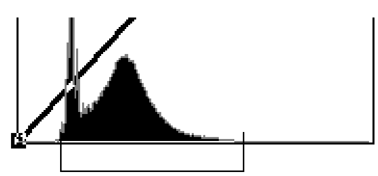
2. Click the **Create default linear transform**  button again.

The transform line returns to its default position and the image redisplays.

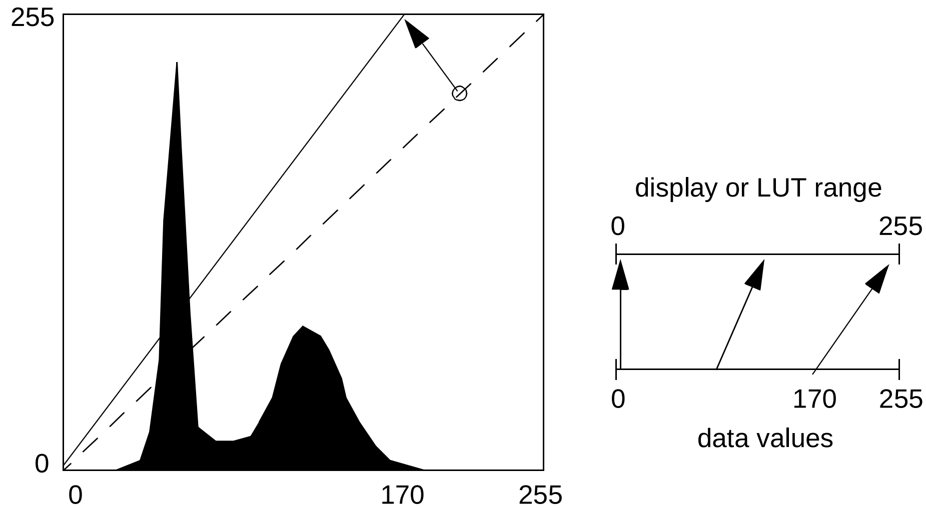
## Apply a linear contrast stretch to increase image contrast

1. Point to the far right-hand edge of the histogram (at the bottom of the slope).

Note that X value displayed in the upper-left is about 170. Even though the highest actual dataset values are close to 255, there are very few values between about 170 and 255 (as indicated by the frequency shown in the histogram).

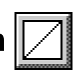


2 As shown in the diagram below, drag the circled part of the transform line up to the left along the horizontal axis.




The image contrast increases. Now the contrast between light and dark parts of the image is enhanced, making spatial features easier to visually interpret. In this case, you adjusted the transform line to map data values of about 170-255 on the horizontal axis to the lightest color in the lookup table (white), and spread the remaining data values (0-169) over the entire range of grey shades.

This mapping better utilizes the dynamic range of grey shades in the lookup table, which improves image contrast. (This effect is often called *histogram clipping* because it clips the tail off the histogram.)

3 Click the **Create default linear transform**  button.

# 3: Highlighting features

***Objectives***

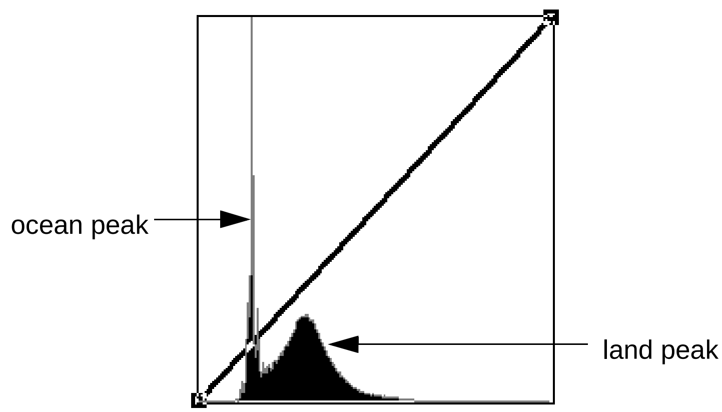
Learn to use piecewise linear transforms to create more complex contrast adjustments that highlight a specific range of values or a feature in an image.

In contrast to the simple transform adjustments you used earlier, piecewise linear transforms break the transform line into several parts (or “pieces”). Each piece of the line can have a different slope (X-Y relationship), which lets you modify the mapping of that range of data differently from data ranges mapped with other pieces of the line. Piecewise linear transforms lets you create more complex types of contrast enhancements.

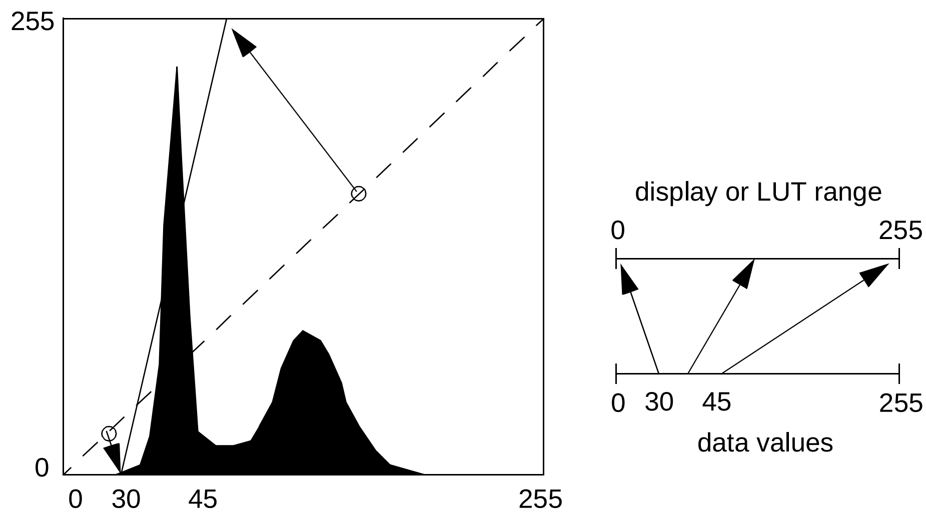
## Adjust the transform to maximize contrast in the ocean areas

The image you are working with is a SPOT Panchromatic satellite image, which records the amount of light reflected from the earth's surface (similar to an aerial photograph). Notice that the image histogram has two peaks that provide information about features in the dataset:

- One very tall, narrow peak on the left–these are primarily the *ocean areas* in the image. Ocean areas typically have low reflectance values that fall within a very narrow range (since the sea surface has little variation compared to the land).
- Another smaller, wider peak to the right–these are primarily the *land areas* in the image. Land areas typically have higher reflectance values than ocean, and the values are spread out over a much wider range (since land areas are comprised of a variety of different cover types).




1 As shown in the diagram below, drag the transform line in two different places–once down the left edge of the ocean peak in the histogram, and another up to the top in line with the right edge of the ocean peak

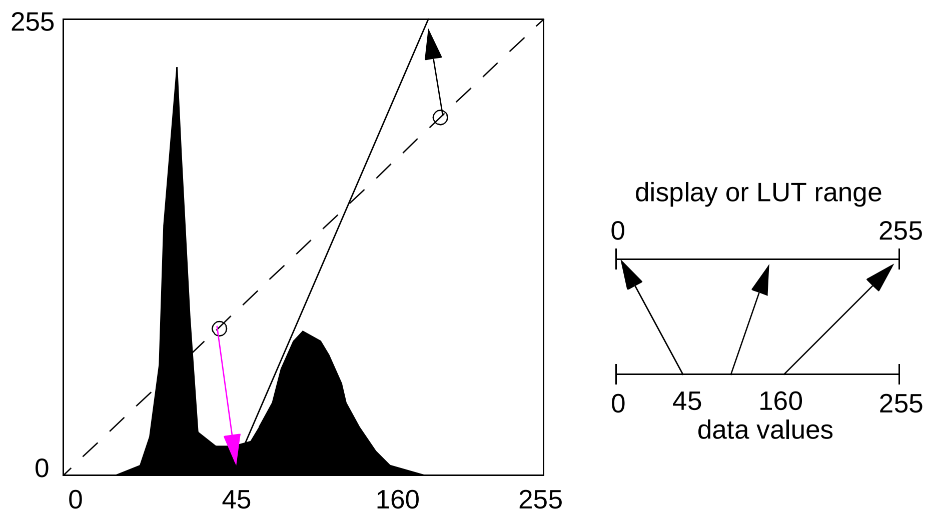


The contrast in the ocean areas is enhanced, while most land areas are displayed as white. In this case, you adjusted the transform line to map the narrow range of data values 30-45 (ocean) over the entire range of grey shades in the lookup table. Data values lower than 30 are mapped to the lowest slot in the lookup table (black) and data values over 45 (mostly land) are mapped to the highest slot (white). The subtle reflectance patterns in the ocean areas are now easier to visually interpret because the entire grey shade range is used to represent them.

2 Click the **Create default linear transform** button.

## Adjust the transform to maximize contrast in the land areas

1 As shown in the diagram below, drag the transform line in two different places–once down the left edge of the land peak in the histogram, and another up to the top in line with the right edge of the land peak.




The contrast in the land areas (data values between about 45 and 160) is enhanced, while most ocean areas (30-45) are displayed as pure black.

2 Click on the **Create default linear transform** button.

# 4: Modifying data and display ranges

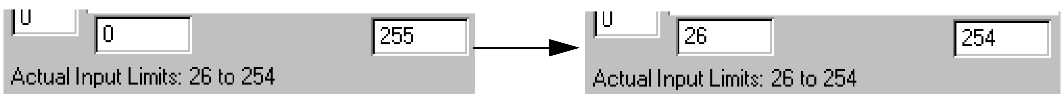
***Objectives*** Learn to use the **Limits** menu options to specify exact ranges of data values and display values to modify image contrast and color mapping.

## Use Limits to Actual to set the X axis data range

Look at the 'Actual Input Limits' field on the **Transform** dialog, and note that it shows values between approximately 25 and 254. ER Mapper records the actual range of data values it finds in the dataset and displays the results in the 'Actual Input Limits' field.

1 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

The data range displayed on the horizontal axis minimum and maximum values changes to match the Actual Input Limits field.




X axis transform min & max set to actual limits of dataset

The image darkens slightly. Since there was no data between zero and 24, **Limits to Actual** shifted the entire histogram slightly to the left on the X axis, so the data is mapped to slightly darker shades of grey on the lookup table.

**Limits to Actual** is a very commonly used option because it allows you to work with only the actual range of data in an image. This is always necessary for datasets that do not use an 8-bit (0-255) data range, such as a 16-bit DEM or radar dataset. **Limits to Actual** is very often the first step in adjusting contrast, followed by another adjustment such as one of the automatic transform options discussed later.

## Set the input limits to 99% of the histogram range

1 From the **Limits** menu, select **Input Limits to 99% Histogram**.

The data range on the horizontal axis changes to approximately 34 to 153, and the histogram itself widens to fill the X axis range.

**Input Limits to 99% Histogram** clips off 1% of all data values in the image, taking 0.5% from the lower end, and 0.5% from the upper end. (The results of the clipping indicates that only 1% of the image data values fall in the ranges 24-34 and 154-254.)

Now image lightens quite a bit since only the range of data where the most values occur is being mapped to the grey shades. (The 0.5% of data values at the upper and lower ends are mapped to white and black respectively.)

---

**Note:** **Input Limits to 99% Histogram** works from the range of data displayed in the current histogram, which can be different than the actual dataset limits if you have entered your own axis limits (as discussed later).

---

## Set exact input limits to highlight the ocean data range

The two text boxes below the histogram window let you enter your own values to define the minimum and maximum X axis limits.

1 Inside the histogram window, point to the right side of the tall, narrow peak in the histogram.

As mentioned previously, this peak corresponds primarily to the ocean portions of the satellite scene. Note that the X value is about 50, so the ocean peak has a minimum value of about 34 and a maximum value of about 50.

2 Select the text in the X axis maximum text box (currently about 153), and enter a value of **50**.


change value to **50**

Now the ocean areas are mapped to the entire range of grey shades to highlight subtle features, while the land areas (values greater than 50) are mapped to white. This is another method to map a specific range of data to the entire display range. (Earlier you adjusted the transform line to accomplish the same enhancement.)

---

**Tip:** You can edit the Y axis minimum and maximum fields to exclude certain colors in the LUT from the display, or to rescale the data into a new range. See the section "Additional tips and information about transforms" at the end of this chapter for details.

---

# 5: Using standard contrast enhancements

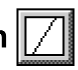
***Objectives*** Learn to use the standard enhancement options such as histogram clipping, Histogram Equalization, Gaussian Equalization, and level slicing.

The automatic transform buttons are displayed on the right side of the **Transform** dialog box. Any time you select one of these options, ER Mapper automatically updates the image display.

## Reset the image display to greyscale and the default transform

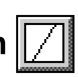
1 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

## Apply an autoclip transform to the data

1 On the **Transform** dialog, click the **Create autoclip transform**  button.


ER Mapper automatically repositions the transform line, and the image updates automatically with increased contrast.

Autoclipping clips off the “tails” of the histogram to map the more frequently occurring data values to the selected display range. By default, ER Mapper performs a 99% autoclip that clips 0.5% of the data at the high and low ends of the data range. Outlying data values on the low end of the data range are assigned zero in the display range (black in this case), and outliers on the high end are given the maximum value (usually 255, white in this case). (This is similar to the Input Limits to 99% Histogram used earlier, but the transform line is automatically adjusted rather than the data range.)

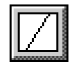
2 This time, double-click the **Create autoclip transform**  button.

A dialog box appears to let you enter any autoclip percentage. The default is 99%.

3 Enter the value **95**, then click **OK**.

The transform line is repositioned closer to vertical to clip the outlying 5% of the histogram frequency distribution (2.5% of the data values from the high and low ends). The image displays with greater contrast between light and dark areas.

**Tip:** The steeper the slope of the line, the more contrast that is created in the image. For best visual results, keep your autoclip percentages greater than 90%. Values around 99 or 99.5% are most commonly used, but lower percentages are sometimes a good alternative for enhancing datasets with many outlying values.

4 Double-click the **Create autoclip transform**  button again, enter the value **99**, then click **OK**.

A 99% autoclip transform is again applied an the image is updated.

## Apply a Histogram equalize transform to the data

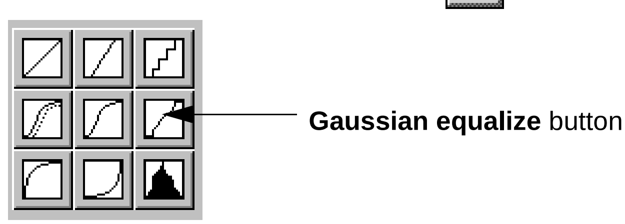
1 On the **Transform** dialog, click the **Histogram equalize**  button.


ER Mapper creates a complex piecewise linear transform line and updates the image.

*Histogram equalization* (also called uniform distribution stretching) automatically adjusts the transform line so that image values are assigned to display levels based on their frequency of occurrence. More display values are assigned to the most frequently occurring portion of the histogram, so the greatest contrast enhancement occurs in the data range with the most values (peaks in the histogram). The overall effect creates an image that has an approximately equal number of each color or brightness level. Histogram equalization usually creates an image with very strong contrast between dark and light areas. In some cases, it can also saturate light and dark areas which can obscure detail.

## Apply a Gaussian equalize transform to the data

1 On the **Transform** dialog, click the **Gaussian equalize**  button.

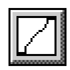


ER Mapper creates a complex piecewise linear transform line and updates the image.

*Gaussian equalization* automatically adjusts the transform line so that image values are assigned as needed to make the output (display) values occur with a Gaussian distribution. (A Gaussian, or “normal” distribution, is characterized as producing a bell-shaped histogram. Notice that the output histogram has a shape similar to this.)

Gaussian equalization is useful when data is skewed in such a way that features could be abnormally dark or light if stretched linearly. This technique prevents saturation of light or dark areas, and most pixels have mid-range brightness values with only a few in the extreme dark or light display regions.

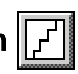
---

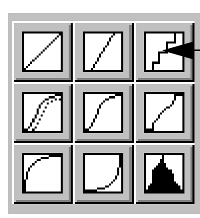
**Tip:** You can set the number of standard deviations used for the Gaussian equalize function by double-clicking on the  button. Smaller values produce more contrast and higher values less contrast. The default is 3 standard deviations.

---

## Apply a level slice transform to the data

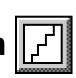
Level slicing (or density slicing) divides the image into discrete colors and removes transitional colors between them. The resulting images appears to be divided into contours or “slices,” each displayed in a specific color. This technique can be useful for looking at data in discrete intervals and colors.

1 On the **Transform** dialog, click the **Create level-slice transform**  button.



**Create level-slice transform** button

ER Mapper creates a stair-stepped transform line at regular intervals.

2 Double-click the **Create level-slice transform**  button.

A dialog box appears to let you enter a number of steps for the transform line.

3 Enter the value **3**, then click **OK** to close the dialog.

The transform line is divided into three steps and the image is updated.

The stair-stepped transform divides the image into three shades–black for mostly ocean areas, mid-grey for middle reflectance land areas (such as vegetation), and white for high reflectance land areas (such as roads, sand, and airport runways). Level slicing is especially useful for quickly viewing digital terrain and geophysical datasets as contours of solid colors.

---

**Tip:** To apply any of the standard enhancements to an RGB algorithm, select each layer to view its transform and select the desired enhancement. You can move between layers in an RGB algorithm either by clicking on the layer the **Algorithm** dialog, or by clicking the R, G and B buttons in the **Transform** dialog.

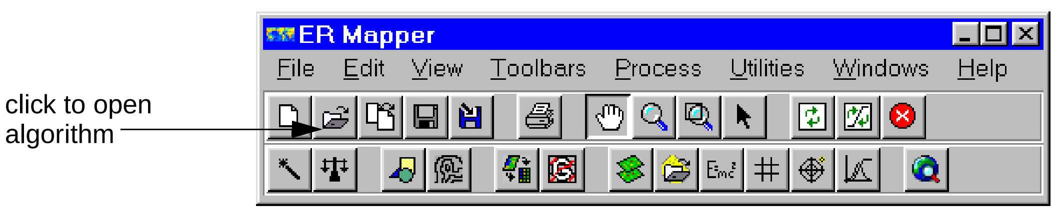
---

# 6: Using automatic contrast enhancement

***Objectives*** Learn to use the special version of the **GO** button that automatically enhances image contrast. This lets you can quickly view various dataset band combinations and images without needing to manually adjust the contrast each time.

## Open an RGB algorithm

1 On the main menu, click the **Open** button.



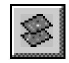

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the 'Data_Types' directory, then open the 'Landsat_TM' directory.

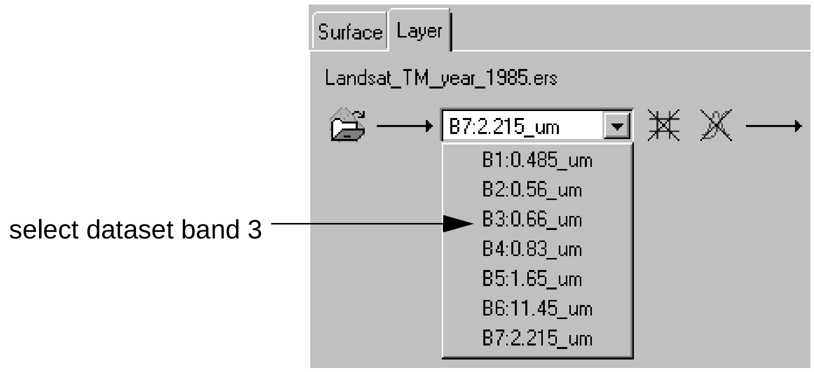
4 Double-click on the algorithm named 'RGB_741.alg.'

ER Mapper displays bands 7, 4 and 1 of a Landsat TM image of the San Diego, California area.

## Change the band combination to RGB=321

1 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** dialog.

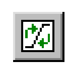
2 On the **Algorithm** dialog, change the dataset band in the Red layer to **B3:0.66_um**.

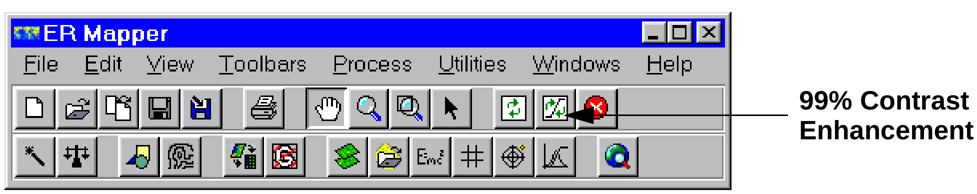



3 Change the dataset band in the Green layer to **B2:0.56_um**.

Notice that the image displays in reddish hues (this band combination usually creates a natural color image when contrast stretched appropriately). This is caused by the current transforms for the Red and Green layers still being set to the data limits for the previous bands (7 and 4) rather than the new bands you selected (3 and 2).

## Use the 99% Contrast Enhancement button

1 On the main menu, click the **99% Contrast Enhancement**  button.




ER Mapper performs some internal operations, then re-runs the algorithm to display the image with an appropriate contrast stretch.

The **99% Contrast Enhancement** button is actually a batch script that automatically performs the following sequence of operations:

**GO->Limits to Actual->GO->99% autoclip->GO**

get limits of dataset

set transform limits to actual

generate new histogram

apply 99% clip transform

display image on-screen

## View different dataset band combinations

1 Select **B4:0.83_um** for the Red layer, **B3:0.66_um** for the Green layer, and **B2:0.56_um** for the Blue layer.

2 Click the **99% Contrast Enhancement** button.

A contrast enhanced image of an RGB=432 band combination displays. Vegetation is shown in red, and urban areas in cyan and grey.

3 Select **B5:1.65_um** for the Red layer, and **B4:0.83_um** for the Green layer.

4 Click the **99% Contrast Enhancement** button.

A contrast enhanced image of an RGB=542 band combination displays. Vegetation is shown in green, and urban areas in magenta.

---

**Tip:** The **99% Contrast Enhancement** button saves you the contrast enhancement steps of setting each layer to Limits to Actual and applying an autoclip transform. However, it will also reset any other transform adjustments you made manually (for example Gaussian or Histogram equalize).

---

## View a different Landsat TM dataset

1 In the **Algorithm** dialog, click the **Load Dataset** button.

2 From the **Directories** menu (on the **Raster Dataset** dialog), select the path ending with **\examples**.

3 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Landsat_TM.ers’ to load it into all three layers.

4 In the process diagram, click the post-formula **Open transform editor** button for the Red layer.

The histogram and transform from the previous San Diego Landsat dataset is still displayed.

5 Click the **99% Contrast Enhancement** button and watch the **Transform** dialog as ER Mapper automatically adjusts it.

The transform is automatically adjusted to account for the new dataset limits and the RGB=542 band combination is displayed. This image is a Landsat TM image of the Netherlands coastal area in Europe.

---

**Note:** To speed processing of the data, ER Mapper internally runs the algorithm at low resolution, then processes the final screen image at the full window size resolution. Therefore the input (X) axis limits in the **Transform** dialog (calculated at low resolution) may not exactly match the Actual Input Limits field (calculated from the final processing). You can manually reset the limits at this point to fine tune the contrast, but usually this is not needed.

---

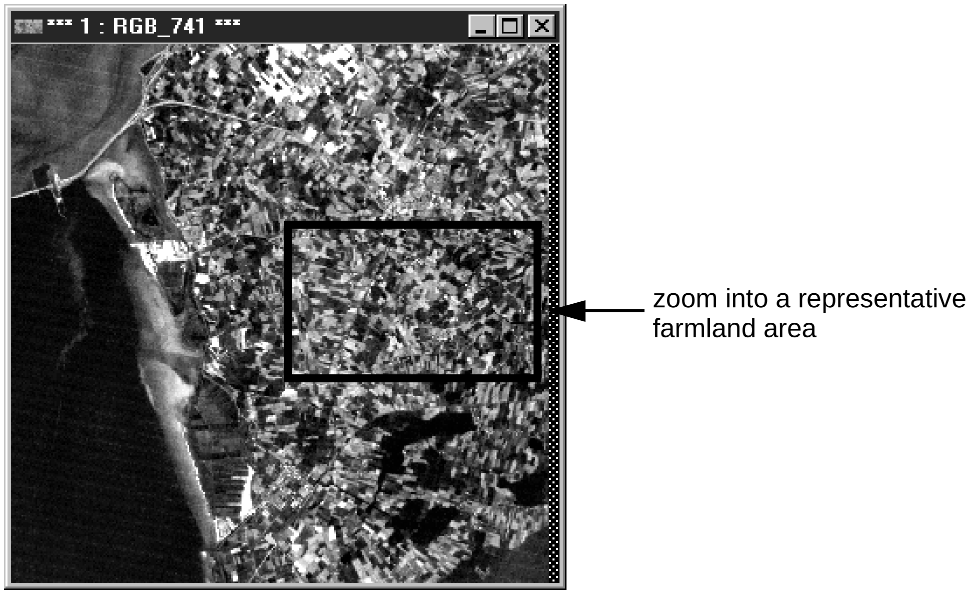
6 Try various band combinations such as RGB=741, RGB=321, and others, then click **99% Contrast Enhancement** to display the new composite image.

## Apply an area-specific contrast stretch

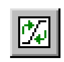
With images that contain a variety of features or surface cover types, it is often desirable to enhance one part of the image that contains the primary features of interest at the expense of other parts of the image. For example, this Netherlands Landsat image contains areas of farmland, towns and ocean. You may want to sacrifice some contrast in the urban and ocean areas to maximize contrast in the farmlands area. This is called *area specific* contrast enhancement.

1 On the main menu, click the **Zoom Box Tool** button.

2 Drag a zoom box to zoom in on the farmland area indicated below:




After zooming, the ‘Actual Input Limits’ field on the **Transform** dialog shows the range of data values *only* within the zoomed area. (This is also a quick way to view the range of values in any subsection of the image.)

3 Click the **99% Contrast Enhancement**  button.

The transforms in all three layers (red, green and blue) are automatically set to apply a 99% clip using the range of data inside the zoomed area. This creates a contrast enhancement optimized for that specific area.

4 Right-click in the image window, select **Quick Zoom**, then **Previous Zoom**.

ER Mapper zooms out to the full image extents. The contrast enhancement that was optimized for the farm areas is now applied to the entire image.

---

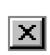
**Tip:** To use this technique effectively, you need to experiment using different areas of the image as your “specific” area to see which give the best result. This technique is typically used to saturate contrast in water or other areas that are considered unimportant for the application.

---

5 Click **Close** on the **Transform** dialog to close it.

## Close the image window and Algorithm dialog

1 Close the image window using the window system controls:

- For Windows, click the  **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned***

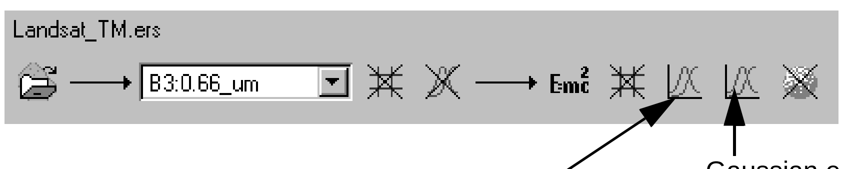
After completing these exercises, you know how to perform the following tasks in ER Mapper:

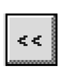
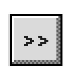
- Edit the transform for a particular raster data layer
- Apply linear and piecewise linear transforms
- Edit the input (data) and output (display) ranges for a transform
- Use the automatic contrast enhancement options
- Apply an “area specific” contrast stretch to an image

## Additional tips and information about transforms

### Using multiple transforms

ER Mapper also lets you use multiple, or sequential, transforms in a single layer. You can add additional transforms before or after the current transform by using the **Insert new transform** or **Append new transform** options under the **Edit** menu on the **Transform** dialog. For example, this lets you apply a 99% clip transform to the data, and then apply a Gaussian equalization to the clipped image.

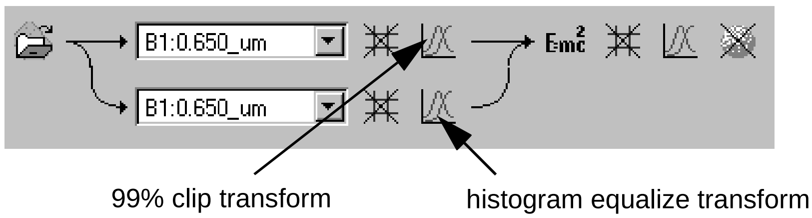



The output histogram of the previous transform is used as the input histogram for the one following it, so the operations are performed in sequence. You can move between multiple transforms in the process diagram by either clicking on the desired  button, or by clicking the **Move to previous transform in layer**  or **Move to next transform in layer**  buttons on the **Transform** dialog.

## Using pre-formula transforms

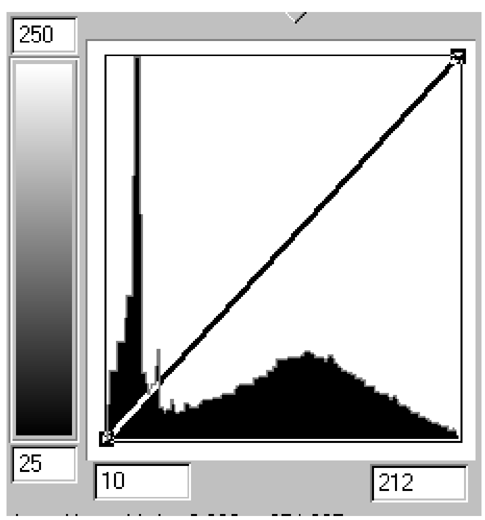
Pre-formula transforms let you rescale or enhance contrast in an image *before* the resulting data is then operated on by formulas or filters. By default, the pre-formula transform button in crossed out, meaning that it is not used in the layer. Most of the time you will use a transform following any formulas or filters you add to an algorithm, but there are also times when pre-formula transforms are useful.

For an example, open the algorithm ‘Hybrid_contrast_stretch.alg’ in the ‘examples\Data_Types\SPOT_Pan’ directory. This algorithm applies a pre-formula 99% clip transform to the data, a pre-formula histogram equalize transform, and then uses a formula to compute a weighted average to create a “hybrid” of the two enhancement techniques.




## Using the Y axis limits to rescale data ranges

The output minimum and maximum range text boxes on the **Transform** dialog also let you rescale the data range by specifying a new range. This can be useful, for example, when you want to linearly rescale a dataset’s range to match the range of another dataset. In this example, the dataset’s actual 10-212 range will be rescaled into a 25-250 range. Any subsequent operations after this transform will operate on the 25-250 range instead of 10-212.




This capability is sometimes used for algorithms that perform dataset merging, brightness balancing or when translation into an specific data range is required. The result can also be written to a new output dataset or saved in a Virtual Dataset.

You can also edit the Y axis min and max values to exclude certain ranges of colors (or image brightness levels) from the image. For example, if you display an image with the ‘greyscale’ color table, a Y axis range of 0-255 means that all 255 colors are available for the image display. If you change the Y maximum value to 200, then colors 201-255 (the light greys) are not used in the image display. This capability is more often used with color tables like ‘pseudocolor’ to display the image using only part of the available colors. (This can also be done by dragging the transform line up to exclude colors as shown in the previous exercise.)

# 7

# Using spatial filters

This chapter explains how to modify raster image data using spatial filtering to enhance edges, highlight structural features, generate slope and aspect images from DEMs, and perform other enhancements to improve visual interpretation. It introduces concepts associated with spatial filtering and gives you practice using ER Mapper's Filter options.

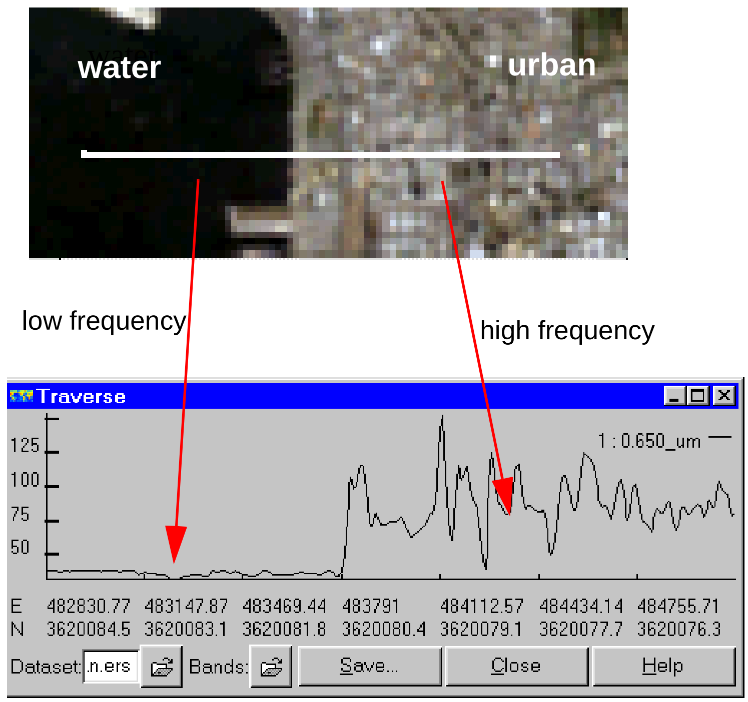
**Note:** For information on frequency domain filtering (Fourier Transforms), see the *ER Mapper User Guide*.

## About spatial filtering

Spatial filtering is a common operation applied to raster image data to enhance or suppress spatial detail to improve visual interpretation. Common examples include applying filters to enhance edge detail in images, or to remove or decrease noise patterns in an image. Spatial filtering is called a “local operation” in image processing because it modifies the value of each pixel in the dataset according to the values of the pixels surrounding it. Filters work by removing certain spectral or spatial frequencies to enhance features in the remaining image.

## Spatial frequency

A characteristic common to all types of raster data is *spatial frequency*, which defines the magnitude of changes in data values per unit distance for any particular part of an image. Areas of an image with small changes or gradual transitions in data values over a given area are termed *low frequency* areas (such as a smooth lake surface). Areas with large changes or rapid transitions are termed *high frequency* areas (such as an urban area with dense road networks). ER Mapper's Traverse feature is an easy way to help visualize spatial frequency.




## Categories of filters

Spatial filters can be divided into three broad categories:

- **Low pass filters** emphasize low frequency detail to smooth out image noise or reduce spikes in the data. Since they de-emphasize detail in an image, low pass filters are sometimes called smoothing or averaging filters.
- **High pass filters** emphasize high frequency detail to enhance or sharpen linear features like roads, faults, and land/water boundaries. High pass filters are sometimes called sharpening filters because they are generally used to enhance detail without affecting low frequency portions of the image.
- **Edge detection filters** emphasize edges surrounding objects or features in an image to make them easier to analyze. Edge detection filters usually create an image with a grey background and black and white lines surrounding the edges of objects and features in the image.

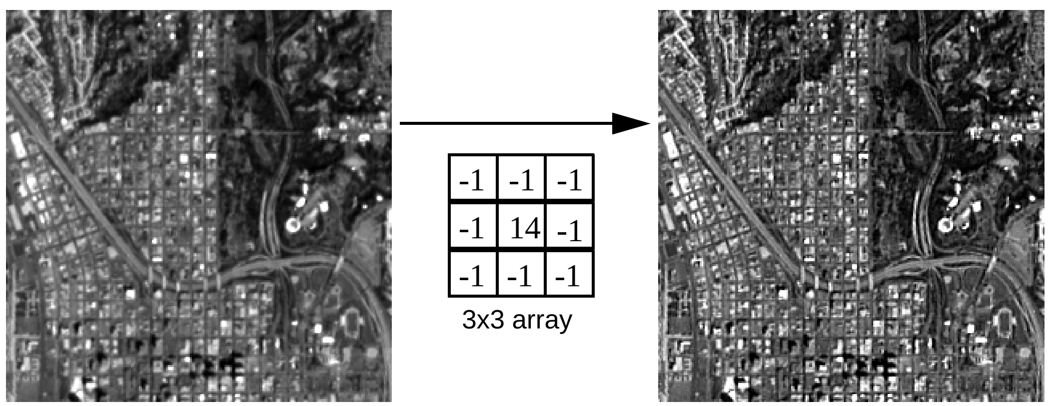
---

**Note:** Filters that generate slope and aspect images from DEM datasets are a special class of filter. These are discussed in this chapter.

---

## How convolution kernels work

Spatial filtering is accomplished by passing a two-dimensional rectangular array (or window) containing weighting values over the image data at each pixel location. The pixel in the center of the window is evaluated according to the surrounding pixels and weighting values defined for each cell in the array, then a new output pixel value is calculated. The window then shifts over to the next pixel and performs the same operation until the entire image has been processed in this manner. This process of evaluating the weighted neighboring pixel values is called two-dimensional convolution, and the filter array is often called a *convolution kernel*.

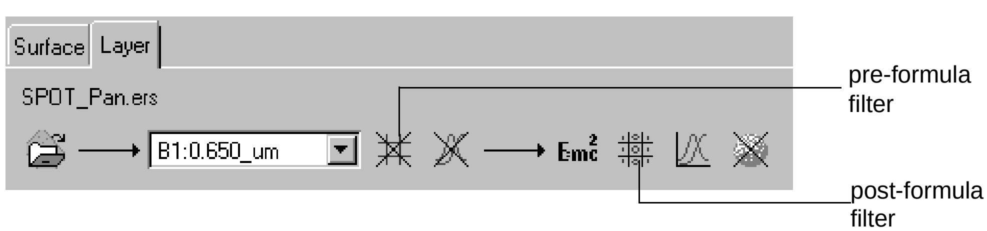


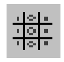

original image

filtered (sharpened) image

## The Filter Editor buttons

By default, each raster layer in ER Mapper has two **Filter editor** buttons in the process stream. One applies a filter *before* a formula (pre- formula), and the other applies a filter *after* a formula (post-formula). You can also insert and append additional filters in either location to create more complex filtering operations.



The button state  indicates that a filter is currently loaded in that position, and  indicates that a filter is not currently loaded.

ER Mapper also lets you use filters that are written in C or Fortran code, and provides several C and Fortran filters as examples. Using C or Fortran allows you implement more complex or specialized filtering techniques that are not possible with simple convolution kernels. There is no limit to the dimensions of filters that can be defined and used in ER Mapper. You can also apply a series or sequence of filters in a single algorithm.

# Hands-on exercises

These exercises give you practice applying filters in ER Mapper, and explain how to insert and delete filters in the process stream using the Filter buttons. You will try various types of filters to evaluate their results.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Insert and delete filters in the process stream diagram
- Apply different types of filters to see their results
- Edit the transform to enhance the contrast of filtered images
- Use filters to generate slope and aspect images from DEMs
- Apply filters in multiple raster layers

***Before you begin...***

Make sure all image ER Mapper image windows and dialog boxes are closed. Only the main ER Mapper menu should be open.

# 1: Adding filters to images

***Objectives*** Learn to apply several types of standard filters to an image, and adjust the contrast of filtered data.

## Open and display a greyscale algorithm

1 On the main menu, click the **Open** button.


An image window and the **Open** file chooser appear.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the directory named 'Data_Types'.

4 In the directory 'SPOT_Panchromatic', load the algorithm 'Greyscale.alg'.

ER Mapper displays a SPOT Panchromatic satellite image of the San Diego, California area in greyscale.

5 Drag the image window by its lower-right corner to make it about 50% larger.

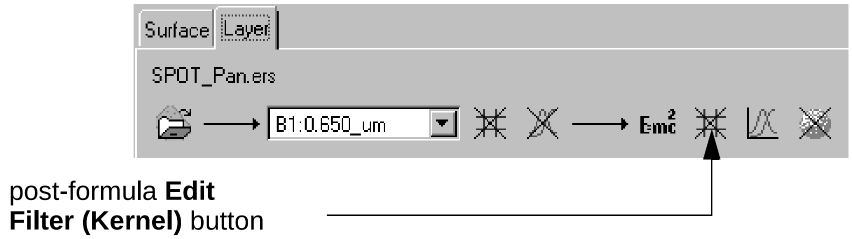
6 Right-click on the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

ER Mapper redraws the image to fill the larger window size.

## Apply a low pass (smoothing) filter to the image

1 On the main menu, click the **Edit Algorithm** button to open the **Algorithm** dialog.

2 In the process diagram, click the post-formula **Edit Filter (Kernel)**  button.




The **Filter** dialog box appears–drag it underneath the image window. This dialog lets you load standard filters supplied with ER Mapper, and create and save your own filters.

3 From the **File** menu, select **Load...**.

The **Load filter** file chooser dialog opens.

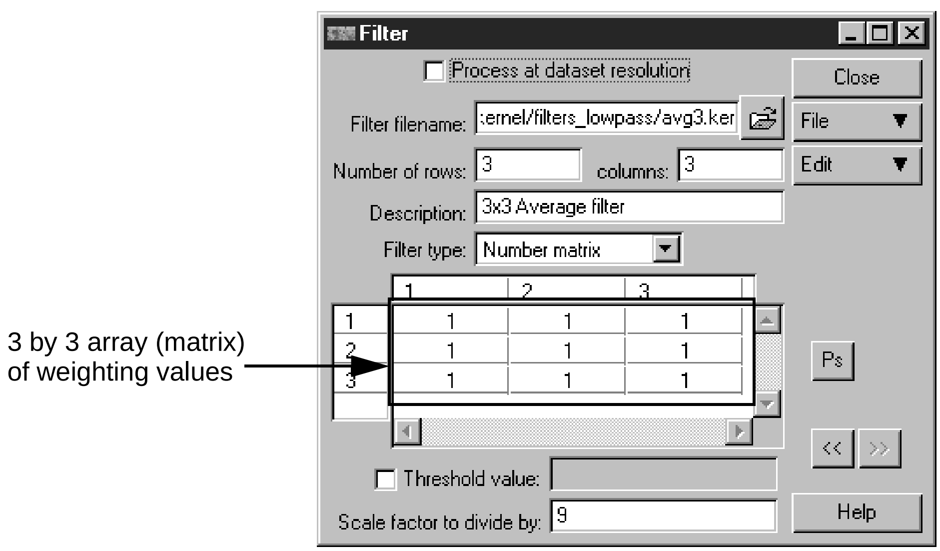
4 From the **Directories** menu (on the **Load filter** dialog), select the path ending with **\kernel**.

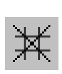
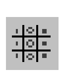
5 Open the 'filters_lowpass' directory.

A list of standard low pass filters with a ".ker" extension appear.

6 Double-click on the filter 'avg3.ker' to load it.

The filter settings are displayed in the dialog box fields. The array (or matrix) of nine weighting values defining the 3 by 3 filter appear in the central scroll window (the "filter matrix window").




In the process diagram, notice that the **Edit Filter (Kernel)** button changes from  to  to indicate that a filter is now loaded in that position.

The low pass filter creates a blurring or averaging effect. In general, low pass filters work by taking the average value of all pixels in the matrix and assigning it to the center pixel, thus smoothing out jumps or spikes in the data. Low pass filters can be useful for reducing periodic “salt and pepper” noise or speckling in an image to make it easier to interpret the major features.

## Delete the low pass filter from the process stream

1 From the **Edit** menu (on the **Filter** dialog), select **Delete this filter**.

The contents of the **Filter** dialog clear, and the filter is deleted from the algorithm (indicated by the button).

The image is rendered without the averaging filter, so it appears as it did before.

## Apply a high pass (sharpening) filter to the image

1 On the **Filter** dialog, click the button next to ‘Filter filename.’

(This is the same as selecting **Load** from the **File** menu.)

2 From the **Directories** menu, select the **\kernel** path.

3 Open the ‘filters_high_pass’ directory, then double-click on the filter ’Sharpen2.ker’ to load it.

The array of nine weighting values defining the 3 by 3 filter appears.

The Sharpen2 filter enhances high frequency detail. In general, high pass or sharpening filters tend to increase the local contrast around edge features in the image, so the image appears “sharper” or crisper. Features like major roads and borders between urban and vegetated areas are therefore more clearly defined.

## Apply a directional gradient edge detection filter

1 On the **Filter** dialog, click the button next to ‘Filter filename.’

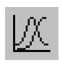
2 From the **Directories** menu, select the **\kernel** path.

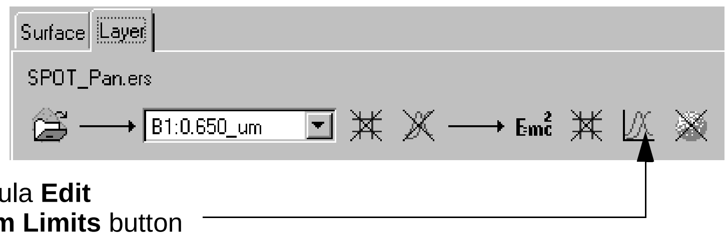
3 Open the ‘filters_sunangle’ directory, then double-click on the filter ’North_West.ker’ to load it.

The North_West filter is designed to isolate and “raise” edge features in an image trending in a northeast to southwest direction. The data range produced by this filter is different from the previous image, so you need to adjust the transform to improve the contrast.

**Note:** When you load a new filter over an existing one (as you did here), the new filter *replaces* the previous one. (The effects of the two filters are *not* added together). You can append or insert additional filters to create a sequence of filters if desired (discussed later).

## Adjust the contrast of the filtered image

1 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button in the process diagram.

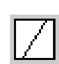



The **Transform** dialog opens. Note the ‘Actual Input Limits’ are about -500 to +500. This is the new data range created by applying the edge detection filter to the original SPOT Pan dataset.

2 On the **Transform** dialog, select **Limits to Actual** from the **Limits** menu.

The X axis limits change to match the Actual Input Limits.

The image contrast is enhanced and most pixels are assigned a mid-grey color in the greyscale lookup table.

3 Click the **Create autoclip transform**  button.

ER Mapper redisplays the image with enhanced contrast. Edge features such as roads and land/water borders are highlighted in black and white, while features without sharp changes (such as ocean) are shown in grey.

This filter highlights edge features in an image as if a sun were shining from the northwest (upper-left) of the image. Therefore, edge features facing northwest are bright, while opposite (southeast) facing edge features are dark (shadowed). Edge enhancement filters are often used in structural geology applications to highlight faults and lineaments occurring in a specific compass direction.

4 Click the **Close** on the **Transform** dialog.

## Apply a Northeast gradient edge detection filter

1 On the **Filter** dialog, click the  button next to ‘Filter filename.’

2 Move the **Load filter** dialog next to the image window.

3 Click ***once*** on the filter 'North_East.ker' to select it, then click **Apply**.

The filter is loaded and the **Load filter** dialog stays open.

This time edge features facing northeast are highlighted in white (features trending in a northwest to southeast direction). Since the data range produced by applying the North_East filter is similar to that produced by the North_West filter, you do not need to adjust the contrast.

4 Try other sun angle filters by selecting one in the **Load filter** dialog, clicking **Apply** to load it.

5 When finished, click **Cancel** on the **Load filter** dialog, and **Close** on the **Filter** dialog.

# 2: Generating slope and aspect images

***Objectives*** Learn to add filters to generate slope and aspect images from a digital elevation model (DEM) dataset.

## Open a greyscale DEM algorithm

1 On the main menu, click the **Open** button.

2 From the **Directories** menu (on the **Open** dialog), select the **\examples** path.

3 Open the 'Data_Types' directory, then open the 'Digital_Elevation' directory.

4 Double-click on the 'Greyscale.alg' algorithm to open it.

ER Mapper displays a digital elevation model (DEM) dataset on the San Diego, California area. The image is displayed with a greyscale color table, so low elevations are dark and high elevations are light.

## Load a filter to generate a slope degrees image

1 In the process diagram, click the post-formula **Edit Filter (Kernel)** button.

2 On the **Filter** dialog, click the button next to 'Filter filename.'

3 From the **Directories** menu, select the **\kernel** path.

4 Open the 'filters_DEM' directory, then double-click on the filter 'slope_degrees.ker' to load it.

The filter settings are displayed in the dialog box fields. As indicated, this 3 by 3 filter is written in C code.

5 Click the **99% Contrast enhancement** button.

After some internal calculations, ER Mapper displays an image showing steep slopes in light greys, and shallow slopes in dark greys. (The **99% Contrast enhancement** button automatically sets the appropriate transform limits for you.)

*Slope* is a measure of steepness of terrain, or the rate of change in elevation in the vicinity of a given part of the topographic surface. This slope filter generates data values in degrees from the horizontal, so the slope values range from 0 (flat terrain) to 90 degrees (vertical terrain). (ER Mapper also provides a filter to calculate slopes in percent named 'slope_percent.ker.')

---

**Note:** Since few geographic areas will have very steep slopes, the output data range will usually not occupy the entire possible data range of slope values. (In the previous example, the steepest slope was 71 degrees but 90 is possible.) If you want to force the color scale to be mapped to the entire possible range of slope values, you can manually set the transform X axis limits to 0-90 for the 'slope_degrees' filter and 0-200 for 'slope' (percent) filter.

---

## Load a different filter to generate an aspect image

1 On the **Filter** dialog, click the button next to 'Filter filename.'

2 Double-click on the filter 'aspect.ker' to load it.

The filter settings are displayed in the dialog box fields. As indicated, this 3 by 3 filter is also written in C code.

3 Click **Close** on the **Filter** dialog.

4 Click the **99% Contrast enhancement** button.

ER Mapper displays an image showing different aspects of the elevation data in various shades of grey.

*Aspect* is a measure of the compass direction a topographic surface faces at a given point. Aspect is computed as a horizontal angle in degrees of azimuth from due north (which is zero degrees). The aspect filter generates aspect values ranging from 0 to 360 degrees (a value of 361 degrees is also generated for a flat surface with no aspect). East-facing slopes have an aspect of 90 degrees, south facing slopes 180 degrees, and west-facing slopes 270 degrees.

### Change the color table to 'azimuth'

1 On the **Algorithm** dialog, select the **Surface** tab.

2 From the 'Color Table' list, select **azimuth**.

The image redisplays in four main colors–one for each primary compass direction. Areas facing primarily north display in black, easterly in yellow, southerly in white, and westerly in blue.

---

**Note:** 'Azimuth' is a special "wrap around" color table that has the same color (black) at the top and bottom end of the color range. This type of color table is often used to display aspect images. (To see the color set, open the **Transform** dialog.) You can use any other multiple color lookup table as well to display aspect images.

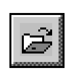
---

3 On the **Algorithm** dialog, select the **Layer** tab again to display the process diagram.

# 3: Adding filters to multiple layers

***Objectives*** Learn to load a filter into several layers of data, for example to apply a filtering operation to the Red Green Blue layers of an RGB algorithm. Also learn to move between algorithm layers using buttons on the **Filter** dialog box.

### Open a SPOT XS RGB algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

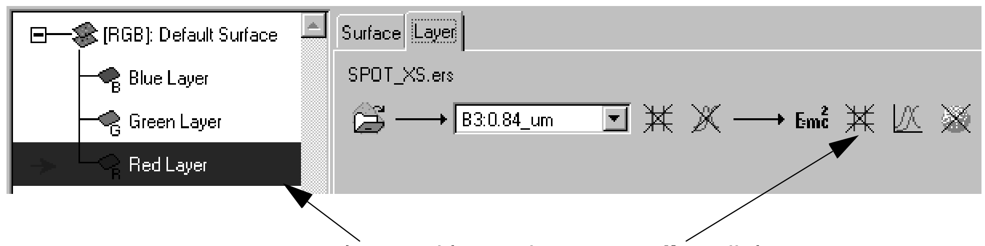
3 Double-click on the directory named 'Data_Types'.

4 In the directory named 'SPOT_XS,' load the algorithm 'SPOT_XS_rgb_321.alg.'

ER Mapper displays a SPOT XS satellite image of the San Diego, California area as an RGB color composite of bands 3, 2 and 1.

## Open the Filter dialog box

1 Select the Red layer in the algorithm, then click the post-formula **Edit Filter (Kernel)** button in the process diagram.




select Red layer, then open **Filter** dialog

The **Filter** dialog appears. Notice that it has R, G and B buttons–these allow you to move between the Red, Green and Blue layers of the algorithm.

## Apply a high pass filter to all three layers in the algorithm

1 On the **Filter** dialog, click the button next to 'Filter filename.'

The **Load filter** dialog opens–move it above the **Algorithm** dialog.

2 From the **Directories** menu (on the **Load filter** dialog), select the path ending with **\kernel**.

3 Open the 'filters_high_pass' directory.

4 Click ***once*** on the filter 'Sharpen2.ker' to select it, then click **Apply**.

ER Mapper loads the filter into the process stream of the Red layer.

5 In the **Filter** dialog, click the **Move to next Green layer** G button.

ER Mapper selects the Green layer in the **Algorithm** dialog.

6 In the **Load filter** dialog, click **Apply** again (the 'Sharpen2' filter is still selected).

ER Mapper loads the filter into the Green layer.

7 In the **Filter** dialog, click the **Move to next Blue layer** B button.

8 In the **Load filter** file chooser, click the **OK** button.

ER Mapper loads the filter into the Blue layer, and closes the **Load filter** dialog.

9 The algorithm now includes your high pass sharpening filter in all three layers.

The high pass filter enhances high frequency detail to make the image appear sharper or crisper. This is the same effect you achieved earlier with a single layer of data, but this time you applied the filter to each layer of a color composite image.

**Tip:** When loading the same filter into multiple layers, it is usually faster to use the **Apply** button to leave the **Load filter** dialog open and move between layers using the R, G and B buttons in the **Filter** dialog.

## Close the image window and Algorithm dialog

1 Close the image window using the window system controls:

- For Windows, click the X **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Insert and delete filters in the process stream diagram
- Apply different types of filters to see their results
- Edit the transform to enhance the contrast of filtered images
- Use filters to generate slope and aspect images from DEMs
- Apply filters in multiple raster layers

## Additional tips for filters

### Creating and saving filters

The filter array fields are editable, so you can easily experiment and create your own filters with custom weighting values and parameters and save them for later use. To save a filter, use **File/Save As** on the **Filter** dialog. It is recommended that you save your own filters either in one of the standard '\kernel' directories, or create your own directory under that path and save the there. (For information on adding custom filters coded in C, see the *Customizing ER Mapper* manual.)

## The 'process at dataset resolution' flag

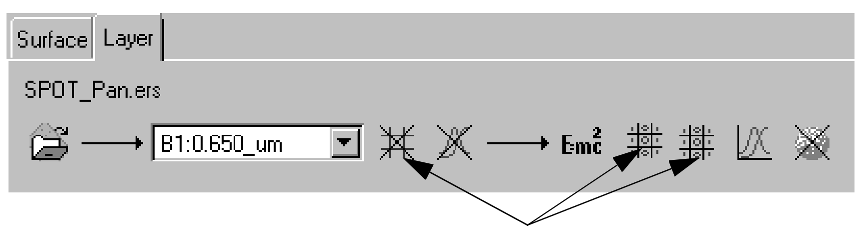
The option 'Process at dataset resolution' on the **Filter** dialog tells ER Mapper to use every pixel in the dataset when running the filtering operation. If this is turned off, ER Mapper processes the data at the current image window resolution (400 by 400 pixels is the default size for new windows). You should turn this on when you want the representation of the filtered image to be as accurate as possible on the screen or hardcopy print. This will increase processing time for large datasets, however, and is often not necessary. (Some filters, such as for slope and aspect generation from DEMs, have this turned on by default to always give the most accurate result.)

## Using multiple sequential filters

In some cases, you may want to add filters in sequence to enhance the result of a previous filter. To do this, open the **Filter** dialog, and use the **Append new filter** or **Insert new filter** options under the **Edit** menu. Append adds a new filter *after* the current one in the process diagram, and Insert adds a new filter *before* the current one. Then load the desired additional filter.

The resulting image is created by a sequence of filters, each acting on the result of the previous one. For example, you might apply a smoothing filter to a DEM dataset to suppress gridding noise, then generate slope or aspect from the smoothed DEM using a following filter. Or, use an edge detection filter and add a sharpening filter afterward to further sharpen the edge filtered image.

When using multiple filters, you can view the contents of any filter (in the **Filter** dialog) by clicking its button in the process diagram:.

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**Tip:** You can also move between filters in the current layer using the [>>] and [<<] buttons on the **Filter** dialog.

---

# 8

# Using formulas

This chapter explains how to use ER Mapper to perform mathematical operations on one or more bands of image data. You learn how to create and edit formulas, and use the standard formulas and functions provided in ER Mapper.

## About formula processing

Formulas are commonly used in image processing to extract information that may reside in two or more bands (or channels) or data. Formula processing can range from simple subtraction or thresholding of data to complex “if-then-else” condition testing for raster spatial modelling and other tasks.

Formula processing is a “point operation” in image processing because it applies a mathematical function to each pixel in the dataset. Common uses of formulas in earth science image processing include:

- extraction of thematic information from multi-band data (for example, vegetation indices or iron oxide ratios);
- merging datasets with different characteristics (data fusion);
- processing the same data in different ways and combining them to isolate specific features (such as edge features or seismic azimuth);
- isolating specific data ranges or geographic areas of interest using thresholding, region (polygon) masking, and other functions;
- reducing the dimensionality of multi-band data (for example, Principal Components Analysis);

- corrections for atmospheric effects, sun angle, or vignetting on optical satellite or airborne data.

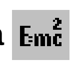
## Formula processing in ER Mapper

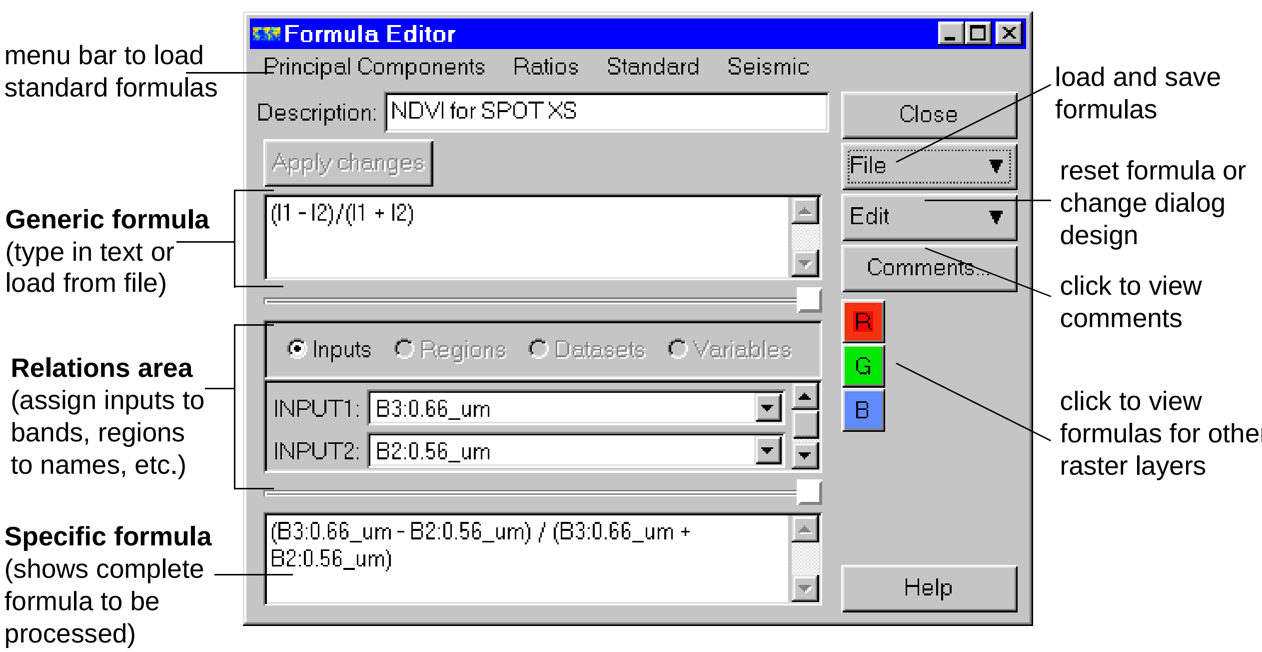
Many common types of data transformations can be implemented in ER Mapper using formula processing. These include data thresholding, data merging (or fusion), image differencing and ratioing, Principal Components Analysis, Tasseled Cap transforms, derivatives, and many others.

Since formulas are part of the algorithm processing stream, you can see the results in real time, and interactively modify the formula to quickly fine tune it. In contrast, conventional products must usually write formula processing results to a file on disk, making experimentation and fine tuning far more difficult.

ER Mapper provides a complete set of standard operators and functions you can reference in formula processing. You can also use dataset statistics, special functions, and functions defined with your own C user code. See the relevant sections and chapters in the *ER Mapper User Guide* for complete information.

## The Formula Editor dialog box

When you click the **Edit Formula**  button in the process diagram, ER Mapper opens the **Formula Editor** dialog box. This dialog lets you create, edit, load, and save formulas, and it has the following components:



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**Tip:** For any algorithm, you can open the **Formula Editor** dialog box from two places: using the **Formula**  button in the process diagram on the **Algorithm** dialog, or using the **Edit Formula** toolbar button on the main menu.

---

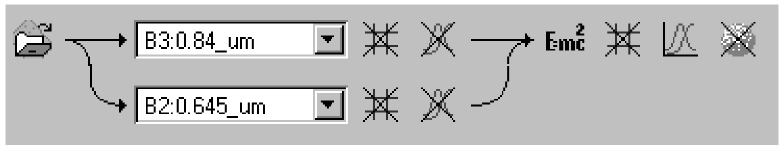
## The formula relations concept

The key concept of *relations* is a very powerful feature that makes ER Mapper's formula processing very flexible and interactive. When you enter or load a generic formula, you may include one or more generic specifications that refer to any arbitrary dataset band, region polygon, dataset, or variable. You then use the Relations window to choose relations between actual dataset band numbers, region names, etc. and the generic specifications in the formula. The actual assignment of references to dataset bands, region names, and so on is then shown in the Specific formula window.

There are four types of generic specifications:

| Reference | Notation in generic formula | Function |
|---|---|---|
| **Input specifications** | INPUTn, In (or lowercase) | References any band in a dataset. |
| **Region specifications** | REGIONn, Rn (or lowercase) | References any region polygon defined for a raster dataset. |
| **Dataset specifications** | DATASETn, Dn (or lowercase) | References any raster dataset (an actual disk file with ".ers" extension). |
| **Variable specifications** | VARIABLEn, or any text not reserved for ER Mapper functions (for example "density" or "threshold") | References any real number or value to be used as an equation variable. |

Formula inputs are also shown graphically in the process stream diagram. For example, the following process diagram shows that two inputs are being used in the formula, and that they are assigned to dataset bands 3 and 2 respectively. As indicated, each band can be modified using filters and transforms before being piped through the formula processing.




To select the specific bands to be used in a formula, you can either use the **Band Selection** drop-down list in the process diagram, or select bands inside the Relations window of the **Formula Editor** dialog box.

# Hands-on exercises

These exercises introduce you to the basic features of the **Formula Editor** dialog box and procedures for creating and implementing simple formulas.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Type and edit a formula, and test formula syntax
- Use generic references for inputs, variables, and regions in a formula
- Assign dataset bands, variables, and region names to generic references
- Save formulas to disk and enter comments
- Use formulas to process areas of interest (regions) in a dataset
- Use formulas to generate Principal Component images

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Entering and testing a formula

***Objectives*** Learn how to enter simple formulas and test formula syntax.

## Load and display a digital terrain dataset

1 On the main menu, click the **Edit Algorithm** button.

An image window and the **Algorithm** dialog box appear.

2 On the **Algorithm** dialog, click the **Load Dataset** button in the process diagram.

3 From the **Directories** menu (on the **Raster Dataset** dialog), select the **\examples** path.

4 Open the ‘Shared_Data’ directory, then double-click on the ‘Digital_Terrain_Model.ers’ dataset to load it.

This dataset is a digital terrain model (DEM) of the San Diego, California area. Higher elevations are shown as light grey.

## Change the color table to ‘pseudocolor’

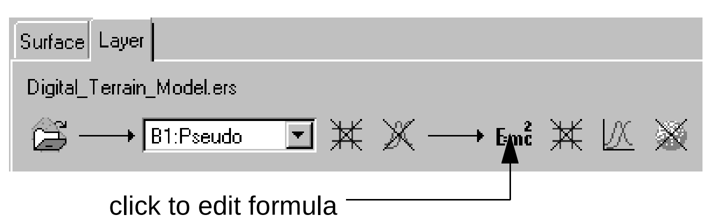
1 Click the **Surface** tab on the **Algorithm** dialog, then select **pseudocolor** from the ‘Color Table’ list.

The image redisplays showing high elevations in yellow and red, and low elevations in blue.

2 Click the **Layer** tab on the **Algorithm** dialog to display the process diagram again.

## Enter a simple formula and test for syntax errors

1 On the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.

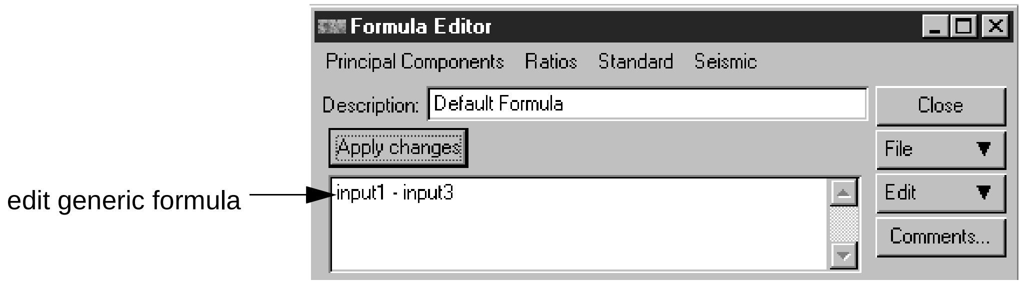



The **Formula Editor** dialog box opens.

Note that the generic formula window contains the text "I1" by default, and that I1 (Input 1) is assigned to dataset band 1 in the Relations window.

2 In the Generic formula window, edit the formula to read as follows (*this purposely has an error*):

```
input1 - input3
```




3 Click the **Apply changes** button (above the formula) to test the syntax.

ER Mapper issues an error message warning that the formula has a syntax error. (In this case you tried to subtract an input number that was out of sequence; you must also have an "input2" before using an "input3."

**Note:** The **Apply changes** button automatically tests for syntax errors in the Generic formula. You must make any corrections before continuing.

## Revise the formula to subtract a value

1 In the Generic formula window, edit the formula text to read:

```
input1 - 100
```

(This subtracts 100 from each pixel in the dataset band assigned to input1.)

2 Click the **Apply changes** button to test the formula.

The formula syntax is approved, and ER Mapper translates the generic formula into a specific formula (displayed in the lower window).

## Delete the formula and test the syntax

1 In the Generic formula window, edit the formula to remove all text (select the existing text and press the Backspace or Delete key on your keyboard).

2 Click the **Apply changes** button to test the formula.

ER Mapper issues an error message regarding the formula syntax.

---

**Caution:** ER Mapper considers no formula at all an error in syntax. At a minimum, the Generic formula window must always contain the text “I1” or “input1” to specify at least one input dataset band to be processed.

---

3 From the **Edit** menu (on the **Formula Editor** dialog), select **Default**:

ER Mapper replaces the formula with the default “INPUT1” formula.

# 2: Creating a threshold formula

***Objectives*** Learn how to enter a simple threshold formula and use boolean “if-then-else” logic in a formula. Also learn about null dataset values, and how to use a variable in a formula.

## Enter a simple threshold formula

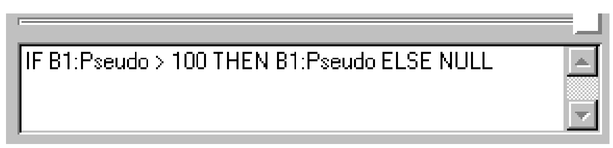
1 In the Generic formula window, edit the formula text to read:

```
if input1 > 100 then input1 else null
```

This formula tells ER Mapper “if the dataset value is greater than 100, then process it, else assign it a value of null.” (Any dataset pixel assigned a value of null is excluded from further processing and does not appear in the final image.)

2 Click the **Apply changes** button.

The formula syntax is approved, and ER Mapper translates the generic formula into a specific formula. Notice that band 1 of the dataset is substituted for both occurrences of “input1” in the generic formula.




## Process the formula and see how it affects the data range

Areas of the image with data values (elevations) greater than 100 are displayed in color, while data values 0-100 display with no color (they appear black).

1 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button in the process diagram.

On the **Transform** dialog box, note that the Actual Input Limits range is 101 to 255. This is expected since data values 0-100 are set to null (no value) by the formula and are thus excluded from further processing. The shape of the histogram also reflects the clipping of the data at the 100 level.

2 Click **Close** on the **Transform** dialog.

## Substitute a variable for the value 100

1 In the Generic formula window, edit the formula text to substitute the word “variable1” for the value 100. Your formula should read:

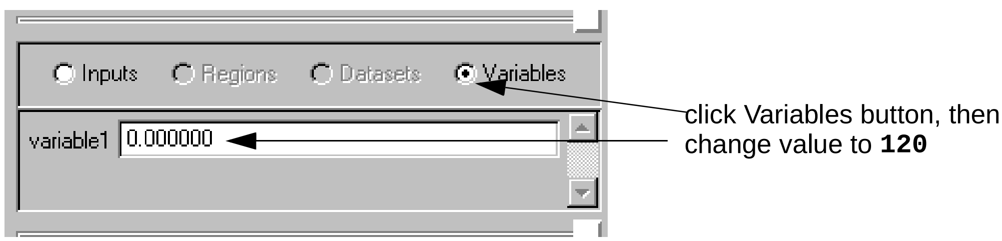
```
if input1 > variable1 then input1 else null
```

Your formula now includes a variable that you can set in the Relations window.

2 Click the **Apply changes** button.

Two things change: the ‘Variables’ option button above the Relations window becomes active, and the value of “variable1” becomes zero in the Specific formula window.

3 Click the **Variables** option button, edit the value of ‘variable1’ field to read **`120`** and press the Return or Enter key on your keyboard.




This time only areas with data values (elevations) greater than 120 are processed.

4 Change the value of the ‘variable1’ field to **`80`**, press Return or Enter to view the new threshold image.

As you can see, using references to variables in your formula (instead of actual values) can speed experimentation.

---

**Tip:** You can have several different variables in a formula, and name them nearly anything (for example *threshold*, *width*, *X*, *y*, are all valid). Be sure the names do not conflict with text strings ER Mapper uses for standard functions.

---

5 Click **Close** on the **Formula Editor** dialog.

# 3: Creating and saving a formula

***Objectives*** Learn how to enter a band ratio formula, change the dataset bands assigned to input numbers in the generic formula, and save the formula to disk for later use.

## Open a template greyscale algorithm and load a new dataset

1 On the main menu, click the **Open** button.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the ‘Miscellaneous\Templates’ directory, then open the ‘Common’ directory.

A list of template algorithms for common tasks displays.

4 Double-click on the algorithm ‘Single_Band_Greyscale.alg’ to open it.

A Landsat satellite image of San Diego displays in greyscale. (You will use this algorithm as a template to display another dataset in greyscale.)

5 On the **Algorithm** dialog, click the **Load Dataset** button in the process diagram.

6 From the **Directories** menu (on the **Raster Dataset** dialog), select the path ending with **\examples**.

7 Open the ‘Applications\Mineral_Exploration’ directory, then double-click on the ‘Newcastle_Landsat.ers’ dataset to load it.

ER Mapper loads the dataset and displays the filename above the process diagram.

8 Click the **99% Contrast enhancement** button.

Band 1 of a Landsat TM satellite image of the Newcastle area of southeastern Australia displays in greyscale.

## Enter a generic band ratio formula

1 On the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.

The **Formula** dialog box opens and shows the default formula “INPUT1.”

2 In the Generic formula window, edit the formula text to read:

```
input1 / input2
```

This formula tells ER Mapper to divide the dataset band assigned to input1 by the band assigned to input 2.

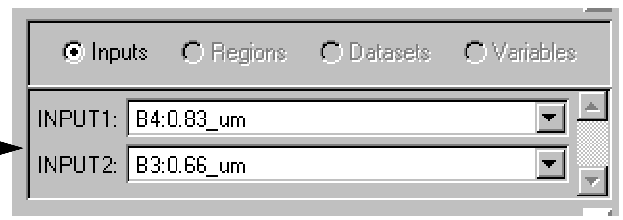
3 Click the **Apply changes** button.

When you enter a new multiple input formula, ER Mapper automatically assigns dataset band 1 to input 1, band 2 to input 2, and so on.

## Assign dataset bands to create a vegetation index image

1 In the Relations window, select **B4:0.83_um** from the 'INPUT1' list, and select **B3:0.66_um** from the 'INPUT2' list.

select the dataset bands for the ratio




The generic reference "input1" is now assigned dataset band 4, and "input2" is assigned to band 3. When used with Landsat TM datasets, the 4/3 band ratio is a simple vegetation index formula.

## Display the image and manually adjust the contrast

The algorithm now includes your band ratio formula.

The image initially appears black because of the very small data range created by the band ratio formula.

1 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button in the process diagram.

On the **Transform** dialog, note the Actual Input Limits created by the formula (about zero to 5).

2 On the **Transform** dialog, select **Limits to Actual** from the **Limits** menu.

3 On the **Transform** dialog, click the **Create autoclip transform**  button.

Your enhanced vegetation index image shows vegetated areas (higher ratio values) in light grey or white, and sparsely or non-vegetated areas in darker shades. This band combination takes advantage of high vegetation reflectance in TM band 4 (near infrared light) and absorption by vegetation in band 3 (red light).

4 Click **Close** on the **Transform** dialog.

## Change the band assignments to create a clay minerals image

1 In the Relations window, select **B5:1.65_um** for 'INPUT1' and select **B7:2.215_um** for 'INPUT2.'

Using the same Generic formula, you have now chosen the appropriate TM band ratio (5/7) to create a simple clay minerals image.

2 Click the **99% Contrast enhancement** button.

Your contrast enhanced clay ratio image shows clay-rich rocks (higher ratio values) in light shades of grey, and clay-poor rocks in darker shades. This band combination takes advantage of strong absorption by clay minerals in TM band 7 and high reflectance in TM band 5.

---

**Tip:** You will typically need to adjust the contrast of images generated using formulas. You can do this quickly using the **99% Contrast enhancement** button, or manually (using the **Transform** dialog) to fine tune the contrast enhancement.

---

## Add a description and comments for your formula

1 In the **Formula Editor** dialog, edit the 'Description' text on top to read:

**`Landsat TM clay minerals ratio`**

2 Click the **Comments...** button.

The **Formula comments** dialog box appears.

3 Type some comments about your formula, such as:

```
This formula is designed to process bands 5 and 7
of Landsat TM data to highlight clay-rich rocks.
It is based on strong absorption by clay minerals in
TM 7 and high reflectance in TM 5. Clay-rich rocks
produce high ratio values, clay poor rocks low values.
```

4 Click **OK** to save your comments and close the dialog.

## Save the clay minerals ratio formula to disk

1 From the **File** menu (on the **Formula Editor** dialog), select **Save As...**.

2 From the **Directories** menu (on the **Save Formula** dialog), select the path ending with **\examples**.

3 Open the 'Miscellaneous\tutorial' directory.

4 In the **Save As:** text field, type your initials followed by the text `clay_ratio` and separate each word with an underscore (_).

5 Click the **OK** button to save your formula to a disk file.

Since bands 5 and 7 of the dataset were chosen as inputs 1 and 2 when you saved the formula, they would be assigned as the default bands if you load the formula in the future.

6 Click **Close** on the **Formula Editor** dialog.

---

**Tip:** When creating and saving your own formulas, it is recommended that you save them in one of the standard formula directories under the 'ERMAPPER\formula' path so they reside in a common area. You can also add your own directories under this path and save your formulas in them as well.

---

# 4: Creating a polygon mask formula

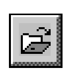
***Objectives*** Learn how to use ER Mapper's "inregion" function to reference areas defined as vector polygons in an image for masking purposes

---

**Note:** This exercise references region polygons in the sample image which have previously been defined using ER Mapper's vector drawing tools. More information on defining regions is contained in the chapter on supervised classification later in this workbook and in the *ER Mapper Reference* manual.

---

## Load the SPOT Panchromatic greyscale algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the 'Data_Types' directory, then open the 'SPOT_Panchromatic' directory.

4 Double-click on the algorithm named 'Greyscale.alg.'

A SPOT Panchromatic satellite image of San Diego displays in greyscale.

5 Right-click inside the image window, select **Quick Zoom**, then select **Zoom In**.

ER Mapper zooms in 50% on the center point of the image.

## Enter a formula using the “inregion” function

1 On the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.

2 In the Generic formula window, edit the formula text to read:

```
if inregion(region1) then input1 else null
```

This formula tells ER Mapper “if the area of the image is within the boundaries defined by region1, then process it, else assign it null.”

3 Click the **Apply changes** button to verify the formula syntax.

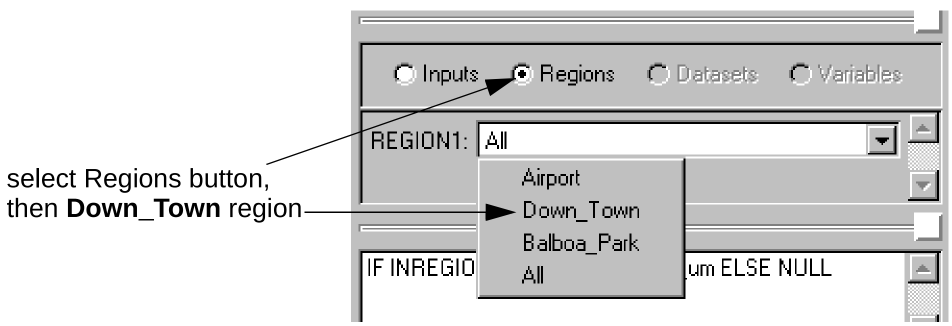
The generic formula is converted to a specific formula. Also notice that the **Regions** option button above the Relations window is now active.

## Assign the “region1” argument to a region name

1 Above the Relations window, click the **Regions** button.

The contents of the Relations window change to show the ‘REGION1’ argument and its default assignment to a region named **All**.

2 From the ‘REGION1’ drop-down list, select **Down_Town**.




You have now selected the ‘Down_Town’ region to be assigned to generic ‘region1.’ (This region is a vector polygon previously drawn to define the boundaries of the San Diego downtown area in this image.)

Only the area inside the region named ‘Down_Town’ is processed, and all other areas of the image are assigned null values (so they appear black). By using the inregion function in your formula, you have created a “mask” to process only data within the region boundary.

## Display a different region in the dataset

1 From the ‘REGION1’ drop-down list, select **Airport**.

You have now selected the ‘Airport’ region to be assigned to generic ‘region1.’ (Airport is a vector polygon previously drawn to define the boundaries of the San Diego Lindbergh Field airport near downtown.)

Only the area inside the region named ‘Airport’ is processed, and all other areas of the image are assigned null values. By using the drop-down list, you can easily change this formula to process any region defined in a dataset.

2 Click **Close** on the **Formula Editor** dialog.

---

**Note:** All raster datasets contain a region named ‘All’ that specifies the entire extents of the image for statistics purposes. Any other regions you wish to add must be defined with ER Mapper’s vector drawing tools (discussed later).

---

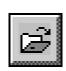
# 5: Generating Principal Components

***Objectives*** Learn how to use and modify a formula to interactively compute Principal Components images.

### About Principal Components Analysis

Principal Components Analysis (PCA) is a statistical form of data compression often used to compress the information content of multiple image bands into just two or three “principal component” images. For example, the seven Landsat TM bands can be compressed into just two or three PC images that contain the majority of the scene information (or variance). PC images sometimes also show specific thematic information. For example, the higher order PCs (PC 3, 4, 5, etc.) sometimes show subtle anomalous information used to map mineral bearing soils and other features.

## Load the Landsat TM greyscale algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the ‘Data_Types’ directory, then open the ‘Landsat_TM’ directory.

4 Double-click on the algorithm ‘Greyscale.alg’ to open it.

A Landsat satellite image of San Diego displays in greyscale. You will add a formula to this algorithm to generate Principal Components images.

## Load a formula to calculate Principal Component 1

1. On the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.
2. From the **Principal Components** menu (on the **Formula Editor** dialog), select **Landsat TM PC1**. ER Mapper loads the following formula into the Generic formula window:

```
SIGMA(I1..I6 | I? * PC_COV(I1..I6 | ,R1 I?, 1))
```

This formula tells ER Mapper to generate Principal Component 1 (PC 1) from six of the seven Landsat TM bands. It uses some of the special functions and constructs ER Mapper provides, including the “SIGMA” summation construct and the “PC_COV” covariance principal component (eigenvector) value.

In this case, you are generating the first principal component of TM bands 1-5 and 7 (shown in the Relations window). TM band 6 is often not used for generation of PC images because it contains thermal information.

## Manually adjust the contrast of the PC 1 image

1. On the **Algorithm** dialog, click the post-formula **Edit Transform Limits** button in the process diagram.

Note that the data range create by the PC1 formula is about 40 to 525.

2. On the **Transform** dialog, select **Limits to Actual** from the **Limits** menu.
3. On the **Transform** dialog, click the **Create autoclip transform** button.

The image is rendered with enhanced contrast. The first principal component usually contains most of the overall scene brightness or albedo information, so it shows large scale terrain features well.

4. Click **Close** on the **Transform** dialog.

## Edit the formula to calculate Principal Component 2

1. In the Generic formula window, edit the formula to change the last value from 1 to **2** as shown below:

```
SIGMA(I1..I6 | I? * PC_COV(I1..I6 | ,R1 ,I?, 1))
```

change to 2

This formula tells ER Mapper to generate Principal Component 2 (PC 2) from Landsat TM bands 1-5 and 7.

2. Click the **Apply changes** button to verify the formula syntax.

3 Click the **99% Contrast enhancement** button.

ER Mapper applies a 99% clip to the data limits created by the PC 2 formula to automatically create a contrast enhanced image. The second principal component often shows the difference between the visible bands (TM 1, 2 and 3) and infrared bands (TM 4, 5 and 7). Materials that have the highest reflectance in the visible spectral region appear as the brightest pixels on the PC2 image. Vegetated areas appear dark because they have higher reflectance in the infrared bands.

## Edit the formula to calculate PC1 of bands 7, 4 and 1

1 In the Generic formula window, edit the formula as shown below:

```
SIGMA(I1..I6 | I? * PC_COV(I1..I6 | ,R1 ,I?, 2))
```

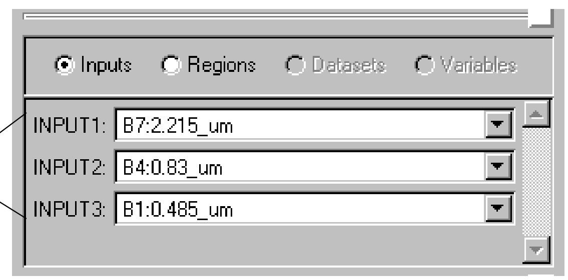
(I6 → change to 3; I6 → change to 3; 2 → change to 1)

These changes tell ER Mapper to generate Principal Component 1 from only three dataset bands instead of six. (Next you will choose which three bands to use.)

2 Click the **Apply changes** button to verify the formula syntax.

3 In the Relations window, assign INPUTs 1, 2 and 3 to bands 7, 4 and 1.

select bands 7, 4 and 1 for INPUTs 1, 2 and 3 respectively




4 Click the **99% Contrast enhancement** button.

The image looks similar to the PC 1 image you created earlier, but is generated using only bands 7, 4 and 1 of the Landsat TM dataset.

---

**Tip:** This example creates a simple greyscale image, but you can easily use the same formulas in RGB algorithms to create color composites of PC images. A typical display is PC1 in red, PC2 in green and PC3 in blue.

---

## Close the image window and Algorithm dialog

1 Close the image window using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Type and edit a formula, and test formula syntax
- Use generic references for inputs, variables, and regions in a formula
- Assign dataset bands, variables, and region names to generic references
- Save formulas to disk and enter comments
- Use formulas to process areas of interest (regions) in a dataset
- Use formulas to generate Principal Component images

# 9

# Geolinking images

This lesson explains how to use ER Mapper's geopositioning controls to display images with exact geographic extents, and use the Geolinking controls to geographically link two or more image windows. Geolinking is a powerful visualization technique that can help you analyze the same geographic area using a variety of different datasets or processing techniques.

## About Geopositioning

In ER Mapper, the term "geopositioning" refers to specifying the position and extents of an image in geographic coordinate space. This can be useful for creating maps showing exact areas or cropping exact subsections from large datasets. Once an image is registered to a map projection, its display can be controlled using ER Mapper's geopositioning options. If the image is not rectified to a map projection, its extents can be controlled in terms of the row and column numbers of the dataset pixels.

## About Geolinking

In ER Mapper, the term "geolinking" refers to linking two or more image windows in geographic coordinate space. This can be useful for viewing the same geographic area with different types of datasets or processing algorithms, and other applications. Once an image is registered to a map projection, it can be geographically linked with other image windows using ER Mapper's geolinking options. ER Mapper provides the following geolinking modes:

| | |
|---|---|
| **Window** | Link two or more image windows to show the same geographic extents. Zooming or panning in one window triggers the same operation in other linked windows. |
| **Screen** | Link image windows to one "master" image that acts like a virtual map sheet on the screen. Linked windows display the geographic extents of their datasets relative to the master window. |
| **Overview Zoom** | Link image windows to one "master" overview control window. Defining a zoom box on the control window causes the other windows to zoom to the defined area. |
| **Overview Roam** | Link image windows to one "master" control window. Dragging the mouse to pan in the control window causes other windows to pan (or "roam") so their center point matches the mouse position in the control window. |

## The Algorithm Geoposition Extents Dialog Box

The **Algorithm Geoposition Extents** dialog box lets you precisely control the geographic extents and display resolution of images, and geographically link (geolink) two or more image windows together. The options shown in this dialog change depending on the mode selected from the tab pages at the top. The five modes and their functions are as follows:

| | |
|---|---|
| **Zoom** | Lets you use buttons to zoom or pan the image in the window by predefined amounts, or zoom to the extents of specific datasets, page extents, or page contents. |
| **Geolink** | Lets you set up geolinking between two or more image windows, and set the window size and display resolution of any image window. |
| **Extents** | Lets you view or specify geographic display extents for an image using Latitude/Longitude, Eastings/Northings, or dataset X (column) and Y (row) values. |
| **Center** | Lets you view or specify the center point for the image display using Latitude/Longitude, Eastings/Northings, or dataset X (column) and Y (row) values. |
| **Mouse info** | Shows quick help for using the mouse and keyboard keys to zoom and pan. |

# Hands-on exercises

These exercises introduce you to many of the basic features of the **Algorithm Geoposition Extents** dialog box and how to use them to control image display extents and set up geolinking between windows.

---

**Note:** The datasets used in the following exercises were previously rectified to the same datum and map projection. This is a requirement when different datasets are to linked in Window, Screen, Overview Zoom, or Overview Roam modes.

---

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Display images with exact geographic extents and display resolutions
- Link image windows to show the same geographic extents
- Link image windows to a virtual map sheet window
- Control interactive image zooming and panning functions from a master window

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

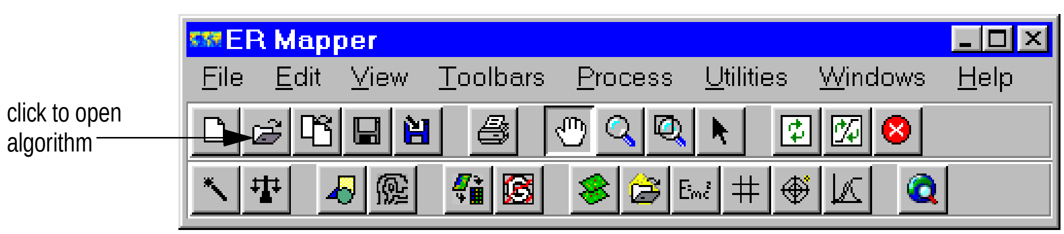
# 1: Geopositioning images

***Objectives***

Learn how to use the Geoposition controls to display an exact geographic area of an image, specify an image center point, and change window sizes and display resolutions.

## Load and display a Landsat image in RGB

1 On the main menu, click the **Open**  button.




An image window and the **Open** dialog box appear.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the ‘Applications\Land_Information’ directory, then double-click on the algorithm ‘Landsat_TM_23Apr85_rgb_541.alg’ to open it.

This algorithm displays a Landsat TM image covering a large portion of the San Diego, California area as an RGB color composite of bands 5, 4 and 1. The image shows an area about 40 by 55 kilometers in size. The country of Mexico is located at the extreme lower part of the image.

4 Make the image window larger by dragging its lower-right corner until it fills the left half of the screen.

5 Right-click on the image, and then select **Zoom to All Datasets** from the **Quick Zoom** menu.

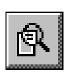
The image will expand to fit the image window.

## Open the Algorithm Geoposition Extents Dialog Box

1 From the **View** menu, select **Geoposition...**.

The **Algorithm Geoposition Extents** dialog box appears. If needed, drag the dialog to the right side of the screen.

---

**Tip:** You can also open the **Algorithm Geoposition Extents** dialog by clicking the  button on the **Algorithm** dialog.

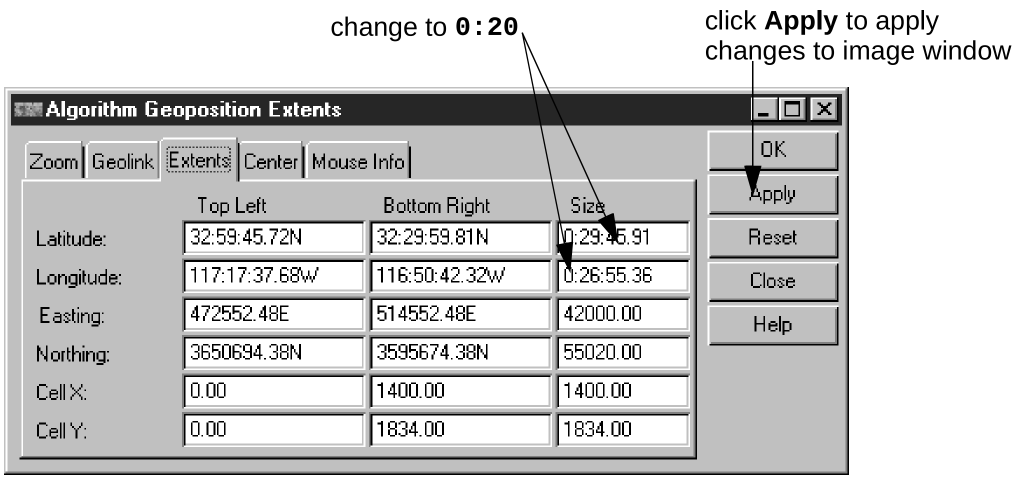
---

## Display an exact geographic area by entering values

1 On the **Algorithm Geoposition Extents** dialog, select the **Extents** tab.

The contents of the dialog change to show a group of text fields for entering coordinate values.

2 Change the values in the **Latitude/Size** and **Longitude/Size** fields to **`0:20`**, then click **Apply**.




ER Mapper reprocesses the algorithm and displays an area 20 minutes of Latitude by 20 minutes of Longitude. (When you adjust the Size fields, the top-left coordinates remain the same and the bottom-right coordinates are adjusted.)

## Display an exact part of the dataset by entering cell values

1 Edit the contents of the four fields as listed below to display an exact portion of the dataset using cell X (column) and cell Y (row) values:

Cell X/Top Left = **800**

Cell Y/Top Left = **1200**

Cell X/Bottom Right = **1300**

Cell Y/Bottom Right = **1800**

2 Click the **Apply** button to apply your new values.

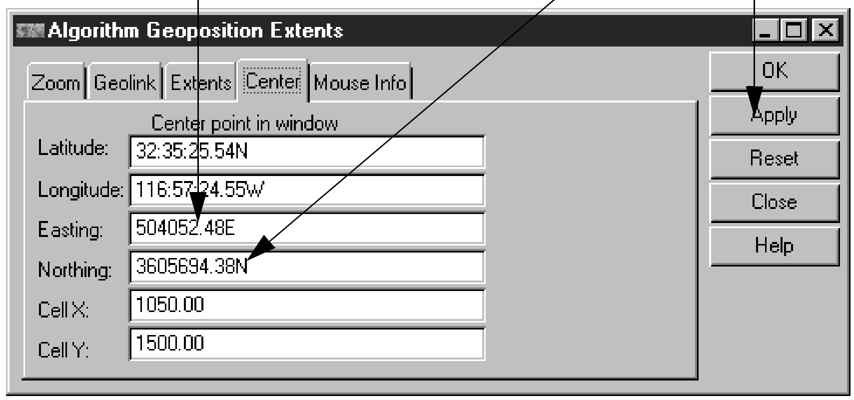
ER Mapper reprocesses the algorithm with your new dataset extents and displays an area 500 pixels (cells) wide by 400 pixels in height. The origin (upper-left corner) is at dataset cell column (X) 800 and dataset cell row (Y) 1200.

## Center the image on an exact point

1 In the **Geoposition** dialog, click the **Center** tab.

The contents of the dialog change to show a group of text fields for entering the center point of the image in geographic or dataset X and Y values.

2 Change the **Easting** value to **507000**, the **Northing** value to **3609500**, then click **Apply** to apply your new center point values.




ER Mapper reprocesses the algorithm and centers the image on the location you defined (Lower Otay Lake that was previously in the upper-right of the image). Centering can be useful for viewing the exact center point of an image, or for focusing on an exact feature of interest in an image.

## Set an exact image display resolution

1 In the **Geoposition** dialog, select the **Geolink** tab.

The contents of the dialog change to show geolink option buttons and text fields for defining window size and display resolution.

2 Change the **Dataset cells per pixel** field to **1** (the value one), then click **Apply** to apply your new display resolution.

ER Mapper reprocesses the algorithm at a “one to one” display resolution, so that every dataset cell in this part of the image is represented by one pixel on the screen display. Values greater than one cause subsampling of the dataset cell values (or image reduction) and less than one cause supersampling (or image magnification).

## Set an exact size for the image window

1 Change the **Width in pixels** field to **400**, the **Height in pixels** field to **400**, then click **Apply** to apply your new window size.

ER Mapper resizes the window to 400 by 400 pixels and redisplays the image.

# 2: Linking windows to common extents

***Objectives*** Learn to link image windows in Geolink “Window” mode, so each linked window displays the same geographic extents.

## Open an RGB algorithm

1 On the main menu, click on the **Open** button.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

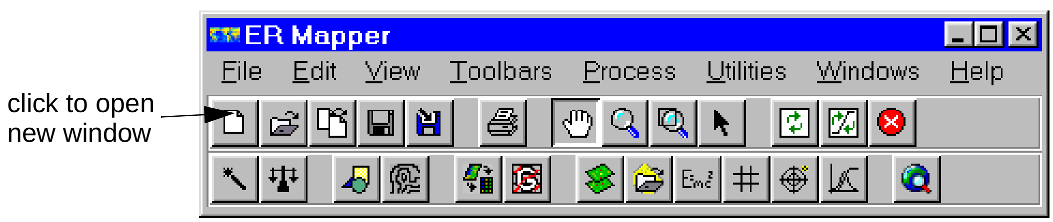
3 Open the ‘Data_Types’ directory, then open the ‘Landsat_TM’ directory.

4 Double-click on the algorithm ‘RGB_341.alg’ to open it.

This algorithm displays a Landsat TM (30 meter resolution) image of San Diego. Bands 3, 4 and 1 are displayed as an RGB color composite, so vegetated areas appear green and urban areas are pink or grey.

## Open a second window and greyscale algorithm

1 On the main menu, click the **New** button.




A second image window opens on top of the first one.

2 On the main menu, click on the **Open** button.

3 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

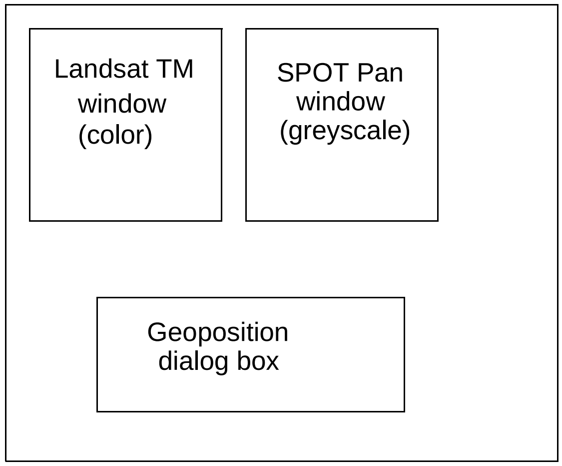
4 Open the ‘Data_Types’ directory, then open the ‘SPOT_Panchromatic’ directory.

5 Double-click on the algorithm named ‘Greyscale.alg.’

This algorithm displays a SPOT Panchromatic (10 meter resolution) image of the same area of San Diego.

## Resize and position the two windows

1 Reposition the two windows as shown so they do not overlap.




You should now have two image windows of about the same size next to each other in the upper part of the screen, and **Geoposition** dialog below them.

## Set the Landsat TM image window to Geolink Window mode

1 On the **Geoposition** dialog, click the **Geolink** tab.

The contents of the dialog show ‘Geolink mode’ option buttons on the left side.

2 Activate the Landsat TM ‘RGB_341’ image window (three stars *** should appear next to the title).

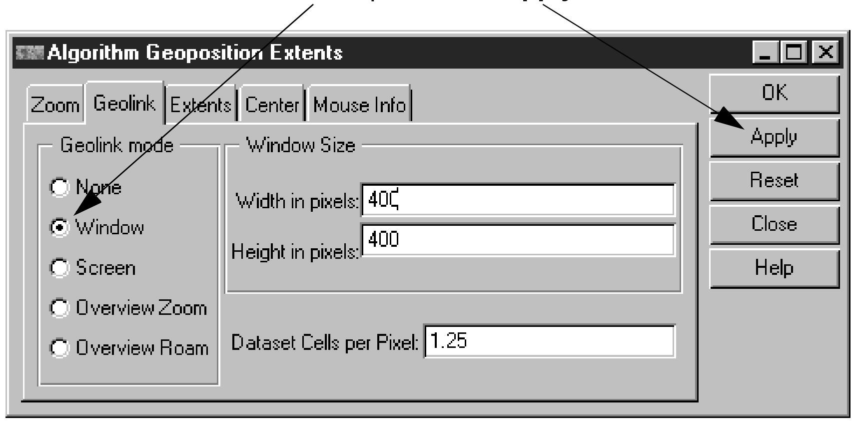
---

**Tip:** You can also activate an image window by selecting its name from the **Windows** menu on the main ER Mapper menu.

---

3 In the **Geoposition** dialog, select the **Window** option, then click **Apply**.

select **Window** option, click **Apply**




The window title indicates that it is now set to "WINDOW" geolink mode.


## Set the SPOT Pan image window to Geolink Window mode

1 Activate the SPOT Pan 'Greyscale' image window.

2 Select the **Window** option button (in the **Geoposition** dialog), then click **Apply**.

The SPOT Pan window is now linked to the Landsat TM window since both are set to Geolink Window mode. Any changes you make to the extents of one window will be automatically duplicated in the other.

## Zoom and pan in both images

1 On the main menu, click the **Zoom Box Tool**  button.

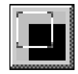
2 Activate the Landsat TM 'RGB_341' image window, then drag a zoom box to magnify the central portion of the image.

The images in both windows automatically zoom to show the same geographic extents.

3 Activate the SPOT Pan 'Greyscale' image window, then click on the right part of the image to pan to the right.

Both images pan to the right.

4 On the **Geoposition** dialog, select the **Zoom** tab.

5 Under ‘Pan,’ click the **Pan up-left**  button.

Both images pan 50% to the upper-left (the previous center point is now on the lower-right corner of the image).

6 Under ‘Set extents to,’ click the **Raster Datasets** button.

Both zoom out to their full extents (which are the same for both datasets).

# 3: Linking windows to the screen

***Objectives*** Learn to link image windows in Geolink “Screen” mode, so a “master” image window becomes a virtual map sheet on the screen. The screen assumes the coordinate space of the “master” image window, and other windows display the geographic extents of their datasets relative to the master window.

## Set both windows to Geolink None mode

1 On the **Algorithm Geoposition Extents** dialog, select the **Geolink** tab.

2 Activate the Landsat TM ‘RGB_341’ image window.

3 In the **Geoposition** dialog, select the **None** option button, then click **Apply**.

The words “WINDOW:geolink” disappear from the window title, indicating that the window is no longer geolinked.

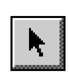
4 Activate the SPOT Pan ‘Greyscale’ image window.

5 Right-click in the image window, select **Quick Zoom**, then **Set Geolink to None**.

The SPOT Pan ‘Greyscale’ window is no longer geolinked.

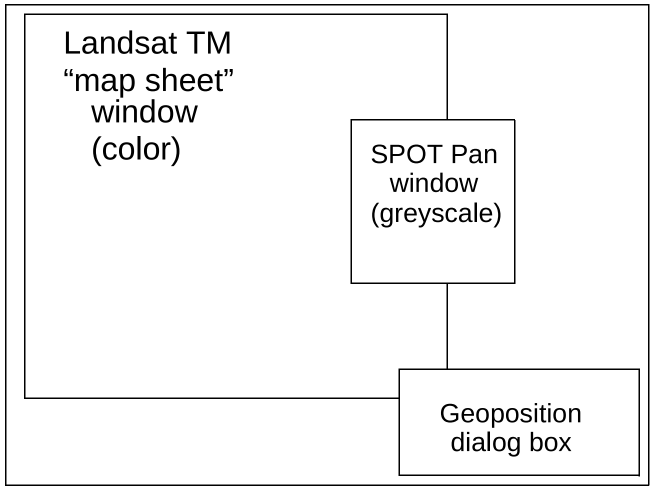
**Tip:** You can link or unlink windows from the **Geoposition** dialog, the image window shortcut menu, or using **View/Quick Zoom** on the main menu.

## Resize and position the two windows

1 On the main menu, click the **Pointer Tool**  button.

The mouse is now set as a pointer. (This prevents accidentally panning or zooming when moving or activating windows.)

2 Resize and reposition the two windows as shown in the following diagram.)




You should now have a smaller SPOT Pan ‘Greyscale’ window partially overlaying a larger Landsat TM ‘RGB_341’ window, and the **Geoposition** dialog in the lower-right corner.

## Set the TM image window to Geolink Screen mode

1 Activate the large Landsat TM ‘RGB_341’ image window.

2 In the **Geoposition** dialog, select the **Screen** option, then click **Apply**.

The window title indicates that it is now set to “SCREEN” geolink mode. This is the first window assigned to Screen mode, so it becomes the “master map sheet” window and the entire screen assumes its coordinate space.

## Set the SPOT Pan image window to Geolink Screen mode

1 Activate the SPOT Pan ‘Greyscale’ image window.

2 Select the **Screen** option button, then click **Apply**.

The SPOT Pan window is now linked to the “master” window, and it automatically redraws to show its portion of the TM master “map sheet” window.

## Move the SPOT Pan window over the TM master window

1 Drag the smaller SPOT Pan window by its title bar to the lower-left portion of the larger Landsat TM window.

The SPOT Pan image automatically redraws to show its new extents in the context of the Landsat “map sheet” window. By comparing the two images, you can clearly see the difference in detail provided by the higher resolution SPOT Pan data (10 meter) over the lower resolution (30 meter) Landsat TM data.

It helps to think of the larger “master” window as a paper map sheet. Any other windows moved on top of the map sheet act like a viewing port into a different dataset or processing technique over the same geographic area.

---

**Tip:** If a smaller window becomes hidden behind a larger one, bring it forward by selecting its name from the **Windows** menu on the main menu.

---

## Zoom in on the SPOT Pan window

1 On the main menu, click the **Zoom Tool**  button.

The mouse is again set to perform zoom functions in image windows.

2 Inside the SPOT Pan image window, drag the mouse down to magnify the image.

The images in both windows automatically zoom in the same amount.

3 Experiment by moving or resizing the SPOT Pan window to view the SPOT Pan data over corresponding areas of the Landsat TM data.

Geolink Screen mode is an excellent way to analyze different datasets covering the same area, or the same dataset processed in different ways.

---

**Tip:** It is best not to resize or move the master “map sheet” window after you have set it to Geolink Screen mode. Plan the window sizes and positions ahead of time for best results and ease of use.

---

## Close one window and unlink the other

1 On the main menu, select **Greyscale** from the **Windows** menu.

The SPOT Pan ‘Greyscale’ window is activated (if it was not already).

2 On the main menu, select **Close** from the **File** menu.

The active window (SPOT Pan ‘Greyscale’) closes.

3 Right-click in the large Landsat ‘RGB_341’ window, select **Quick Zoom**, then **Set Geolink to None**.

4 Click **Close** on the **Algorithm Geoposition Extents** dialog.

# 4: Using Overview Zoom mode

***Objectives*** Learn to link image windows in Geolink “Overview Zoom” mode, so you can define an area of interest on an overview window, and other linked windows automatically zoom to the defined area.

## Open an RGB Landsat algorithm

1 On the main menu, click the **Open** button.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the ‘Applications\Land_Information’ directory, then double-click on the algorithm ‘Landsat_TM_23Apr85_rgb_541.alg’ to open it.

This algorithm displays the Landsat TM image of the San Diego, California area you used earlier in this chapter.

## Open a second window and load the same Landsat algorithm

1 On the main menu, click the **New** button.

A second image window opens. Drag it to the right side of the screen.

2 Click the **Open** button.

3 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

4 Open the ‘Applications\Land_Information’ directory, then double-click on the algorithm ‘Landsat_TM_23Apr85_rgb_541.alg’ to open it.

This is the same algorithm displayed in the first image window.

## Open a third window and SPOT Pan algorithm

1 On the main menu, click the **New** button.

A third image window opens. Drag it to the lower-right part of the screen.

2 Click the **Open** button.

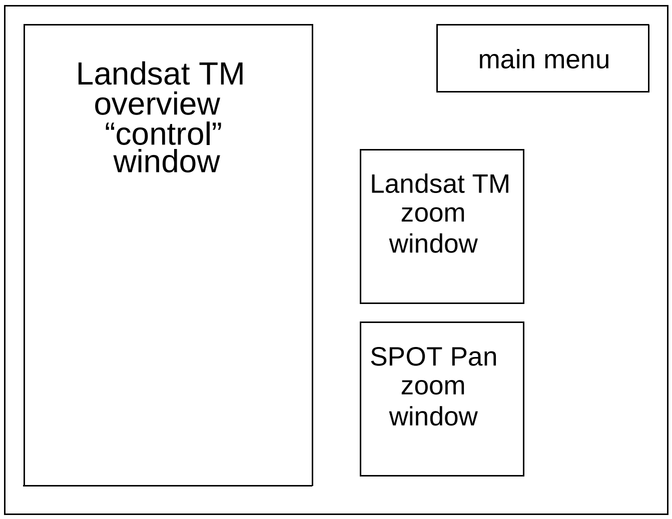
3 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

4 Open the Applications\Land_Information' directory, then double-click on the algorithm 'SPOT_Pan.alg' to open it.

This algorithm displays a SPOT Panchromatic (10 meter resolution) image of approximately the same area of San Diego as the two Landsat TM windows.

## Resize and position the three windows

1 Resize and reposition the three windows as shown in the following diagram. Make the Landsat window on the left larger and taller, and make the other two windows smaller and move them to the right.




You should now have the two smaller image windows next to the larger window. The two smaller windows will be used as "zoom" windows to examine areas in more detail.

## Set the large Landsat TM window to Overview Zoom mode

1 Activate the large Landsat TM window on the left.

When using Geolink Overview Zoom, it is important that the window to be used as the master "control" window be linked first.

2 Right-click inside the large TM window, select **Quick Zoom**, then **Set Geolink to Overview Zoom**.

The window title indicates that it is now set to "OVERVIEW ZOOM" mode.

---

**Note:** When one window is set to **Overview Zoom** mode, any other image windows containing datasets in the same map projection are automatically linked to become “zoom” windows for that window. (This is different than Window and Screen geolink modes where each window must be linked individually.) Windows containing datasets in different datums or map projections are not linked.

---

## Define an area of interest on the large TM window

1 On the main menu, click the **Zoom Box Tool** button.

The mouse is set to perform zoom and pan functions in image windows.

2 Inside the large TM window on the left, drag a box to define an area of interest anywhere in the image.

Both of the smaller windows automatically zoom to show the same area you defined with the box. The larger window remains unchanged because it is the master control window.

3 Drag to define other areas of interest in the master TM image window.

Both of the smaller “zoom” windows automatically zoom to magnify the area of interest. You can clearly see the difference in spatial resolution between the Landsat TM (30m) and SPOT Pan (10m) datasets in their respective zoom windows.

---

**Tip:** **Overview Zoom** allows you quickly pick an area on an overview window and examine it in more detail in the zoom windows. This is an especially effective analysis technique when using different types, dates, or resolutions of imagery in the zoom windows. You can open as many zoom windows as you need.

---

# 5: Using Overview Roam mode

***Objectives*** Learn to link image windows in Geolink “Overview Roam” mode, so you can click or drag the mouse to pan in an overview window, and other windows pan or “roam” so their center point matches the current mouse position the overview window.

## Unlink the master Landsat TM window

1 Activate the larger Landsat TM window on the left.

2 Right-click in the image window, select **Quick Zoom**, then **Set Geolink to None**.

## Close the SPOT Pan window

1 Close the window containing the SPOT Pan ‘Greyscale’ algorithm using either the window controls, or activating it and selecting **File/Close**.

## Make a copy of the smaller Landsat window and algorithm

1 Activate the smaller Landsat TM window on the right.

2 On the main menu, click the **Copy Window** button.


A third image window opens containing an exact copy of the active algorithm. Drag it underneath the smaller window on the right (where the SPOT Pan image was before). You now have the same algorithm loaded into all three windows.

---

**Tip:** The **Copy Window** button lets you quickly create a copy of the current window and algorithm. This can be very helpful if you want to modify the processing technique and compare it to the original, for geolinking, or many other purposes.

---

## Set different display resolutions for the two zoom windows

1 Activate the smaller Landsat window on the upper-right.

2 On the main menu, select **Geoposition** from the **View** menu.

3 On the **Algorithm Geoposition Extents** dialog, click the **Geolink** tab.

4 Edit the **Dataset cells per pixel** field to read **`1`** (the value one), then click the **Apply** button to apply your new display resolution.

ER Mapper reprocesses the algorithm at a “one-to-one” display resolution.

5 Activate the smaller Landsat window on the lower-right.

6 Edit the **Dataset cells per pixel** field to read **`0.33`** then click **Apply**.

ER Mapper reprocesses the algorithm at a higher display resolution, so the image is magnified three times greater than the image in the one-to-one resolution window above it.

## Set the large Landsat TM window to Overview Roam mode

1 Activate the large Landsat TM window on the left side.

2 In the **Geoposition** dialog, click the **Overview Roam** option, then click **Apply**.

The window title indicates that it is now set to “OVERVIEW ROAM” mode.

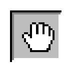
---

**Note:** As with Overview Zoom, when one window is set to Overview Roam mode, any other image windows containing datasets in the same map projection are automatically linked to the master Overview Roam window.

---

3 Click **Close** on the **Geoposition** dialog.

## Point to an area in the large TM window

1 Click the **Hand (Roam) Tool**  button on the main menu.

2 Inside the large TM master window, drag the mouse to pan around the image.

Both of the smaller windows automatically pan so that they are the same as the master window. Both smaller zoom windows keep their current magnification levels. This allows you to “roam” through the overview image to quickly view any area in detail. The master window remains unchanged because it is the control window.

3 Click or drag to define other features of interest in the master window, such as lakes, urban areas, and so on.

Both of the smaller windows automatically roam to center on your feature of interest. By setting up your two smaller windows at different magnifications, you can see different levels of detail in your feature area. (This is the primary advantage of using Overview Roam over Overview Zoom.)

---

**Tip:** **Overview Roam** is an effective visualization technique for quickly analyzing many features in an image using different resolutions and/or types of imagery in the roam windows. You can open as many roam windows as you need.

---

## Close all image windows

1 Close all three image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

Only the ER Mapper main menu is now open.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Display images with exact geographic extents and display resolutions
- Link image windows to show the same geographic extents
- Link image windows to a virtual map sheet window
- Control interactive image zooming and panning functions from a master window

# 10

# Colordraping images

This chapter explains how to create “colordrape” algorithms that drape color information over intensity (brightness) information. You will also learn to use ER Mapper’s realtime shading feature to create shaded relief images.

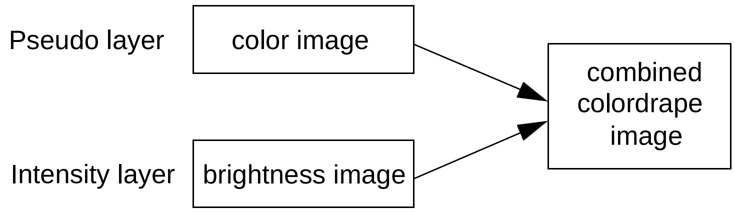
## About colordraping

The term *colordraping* refers to the technique of draping one set of image data in color over another set of data that controls the color brightness or intensity. This allows you to effectively view two (or more) different types of data or methods of processing simultaneously in a *combined display*. ER Mapper makes colordraping very fast and interactive by providing the special Intensity layer type.

The colordraping technique is very useful for a wide range of earth science image processing applications. For example, showing elevation data in both color and shaded relief makes it easy to see absolute elevation (color) as well as terrain features such as mountain ranges (intensity). Or, band ratios or PC images are easier to interpret when they are draped over images that also show albedo or surface structure. Colordraping can also be used to interactively merge images together (data fusion), for example to merge Landsat TM with SPOT Panchromatic or imaging radar (SAR) imagery.

### The Intensity Layer Type

ER Mapper provides a special type of layer named Intensity that is the key to the colordraping technique. When you add an Intensity layer to an algorithm, the *brightness* (or intensity) of the image colors are automatically controlled by the data loaded into the Intensity layer. Low data values in the Intensity layer produce dark colors in the image, and high data values produce bright colors.




The diagram above shows how Pseudo and Intensity layers in an algorithm are combined to create a colordrape image. Colordrape images can also be created by combining RGB and Intensity layers, and Hue, Saturation and Intensity layers.

# Hands-on exercises

These exercises give you practice creating colordrape algorithms for several types of common earth science applications.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Combine Intensity and Pseudo layers to create colordrape algorithms
- Apply sun angle shading to create shaded relief images
- Adjust transforms and apply filters to individual components of an image
- Combine datasets with different resolutions to create a merged image
- Understand the purpose and use of the algorithm “smoothing” option

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Creating shaded relief colordrapes

***Objectives*** Learn how combine Intensity and Pseudo layers to create a colordrape algorithm showing digital elevation data as both color and shaded relief.

## Open an image window and the Algorithm dialog

1 On the main menu, click the **Edit Algorithm**  button.


**Edit Algorithm** button

An image window and the **Algorithm** dialog box open.

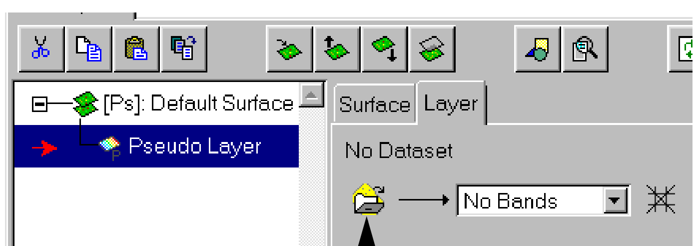
## Change the Pseudo layer to an Intensity layer

1 In the **Algorithm** dialog, right-click on the ‘Pseudo Layer’ and select **Intensity**.

The Pseudo layer changes to an Intensity layer and ER Mapper sets the layer label to “Intensity Layer.”

## Load and display a digital elevation model (DTM) dataset

1 In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.




**Load Dataset** button

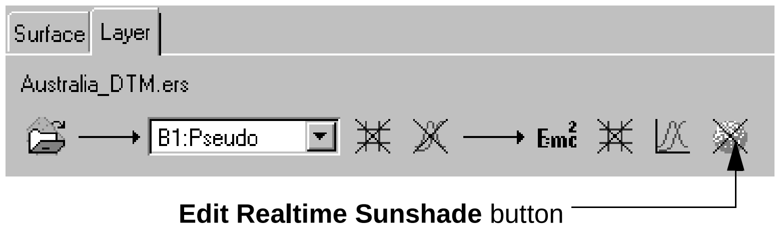
2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Australia_DTM.ers’ to load it.

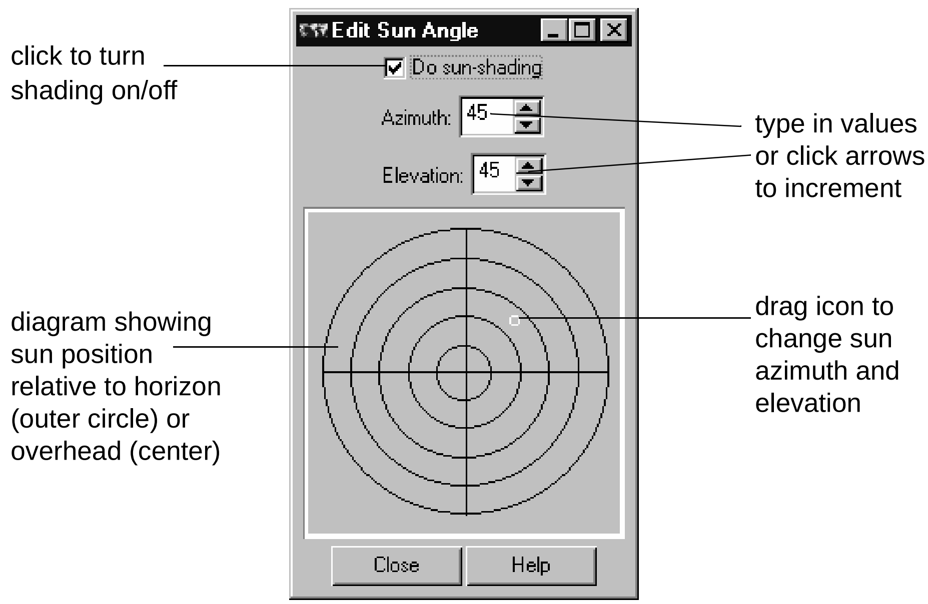
A digital elevation image of the Australian continent displays in greyscale. Dark greys are low elevations, light greys are high elevations.

## Turn on sun shading to create a shaded relief image

1 On the **Algorithm** dialog, click the **Edit Realtime Sunshade**  button in the process diagram.




The **Edit Sun Angle** dialog box opens to let you specify shaded relief effects for the Intensity layer image.



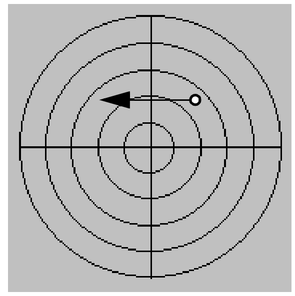

2 Turn on the **Do sun-shading** option.

ER Mapper applies an artificial illumination effect to clearly define mountain ranges and structural features in the DTM.

Also notice that the **Edit Realtime Sunshade** icon in the process diagram is now a yellow sun  to indicate that shading is active for the Intensity layer.

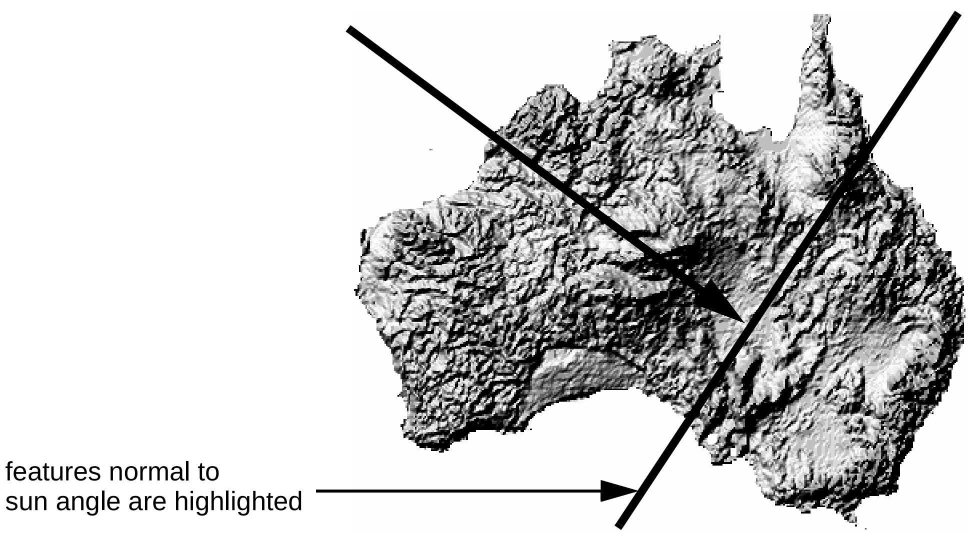
## Change the sun azimuth

1 In the **Edit Sun Angle** dialog, drag the small sun icon (the circle) to the upper-left quadrant of the circular grid.



The shading angle of the image changes in real time to show the shading effect as if the sun were shining from the northwest.

The *azimuth* (compass direction) from which the sun shines highlights structural features normal to the sun angle. In this case, features trending in a northeast to southwest direction are now highlighted (since they are normal to the northwest sun angle).




2 Drag the sun icon to shade from different compass directions (azimuths).

Structural features normal to your new sun azimuths are highlighted.

## Change the sun elevation

1 In the **Edit Sun Angle** dialog, drag the sun icon to the outer rim of the circular grid.

The image becomes darker overall and with larger areas of shadows.

The *elevation* from which the sun shines determines the length of shadows in the shaded relief image. In this case, the sun is shining from a very low sun angle (near the horizon), so you get longer shadows just as you would see right after sunrise or before sunset.

2 Experiment by dragging the sun icon until you create an image that highlights structural features of interest. (Setting the sun elevation at 45 degrees or greater is usually recommended to reduce shadowing.)

---

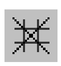
**Tip:** You can also adjust the sun azimuth and elevation to exact values using the adjustment arrows or entering values in the 'Azimuth' and 'Elevation' fields.

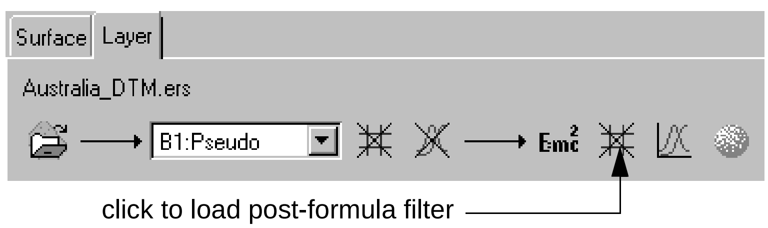
---

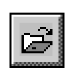
3 Click **Close** on the **Edit Sun Angle** dialog.

## Add a low pass filter to smooth the DTM data

Notice that this DTM data is rather coarse. Applying a smoothing filter will help reduce noise and make the major features easier to interpret.

1 In the algorithm process diagram, click the post-formula **Edit Filter (Kernel)**  button.




2 On the **Filter** dialog, click the  button next to 'Filter filename.'

3 From the **Directories** menu (on the **Load filter** dialog), select the path ending with **\kernel**.

4 Open the 'filters_lowpass' directory, then double-click on the filter 'avg3.ker' to load it.

The three-by-three low pass (smoothing) filter is loaded.

5 Click **Close** on the **Filter Editor** dialog.

The coarse resolution of the DTM data is averaged to create a more smoothly varying image.

## Add a new Pseudo layer and load the DTM dataset

Now you are ready to create the color component of the colordrape algorithm. (You will turn off the Intensity layer to work with only the color image first.)

1. Right-click on the ‘Intensity Layer’ and select **Turn Off**.
2. From the **Edit** menu (on the **Algorithm** dialog), select **Add Raster Layer**, then **Pseudo**.

   A new, empty Pseudo layer is added to the algorithm.

3. In the **Algorithm** dialog, click the **Load Dataset**  button.
4. From the **Directories** menu, select the **\examples** path.
5. Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Australia_DTM.ers’ to load it.

   The dataset is loaded into the Pseudo layer.

6. Click the **Surface** tab, then select **pseudocolor** from the ‘Color Table’ list.

   The DTM dataset displays in color. Low elevations are blue, high elevations are yellow and red.

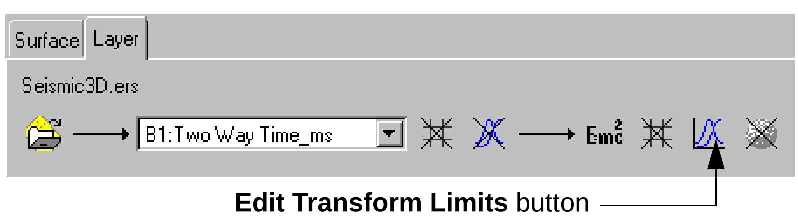
---

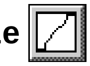
**Tip:** You could also have created the Pseudo layer by duplicating the Intensity layer and changing its type. In this case the Intensity layer had sun shading and a filter that you did not want for the color layer, so it was easier to create a new layer and load the same dataset.

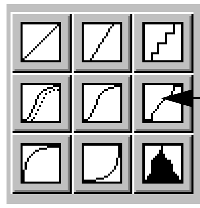
---

## Enhance the color mapping in the image

1. Click the **Layer** tab again to display the process diagram.
2. In the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button.



3 On the **Transform** dialog, click the **Gaussian Equalize**  button.




The image is redisplayed using a Gaussian Equalization transform (which provides a more even distribution of the colors).

4 Click **Close** on the **Transform** dialog.

## Turn on Intensity and display the colordrape image

1 Right-click on the ‘Intensity Layer’ and select **Turn On**.

The colors in the Pseudo layer are “draped” on top of the brightness (shaded relief) image created by the Intensity layer. Structural features are clearly defined in the shaded relief image, and absolute elevations are also shown in color. This technique is a common way to display DTM datasets.

---

**Note:** The sun shading feature is usually only applied to data displayed in an Intensity layer. Turning on shading for color layers such as Pseudo, Red, Green and Blue yields unusual results that are difficult to interpret.

---

## Display the shaded relief and color images separately

1 Right-click on the ‘Pseudo Layer’ and select **Turn Off**.

Only the shaded relief component of the image displays since the color component (the Pseudo layer) is turned off.

---

**Note:** Data displayed in an Intensity layer by itself always creates a greyscale image. The ‘Color Table’ setting only applies to colors used for Pseudo layers.

---

2 Turn off the ‘Intensity Layer,’ and turn on the ‘Pseudo Layer.’

Only the color image is displayed.

3 Turn on the ‘Intensity Layer’ again.

The combined colordrape image is again displayed. The Pseudo and Intensity layers are separate entities, and each creates and image independent of the other. For example, you can change the shade angle of the Intensity layer without affecting the color mapping in the Pseudo layer.

---

**Tip:** There is a special version of colordrape algorithm called the “wet look” that creates images that look like plastic raised relief maps. See the section “Wet look colordrape images” at the end of this chapter for details.

---

# 2: Merging datasets using colordraping

***Objectives***

Learn how to use colordraping to interactively merge two different raster datasets (sometimes called “data fusion”). In this case, you will merge a 60-meter resolution multispectral satellite image (Landsat MSS) with a 10-meter high resolution panchromatic satellite image (SPOT Pan).

Data fusion is commonly used to merge datasets acquired by different sensors to exploit the strengths or advantages of each particular system. Spatial merging of datasets is a common need because most types of image data focus on meeting a certain set of requirements at the expense of others. By merging data with different characteristics, you can create hybrid images that show more information than either image by itself.

## Load an algorithm to display a Landsat MSS dataset

1. On the main menu, click the **Open**  button.
2. From the **Directories** menu, select the **\examples** path.
3. Open the ‘Data_Types’ directory, then open the ‘Landsat_MSS’ directory.
4. Double-click on the algorithm ‘RGB_321.alg’ to open it.

   This algorithm displays an RGB color composite of bands 3, 2 and 1 of a Landsat MSS satellite image of the San Diego, California area. Vegetation appears in reddish tones. Landsat MSS (Multispectral Scanner) data has four spectral bands and a spatial resolution of approximately 60 meters.
5. Make the image window about 50% larger.
6. Right-click on the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

   ER Mapper redisplays the image in the larger window size.

## Add an Intensity layer to display a SPOT Pan dataset

1 From the **Edit** menu (on the **Algorithm** dialog), select **Add Raster Layer**, then **Intensity**.

An Intensity layer is added to the algorithm layer list.

2 In the **Algorithm** dialog, click the **Load Dataset**  button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Shared_Data' directory, then double-click on the dataset 'SPOT_Pan.ers' to load it.

The dataset is loaded into the Intensity layer. The SPOT Panchromatic dataset is a high resolution image (10 meters) with one spectral band. It is often used to enhance the spatial resolution of lower resolution multispectral datasets like Landsat MSS and TM.

The two images are merged on the display. As you can see, the SPOT Pan image only covers a portion of the larger area covered by the Landsat MSS image.

**Note:** The Landsat MSS and SPOT Panchromatic datasets used in this example were previously rectified to the same map projection, so they align precisely. This is a requirement before two images can be merged or displayed together as shown here.

## Enhance the contrast of the SPOT Pan dataset

1 With the 'Intensity Layer' selected, click the post-formula **Edit Transform Limits**  button in the process diagram.

2 On the **Transform** dialog, click the **Gaussian equalize**  button to increase the contrast.

The SPOT Pan image is redisplayed with enhanced contrast. You can now more clearly see the effect of the resolution enhancement provided by colordraping the Landsat MSS data over the high resolution SPOT Pan data.

In this case, the SPOT Pan data substitutes for the original intensity (brightness) of the Landsat MSS image. Intensity substitution is a common way to merge two remotely sensed datasets, and it is made easy by ER Mapper's Intensity layer type.

3 Click **Close** on the **Transform** dialog.

## Zoom in to the geographic extents of the SPOT Pan dataset

1 Make sure the ‘Intensity Layer’ containing the SPOT Pan dataset is selected.

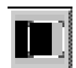
2 From the **View** menu, select **Geoposition...**.

The **Algorithm Geoposition Extents** dialog opens.

3 In the **Geoposition** dialog, select the **Zoom** tab.

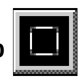
4 Click the **Current Datasets** button.

ER Mapper zooms in to the geographic extents of the SPOT Pan dataset. (This feature lets you instantly display only the full extents of the dataset in the currently selected layer, so it is very useful for merge and mosaic algorithms.)

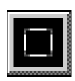
5 Under Pan, click the **Pan right**  button to pan 50% to the right.

The seam between the MSS/Pan merge (on the left side) and the MSS data by itself (on the right) in clearly visible.

## Zoom in further and turn off smooth resampling

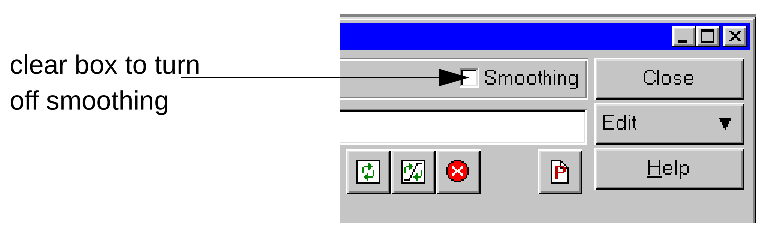
1 Under Zoom, click the **Zoom in 100%**  button to zoom in 100%.

ER Mapper zooms in on the image center point.

2 Click the **Zoom in 100%**  button again to zoom in further.

Notice that the MSS data on the right appears smoothed or blurred–this is the result of the turning on the ‘Smoothing’ option for the algorithm.

3 On the **Algorithm** dialog, turn off the ‘Smoothing’ option.




The difference in pixel size between the two datasets is more clearly visible.

**Tip:** Enabling the ‘Smoothing’ option tells ER Mapper to smooth the image by performing a bilinear interpolation on the displayed data. This can be very useful when zooming in at high magnifications because it smooths out the blocky “pixelated” look of raster images and makes general features easier to interpret. If you want to see individual pixels, turn ‘Smoothing’ off.

4 Click **Close** on the **Geoposition** dialog.

## Turn the Intensity layer on/off to compare the resolutions

1 Right-click the ‘Intensity Layer’ and select **Turn Off**.

The SPOT Pan data is no longer merged with the Landsat MSS data, so the detail on the left side of the image greatly decreases.

2 Turn the ‘Intensity Layer’ on again.

The datasets are again merged on the left side. The *color* of the merged image comes from the Landsat MSS data, while the *brightness* (intensity) comes from the SPOT Pan data.

This is called an “RGBI” (Red Green Blue Intensity) colordrape, and is a simple way to merge any two remotely sensed datasets. Typically the lower resolution multispectral image is displayed in RGB layers, and a higher resolution image is displayed in the Intensity layer.

**Tip:** For example algorithms showing other ways to merge multi-resolution datasets, look in the ‘Functions_And_Features\Data_Fusion’ directory under the \examples path. Included there are examples of other techniques such as Hue Saturation Intensity merging and the Brovey Transform merge that uses formulas and virtual datasets.

## Close the image window and Algorithm dialog

1 On the main menu, select **Close** from the **File** menu to close the image window.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Combine Intensity and Pseudo layers to create colordrape algorithms
- Apply sun angle shading to create shaded relief images
- Adjust transforms and apply filters to individual components of an image
- Combine datasets with different resolutions to create a merged image
- Understand the purpose and use of the algorithm “smoothing” option

## Wet look colordrape images

There is a special form of the colordrape algorithm called the “wet look” that lets you create images that look like plastic raised relief maps. This technique uses the Hue Saturation Intensity (HSI) color mode and Hue, Saturation and Intensity layers to achieve this result. Wet look images are not usually used for interpretation, but they are sometimes used for presentations because they are flashy and colorful.

Following is a short-cut way to create a “wet look” image with your own data using an existing algorithm as a template (a complete explanation is beyond the scope of this workbook):

1 Create and save a colordrape algorithm with one Intensity and one Pseudo layer.

The DTM colordrape algorithm you created in Part 1 of this chapter is a good example.

2 Open a new image window (**File/New** or ).

3 Click the **Open** button.

4 From the **Directories** menu, select the **\examples** path.

5 Open the ‘Data_Types’ directory, then open the ‘Geophysics’ directory.

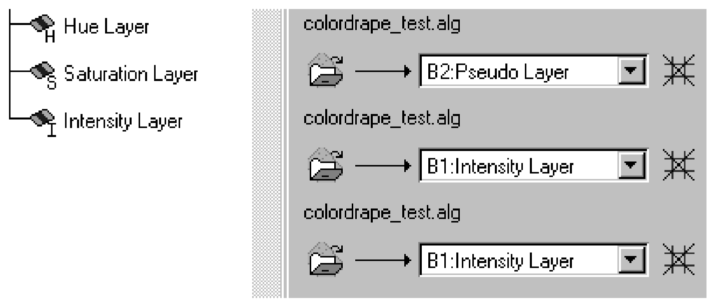
6 Open the algorithm ‘Magnetics_Colordrape_wet_look.alg.’

This is an example of the wet look applied to a magnetics dataset.

7 Load your colordrape algorithm (from step 1) as if it were a dataset *into* the ‘Magnetics_Colordrape_wet_look’ algorithm.

(Load the colordrape algorithm just like a dataset using the **Load Dataset**  button on the **Algorithm** dialog. You will need to select “ER Mapper Algorithm (.alg)” from the Files of Type menu on the **Raster Dataset** dialog to see the algorithm files.)

8 Using the **Band Selection** list, make sure you have the Pseudo (color) band of the algorithm selected for the Hue layer, and the Intensity (shaded) band selected for the Saturation and Intensity layers.




This colordrape shows the same data as your original colordrape, but with a special enhancement that creates the illusion of a reflected light source. (The shiny surface is created by removing all saturation from the brightest sun shaded areas of the image so they look bright white.)

11

# Creating image mosaics

This chapter explains how to create algorithms to display and process two or more separate image datasets as a mosaic. You will learn how ER Mapper approaches the concept of mosaicing and how to build an image mosaic algorithm.

ER Mapper 6 has the **Image Display and Mosaic Wizard** and the **Color Balancing Wizard for Airphotos** which simplify image mosaicing to a large extent. The exercises in this chapter show you how to mosaic and balance images manually and by using the wizards. The manual exercises are included to give you background knowledge and can be skipped over.

## About creating mosaics

In the context of remote sensing, a mosaic is an assemblage of two or more adjacent or overlapping images to create a continuous representation of the area covered by the images. You might, for example, create a mosaic of several overlapping satellite scenes or aerial photos to cover a larger geographic area. The process of creating image mosaics is very simple in ER Mapper once the images are rectified to the same coordinate space. Any number of co-registered images used in the same processing algorithm are automatically displayed in their correct geographic positions relative to each other.

## Image requirements for creating mosaics

In order for ER Mapper to create a mosaic, each of the images must have the following in common:

- they must be registered to the same geographic datum
- they must be registered to the same map projection
- they must be rotated the same amount from north (if rotation is used).

You will learn how to rectify images to datums and map projections later.

## ER Mapper mosaic capabilities

Other than having a common datum and map projection, you can create mosaics that contain very different types of data. An image mosaic can be built with datasets that have:

- different numbers of bands (i.e., seven for Landsat TM versus three for SPOT XS)
- different data formats (i.e., byte format versus floating point format)
- different resolutions or cell sizes (i.e., 30 meter versus 10 meter).

## Image display priority

By changing the order of the algorithm layers containing the separate image datasets, you can control dataset display priority (that is, which images appear on top of others in the event of overlap). Images loaded into the uppermost layer of any type always appear on top of any other images in layers below where overlap occurs between them.

Images loaded into the lowest layer of any type always have the lowest display priority and will only be visible in areas where there is no overlap from datasets in layers above them. For example, if you are mosaicing a high resolution image with one of lower resolution, you can display the entire extents of the high resolution image by putting its layer(s) on top in the algorithm layer list.

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**Note:** Layer priority only applies to raster layers; vector layers always appear on top of raster layers regardless of their position in the algorithm layer list.

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# Hands-on exercises

These exercises show you how to create greyscale and RGB image mosaic algorithms, and how to use histogram matching and feathering to help balance image contrast and blend seam lines between images.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Create an image mosaic by building an algorithm containing two or more sets of layers of the same type
- Specify different processing for each image in the mosaic
- Specify image priority for the mosaic (which images appear on top of others in the event of overlap)
- Use histogram matching and feathering to minimize seams in mosaics

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Creating a greyscale image mosaic

***Objectives***

Learn how display several overlapping images in different Pseudo layers to create an image mosaic, and learn to specify image priority in areas of overlap.

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**Note:** The sample images used in the following exercise were previously rectified to the same map projection, so they can be displayed together in a mosaic.

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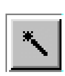
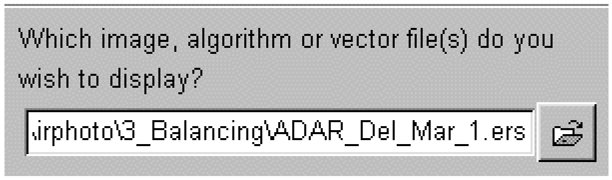
## Select files to display and mosaic

1 On the **Common Functions** toolbar, click the **Image Display and Mosaic Wizard**  button.

The **Select files to display and mosaic** page of the Image Display and Mosaic Wizard opens

2 Click the **Load Image**  button.




The **Select File** dialog opens.

3 From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4 Double_click on the ‘Applications’ directory to open it.

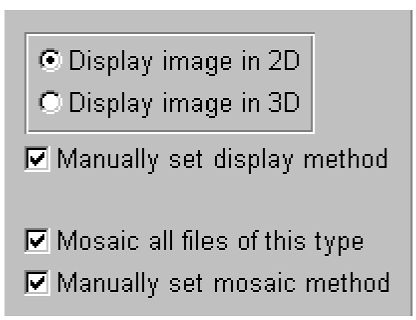
5 Double_click on the ‘Airphoto’ directory.

6 Open the ‘3_Balancing’ directory.

7 Double-click on the image dataset ‘ADAR_Del_Mar_1.ers’ to select it.

This dataset is a high resolution image covering a portion of Del Mar, California near San Diego. This dataset is a multispectral image acquired by the ADAR 5000 system mounted on an aircraft. The data values represent reflectance of light in three different wavelengths (similar to a multispectral satellite image).

8 Select the following options on the wizard page:




**Display image in 2D** Image will be displayed in a 2D mode.

**Manually set display method**
Enables you to set how the image is to be displayed. If you do not select this option, the wizard will set the display method.

**Mosaic all files of this type**
The wizard will search for files of the same type and automatically mosaic them.

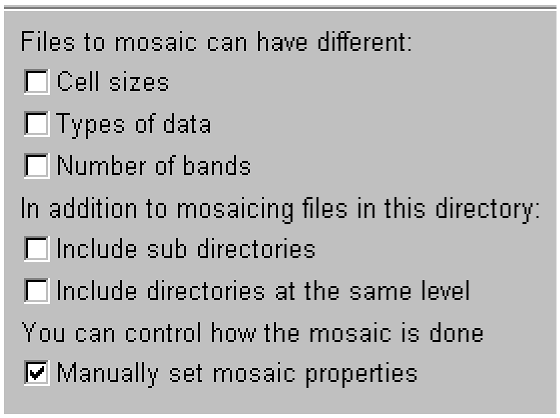
**Manually set mosaic method**
Enables you to set how the images are to be mosaiced. If you do not select this option, the wizard will set the mosaicing

9 Click on the **Next>** button to go to the next wizard page.

## Select file types to mosaic

This page allows you to specify the characteristics and location of image files that the wizard must search for to mosaic with the image already selected.

1 Select the **Manually set mosaic properties** option. Do not select the other options on the page.



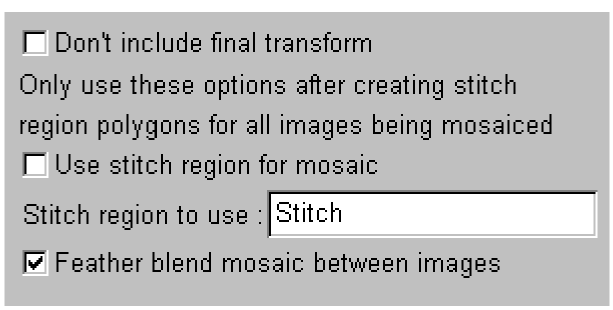

The images to be mosaiced all have the same cell sizes, data types and number of bands. They are also in the same directory.

2 Click on the **Next>** button to go to the next wizard page.

## Select mosaic properties

This page allows you to specify properties of the mosaiced image.

1 Select the **Feather blend mosaic between images** options. Do not select the other two options.



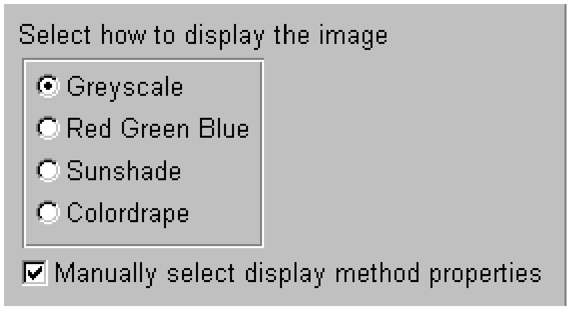

To simplify the exercise, we will not be defining and using stitch regions.

2 Click on the **Next>** button to go to the next wizard page.

## Select display method

This page allows you to specify how you want the mosaiced image to be displayed.

1 Select the **Greyscale** display option and **Manually select display method** properties.




2 Click on the **Next>** button to go to the next wizard page.

## Select display band

This page allows you to select the image band to display as a greyscale.

1 Select band B1 from the drop-down menu.


2 Click on the **Next>** button to go to the next wizard page.

## Mosaic and display the images

The wizard searches the current directory and mosaics and displays the following images:

- ADAR_Del_Mar_1.ers
- ADAR_Del_Mar_2.ers
- ADAR_Del_Mar_3.ers

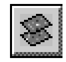
1 For the moment, leave the **Image wizard has finished** page open.

2 Drag the lower border of the image window downward about 50%.

3 Right-click in the image window, select **Quick Zoom,** then **Zoom to All Datasets**.

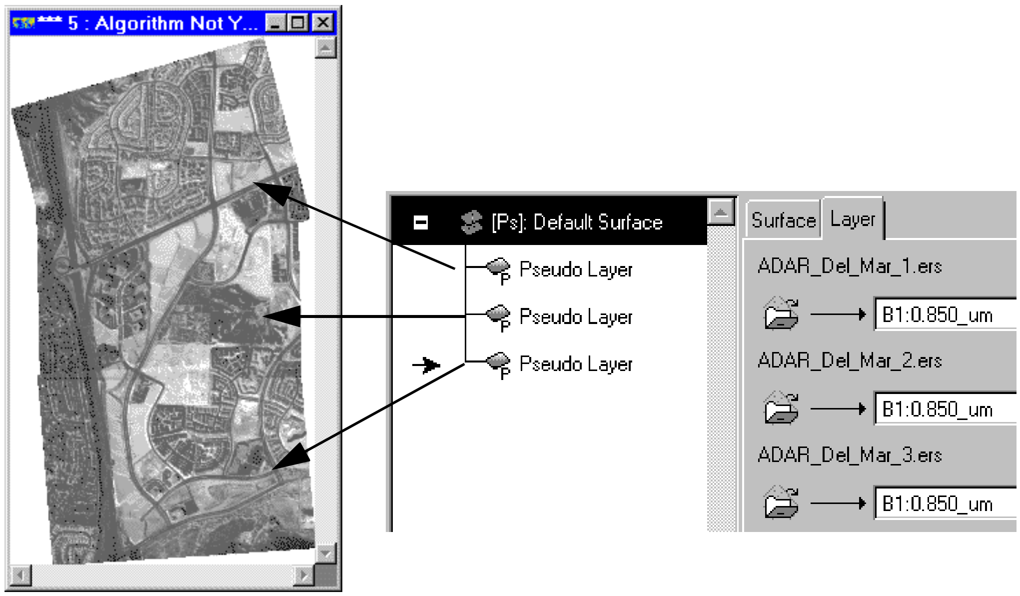
ER Mapper zooms out to show the full extents of all three ADAR images.

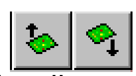
Since this image mosaic is taller than it is wide, increasing the window's width would have created a large unfilled area on the right side. This is an example of shaping the window to best fit a particular image display.

4 On the main menu, click the **Edit Algorithm**  button.

The **Algorithm** dialog box opens.

You now have a algorithm that displays band 1 of each dataset as a greyscale image mosaic.




5 If necessary, use the **Move Up** and **Move Down**  buttons to arrange the layers so that they are as shown in the diagram above.

## Turn the center image on and off

1 Right-click on the middle 'Pseudo Layer' and select **Turn Off**.

Only the top and bottom images display (since the center image is turned off).

2 Right-click on the middle 'Pseudo Layer' and select **Turn On**.

The center image redisplays in its appropriate geographic position again. Any images in a mosaic can be displayed or not displayed by turning their layers on or off.

## Zoom in to the geographic extents of any image dataset

1 Widen the image window

2 Select the top ‘Pseudo Layer’ (‘ADAR_Del_Mar_1’) in the algorithm.

3 Right-click in the image window, select **Quick Zoom,** then **Zoom to Current Dataset**.

ER Mapper zooms in to the full extents of the ‘ADAR_Del_Mar_1’ dataset (but also displays part of the lower dataset that occupies the same extents).

**Zoom to Current Dataset** lets you instantly zoom in or out to the extents of any raster image dataset(s) in the currently selected layer, so it is very useful for mosaic algorithms.

# 2: Creating an RGB image mosaic

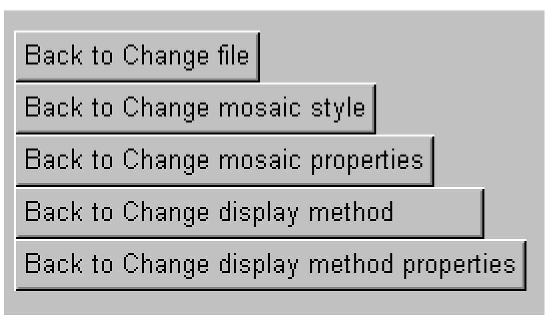
***Objectives*** Learn how display several overlapping images in different sets of red, green, and blue raster layers to create an RGB image mosaic.

We use the Image Display and Mosaicing wizard to re-display the existing greyscale mosaiced image as an RGB image.

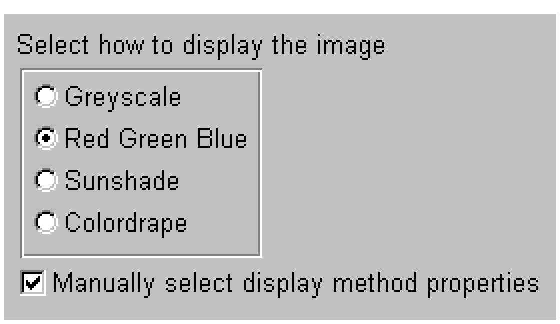
The final page of the wizard should still be open from the previous exercise.

## Change the image display method

1 Select the **Back to Change display method** button from the still open **Image Wizard has finished** wizard page.




2 On the **Select display method** page, select the **Red Green Blue** option.



3 Click on the **Next>** button to go to the next wizard page.

4 Select **RGB 123** as the Red Green Blue display mode type.

This option allocates band 1 to Red. band 2 to Green and Band 3 to Blue.

5 Click on the **Next>** button to mosaic and display the images, and to go to the final wizard page.

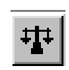
The wizard will now display the mosaiced image in RGB mode.

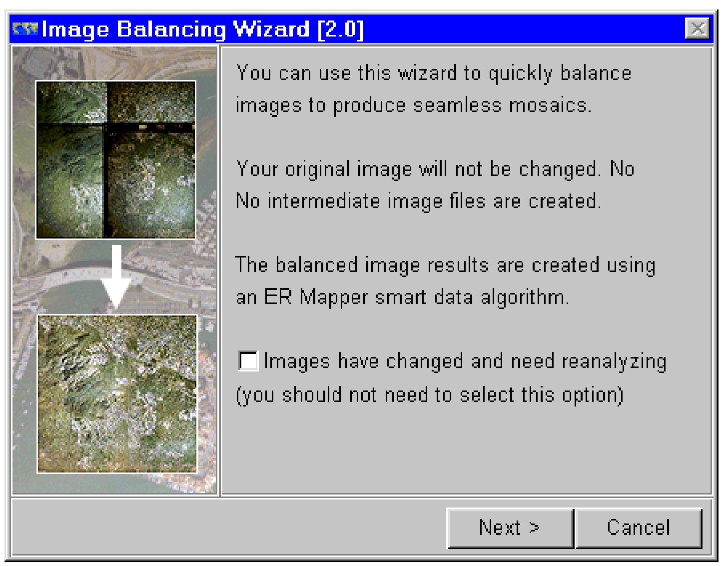
6 Click on the wizard **Finish** button to exit the wizard. Do not close the image window yet.

# 3: Color balancing the mosaic

***Objectives*** Learn how to use the Color Balancing Wizard for Airphotos to color balance mosaiced images so that they interface seamlessly with one another.

## Open the Image Balancing Wizard for Airphotos

1 Click on the **Image Balancing Wizard for Airphotos**  button on the **Common Functions** toolbar to open the wizard.




The wizard processes the currently active image window which you left open after the previous exercise

2 Click on the **Next>** button to go to the next wizard page.

## Analyze images for balancing

The wizard requires the images to be analyzed before it can do the balancing. The analysis information is stored in the image dataset header files. If the images have not yet been analyzed, the wizard will now do so.

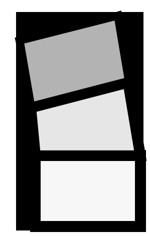
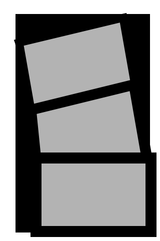
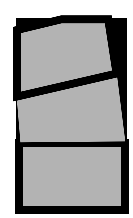
1 Click on the **Next>** button for the wizard to analyze the images.

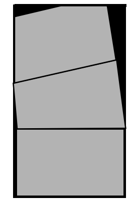
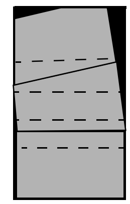
The wizard will calculate the statistics for the three ADAR images and write the information into their respective header files.

2 Click on the **Next>** button to go to the next wizard page.

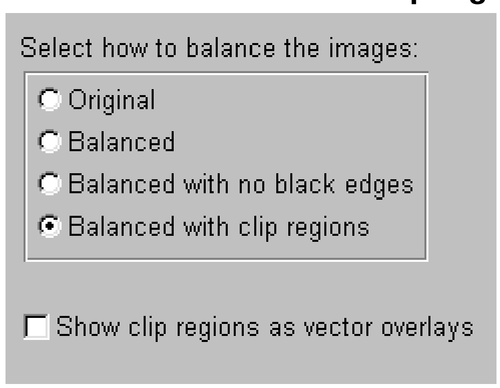
## Select how to balance the images

In addition to color balancing, you also have a number of options for clipping the image. These are described below:

| | | |
|---|---|---|
| **Original** | Remove any color balancing and display the unbalanced images |  |
| **Balanced** | Display the balanced images but do not clip edges. |  |
| **Balanced with no black edges** | Display the balanced image(s) and remove the black edges.<br>It is preferable not to select this option when balancing images that have very dark water, near the edges of the image. The color balancing wizard for airphotos may select too much of the image as dark edges to be removed. |  |

| | | |
|---|---|---|
| **Balanced with clip regions** | When mosaicing images, compute clip regions to hide the edges between images. (The wizard re-computes the clip regions every time you run it.)<br>By default, the color balancing wizard for airphotos turns feathering ON for when balancing with clip regions, and OFF in all other cases. |  |
| **Show clip regions as a vector overlay** | Create a vector layer which outlines the clip regions. |  |

1 Select the **Balanced with clip regions** option.




2 Click on the **Next>** button for the wizard to balance the images and go to the Color matching page.

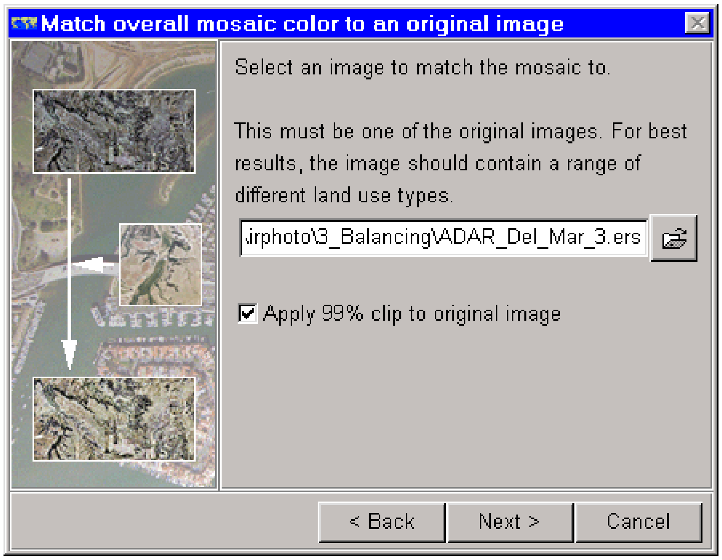
The wizard will balance and clip the image. It will then display it in the image display window as the temp-balance algorithm.

## Color matching the image

To create a seamless mosaic, the wizard is able to match the colors of the mosaiced image to the whole mosaiced image or to one of the images that are part of the mosaic. Alternatively you can skip the color matching altogether.

For this exercise we will match the color to the ‘ADAR_Del_Mar_3.ers’ image.

1 Select the **Select a single file to match colors to** option, and then click on the **Next** button.




2 Use the file chooser button to select the image to which the colors are being matched. In this case we will select ‘ADAR_Dek_Mar_3.ers’.

3 Select the **Apply 99% clip** option to improve the contrast, and click on the **Next** button.

**Caution:** Do not select the **Apply 99% clip** option if you are going to compress the image. You will not be able to reverse it when the image is decompressed.

The wizard will display the status of the color matching which can take some time to finish. It will then display the final balanced and matched image in temporary algorithm.

4 Click on the **Finish** button to exit the Color Balancing Wizard for Airphotos.

### Close the image window and Algorithm dialog

1 On the main menu, select **Close** from the **File** menu to close the image window.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create an image mosaic using the Image Display and Mosaicing Wizard
- Use the Color Balancing Wizard for Airphotos to balance the mosaiced images.
- Use histogram matching and feathering to minimize seams in mosaics

# 4: Creating a greyscale image mosaic manually

***Objectives***

Learn how display several overlapping images in different Pseudo layers to create an image mosaic, and learn to specify image priority in areas of overlap.

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**Note:** The sample images used in the following exercise were previously rectified to the same map projection, so they can be displayed together in a mosaic.

---

### Open a new image window and the Algorithm dialog

1 On the main menu, click the **Edit Algorithm**  button.

An image window and the **Algorithm** dialog box open.

2 Click the **Surface** tab (in the **Algorithm** dialog), and select **greyscale** from the ‘Color Table’ list.

3 Click the **Layer** tab again to display the process diagram.

### Load a dataset into the Pseudo layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.

The **Raster Dataset** dialog opens–move it below the image window (so the image window and **Algorithm** dialogs are visible).

2 From the **Directories** menu (on the **Raster Dataset** dialog), select the **\examples** path.

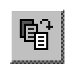
3 Open the ‘Applications\Airphoto\Balancing’ directory.

4 Click ***once*** on the dataset ‘ADAR_Del_Mar_1.ers’ to select it, then click the **Apply** button.

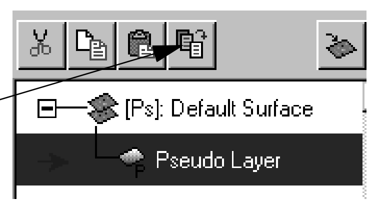
ER Mapper loads the dataset into the Pseudo layer and leaves the **Raster Dataset** dialog open (you will use it later load additional datasets).

This dataset is a high resolution image covering a portion of Del Mar, California near San Diego. This dataset is a multispectral image acquired by the ADAR 5000 system mounted on an aircraft. The data values represent reflectance of light in three different wavelengths (similar to a multispectral satellite image). Band 1 of the three band dataset is displayed by default.

## Create a mosaic by adding a second adjacent dataset

1 In the **Algorithm** dialog, click the **Duplicate**  button.

**Duplicate** button




A copy of the Pseudo layer is added to the layer list.

2 In the **Raster Dataset** dialog, click once on the dataset ‘ADAR_Del_Mar_2.ers’ to select it, then click the **Apply this layer only** button.

ER Mapper loads the dataset into *only* the selected Pseudo layer and leaves the **Raster Dataset** dialog open.

---

**Note:** Since the two Pseudo layers initially contained the same dataset, **Apply** or **OK** would have loaded the ‘Del_Mar_2’ dataset into *both* layers. When duplicating layers, use **Apply this layer only** to load into *only* the selected layer.

---

A portion of the second image displays below the first one.

## Zoom out to view the extents of both images

1 Right-click in the image window, select **Quick Zoom,** then **Zoom to All Datasets**.

ER Mapper zooms out to show the full extents of both ADAR images.

---

**Tip:** When building image mosaics, **Zoom to All Raster Datasets** lets you zoom out to view the full extents of *all* images comprising the mosaic. To zoom to the extents of specific dataset in a mosaic, select the dataset's layer then use **Zoom to Current Dataset**.

---

## Add a third dataset to the mosaic

1 In the **Algorithm** dialog, click the **Duplicate**  button.

A copy of the second Pseudo layer is added to the layer list.

2 In the **Raster Dataset** dialog, click once on the dataset 'ADAR_Del_Mar_3.ers' to select it, then click the **OK this layer only** button.

ER Mapper loads the dataset into only the third Pseudo layer and closes the **Raster Dataset** dialog.

---

**Tip:** As shown here, if you plan to load multiple datasets into an algorithm, it is often easier to leave the **Raster Dataset** dialog open until you are finished. This saves the time of opening the file chooser each time.

---

3 Right-click in the image window, select **Quick Zoom,** then **Zoom to All Datasets**.

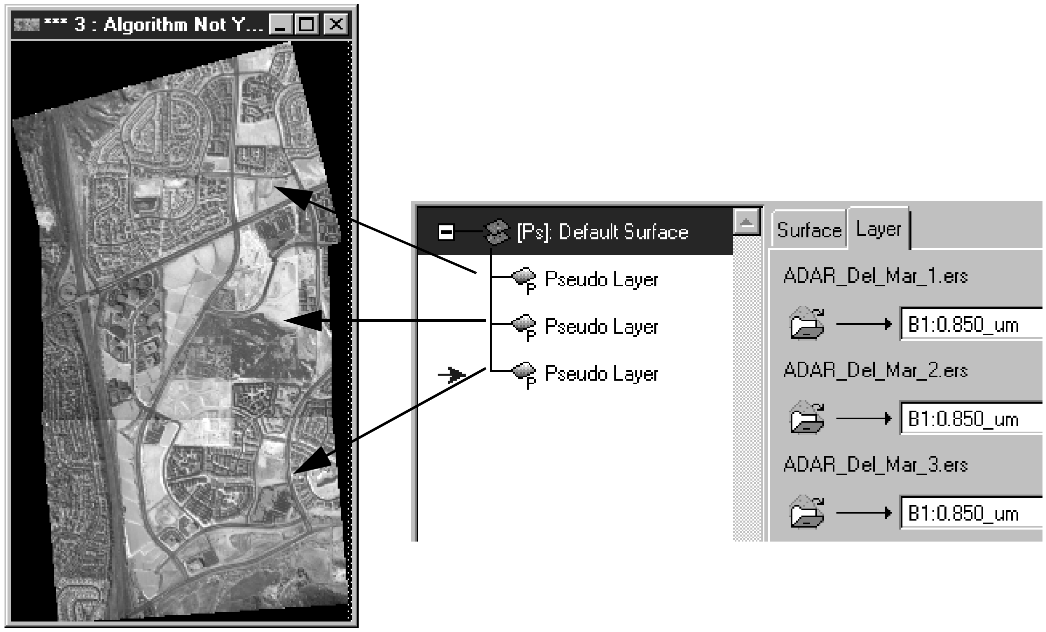
ER Mapper zooms out to show the full extents of all three ADAR images.

4 Drag the lower border of the image window downward about 50% so the window shape matches the shape of the image mosaic.

5 Right-click in the image window, select **Quick Zoom,** then **Zoom to All Datasets**.

The mosaic of images redraws to fill the new window size. (Since this image mosaic is taller than it is wide, increasing the window's width would create a large unfilled area on the right side. This is an example of shaping the window to best fit a particular image display.)

You now have a algorithm that displays band 1 of each dataset as a greyscale image mosaic.




## Turn the center image on and off

1 Right-click on the middle ‘Pseudo Layer’ and select **Turn Off**.

Only the top and bottom images display (since the center image is turned off).

2 Right-click on the middle ‘Pseudo Layer’ and select **Turn On**.

The center image redisplays in its appropriate geographic position again. Any images in a mosaic can be displayed or not displayed by turning their layers on or off.

## Brighten the center image to enhance the seam lines

1 Select the middle ‘Pseudo Layer’ containing the ‘ADAR_Del_Mar_2’ dataset.

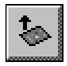
2 Click the post-formula **Edit Transform Limits** button in the process diagram.

3 On the **Transform** dialog, click the **Histogram equalize** button.

The center image in the mosaic displays with more contrast between light and dark areas than the top and bottom images, and the seam lines become clearly visible. (This is helpful for understanding image display priority in the next section.)

4 Click **Close** on the **Transform** dialog.

## Change the display priority of the center image

1 Select the middle ‘Pseudo Layer’ (‘ADAR_Del_Mar_2’), then click the **Move Up**  button.

The layer containing the ‘ADAR_Del_Mar_2’ dataset moves up, so it is now the top layer (and has display priority over datasets in layers below it).

The center image ‘ADAR_Del_Mar_2’ displays on top of the other two datasets where overlap occurs.

2 Point to the top ‘Pseudo Layer’ (‘ADAR_Del_Mar_2’), and drag it to the bottom of the layer list.

The layer containing the ‘ADAR_Del_Mar_2’ dataset now has the lowest display priority.

The center image ‘ADAR_Del_Mar_2’ displays underneath the other two datasets where overlap occurs.

---

**Note:** When displaying two or more images in a mosaic algorithm, the image in the top layer in the **Algorithm** dialog appears on top of the others when the algorithm is processed. The image in the lowest layer has the lowest priority and will only be visible in areas where there is no overlap from other datasets in layers above it. By adjusting to order of layers, you can set which datasets appear on top of others in areas where they overlap.

---

## Zoom in to the geographic extents of any dataset

1 Select the top ‘Pseudo Layer’ (‘ADAR_Del_Mar_1’) in the algorithm.

2 Right-click in the image window, select **Quick Zoom,** then **Zoom to Current Dataset**.

ER Mapper zooms in to the full extents of the ‘ADAR_Del_Mar_1’ dataset (but also displays part of the lower dataset that occupies the same extents).

**Zoom to Current Dataset** lets you instantly zoom in or out to the extents of any raster dataset(s) in the currently selected layer, so it is very useful for mosaic algorithms.

# 2: Creating an RGB image mosaic manually

***Objectives*** Learn how display several overlapping images in different sets of red, green, and blue raster layers to create an RGB image mosaic.

When creating a mosaic algorithm in Red Green Blue (RGB) Color Mode, the order of layers becomes slightly more complex but still works the same way as the single Pseudo layers you used earlier. In this case, the RGB layers act together as a set, so you normally want to keep them grouped together in the layer list in the **Algorithm** dialog.

## Load the template RGB algorithm

1 On the main menu, click the **Open**  button.


2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Miscellaneous\Templates’ directory, then open the ‘Common’ directory.

4 Double-click on the algorithm ’RGB.alg’ to open it.

This algorithm is a template for displaying datasets in Red Green Blue (RGB) Color Mode. The existing dataset is an airphoto of San Diego.

## Load an ADAR image into the RGB layers

1 In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.

2 From the **Directories** menu (on the **Raster Dataset** dialog), select the **\examples** path.

3 Open the ‘Applications\Airphoto\Balancing’ directory, then double-click on the dataset ‘ADAR_Del_Mar_1.ers’ to load it.

ER Mapper loads the ‘ADAR_Del_Mar_1’ dataset into all three layers. (Since all three initially contained the same airphoto dataset, double-clicking, **OK** or **Apply** loads the new dataset into all three automatically.) By default, band 1 is loaded into the Red layer, band 2 in the Green, and band 3 in the Blue.

This ADAR dataset is the same image you displayed earlier, but is now displayed as an RGB false color composite. Dataset band 1 (near infrared reflectance) is displayed in the red layer, band 2 (red reflectance) in the green channel, and band 1 (green reflectance) in blue. Vegetation appears red, buildings appear blue or green, and barren ground appears white.

## Add a second group of new RGB layers

1. Select the ‘Red Layer’ in the layer list.
2. From the **Edit** menu (on the **Algorithm** dialog), select **Add Raster Layer**, then **Blue**.

   ER Mapper adds a new Blue layer below the Red layer. (Since no dataset is loaded, the layer is turned off.)

3. From the **Edit** menu, select **Add Raster Layer**, then **Green**.
4. From the **Edit** menu, select **Add Raster Layer**, then **Red**.

   Now you have a second set of RGB layers you can use to add a second image to your RGB mosaic algorithm.

## Load an adjacent ADAR dataset into the new RGB layers

1. With new Red (lowest) layer selected, click the **Load Dataset**  button in the process diagram.
2. From the **Directories** menu (on the **Raster Dataset** dialog), select the **\examples** path.
3. Open the ‘Applications\Airphoto\Balancing’ directory, then double-click on the dataset ‘ADAR_Del_Mar_2.ers’ to load it.

   The ‘ADAR_Del_Mar_2’ dataset is loaded into all three new RGB layers. (If a set of RGB layers has no dataset, they are treated the same as a set that has the same dataset when loading data.)

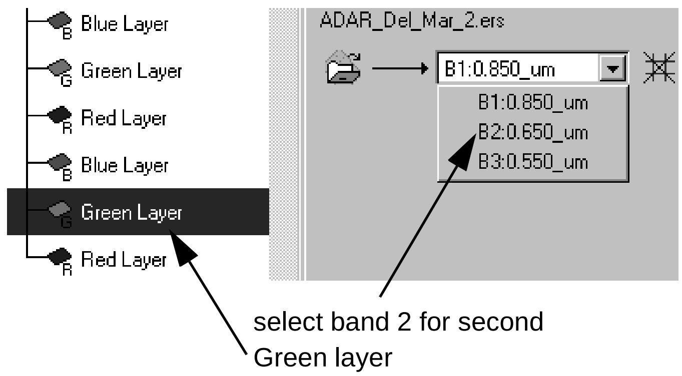
4. Turn on the new Green and Blue layers by right-clicking them and selecting **Turn On**.

   When loading a dataset into a new set of RGB layers that do not already have one, only the selected layer (Red in this case) is turned on by default. You must turn the other layers on as shown here.

## Select bands for the new Green and Blue layers

All three of the new RGB layers contain band 1 of the dataset since that band is always chosen by default when loading a new dataset into an empty layer.

1 Select the Green layer containing the ‘ADAR_Del_Mar_2’ dataset, then select **B2:0.650_um** from the **Band Selection** list in the process diagram.




2 Click on the Blue layer containing the ‘ADAR_Del_Mar_2’ dataset, then select **B3:0.550_um** from the **Band Selection** list.

You now have two groups of Red, Green, and Blue layers. Each group contains a different dataset but the same assignments of band numbers to layer types (i.e., band 1 is loaded into both Red layers, band 2 in both Green, and so on.)

3 Right-click in the image window, select **Quick Zoom,** then **Zoom to All Datasets**.

ER Mapper zooms out to display the full extents of both images in the RGB mosaic. You could continue this process to add additional RGB layers for other datasets in your color composite mosaic algorithm.

### Creating multiple sets of RGB layers

There are several alternative ways to add additional sets of RGB layers to an algorithm. Three of these alternatives are:

- Add a new Blue layer (**Edit/Add Raster Layer/Blue**), load the new dataset into it, then duplicate it twice and change the duplicate layers to Green and Red layers.
- Ctrl-click three RGB layers containing the same dataset to select them, click **Copy**, then click **Paste**. This creates a new set of RGB layers within the same surface that contain the original dataset, so you can then load the new one.
- Use **File/Add into Current Surface** to add the layers from an existing RGB algorithm into the selected surface of the current algorithm.

# 3: Using histogram matching

***Objectives*** Learn how to use ER Mapper's histogram matching feature to help balance contrast between multiple images in a mosaic.

*Histogram matching* is the process of automatically modifying the transform line(s) for one or more datasets to force their output histograms to match the output histogram of a reference dataset. This is a standard technique used to balance brightness across a mosaic of datasets to help minimize seams and make them appear to be one continuous image.

Look at the RGB mosaic you created in part 2 and notice the color difference between the two images. This is due to the slightly different range and distribution of data values in the two datasets. You will use histogram matching to alter the transforms of the layers containing the 'ADAR_Del_Mar_1' dataset to match the output histograms of the layers containing the 'ADAR_Del_Mar_2' dataset.

## Open the Transform dialog box

1 Select the lowest Red layer in the algorithm (for 'ADAR_Del_Mar_2').

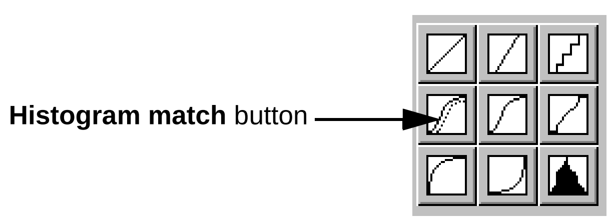
2 Click the post-formula **Edit Transform Limits** button in the process diagram.

The histogram for the Red layer of the 'ADAR_Del_Mar_2' dataset is displayed.

If needed, move the **Transform** dialog so it does not overlap with the **Algorithm** dialog or image window.

## Histogram match the Red layers

1 In the **Transform** dialog, click the **Histogram match** button.




A dialog appears explaining the effects of the histogram match function and asking you to confirm that you want to proceed.

2 Click **Yes** to proceed with the histogram match operation.

3 Click the **Move to next red layer** button on the **Transform** dialog.

The next Red layer (for band 1 of ‘ADAR_Del_Mar_1’) is selected and its histogram is displayed. Notice that it has a complex piecewise transform line–this was automatically created by ER Mapper to make the output histogram match the output histogram of the Red layer of the ‘ADAR_Del_Mar_2’ dataset.

## Histogram match the Green layers

1 In the **Algorithm** dialog, select the Green layer for ‘ADAR_Del_Mar_2’ dataset (the lower of the two Green layers).

Its histogram appears in the **Transform** dialog.

2 In the **Transform** dialog, click the **Histogram match** button.

The transform line for the other Green layer is modified to match the output histogram for the current Green layer. Notice the shape of the output histogram (same as the input or solid green histogram in this case since the default linear transform line is used).

3 Click the **Move to next green layer** button on the **Transform** dialog.

The Green layer for ‘ADAR_Del_Mar_1’ is selected. Notice the shape of the output histogram (the outline histogram) approximately matches the shape of the output histogram in the other Green layer. This is what histogram matching tries to accomplish.

## Histogram match the Blue layers

1 In the **Algorithm** dialog, select the Blue layer for ‘ADAR_Del_Mar_2’ dataset (the lower of the two Blue layers).

Its histogram appears in the **Transform** dialog.

2 In the **Transform** dialog, click the **Histogram match** button.

The transform line for the other Blue layer is modified to make its output histogram match the output histogram of the current Blue layer.

3 Click the **Move to next blue layer** button on the **Transform** dialog.

The histogram for the ‘ADAR_Del_Mar_1’ layer and its modified transform line are displayed.

The brightness differences between the two datasets are minimized and they appear much closer in color and contrast. This same technique can be used to histogram match many different images to a reference image. In this case, ‘ADAR_Del_Mar_2’ was the reference image, and the transforms of the ‘ADAR_Del_Mar_1’ layers were histogram matched to it.

4 Click **Close** on the **Transform** dialog.

You can apply other contrast stretching options such as autoclipping or Histogram Equalization to your reference layers first, and then use histogram matching to modify the other layers to match them. This is likely to be desirable in most cases. (In this case the default linear transform was used for the reference layers to simplify explanation.)

---

**Note:** Histogram matching affects all layers contained in the same surface. For example, if you have six sets of RGB layers, the other five Red layers will be matched to the reference Red layer. Histogram matching does not affect layers in other surfaces in an algorithm.

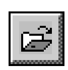
---

# 4: Using mosaic seam feathering

***Objectives*** Learn how to use ER Mapper's mosaic feathering feature to help blend areas of overlap to smooth seam lines between images in a mosaic.

*Feathering* is the process of blending the data values in areas where two datasets overlap so they gradually transition (or "feather") from one to the other. Feathering can help to reduce the visual effect of seams between two or more images and helps them appear to be one continuous image. Feathering is an option on the **Algorithm** dialog. It is only available when you have more than one of the same layer type in your algorithm (which is necessary to create an image mosaic).

## Load the mosaic of four datasets algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Functions_And_Features' directory, then open the 'Data_Mosaic' directory.

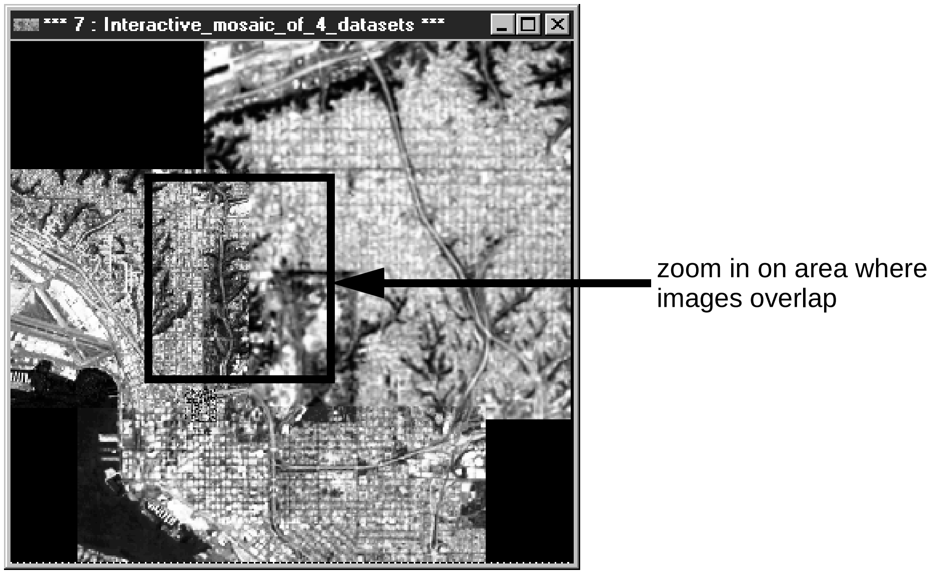
4 Double-click on the algorithm 'Interactive_mosaic_of_4_datasets.alg.'

This algorithm is a greyscale mosaic of four datasets with different spatial resolutions–a Landsat TM image, a SPOT XS image, and SPOT Pan image, and a digitized aerial photograph.

## Zoom in on a seam line between two datasets

1 Click the **Zoom Box Tool**  button on the main menu.

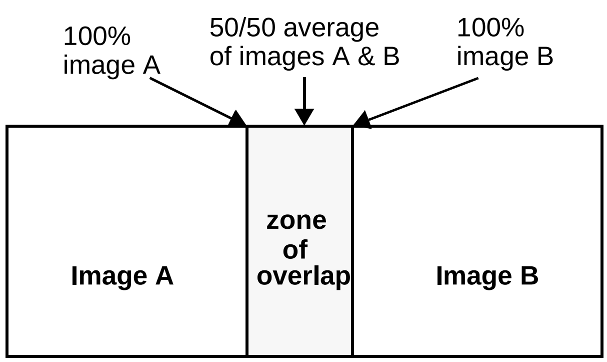
2 Drag a zoom box in the image to zoom in on the vertical seam between the Landsat and SPOT XS images in the mosaic (see below):



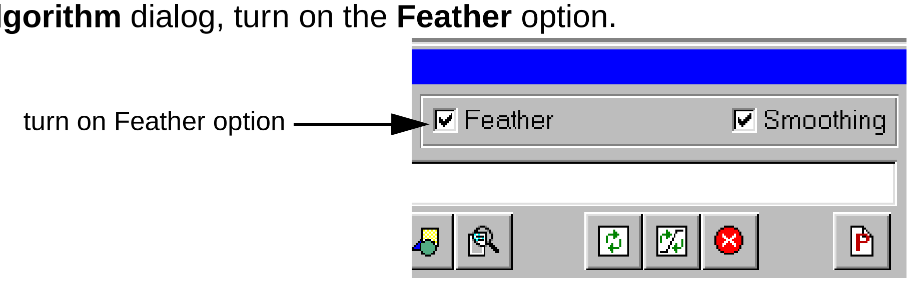

You should clearly see the seam line and difference in spatial resolution between the two images (the SPOT XS image on the left has higher resolution).

## Turn on the mosaic feathering option

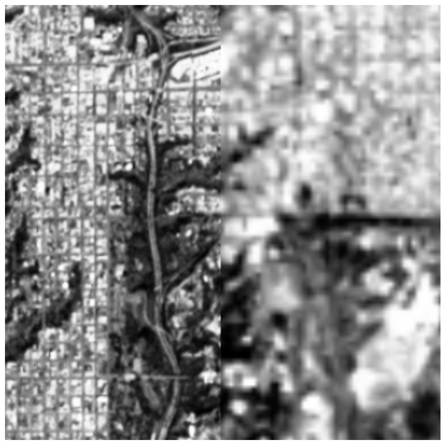
Feathering works by blending, or averaging, the data values between two images in the zone where they overlap:

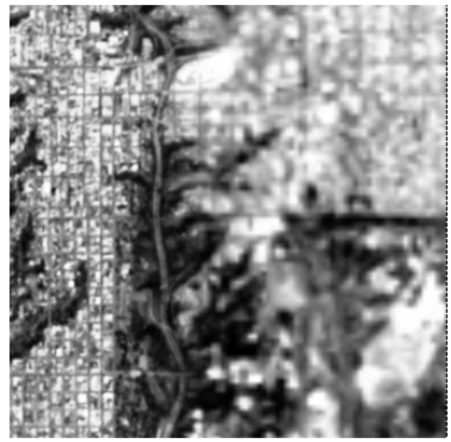



1 On the **Algorithm** dialog, turn on the **Feather** option.



The seam line between the two images is blended to create a smooth transition between them. Feathering works by progressively blending the data values in the two datasets in the area where overlap occurs. Since the feathering computations occur in a left to right direction, it works best on vertical seams such as in this case.


feathering off


feathering on

Feathering can also be effective to hide small misalignments between features on adjacent images. (However gross misalignments will create a blurred look, and you should consider rectifying one or both images again to improve this.)

## Close the image window and Algorithm dialog

1 On the main menu, select **Close** from the **File** menu to close the image window.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned***

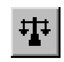
After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create an image mosaic by building an algorithm containing two or more sets of layers of the same type
- Specify different processing for each image in the mosaic
- Specify image priority for the mosaic (which images appear on top of others in the event of overlap)
- Use histogram matching and feathering to minimize seams in mosaics

## Tips for mosaic algorithms

The following section contains additional tips for creating mosaic algorithms, balancing contrast and minimizing seam lines. When creating a mosaic of images, there are two primary issues to be addressed that help make the mosaic appear to be a single, seamless image:

- correcting shifts in brightness or color within individual images–this problem occurs mostly with airphotos and airborne scanner data, but occasionally with satellite images as well
- balancing the overall contrast of the mosaic (normalizing the contrast of all images to a common level)

The easiest solution to these issues is to use the Image Balancing Wizard after mosaicing the images. This will automatically balance and match the colors. To use the Image Balancing Wizard, click on the  button on the **Common Functions** toolbar.

You do not generally need to use other methods, which are described below.

When balancing the brightness and contrast of images (and mosaics of images), it is often easier to work with a single band of the image at a time in greyscale. This is because subtle brightness and contrast adjustments can be more difficult to carry out when working with three components (red, green and blue) than one component (red, for example). For example, you might start by creating a balanced mosaic showing only the red band of each image. Then do the same for the green and blue components, and add them back together into an RGB mosaic at the end.

### Correcting brightness shifts and vignetting

Airphotos and some other images sometimes exhibit shifts in brightness or intensity across the image, for example one side of an image is noticeably darker than another. This intensity “roll off” problem results in darkening toward one side or toward the edges of the image (“vignetting”). It is usually desirable to try to correct brightness shifts because they will be more noticeable when the images are displayed side-by-side in a mosaic.

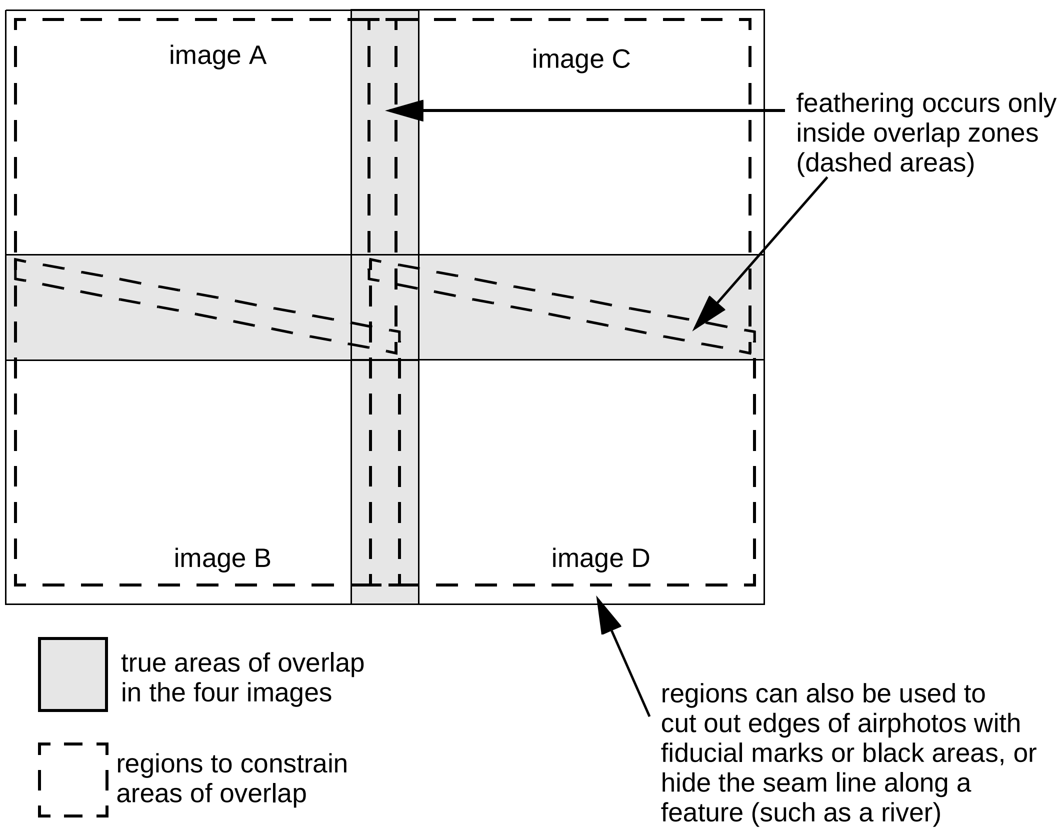
ER Mapper contains two standard formulas for correcting brightness shifts. These are “hot_spot_correction.frm” and “linear_ramp.frm” in the ERMAPPER\formula\mosaic directory. The “hot_spot_correction’ formula is designed to lighten dark edges surrounding a brighter (or “hot”) spot in the image. The “linear_ramp” formula is designed to correct for linear brightness shifts occurring from one side of an image to another. See the formula comments for more information about using them.

## Creating hidden stitch line regions to remove seams

Even with histogram matching and other color balancing techniques, many times there are minor contrast problems between adjacent images that cannot be removed, and slight mismatches of features along seam lines due to errors in the rectification of the images.

One effective technique for removing seam lines is to define a special region for each image that constrains the area of overlap with other images to a specific area. Inside this area of overlap, ER Mapper's feathering feature can be used to blend the two images, thus creating a seamless merge between adjacent images. You can also create specially shaped regions that hide seams between images along the border of a specific feature, for example a river.

Since the feathering feature works *across* an image (horizontally), it is sometimes useful to define specially shaped regions that create a diagonal zone of overlap between the top and the bottom image. You can also do this between left and right images:




The goal is to create a narrow zone of overlap between the images as this will make the feathering feature more effective for blending out seam lines. To have ER Mapper display only the area inside the region for each dataset, use the "inregion" function in a formula (as you did in the earlier formulas exercise).

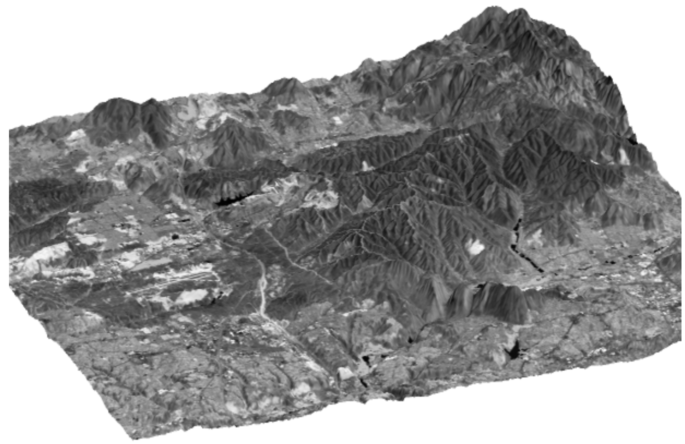
# 12

# 3-D perspective viewing

This chapter explains how to view and manipulate images in 3D perspective to gain a better understanding of terrain features, relationships, and other aspects of your data. ER Mapper lets you quickly change between 2D and 3D views of your data, stack multiple surfaces in a single view, set transparency between surfaces, and many other features.

# About perspective viewing

Two-dimensional (planimetric) view



Three-dimensional perspective view

Viewing images in three-dimensional perspective is a valuable tool that helps increase understanding of features and relationships in datasets. Many types of earth science datasets can be integrated to create 3D scenes that show features and anomalies much more clearly than traditional two dimensional views. To create a 3D view, you simply add a Height layer to your 2D algorithm that contains an elevation dataset (such as a digital terrain model), then change the View Mode to 3D perspective or 3D flythrough.

ER Mapper's 3D viewing capabilities are extensive and easy to use, including:

- view any dataset in 3D, and quickly switch between 2D and 3D views
- use static 3D perspective or real-time "flythrough" modes
- stack multiple surfaces in a single view
- set transparency between surfaces to view underlying features
- incorporate vector data in 3D, such as roads or cultural data
- generate top quality, high resolution 3D hardcopy prints

# Hands-on exercises

These exercises give you practice setting up algorithms for 3D viewing, and manipulating the images using the viewing and display controls in ER Mapper's 3D perspective viewer.

***What you will learn...***

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Prepare an algorithm for 3D viewing by adding a Height layer
- Change the viewpoint, zoom level, and other 3D view parameters
- Use the 3D Flythrough viewing mode
- Stack multiple surfaces in a 3D view and set surface offset and transparency
- Merge separate algorithms into surfaces in a single algorithm

***Before you begin...***

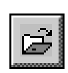
Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: 3D viewing basics

***Objective***

Learn to prepare an algorithm for 3D viewing by adding a Height layer that contains the desired elevation data. Also learn to use 3D perspective view mode, and control the viewpoint and display parameters of the 3D scene.

## Open a Landsat TM RGB algorithm

1 On the main menu, click the **Open**  button.


An image window and the **Open** dialog appear.

2 From the **Directories** menu (on the **Open** dialog), select the **\examples** path.

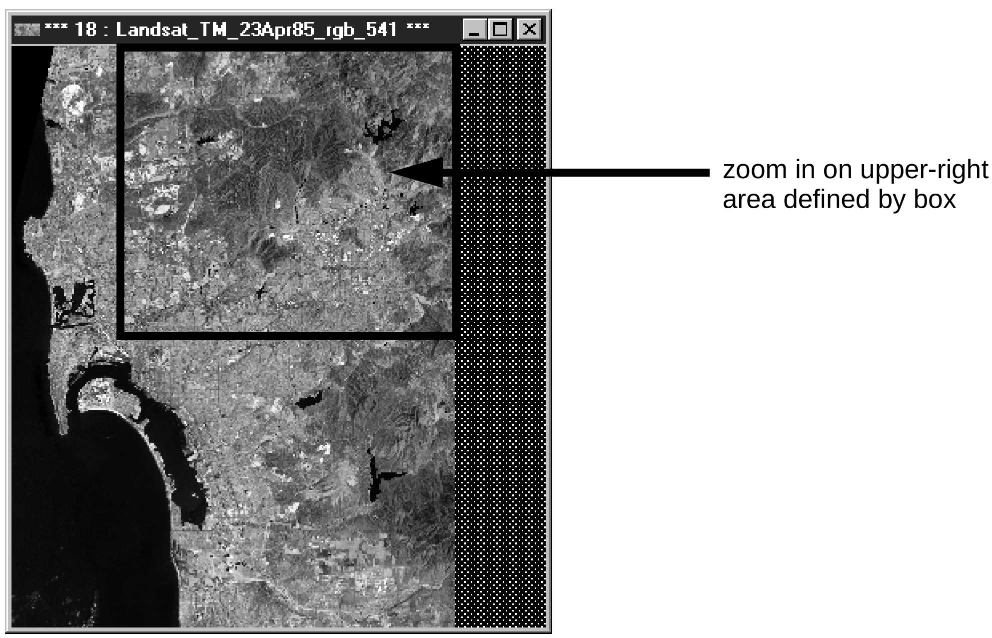
3 Open the ‘Applications\Land_Information’ directory, then double-click on the algorithm ‘Landsat_TM_23Apr85_rgb_541.alg’ to open it.

This algorithm displays a Landsat TM satellite image of a large area of San Diego, California. Bands 5, 4 and 1 are displayed in RGB so vegetation appears in various shades of green and brown.

## Zoom in to the upper-right portion of the image

1 Click the **Zoom Box Tool** button on the main menu.

2 Drag a zoom box in the image to zoom in on the upper-right portion of the image indicated below.




This is the area you will display in 3D perspective. (You can select a subset of an area to display in 3D simply by zooming in on it.)

## Add a Height layer and load the DTM dataset

1 On the main menu, select **Algorithm** from the **View** menu.

2 From the **Edit** menu (on the **Algorithm** dialog), select **Add Raster Layer**, then **Height**.

ER Mapper adds a new, empty Height layer to the algorithm. The layer is crossed out because you are currently viewing the image in 2D view mode.

3 With the ‘Height Layer’ selected, click the **Load Dataset** button in the process diagram.

4 From the **Directories** menu (on the **Raster Dataset** dialog), select the **\examples** path.

5 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Digital_Terrain_Model_20m.ers’ to load it.

This dataset is a digital terrain model (DTM) dataset of the northern San Diego area with a 20-meter grid resolution (or posting). The dataset values are in meters above sea level. This is the dataset you will use to add a height component to the algorithm to enable the Landsat image to be viewed in 3D perspective.

---

**Note:** In the **Algorithm** dialog, notice that the Height layer has a “Histogram only” post-formula transform. This is automatically inserted for new Height layers because it forces use of the entire range of values in the DTM and prevents the data from being rescaled. (Using a transform will skew the data, for example a 99% autoclip on a Height layer will usually create flat spots in the highs and lows of the 3D image. If you duplicate an existing layer and change it to Height, delete the transform to use the full range of data for the elevation component.

---

## Select 3D Perspective mode to view the image in 3D

1 From the ‘View Mode’ menu (on the **Algorithm** dialog), select **3D Perspective**.

ER Mapper displays a message that the image is being processed, then displays a 3D perspective view of the Landsat image in color. The message “Regenerating Terrain” appears in the image window as ER Mapper performs iterations to increase the resolution (detail) in the 3D image.

The perspective view provides clear definition of the topography of the area, which can add valuable information to aid interpretation of satellite and other types of images.

---

**Tip:** If your algorithm does not contain a Height layer, ER Mapper automatically uses an Intensity layer (if one is present) as a Height layer when you switch to **3D Perspective** view mode.

---

## Turn off the Lighting (artificial illumination) option

1 In the **Algorithm** dialog, select the **3D View** tab.

The **3D View** tab page provides draw mode, terrain detail, lighting, and other options.

2 Turn off the **Lighting** option.

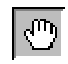
The image redraws without illumination from a light source.

---

**Tip:** When displaying datasets that contain natural shadows (such as airphotos or optical satellite images like Landsat), the 3D image appears more natural when the Lighting option is turned off. (Lighting is discussed more later.)

---

## Tilt the image forward or backward

1 On the main menu, click the **Hand (Roam) Tool**  button.

**Set Zoom mode** must be selected to manipulate the viewpoint of the image.

2 Point to lower edge of the 3D image and drag slightly downward.

The image moves into a more overhead perspective, and regenerates detail when you release the mouse button.

3 Point to lower edge of the image and drag slightly upward.

The image moves into a flatter, side view perspective. Dragging the image up or down tilts the 3D model forward or backward (rotates it around its X axis).

---

**Tip:** If you accidently change the 3D view too much, click the **3D View** tab in the **Algorithm** dialog, then click the **Reset View** button. This resets the the image to a standard default view.

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## Rotate the image around its center point

1 Point to lower edge of the image and drag slightly to the right.

The image rotates to the right around its center point.

2 Point to lower edge of the image and drag slightly left.

The image rotates to the left around its center point. Dragging the image left or right lets you view it from a side angle (rotate around the Z axis).

## Zoom the image in and out

1 Drag the image window corner to make it 50% larger.

The 3D view resizes to fit the window.

2 Point to the center of the image. Then press right mouse button and drag slightly upward.

As you drag, ER Mapper zooms out so the image redraws at a smaller size.

3 Point to the image center again, press right mouse button and drag slightly downward.

ER Mapper zooms in so the image redraws at a larger size.

Right-dragging up or left reduces the image (zooms out); right-dragging down or right magnifies the image (zooms in).

4 Right-drag to set the zoom extents for the image so it fills as much of the window as possible.

## Rotate the image side to side

1 Point to the center of the image. First depress the left mouse button, then the right button (hold down both), then drag slightly to the right.

ER Mapper rotates the image to the right.

2 Point to the image center again, depress the left then the right mouse buttons, and drag slightly to the left.

The image rotates left. Pressing the left *then* the right mouse buttons and dragging left or right is how you rotate the image side to side (around its Y axis).

## Pan (scroll) the image within the window

1 Point to the center of the image. First depress the right mouse button, then the left button (hold down both), then drag slightly upward.

ER Mapper pans (or scrolls) the image upward without changing the perspective.

2 Point to the image center again, depress the right then the left mouse buttons, and drag around inside the window.

The image repositions as you drag. Panning in 3D is useful when want to reposition the image in the window without changing the zoom factor or viewing perspective.

### Summary of 3D movement procedures

- To tilt the image backward or forward, press left mouse button and drag toward the top of the image window (to tilt backward) or bottom (to tilt forward).
- To tilt the image side to side, press left mouse button followed by right mouse button and drag to the left (to tilt left) or right.

- To the zoom the image in or out, press right mouse button and drag toward the bottom of the image window (to zoom in) or top (to zoom out).
- To rotate the image around it center axis, press left mouse button and drag the left or right side of the image (or bounding box) toward the edge of the image window.
- To move (or pan) the entire image within the window (without changing size or perspective), press right mouse button followed by left mouse button and drag to the desired location in the image window.

## Increase the vertical exaggeration of the image

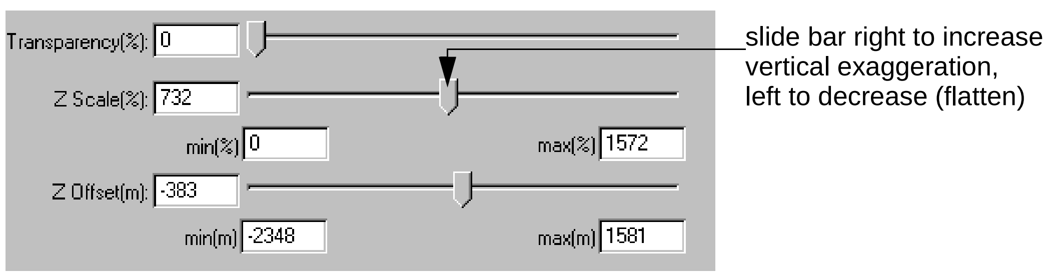
1 With the **3D View** tab selected (in the **Algorithm** dialog), click the **Reset View** button.

The 3D image perspective is reset to the initial default size and viewpoint.

2 In the **Algorithm** dialog, select the **Surface** tab.

The **Surface** tab contains controls that apply to the entire surface (such as Color Mode), and also controls for 3D perspective views.

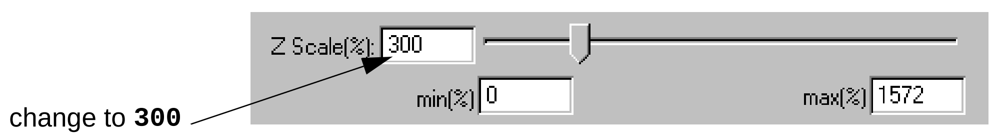
3 Move the **Z scale** slider bar right to about it mid-point.




The image redisplays with increased vertical exaggeration, so high and low elevations in the image become more apparent.

4 Try different vertical exaggerations by moving the the **Z scale** slider bar left or right.

5 Change the value in the **Zscale** field to **`300`**, then press Enter/Return.




The 3D image redraws at 3 times normal vertical exaggeration.

**Note:** ER Mapper interprets height values to be in the same units as X and Y distances. For example, if your X and Y distances are measured in meters (as in this case) and you set **Z scale(%)** to 100, a DTM value of 10 is interpreted as 10 meters (so elevation is true to geographic scale). However, much greater vertical exaggeration is often needed to clearly bring out subtle topographic details in low relief areas such as this part of San Diego.

## Apply different rendering modes for the 3D image

1 Select the **3D View** tab in the **Algorithm** dialog.

The 3D View tab page provides draw mode, terrain detail, lighting, and other options. These settings affect the entire 3D image (which can contain multiple surfaces as you will see later).

2 From the **Draw Mode** drop-down list, select **WireFrame**.

ER Mapper redisplays the image as a mesh connected grid lines. Wireframe is the fastest rendering mode, so the image regenerates quickly.

3 For **Draw Mode**, select **Textured**.

ER Mapper redisplays the image in blocks using a texture algorithm. (If your computer's graphics adapter has built-in hardware texturing, ER Mapper uses this capability to render the image quickly. If it does not, this mode requires the most calculations and may take some time for large images.)

4 For **Draw Mode**, select **Smooth Shaded** again.

ER Mapper redisplays the image with a smooth, solid fill.

## Use the Lighting and Bounding Box options

1 Turn on the **Lighting** option.

The image redraws with artificial illumination from a light source, so it has a "shiny" quality to it.

2 Turn the **Lights** option off again.

The image redraws without shading effects from a light source. (Lighting is recommended when displaying geophysical or digital terrain datasets in color layers because they have no natural shadowing.)

**Tip:** You can control the amount of shininess and the material qualities used for the **Lights** option by selecting the **3D Properties** tab.

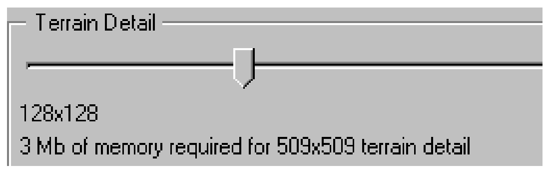
3 Turn on the **Bounding Box** option.

The image redraws with a bounding box surrounding it. The box shows the extents of the image in the X, Y and Z (vertical) directions.

4 Turn off the **Bounding Box** option.

## Adjust the amount of Terrain Detail

1 Move the **Terrain Detail** slider to the right until it reads “3 Mb of memory required for 509 x 509 terrain detail” under the slider bar.




The image redraws with increased detail in the terrain.

2 Move the **Terrain Detail** slider all the way to the left.

The image redisplays with the lowest detail (128 x 128).

Terrain Detail refers to the resolution, or amount of detail, at which the image will be rendered. As you increase the detail, the rendering time, number of regeneration iterations, and amount of system memory needed also increase. It is recommended that you start at low detail settings, then slowly increase the detail to get a more accurate, high resolution image. This setting can also be important when printing 3D images to hardcopy, where you may want to use higher settings to get more detailed images.

## Save the 3D algorithm

1 Adjust the viewpoint of the image to a pleasing position.

2 In the **Algorithm** dialog, change the **Description** field text to:

**`San Diego Landsat RGB=541 in 3D perspective`**

3 On the main menu, click the blue **Save As**  button.

4 In the Files of Type: field (on the **Save As** dialog), select ‘ER Mapper Algorithm (.alg)’.

5 From the **Directories** menu, select the **\examples** path.

6 Open the ‘Miscellaneous’ and then the ‘Tutorial’ directory.

7 In the **Save As:** text field, enter your initials followed by the text **`Digital_terrain_3D`** and separate each word with an underscore (_).

8 Click **OK** to save the algorithm.

Your 3D perspective algorithm is now saved to an algorithm file on disk. The next time you open it, the image automatically displays in 3D with the same viewpoint and rendering parameters.

# 2: 3D flythrough basics

***Objective*** Learn to view an image in 3D Flythrough mode, and control the viewpoint and flight parameters.

In 3D Flythrough mode, it is as though the ground is stationary and you move around it, exploring the terrain. You depress the mouse button to begin your flight through the image, and the area where you position the mouse cursor controls the direction and speed of your flight.

## Open a standard 3D view algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu (on the **Open** dialog), select the **\examples** path.

3 Double_click on the ‘Functions_And_Features’ directory to open it, then open the ‘3D’ directory.

4 Double-click on the algorithm ‘Landsat_over_DTM.alg’ to open it.

This algorithm displays smaller Landsat TM satellite image of San Diego in 3D perspective (with Lights on).

## Select 3D Flythrough mode to move through the image in 3D

1 From the ‘View Mode’ menu (on the **Algorithm** dialog), select **3D Flythrough**.

The image re-renders from a side view.

## Fly through at different directions and speeds

To fly through the image, depress the left mouse button and point to an area of the image window to control the direction and speed of the flight. As you fly through the image, the terrain will appear to move in the opposite direction of your motion.

1 Point to the lower center of the image window and depress the left mouse button.

You fly backward away from the image, and the detail regenerates when you release the mouse.

2 Point to the upper center of the image and depress the left button.

You fly forward toward the image.

3 Point to the right center of the image and depress the left button.

You fly toward the right side of the image.

4 Point to the left center and depress the left button.

You fly back toward the left side of the image.

5 Point to the lower-right corner of the window and depress the left button.

You fly backward *and* to the right away from the image.

6 Point slightly above the center point of the window and depress the left button.

You fly forward slowly into the image.

**Tip:** To fly slowly, point near the window center. To fly faster, point further out toward the window edges.

## Change the viewing altitude

1 Point to the center of the image, depress the right mouse button and drag slightly upward.

Your altitude increases, so you look more down on the 3D image.

2 With the right button depressed, drag slightly downward.

Right-dragging up or down lets you change viewing altitude.

**Tip:** With a little practice, you can become very good at precisely controlling your flight path and altitude. If you become lost while flying around, click the **Reset View** button to return to the default viewpoint again.

### Summary of 3D Flythrough controls

- To fly forward or backward, press the left mouse button in the top half of the image window (to fly backward) or bottom half (to fly forward).
- To fly left or right, press the left mouse button in the left half of the image window (to fly left) or right half (to fly right).

- To the change viewing altitude, press the right mouse button and drag up or down.
- To control the speed of flight, point close to the center of the window for slow speed, and further out toward the window edges for progressively faster speeds.

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**Note:** In 3D Flythrough mode, you can also add “fog” to the image display by selecting the **3D Properties** tab. Fog is only available in 3D Flythrough mode.

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# 3: Viewing multiple surfaces in 3D

***Objective*** Learn to view two or more surfaces in 3D perspective, and control the offset, transparency, and other parameters of the view.

Up until now, you have created algorithms that contained only one surface. In a sense, you can think of each surface as a separate image, or a separate view of your data. Since you use an algorithm to create a certain type of image, you can copy or merge different types of algorithms as separate surfaces in a single algorithm and stack the images in a single 3D view. Stacking multiple surfaces into a single 3D view lets you quickly see relationships between datasets in 3D.

## Open a DTM 3D color algorithm

1. On the main menu, click the **Open**  button.
2. From the **Directories** menu (on the **Open** dialog), select the **\examples** path.
3. Double_click on the ‘Functions_And_Features’ directory to open it, then open the ‘3d’ directory.
4. Double-click on the algorithm ‘Digital_Terrain_Map_Colordrape.alg’ to open it.

   This algorithm displays a DTM of the San Diego downtown area. The same image is used in both the Height and Pseudo layers, so the DTM data is shown as relief and also color coded (reds are high elevations, blues are lows).

---

**Tip:** You can use any type of data in the Height layer of an algorithm. For example, a vegetation index image would create high elevations in the 3D image where vegetation was most abundant.

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## Open a Landsat 3D algorithm as a second surface

You can easily add a surface to an existing algorithm by opening another algorithm into it as a separate surface (transfer its layers to the current algorithm).

1 On the main menu, select **Open into New Surface** from the **File** menu.

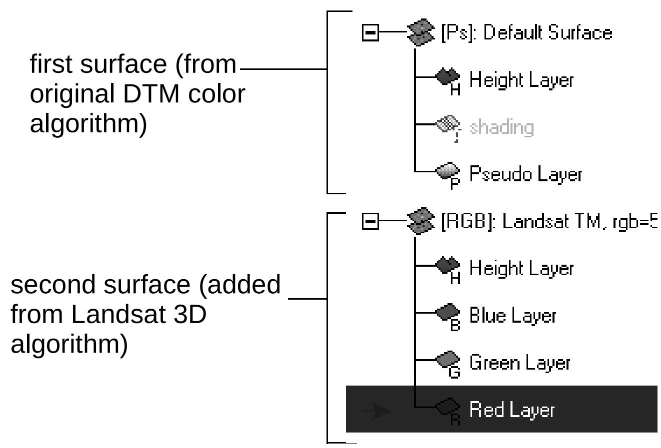
The **Open into New Surface** dialog opens.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Functions_And_Features' directory, then open the '3D' directory.

4 Double-click on the algorithm 'Landsat_over_DTM.alg' to open it.

ER Mapper loads the algorithm into a second surface and renders the image underneath the 3D color DTM image. The new algorithm shows Landsat TM bands 5, 4 and 1 in RGB. Your algorithm now has two surfaces:

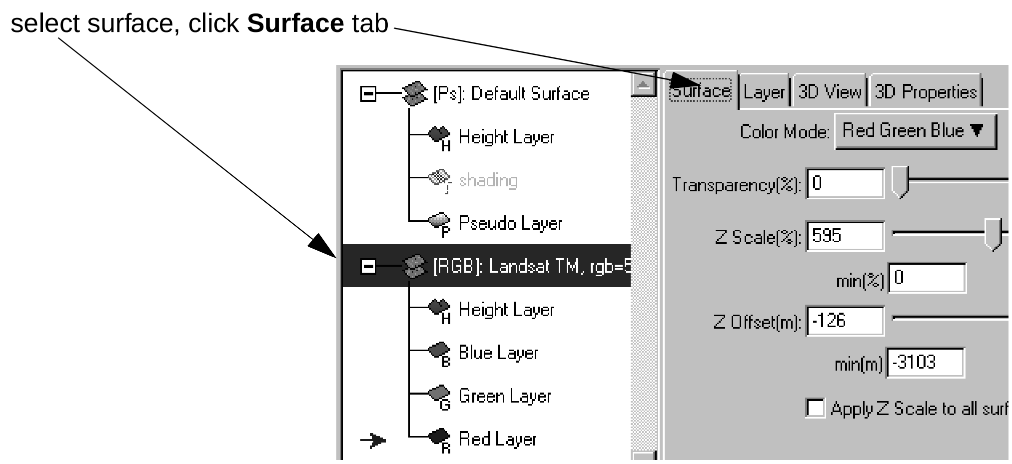



Notice that the two surfaces have different color modes (indicated in the surface name–[Ps] for Pseudocolor and [RGB] for Red Green Blue). Each surface can have its own color mode, color table or other settings independent of others.

## Change the Z Offset to shift the surface in 3D space

1 Click the **Hand Tool** button (if needed), then tilt the 3D image up slightly to view it more from the front side (so that the gap between surfaces is more apparent).

2 On the **Algorithm** dialog, select the lower Landsat surface ([RGB:Landsat TM]) icon in the data structure diagram, then select the **Surface** tab.




3 Move the **Z Offset** slider all the way to the right.

The Landsat image created by the lower surface slides up above the DTM image.

4 Move the **Z Offset** slider to the far left.

The Landsat image slides below the color DTM image again. To move a surface relative to other surfaces in an algorithm, select the surface in the data structure diagram, then move the **Z Offset** slider. (You could also select the top surface and move up or down it relative to the lower surface's image if desired.)

## Change the transparency of the top surface

1 Tilt the 3D image downward slightly until the top surface mostly covers the one below.

2 Select the top surface '[Ps]:Default Surface' in the data structure diagram.

3 Move the **Transparency** slider right to its midpoint.

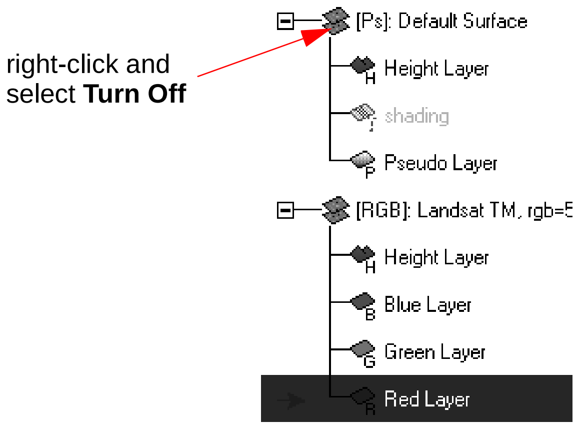
The color DTM image becomes semi-transparent, so some of the color of the Landsat image below shows through.

The **Transparency** setting ranges from 0-100 to specify how the image is "blended" with other surfaces in the image window. Zero displays the full image, 50 creates 50% transparency, and 100 makes the image invisible. Each surface can have it own transparency setting independent of others.

4 Move the **Transparency** slider to the far left to make the image fully visible.

## Turn individual surfaces on and off

1 Right-click on the icon for the top surface, and select **Turn Off**.:



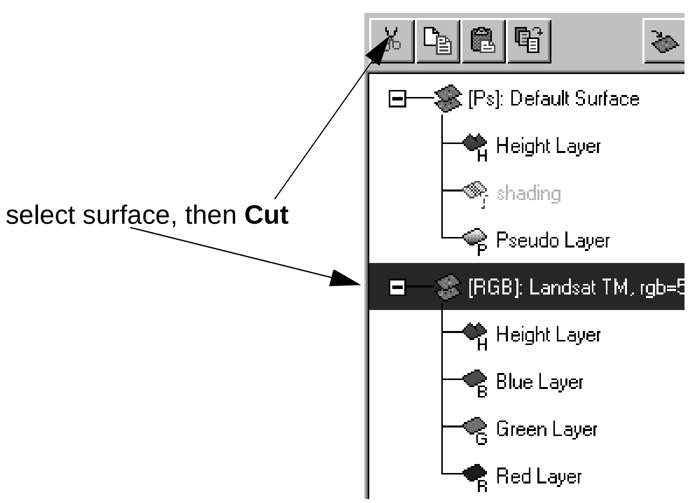

ER Mapper renders only the lower surface (the Landsat image).

2 Turn the top surface on again.

Both surfaces are again rendered.

## Delete the lower surface from the algorithm

1 Select the lower surface in the data structure diagram, then click the **Cut** button (above the diagram) to delete it.




## Open a second image window and algorithm

1 On the main menu, click the **New** button.

Drag the new window down below the first one.

2 On the main menu, click the **Open** button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Functions_And_Features' directory, then open the '3d' directory.

5 Double-click on the algorithm 'Landsat_over_DTM.alg' to open it.

This is the same algorithm as that you used earlier.

## Copy and paste the surface into the first algorithm

1 Select the surface icon in the Landsat 3D algorithm, then click the **Copy** button (above the data structure diagram).

The surface and its layers are copied into the clipboard.

2 Activate the color DTM 3D image window.

3 Click the **Paste** button.

The surface and its layers are pasted into the DTM algorithm as a second surface.

(In this case the **Z Offset** settings are such that the lower levels of the DTM image are hidden by the Landsat data.)

---

**Tip:** To add surfaces to an existing algorithm, you can choose **Open into New Surface** from the **File** menu, or copy and paste surfaces between image windows. You can also copy and paste layers or surfaces within the same algorithm and modify them as desired, or a new empty surface and load datasets and specify processing as needed (using **Add New Surface** or on the **Algorithm** dialog).

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## Close both image windows and the Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** dialog.

Only the ER  Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Prepare an algorithm for 3D viewing by adding a Height layer
- Change the viewpoint, zoom level, and other 3D view parameters
- Use the 3D Flythrough viewing mode
- Stack multiple surfaces in a 3D view and set surface offset and transparency
- Merge separate algorithms into surfaces in a single algorithm

## General information on 3D viewing and printing

### Notes about 3D rendering speed

ER Mapper can render very large image files quickly in 3D due to it’s progressive rendering technology (i.e., starting with a low resolution view and progressively increasing detail with subsequent processing iterations). However, large files can take much longer to render, especially at higher Terrain Detail settings and using Textured draw mode. The speed at which the image renders in 3D is proportional to the processing speed of your computer and the 3D capabilities of your graphics display card.

ER Mapper’s 3D viewer features are designed take full advantage of the latest 3D graphics hardware rendering technologies. If your graphics card has 3D acceleration, images will render much faster when using ER Mapper’s 3D view modes. Be sure to turn on 3D acceleration if your graphics card supports it.

### Height layer data area of coverage

If the dataset in your Height layer covers only part of the area of the color layers, there will be no relief in those areas of the color image (they will be flat). If the Height dataset covers a larger area than the color dataset, the height data outside the extents of the color dataset is not used in the 3D image.

### Printing 3D images

ER Mapper has the ability to print very crisp, high resolution 3D images that are much better than can usually be viewed on a screen display. To print a 3D image, simply choose **File/Print** or click the **Print**  button while the image is displayed in the active window. Higher Terrain Detail settings produce more detail in your output print and is usually desirable when printing very large images to get the full detail possible in the data. However, high Terrain Detail settings are sometimes not necessary and do increase the print time significantly.

## When to use Lights option

For perspective views of geophysical data (such as magnetics or radiometrics) and digital terrain data, best results are obtained using Lights turned on. This is because these images have no inherent shadows, so artificial lighting enhances detail. Satellite images or airphotos look best with Lights off because these images have natural shadows inherent in the data.

## Annotation of 3D images

You cannot draw annotation directly on an image in **3D Perspective** or **3D Flythrough** modes. Here are two options:

- Save the 3D view as an algorithm, then display the 3D image as an embedded algorithm map object on another image using the map composition feature.
- Print the 3D image to an ER Mapper file, then display the resulting 3-band dataset in an RGB algorithm. For 'Output Name' on the **Print** dialog, select 'ER_Mapper.hc' in the '\hardcopy\Graphics' directory. Once displayed in an RGB algorithm, you can then draw on the image but cannot change the perspective view.

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# Saving images to disk

This chapter explains how to send the processing results of an algorithm to a raster output file on disk instead of to the computer display.

## About saving images to disk

Up until this point you have not needed to save image files to disk since you have been doing all processing interactively using ER Mapper algorithms. In general, processing your data interactively to the display is preferred since it is faster, easier, and takes full advantage ER Mapper's flexibility and the processing power of your computer. However, there are times when you may want to save your processing results to a separate raster dataset file on disk. Following are some typical examples of this:

- You may want to crop or subset an area of interest from a large dataset to conserve disk space.
- If you want to use the **Traverse** or **Cell Values** functions to view the values of a processed image (band ratios, filters, etc.), you must write the processed image to a raster file on disk first.
- You may want to use the processed image in another software application that can read datasets in ER Mapper's native BIL format or other formats supported by ER Mapper.)

- If you are using very compute-intensive algorithms (with large filters or complex formulas for example), you may want to write a processed copy of the data to disk at some point so it does not need to be continuously recomputed.
- You can save the image in compressed format using the ER Mapper ECW (Enhanced Compression Wavelet) compressor. This allows you to compress the imagery with a very high compression ratio with no discernible loss in quality.

### Combining raster layers

Raster layers in the **Algorithm** dialog can be combined when saved to a new dataset, or they can be written as separate bands in the output file. The layers in the **Algorithm** dialog are processed as follows:

- Non-Classification raster layers (Pseudo, Red, etc.) with *no* layer description or the *same* layer description are combined into a single band upon output (useful for mosaics, for example).
- Non-Classification raster layers with unique layer descriptions are written to a separate band in the output dataset.
- All Classification raster layers are processed into a single band in the output dataset.

# Hands-on exercises

This exercise demonstrates the procedure for sending algorithm output to a file on disk rather than to the display.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Create an algorithm to send output to a raster dataset on disk
- Subset an exact area using geographic coordinates
- Specify output dataset parameters and save the new dataset to disk
- View information about the output dataset
- Save the image in compressed format.t

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Saving a dataset to disk

***Objectives*** Learn how to send algorithm processing output to a raster dataset on disk. In this case, you will crop an area from a Landsat image and write three of the dataset bands to a new ER Mapper raster file on disk.

## Open a Landsat greyscale algorithm

1 On the main menu, click the **Edit Algorithm**  button.

An image window and the **Algorithm** dialog box open.

2 On the main menu, click the **Open**  button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Data_Examples’ directory, then open the ‘Landsat_TM’ directory.

5 Double-click on the algorithm ‘Greyscale.alg’ to open it.

The algorithm displays band 1 of a Landsat TM dataset of San Diego as a greyscale image. You will define a subset of the image, and save only bands 1, 4 and 7 of the Landsat dataset to a new raster file on disk.

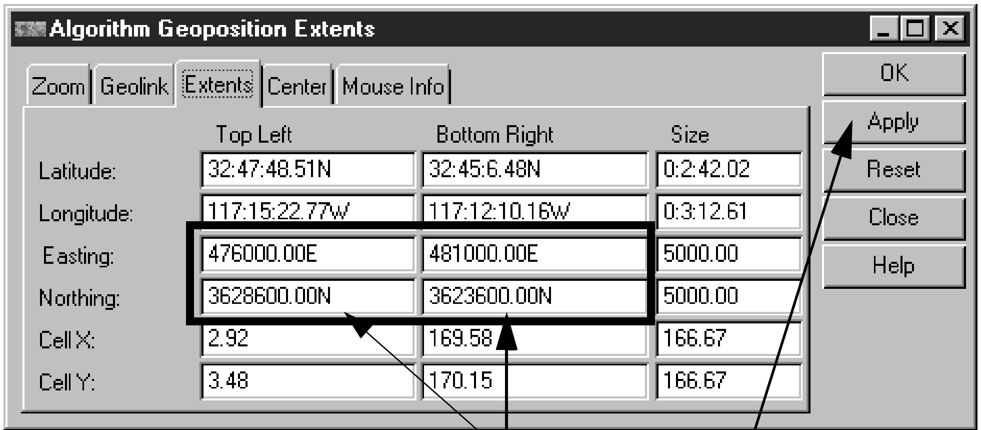
## Use Geoposition to define an exact subset of the image

When cropping or subsetting a large image, it is often desirable to define an exact geographic area. This is easy to do using the **Geoposition** dialog.

1 On the **Algorithm** dialog, click the **Geoposition Window**  button.

2 On the **Algorithm Geoposition Extents** dialog, click the **Extents** tab.

3 Enter the following Easting and Northing values, then click **Apply**.




enter these values, then click **Apply**

ER Mapper zooms in to define a 5 by 5 Km area (5000 by 5000 meters) centered on Mission Bay in San Diego.

4 Click **Close** on the **Algorithm Geoposition Extents** dialog.

## Create layers for two other output dataset bands

When building an algorithm to create a new dataset, you must create a layer for each band of the input dataset to be written to the new file.

1 In the **Algorithm** dialog, click the **Duplicate**  button twice.

Two additional Pseudo layers are added. Each already contains the ‘Landsat_TM_year_1985’ dataset and has the transform deleted since they are duplicates of the first one.

## Select bands 1, 4 and 7 and label the layers

1 Select the top ‘Pseudo Layer’ in the layer list.

This layer already has dataset band 1 selected.

2 Change the layer’s label (currently ‘Pseudo Layer’) to `TM band 1` then press Enter or Return.

3 Select the middle ‘Pseudo Layer.’

4 From the **Band Selection** drop-down list (in the process diagram), select **B4:0.83_um**.

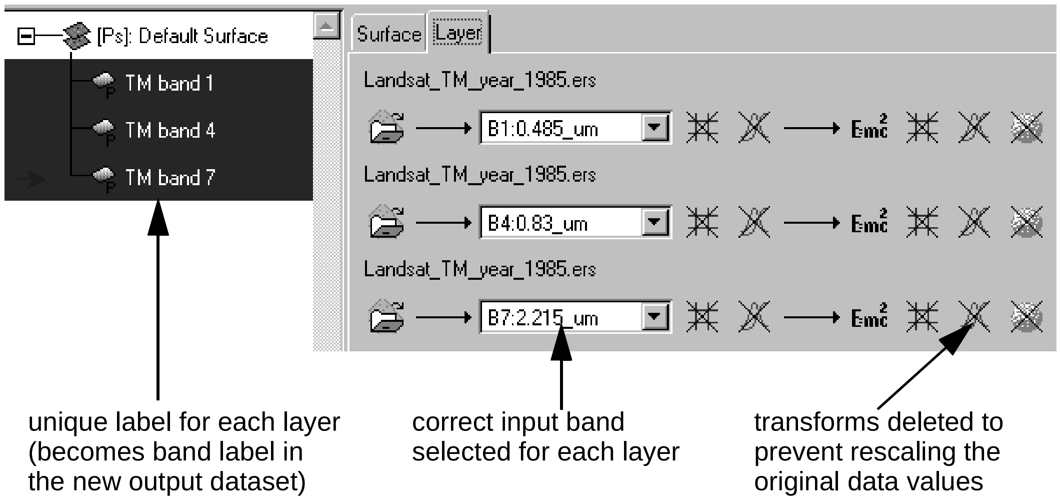
5 Change the middle layer’s label to `TM band 4` then press Enter or Return.

6 Select the lowest ‘Pseudo Layer.’

7 From the **Band Selection** drop-down list, select **B7:2.215_um**.

8 Change the layer’s label to **`TM band 7`** then press Enter or Return.

9 Ctrl-click all three layers to display all three process diagrams. Your algorithm should look like the following:




You have now created an algorithm that defines a subsection of the image and selects three bands from the original dataset (bands 1, 4, and 7) to be written to a new dataset on disk.

**Note:** The order of layers in the algorithm determines the order of bands in the output dataset. In this case, the top layer labelled ‘TM band 1’ will become band 1 in the output dataset.

## Specify a filename for the output dataset

1 On the Standard toolbar, click the **Save As** button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and the type of file to be saved.

You can save the output image in any of the following formats:

- ER Mapper Algorithm
- ER Mapper Raster Dataset (.ers)
- ER Mapper Virtual Dataset (.ers)
- ESRI BIL and GeoSPOT (.hdr)
- Windows BMP (.bmp)
- GeoTIFF/TIFF (.tif)
- JPEG (.jpg)

- UDF (Universal Data Format)

  The format in which you save the image depends on what you are going to do with it. If you intend opening the image in another application, use the format best suited to that application. If you intend using the image in ER Mapper then you should save it in ER Mapper Raster Dataset format. The Universal Data Format (UDF) allows you to use the image in ER Mapper and in other applications that use the ESRI BIL and GeoSPOT formats.

  In this exercise, we will save the image in ER Mapper Raster Dataset format.

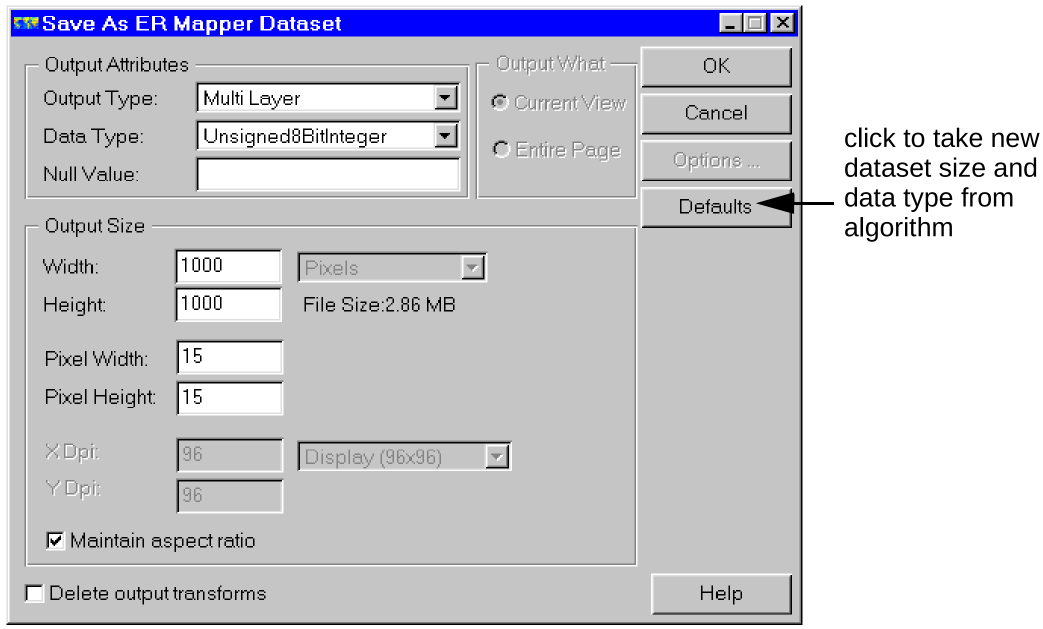
2. On the **Save As** dialog, select ‘ER Mapper Raster Dataset (.ers) in the **Files of Type:** field.
3. From the **Directories** menu, select the path ending with the text **\examples**.
4. Double-click on the directory named ‘Miscellaneous’ to open it.
5. Double-click on the directory named ‘Tutorial’ to open it.
6. In the **Save As:** text field, enter your initials followed by the text **`147_TM_Mission_Bay`** and separate each word with an underscore (_).
7. Click **OK** on the file chooser dialog.

   Your filename appears as the Output Dataset name with a ‘.ers’ extension.

## Choose options for the output dataset

1. On the **Save As ER Mapper Dataset** dialog, click the **Defaults** button.

ER Mapper automatically fills in appropriate values in the **Width:** and **Height:** fields by examining the extents of the area you zoomed on, and figuring the corresponding number of actual dataset pixels to be output.




---

**Note:** You should *almost always* click **Defaults** to let ER Mapper calculate the settings that will create your new dataset at the same resolution as the original. (That is, to write one output dataset pixel for each input dataset pixel.) Changing these values causes ER Mapper to supersample or subsample the original data during output. For example, halving these values creates a new dataset at half the original dataset's spatial resolution (60m vs the original 30m for example).

---

2 Select the **Delete output transforms** option.

---

**Note:** When writing images to disk, you should usually delete the output transforms for each raster layer to maintain the native data range of the input image. Otherwise, the output data may be scaled or clipped according to the current transform. (You can, however, use a transform to rescale the data if desired.)

---

The other fields on the **Save As ER Mapper Dataset** dialog are:

**Data Type** is the data format for the new output image. For example, if your algorithm processing produces floating point data using a formula, choose one of the Real options to write output image dataset values as real numbers.

**Null Value** specifies the value that cells with values of 0.0 will be assigned in the output image.

**Width** and **Height** specify the width and height of the new output image in pixels. You can enter any size and ER Mapper automatically subsamples or supersamples the original image data to fill the requested dimensions.

**Pixel Width X** and **Pixel Width Y** specify the magnification in terms of the are of the image bounded by a pixel.

If image had been setup for a page, the **Output What** box would have allowed you to select either **Current View** or **Entire Page**. The **Current View** saves only the part of the image currently being displayed in the image window, while the **Entire Page** saves the whole page containing the image. Since the image being saved has not had a page setup, only the **Current View** can be saved.

---

**Tip:** For additional information about creating output datasets, such as combining single band datasets or cutting out irregular areas, see the section “Tips for saving datasets” at the end of this chapter.

---

## Write the output disk file

1. Click **OK** on the **Save As ER Mapper Dataset** dialog.

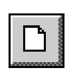
   ER Mapper asks you to confirm the creation of the output file.

2. Click **Yes** on the output path dialog to proceed.

   ER Mapper shows the progress of the write to disk operation, and presents a confirmation dialog when the process is complete.

3. Click **OK** on the confirmation dialog to close it.
4. Click **Close** on the **Save As ER Mapper Dataset** dialog.

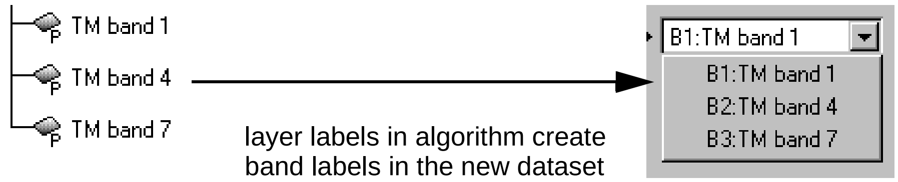
## Display the new dataset

1. On the main menu, click the **New**  button.

   Drag the new, empty window down below the original one.

2. On the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.
3. From the **Directories** menu, select the **\examples** path.
4. Open the ‘tutorial’ directory, then double-click on your ‘TM_147_Mission_Bay’ dataset to load it.
5. Open the **Band Selection** list in the process diagram to see the three bands in your output dataset.

Notice that the band labels are the same as the layer labels you entered previously in the subset algorithm.




## View information on the new dataset

1 On the **Algorithm** dialog, click the **Load Dataset** button again.

2 On the **Raster Dataset** dialog, click the **Info...** button.

Information on your new dataset displays, including the number of bands (3), dimensions, and file size. The new dataset also has the same datum and map projection information as the original dataset.

---

**Tip:** To edit the information about the dataset, click the **Edit** button on the **Dataset Information** dialog to open the **Dataset Header Editor**. You can use this, for example, to choose the correct datum, projection, cell size and other parameters of a dataset that was previously georeferenced but imported into ER Mapper as a "raw" dataset.

---

3 Click **Cancel** on the **Dataset Information** dialog.

4 Click **Cancel** on the **Raster Dataset** file chooser dialog.

---

**Tip:** You can calculate multivariate statistics for any dataset by selecting **Calculate Statistics** from the **Process** menu, and view them using **View/Statistics**. (You will do this later.)

---

## Close both image windows and dialog boxes

1 Close both image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen

# 2: Saving a compressed image to disk

***Objectives*** Learn how to save large images in compressed format using the ER Mapper ECW compression.

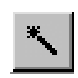
ER Mapper compresses images using wavelet compression technology which offers very high quality results at high compression rates. You can typically compress a color image to less than 2% to 5% of its original size (50:1 to 20:1 compression ratio) and compress a grayscale image to less than 5% to 10% of its original size (20:1 to 10:1 compression ratio).

This means that, at 20:1 compression, 10GB of color imagery will compress down to 500MB, which is small enough to fit on to a single CD-ROM. You may actually achieve higher compression rates where your source image has a structure well suited to compression.

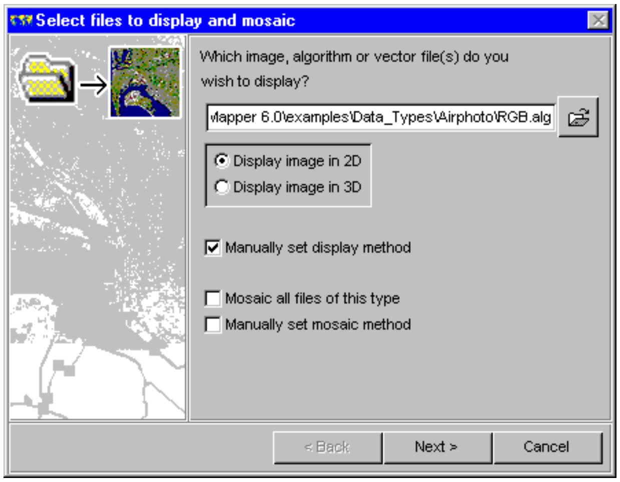
In addition to reducing storage requirements, you can also use the free imagery plugins for GIS and office applications to read the compressed imagery in a wide range of software applications such as ArcView®, AutoCAD MAP®, MapInfo®, ER Viewer, Photoshop™, Microsoft Office® and Excel®, and other software applications.

## Open a Large image algorithm

In this example we will use the **Image Display And Mosaic Wizard** to mosaic two large images together. we will then use ECW compression to save the mosaiced image in a compressed format.

1 Click on the **Image Display And Mosaic Wizard**  button on the **Common Functions** toolbar.

The Image Display And Mosaicing Wizard will open the **Select files to display** dialog box.




2 On the wizard dialog, click the **Open**  button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Applications’ directory, then open the ‘Airphoto’ directory and then open the ‘1_Geocoding’ directory

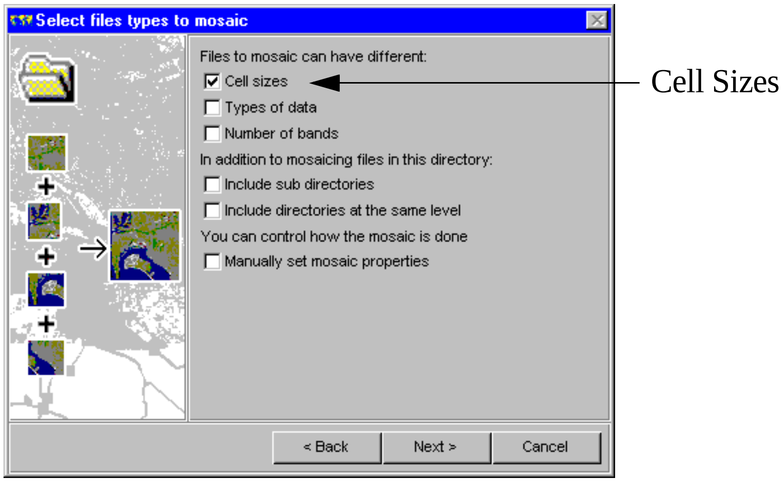
5 Double-click on the ‘San_Diego_Airphoto_34_rectified.ers’ to select it.

6 Select **Mosaic all files of this type** for the wizard to search for other files of the same type to mosaic.

7 Select **Manually set mosaic method** to specify the file types to mosaic.

8 Click on the **Next >** button to go to the **Select file types to mosaic** dialog box.

### Select file types to mosaic.




9 In the **Select file types to mosaic** dialog box, select the **Cell Sizes** check box.

Do not check any of the other option boxes.

This will cause the wizard to mosaic images that meet the following criteria:

The images must :

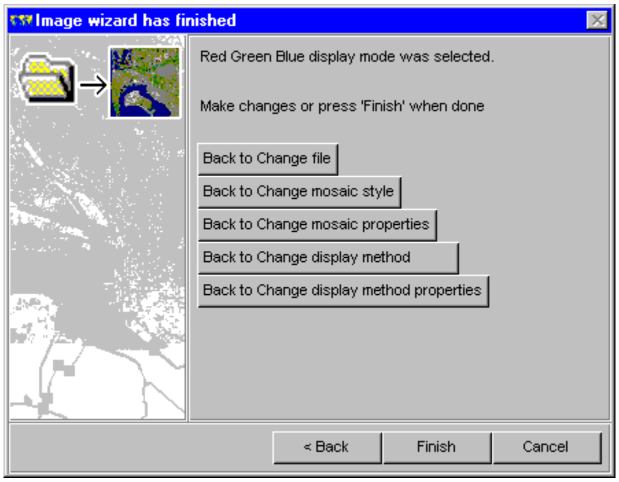
- be registered to the same geographic datum
- be registered to the same map projection
- be rotated the same amount from north (if rotation is used)
- have the same data formats
- have the same number of bands
- be located in the same directory as the selected image file.

10 Click on the **Next >** button.

The wizard will search for files of the same type, mosaic the image and display it with the transform clip limits set to 99%.

The wizard will then display the **Image Display and Mosaicing Wizard has finished** dialog box.

**Image Display and Mosaicing Wizard has finished (mosaicing)**.




11 In the **Image Display and Mosaicing Wizard has finished** dialog box, select **Finish** to close the wizard.

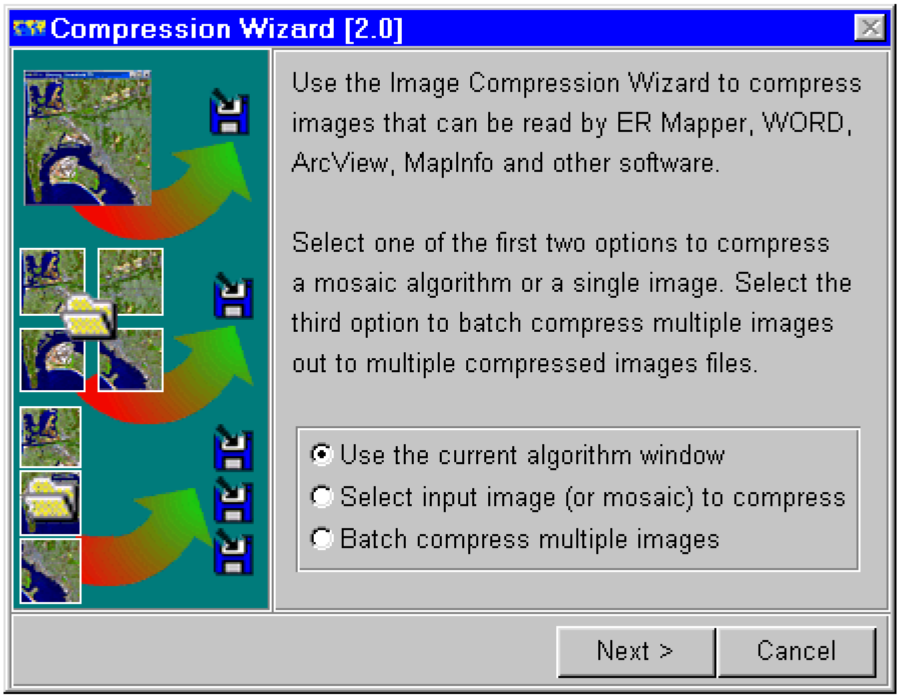
12 On the main menu, click the **Edit Algorithm**  button to open the Algorithm dialog box.

You should see that the wizard has created an algorithm which mosaics two image datasets, ‘San_Diego_Airphoto_34_rectified.ers’ and ‘San_Diego_Airphoto_36_rectified.ers’. If we were to save the mosaiced image as an uncompressed ER Mapper Raster Dataset, it would take up 58.36 MB of disk space.

13 From the main ER Mapper **File** menu, select **Save as a Compressed Image**.

The **Compression Wizard** will open.

## Input image to be compressed




1 Select the **Use the current algorithm window** option as the source of the image(s) to be compressed and click on the **Next >** button.

In addition to using an algorithm as the source image to be compressed, you can specify any other file format supported by ER Mapper, such as ESRI BIL, TIFF, JPG as the input.

## Compressed image file name

2 In the **Output file:** click the **Select File** button.

3 From the **Directories** menu, select the **\examples** path.

4 In the **Select File** dialog, choose ER Mapper compressed images (.ecw) in the **Files of Type** field.

5 Open the 'Miscellaneous' directory, then open the 'Tutorial' directory.

6 In the **Open:** text field, enter your initials followed by the text **`ECW_Compressed`** and separate each word with an underscore (_).

7 Click **OK** on the **Select File** dialog.

Your file name appears as the **Output File** name with a '.ecw' extension.

ER Mapper will save the compressed image as a header (.ers) and a compressed data (.ecw) file. You can use **File / Open** or one of the wizards to open the header (.ers) or data (.ecw) file just like any other image file supported by ER Mapper.

**Note:** The data (.ecw) file contains embedded georeferencing information, so the header (.ers) file can be dispensed with if the compressed image is to be used in applications other than ER Mapper.

## Compress to Grayscale, RGB or Multi

8 In the **Compress to:** field, select the ***Color (RGB)*** option

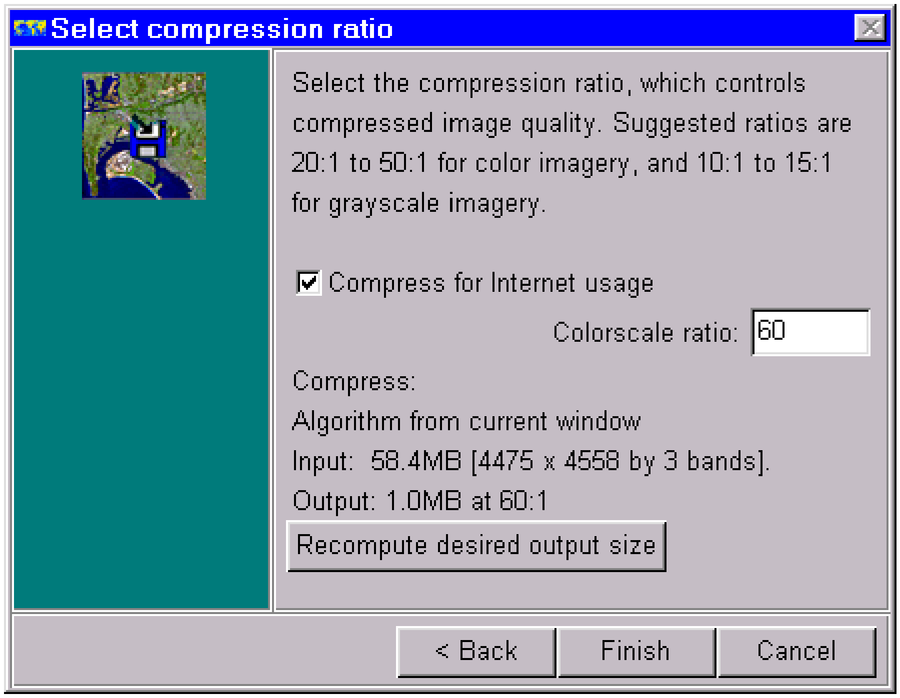
The compression engine internally converts the RGB color image into YUV color space, specifically the one defined as the "JPEG Digital version of YUV". YUV is a color space that separates out intensity (Y) from chromatic or color changes (U and V). This enables more efficient compression of color imagery, ensuring that detail is preserved. The RGB to YUV conversion (and back again for decompression) is automatic; the user always sees the file as a RGB file.

Other compression options available are:

| | |
|---|---|
| **Grayscale** | The compression engine constructs and compresses a grayscale view of your input image data using the normal formula for Intensity from Red, Green and Blue. |
| **Multi (RGB)** | There may be cases where you wish to compress three-band images where the three separate bands are not directly correlated. An example of this might be the compression of Radiometric values of Potassium, Thorium and Uranium. In this instance, it may not be desirable to do YUV compression. |

9 Click on the **Next >** button to continue

## Compression ratio




10 If necessary change the **Colorscale ratio:** to 60 and click on the **Recompute desired output size** button.

This value is the desired compression ratio that you would like to achieve. For example, you might specify a ratio of 20:1 for an input file of 1,000MB to achieve a desired a 50MB compressed image (so the output image is 5% of the size of the input image).

11 Check the **Compress for Internet** usage box.

This option is for compressed images to be served on an ER Mapper Internet Web Server (IWS). The transfer rate over a network for images compressed with this option is higher, thus allowing faster zooming and roaming. However, the actual compression ratio achieved will be less than that for images compressed without this option. For more information on the IWS, refer to the ER Mapper website, http://www.ermapper.com.

The Compression Wizard uses the Target Compression ratio as a measure of how much information content to preserve in the image; i.e as a quality indicator. If, however, your image has areas that are well suited to compression, a greater rate of compression may be achieved while still achieving the desired information content. The actual compression ratio could also be less than the target if you are compressing small files. The Compression Wizard uses multiple wavelet encoding techniques at the same time, and adapts and chooses the best technique depending on the area currently being compressed.

One example of this is an image that has large areas of water or desert. These can often be compressed with greater efficiency. Another example is a compressed image that consists of high resolution airphotos, over lower resolution satellite imagery where there are no airphotos. Because the satellite images are lower spatial resolution, greater compression can be achieved in these areas of the image, while still preserving high quality detail in the airphoto area.

12 Click on the **Finish** button to start the compression process.

### Compression process

A status dialog will display the progress of the compression. When the compression is complete, a dialog will display the Target and Actual compression rates.

You may note that the Actual compression rate achieved is, in fact, considerably greater than the Target rate.

Except when compressing very small files (less than 2MB in size), the Actual compression ratio will generally be greater than the Target compression ratio.

## Close both image windows and dialog boxes

1 Close the image window using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen

***What you learned***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create an algorithm to send output to a raster dataset on disk
- Subset an exact area using geographic coordinates
- Specify output dataset parameters and save the new dataset to disk
- View information about the output dataset
- Save the image in compressed format using the ECW compressor.

## Tips for creating raster datasets

The following are some additional tips for creating raster datasets on disk, including combining and resampling datasets, cutting out non-rectangular areas, using dataset output template algorithms, and rasterizing vector overlays.

### Combining raster datasets

There are times when you may want to combine several datasets into a single dataset with multiple bands. You can do this simply by loading each dataset into its own layer in an algorithm, and following the steps earlier in this chapter.

If your datasets have different cell sizes or data types, you must choose a common cell size and data type for all bands in the output dataset. When you click the **Defaults** button, ER Mapper uses the cell size (expressed in the cells down and across values) and data type of the dataset in the *currently selected layer* of the algorithm. To choose the cell size and data type used for all bands in the output dataset, select a layer containing a dataset with the desired characteristics *before* clicking **Defaults**.

You can also choose a combination of output parameters. For example, suppose you have a 10m 8-bit integer (0-255) dataset that you want to combine with a 30m real dataset. To maintain the spatial resolution of the 10m dataset and the real precision of the real dataset, you could select the 10m layer, click **Defaults** (to set the cell size to the 10m dataset), then change the 'Output Data Type' to **IEEE4ByteReal**. The resulting dataset would have 10m resolution and real values for all bands.

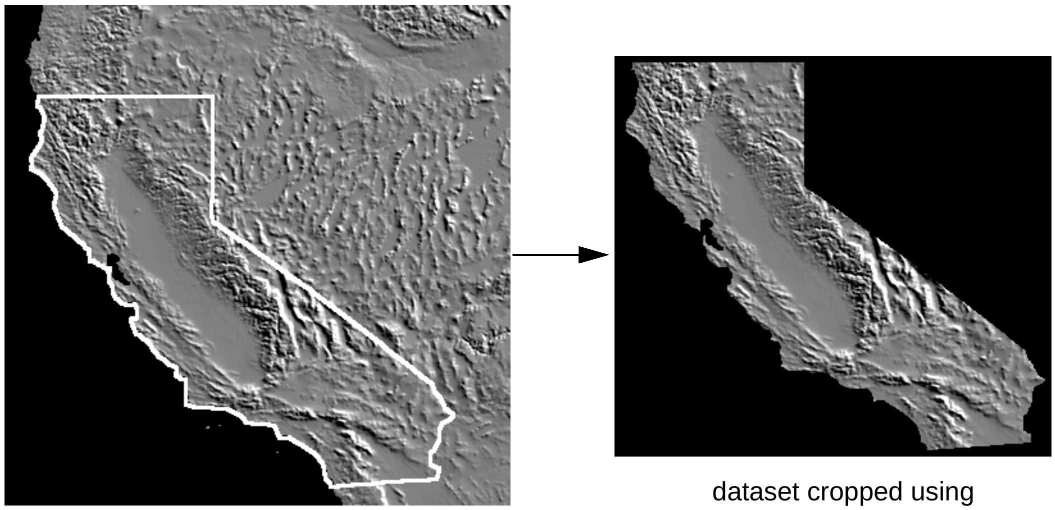
### Resampling datasets

If you change the cells across and/or down values, ER Mapper resamples the output dataset to the new dimensions you enter. For example, if your dataset is 500 by 500 pixels at 10m resolution, changing the cells across and down values to 250 resamples the dataset to a 20m resolution. If the 'Smoothing' option is turned off in the **Algorithm** dialog, ER Mapper uses the nearest neighbor technique to resample the output dataset. If 'Smoothing' is on, bilinear interpolation is used to do the resampling.

An alternative way to resample the cell size that lets you enter exact cell size values is to use the **Process\Rectifcation\Rotate Dataset** function. On the **Setup** dialog, enter a rotation value of zero and set the output cell width and height fields to the desired cell size (in meters unless the dataset is geodetic). You can check the size of the output file for the cell sizes you entered beforehand by clicking the **Output Info** button.

## Cutting out irregular areas from a dataset

This exercise showed you how to crop a rectangular area, but you can also cut out any irregularly shaped area as well. To do this, first define a region (vector polygon) that defines the are of interest. Then use the “inregion” formula (as described in the “Using Formulas” chapter) to display only the data inside the region. Then save the cut out area to a new file on disk as described in this chapter.



dataset cropped using “inregion” formula

The region polygon can be defined using ER Mapper’s drawing tools, or imported from a GIS application or other vector data source. (Defining regions is discussed in the “Supervised Classification” chapter.)

## Using template algorithms

This exercise showed you how to create an algorithm designed write a dataset to disk, but ER Mapper also provides several predefined “template” algorithms for Landsat TM, SPOT and other image types to make this easier. For example, the Landsat TM template has seven layers (one for each band), appropriate layer labels, and the final transforms deleted. These algorithms are located in the ‘Dataset_Output’ directory under ‘ERMAPPER\algorithm\templates.’ All you need to do is load in the desired dataset and follow the rest of procedure described in this chapter.

## Rasterizing vector data using Save As Dataset

You can also use the **Save As** feature to convert vector data to a raster gridded dataset. Any vector layers displayed on a raster image are combined into a separate raster band named “Vector” when the new dataset is created. The pixels representing different color vector objects are assigned a value 1-8 in the output “Vector” band. You can use a Classification layer and threshold formula, for example, to display the rasterized vector data in a particular color.

### Rasterizing vectors by printing to an ER Mapper file

In addition to writing to a raster dataset, you can also print an algorithm to an ER Mapper file using the **Print** function. This lets you take a complete image (with vectors, map objects, etc) and print it to a 3-band raster image file in ER Mapper ('.ers') format. The resulting 3-band dataset can then be displayed in an RGB algorithm and it will look the same as before.

On the **Print** dialog, select the 'Output Name' 'ER_Mapper.hc' in the 'ERMAPPER\hardcopy\Graphics' directory. This directs output to a 3-band ER Mapper format file (BIL). The output file has all the processing and vector overlays "burned into" the raster image file.

# 14

# Virtual datasets

This chapter explains how to create and use a special type of algorithm called a Virtual Dataset. Virtual datasets are an innovative ER Mapper feature that allow you to work with data in an intermediate processed state without actually needing to write the results to a raster file on disk.

## About virtual datasets

A Virtual Dataset ("VDS" for short) is a special type of algorithm that can be used as if it were a file on disk, except that the data is computed on demand so it takes no additional disk space. Virtual Datasets are an extension of the algorithms concept, so you can carry out processing on a raw dataset, then save the results as a "virtual" dataset for use as input for another algorithm. By saving processing results in a Virtual Dataset, you can define "views" into your data that can be used in subsequent processing as if they were real datasets on disk.

Some of the many uses and advantages of Virtual Datasets include:

- *Reduced data complexity*–layers that process combinations of bands can become a single band of data in the virtual dataset (for example, a band ratio or PC).
- *Reduced disk storage*–virtual datasets are computed on demand, so no extra disk storage is needed.
- *Virtual image mosaics*–two or more adjacent images can be merged and processed as if they were a single image.
- *Virtual multi-date images*–two or more images of the same area acquired at different dates can be used as a single multi-band image (for change detection).

- *Virtual pre-processed images*–datasets can have pre-processing steps applied (for example atmospheric correction), then be used as input to further processing.
- *New types of data*–datasets with different characteristics can be merged to create hybrid virtual datasets.

All of these types of operations can be saved as Virtual Datasets, thereby making the processing techniques used to create them transparent to the user.

### Limitations of Virtual Datasets

There are certain limitations to Virtual Datasets, and you may want to create a real raster dataset if these are a concern (described in the previous chapter):

- You cannot use the **Cell Values Profile** or **Traverse** features to view data values in a displayed Virtual Dataset. (Use a real dataset in these cases.)
- You cannot rectify a Virtual Dataset since it is not a real raster file. (Rectification is discussed later.)
- A Virtual Dataset file saves references to the locations of real datasets it uses as the source raster data. Therefore, if you move the real dataset files to another area on your system, ER Mapper will not find them when you load the Virtual Dataset**.** (You can fix this by using **File / Open from Virtual Dataset** to open the VDS into an algorithm, reloading the dataset in each layer from the new location, then saving the VDS again.)

# Hands-on exercises

These exercises give you practice creating Virtual Datasets and understanding how to use them in subsequent image processing algorithms.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Prepare an algorithm to be saved as a Virtual Dataset
- Compute a Tasseled Cap formula transform on a dataset, and save the resulting images in a “virtual” Tasseled Cap dataset
- Create a mosaic of three images, and save the algorithm as “virtual” image mosaic
- Create a Virtual Dataset referencing two images with different spatial resolutions, and use it to merge the two images

- Create a Virtual Dataset that performs a simple haze correction, so it can be used as input for subsequent quantitative or change detection processing

***Before you begin...*** Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Creating a Tasseled Cap VDS

***Objectives*** Learn to create an algorithm that generates three “Tasseled Cap” images, then save the algorithm as a Virtual Dataset for later use. This example shows how Virtual Datasets can be used to reduce the complexity of manipulating image data and make it easier to use.

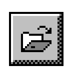
### About the Tasseled Cap transformation

The three Tasseled Cap formulas used in this example are designed to transform Landsat TM data into three separate images representing the scene brightness, vegetation greeness, and surface moisture (wetness). The Tasseled Cap (TC) transformation provides useful information for agricultural and forestry applications because it separates barren (bright) soils from vegetated and wet soils.

## Open a Tasseled Cap algorithm

1 On the Standard toolbar, click the **Edit Algorithm**  button.

   An image window and the **Algorithm** dialog box open.

2 On the Standard toolbar, click on the **Open**  button to open the file chooser dialog.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the ‘Data_Types’ directory to open it.

5 In the directory ‘Landsat_TM,’ load the algorithm named ‘Tasselled_Cap_Transforms.alg.’

   This algorithm generates the three Tasseled Cap transformation images, each in its own Pseudocolor layer. The dataset is a Landsat TM image of the San Diego, California area. The Brightness image is initially displayed because its layer is turned on and the Wetness and Greeness layers are turned off.

## View the different Tasselled Cap images

1 Turn the ‘Brightness’ layer off (right-click and select **Turn Off**), and turn the ‘Greeness’ layer on.

The Greeness image shows the location and relative abundance of vegetation (light shades are vigorous vegetation). This is similar to the NDVI and 4/3 vegetation index images you generated in earlier exercises.

2 Turn the ‘Greeness’ layer off, and turn the ‘Wetness’ layer on.

The Wetness image is an indicator of surface moisture, so ocean areas are shown as light grey shades, and areas lacking moisture are shown as dark shades (barren land, beaches, and airport runways).

## View the formulas used to create the TC images

1 Turn all three layers on.

2 Select the ‘Brightness’ layer in the algorithm.

3 Click the **Edit Formula** button in the process diagram to open the **Formula Editor** dialog.

The formula used to generate the Tasselled Cap Brightness image displays. This image is generated by multiplying bands 1-5 and 7 by weighted coefficients. (For best results in any particular area of the world, these coefficients should be adjusted for local conditions. However, the standard coefficients generally provide good indicators of the three parameters in most cases.)

4 View the formulas used to create the ‘Wetness’ and ‘Greeness’ images.

(Either click the **Move to next Pseudocolor layer** button on the **Formula Editor** or select the layer in the **Algorithm** dialog.)

5 Click **Close** on the **Formula Editor** dialog to close it.

You have now prepared an existing algorithm to be saved as a Virtual Dataset. The three key elements are:

- each layer has the appropriate Tasselled Cap formula loaded
- each layer has a description that will become its band label in the Virtual Dataset (‘Greeness,’ ‘Wetness,’ and ‘Brightness’ in this case).

## Save the algorithm as a Virtual Dataset

1 From the **File** menu, select **Save As...**.

The **Save As** dialog box appears.

2 In the **Files of Type:** field, select ‘ER Mapper Virtual Dataset (.ers).

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named ‘Miscellaneous’ to open it.

5 Double-click on the directory named ‘Tutorial’ to open it.

6 In the **Save As:** text field, type in a name for the Virtual Dataset file. Use your initials at the beginning, followed by the text ‘Tasseled_Cap_VDS,’ and separate each word with an underscore (_). For example, if your initials are "DB," type in the name:

```
DB_Tasseled_Cap_VDS
```

7 Click **OK** to save the Virtual Dataset and close the file chooser dialog.

## Delete the transforms from all three algorithm layers

1 Click **Yes** in the ER Mapper query about deleting output transforms dialog.

This will make sure that the original data ranges created by the Tasselled Cap formulas are not rescaled in any way using a transform when the images are saved as a Virtual Dataset. (In this algorithm, each layer had a contrast stretch applied to enhance visual presentation.)

The Virtual Dataset is actually saved as a small ASCII text file on disk that describes the processing and image dataset in each layer (very similar to an algorithm). Because of this, it consumes almost no additional disk space.

---

**Tip:** It is often helpful to append the text “VDS” on the end of the name you assign to a Virtual Dataset. This helps you easily determine that the image is *virtual*, and not an actual dataset file on disk.

---

## Open a template RGB algorithm to display your Virtual Dataset

1 On the Standard toolbar, click on the Open  button to open the file chooser dialog.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the ‘Miscellaneous’ directory and then on the ‘Templates’ directory.

4 In the directory ‘Common,’ load the algorithm named ‘RGB.alg.’

The template RGB algorithm with an airphoto image displays.

### Load and display the Virtual Dataset in RGB

1 On the **Algorithm** dialog, click the **Load Dataset** button in the process diagram.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 In the 'Miscellaneous\Tutorial' directory, load your Tasselled Cap Virtual Dataset image (it will have a '.ers' file extension).

4 In the process diagram, select the following band for each layer: **Blue=B1:Wetness**, **Green=B2:Greeness**, and **Red=B3:Brightness**.

The three Tasselled Cap bands are displayed as an RGB color composite image with 99% clip transforms to enhance contrast. The resulting RGB color composite image shows bright, dry areas (barren land, pavement) in red, vegetation in green or cyan, and water areas are bright blue. This is a traditional way of displaying the three Tasseled Cap images as an RGB color composite.

ER Mapper computes the Tasseled Cap calculations from the original TM data on disk. Virtual Datasets are great way to create organized, processed data without consuming additional disk space. You could make similar VDSs containing Principal Components images, various band ratios, or other mathematical transformations of your data.

---

**Note:** Virtual Datasets have '.ers' file extension, the same as real raster disk files. It can be helpful to name your Virtual Datasets with "vds" appended somewhere in the name to make it easy to identify them from real datasets.

---

# 2: Creating a virtual mosaic

***Objectives*** Learn how to save a mosaic of images as a "virtual" mosaic that can be used as if it were a single dataset.

### Open an RGB algorithm that displays three adjacent datasets

1 Click the **Open** toolbar button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the 'Applications' directory to open it.

4 Double-click on the 'Airphoto' directory to open it.

5 In the directory ‘3_Balancing’, load the algorithm named ‘ADAR_mosaic.alg.’

This algorithm displays an RGB color composite of three separate ADAR 5000 scenes covering a portion of the Del Mar, California area near San Diego. (This data is from the ADAR multispectral scanner system acquired by aircraft.)

6 Expand the image window by 50% downward to make it taller.

7 Right-click on the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

8 Scroll through the layers in the layer list on the **Algorithm** window.

Notice that there are nine layers in the algorithm because each of the images is displayed in its own set of RGB layers. Also, each layer has a description that indicates the band of image data loaded into it.

## Save the algorithm as a Virtual Dataset

1 From the **File** menu, select **Save As...**.

The **Save Algorithm** dialog box appears.

2 In the **Files of Type:** field, select ‘ER Mapper Virtual Dataset (.ers)’.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named ‘Miscellaneous’ to open it.

5 Double-click on the directory named ‘Tutorial’ to open it.

6 In the **Save As:** text field, type in a name using your initials followed by the text ‘image_mosaic_VDS,’ and separate each word with an underscore (_). For example, if your initials are "SN," type in the name:

```
SN_image_mosaic_VDS
```

7 Click **OK** to save the Virtual Dataset and close the file chooser dialog.

8 Click **No** in the query dialog to remove output transforms.

The Virtual Dataset is actually saved as a small ASCII text file on disk that describes the processing and image dataset in each layer (very similar to an algorithm). Because of this, it consumes almost no additional disk space

---

**Note:** In this case, you did not delete the transform from each layer before saving the algorithm as Virtual Dataset. The contrast enhancement is desirable in this case because it serves to balance the brightness between the three images and makes seam lines less apparent.

---

9 Close the image window.

## Use the Image Display and Mosaic Wizard to display your Virtual Dataset

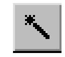
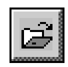
1 On the main menu, click the **Image Display and Mosaic Wizard**  button.


**Image Display and Mosaic Wizard** button

The wizard dialog box opens.

2 On the **Select files...** dialog, click the  button.

The **Select File** file chooser dialog box opens.

3 From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4 Open the ‘miscellanous\tutorial’ directory, then double-click on your ‘image_mosaic_VDS.ers’ Virtual Dataset to load it.

5 Select the **Display image in 2D** and **Manually set display method** options on the wizard page.

6 Click **Next** on the wizard page.

7 On the **Select display method** wizard page, select the **Red Green Blue** and **Manually select display method properties** options. Click on the **Next** button.

8 On the **Select how to display..** wizard page, select ‘RGB321’ for the **Type.**

This will display the image with band 1 as Blue, band 2 as Green and band 3 as Red.

9 Click on the **Next** button.

ER Mapper executes a batch script that loads the Virtual Dataset mosaic into Red, Green, and Blue layers in an algorithm, and applies the 99% contrast enhancement. (You will learn more about image wizards later.)

The three images are displayed as if they were one, but the data is actually being computed from the three original ADAR datasets on disk.

10 Click on the **Finish** button to close the wizard.

11 On the Standard toolbar, click the **Edit Algorithm** button to open the **Algorithm** window.

12 Open the **Band Selection** drop-down list in the process diagram to see the three bands in your Virtual Dataset.

The “virtual” band 1 references the band 1 data from each of the three original ADAR dataset files, and so on for virtual bands 2 and 3. You can now manipulate the three images as if they are a single dataset, for example to contrast stretch them, apply filters, and so on.

---

**Note:** In the original algorithm (open in another image window for reference), each of the Red layers displayed band 1 of their dataset. Since each Red layer had the same layer description (B1:0.850_um), ER Mapper merged them into a single “virtual” band with that label when the algorithm was saved as a Virtual Dataset. Any layers in an algorithm with the same layer description are merged and referenced as a single layer in a Virtual Dataset.

---

### Close both image windows

1 Close both image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

# 3: Creating a multiple image VDS

***Objectives*** Learn how to save and reference multiple images as single Virtual Dataset, and use the VDS to merge the two images. In this case, you will merge a SPOT XS and a SPOT Panchromatic satellite image.

### Open a window and template greyscale algorithm

1 Click the **Open** toolbar button.

A new image window and the **Open** file chooser appear.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the ‘Miscellaneous’ directory and then on the ‘Templates’ directory.

4 In the directory ‘Common,’ load the algorithm named ‘Single_Band_Greyscale.alg.’

## Load the SPOT XS dataset

1 On the **Algorithm** window, click on the **Load Dataset**  button in the process diagram.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 In the ‘Shared_Data’ directory, load the file ‘SPOT_XS.ers.’

This image is band 1 of a SPOT XS multispectral satellite image. (The contrast of the image is not relevant at this point so there is no need to adjust it.)

4 Open the **Band Selection** drop-down list in the process stream.

Note that the SPOT XS image has three spectral bands.

## Delete the transform from the Pseudo layer

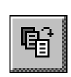
1 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button in the process diagram.

2 From the **Edit** menu (on the **Transform** dialog), select **Delete this transform**.

ER Mapper deletes the post-formula transform from the layer. (Since you will be performing computations on the Virtual Dataset later, you should delete the transform to prevent the original data from being rescaled.)

3 Click **Close** on the **Transform** dialog.

## Duplicate the Pseudo layer three times

1 On the **Algorithm** dialog, click the **Duplicate**  button three times to create three copies of the original layer.

## Select bands and enter labels for the upper three layers

1 Select the top ‘Pseudo Layer’ in the algorithm.

2 Change the layer label to **SPOT XS1.**

(It should already have band 1 chosen by default.)

3 Select the second layer, choose **B2:0.645_um** from the **Band Selection** drop-down list in the process diagram, and change the layer label to **SPOT XS2**.

4 Select the third layer, choose **B3:0.84_um** from the **Band Selection** list, and change the layer label to **SPOT XS3**.

You should now have dataset bands 1, 2 and 3 loaded in the first, second and third algorithm layers respectively, and each layer should be labelled accordingly.

## Load the SPOT Pan dataset into the lowest layer

1 Select the fourth (lowest) layer.

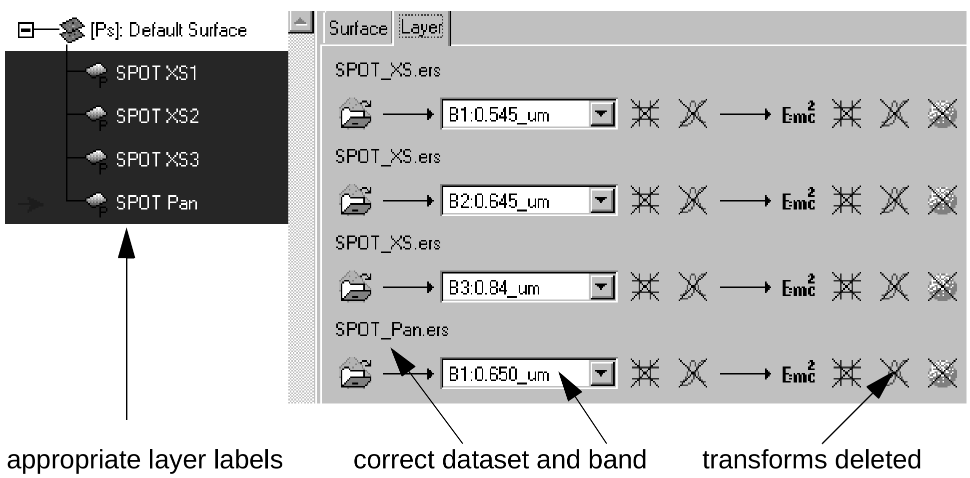
2 Click the **Load Dataset**  button in the process diagram.

3 Click ***once*** on the dataset 'SPOT_Pan.ers' to select it, then click the **OK this layer only** button.

ER Mapper loads the dataset into *only* the current Pseudo layer of the algorithm. (If you had used **OK** or **Apply**, the SPOT Pan dataset would be loaded into all four layers since they originally all contained the same SPOT XS dataset.)

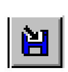
4 Change the layer label to **SPOT Pan** for the fourth layer.

5 Ctrl-click all four layers to view their process diagrams. Your algorithm should look like this:




You have now prepared an algorithm for use in saving a Virtual Dataset that will have four bands. Virtual bands 1, 2 and 3 will reference bands 1-3 in a SPOT XS dataset, and band 4 will reference a separate SPOT Pan dataset.

## Save the algorithm as a Virtual Dataset

1 Click the **Save As**  toolbar button.

The **Save As** dialog box appears.

2 In the **Files of Type:** field, select ‘ER Mapper Virtual Dataset (.ers)’.

3 From the **Directories** menu, select the path ending with the text **examples**.

4 Double-click on the directory named ‘Miscellaneous’ to open it.

5 Double-click on the directory named ‘Tutorial’ to open it.

6 In the **Save As:** text field, enter your initials followed by the text ‘SPOT_XS_and_Pan_VDS,’ and separate each word with an underscore (_). For example, if your initials are “JM,” type in the name:

`JM_SPOT_XS_and_Pan_VDS`

7 Click **OK** to save the Virtual Dataset, and then Yes to deleting output transforms.

The two images are saved in a single Virtual Dataset, so they can now be referenced as if they are a single image on disk.

---

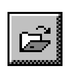
**Tip:** At this point, you may also want to save the layers you set up as a normal algorithm file (using **File/Save As**) so that you can use as a template for creating other SPOT XS and Pan Virtual Datasets in the future. This saves you the trouble of building and labelling the layers again.

---

## Close the image window

1 Select **Close** from the **File** menu to close the image window.

## Open a template RGB algorithm to process your Virtual Dataset

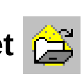
1 Click on the **Open**  toolbar button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the ‘Miscellaneous’ directory and then on the ‘Templates’ directory.

4 In the directory ‘Common,’ load the algorithm named ‘RGB.alg.’

## Load the SPOT XS and Pan Virtual Dataset

1 On the **Algorithm** window, click the **Load Dataset**  button in the process diagram.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 In the ‘Miscellaneous\Tutorial’ directory, load your SPOT XS and Pan Virtual Dataset image (it will have a ‘.ers’ file extension). Double-click on the image name or use the **OK** or **Apply** buttons to load the image into all three layers at once.

4 Click the **Band Selection** button in the process stream diagram.

Notice that your Virtual Dataset has four bands. Bands 1-3 reference the bands in the SPOT XS image, and band 4 references the SPOT Pan image.

## Enter a formula in the Red layer to merge the datasets

1 Select the ‘Red Layer’ in the algorithm.

2 Click the **Edit Formula** button in the process diagram to open the **Formula Editor** dialog.

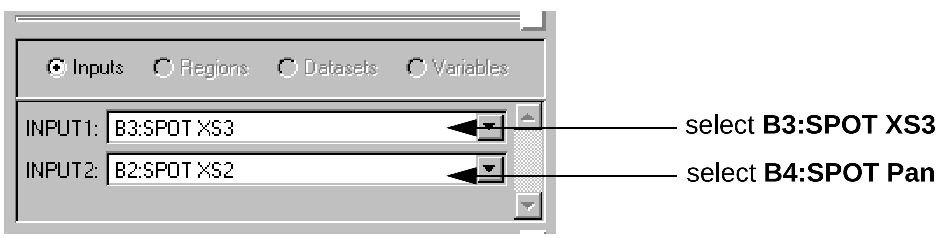
3 Edit the formula text to read:

```
input1 * input2 / 255
```

This formula tells ER Mapper to multiply the dataset band assigned to ‘input1’ by the band assigned to ‘input 2,’ and then divide the result by 255.

4 Click the **Apply changes** button to validate the formula.

5 In the Relations window, select **B3:SPOT XS3** for ‘INPUT1’ and select **B4:SPOT Pan** for ‘INPUT2.’



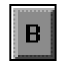

This formula is called a “multiplicative merge” because multiplying two images is a simple way to merge them. It will merge band 3 of the SPOT XS dataset with the SPOT Pan dataset to create a merged image with the color of the SPOT XS multispectral dataset and the high resolution of the SPOT Pan dataset.

## Enter similar formulas in the Green and Blue layers

1 In the **Formula** dialog, click the **Move to next Green layer** button.

2 Enter the same Generic formula `input1 * input2 / 255` and click the **Apply changes** button to validate it.

3 In the Relations window, select **B2:SPOT XS2** for ‘INPUT1’ and select **B4:SPOT Pan** for ‘INPUT2.’

4 Click the **Move to next Blue layer**  button.

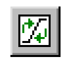


5 Enter the same Generic formula **`input1 * input2 / 255`** and click **Apply changes**.

6 In the Relations window, select **B1:SPOT XS1** for ‘INPUT1’ and select **B4:SPOT Pan** for ‘INPUT2.’

7 Click **Close** on the **Formula Editor** dialog.

### Adjust the transforms for the RGB layers to increase contrast

1 Click the **99% Contrast Enhancement**  button to display your merged RGB image.

ER Mapper displays the image with 99% clip transforms on each layer. The result is a merge of the SPOT XS multispectral image (20 meter resolution) and the SPOT Pan image (10 meter resolution). (If desired, adjust the transforms to create a better enhancement.)

This example shows how using Virtual Datasets lets you perform mathematical operations between two or more separate datasets *without* having to resample them to a common resolution and write them into a single dataset first.

2 From the **File** menu, select **Close** to close the image window.

# 4: Creating a haze adjusted VDS

***Objectives*** Learn how to perform a simple, first-order adjustment for haze and atmospheric scattering on a Landsat image, and save the adjusted image as a Virtual Dataset. This is a good example of creating a VDS that performs a pre-processing step, so it can be used as input to subsequent algorithms.

### About haze correction and histogram adjustments

The shorter (visible) wavelength bands of optical satellite images such as Landsat TM and SPOT XS are affected by haze and atmospheric scattering, which tend to add brightness to the image in those bands. A result is that visible wavelength bands usually have much higher minimum values that do not occupy the lower end of the possible dynamic range of 0-255. When performing quantitative analysis of the data, it is usually desirable to first perform a “haze correction” adjustment to the brightness range in all bands.

When performing change detection between two images, this same type of correction should be performed on both images to normalize their brightness levels into a common range so they can be accurately compared. (Differences in the sun elevation, atmospheric conditions and other factors during the image acquisitions the two datasets cause them to have different ranges of values in each band.)

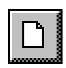
One simple way to do a haze correction is the *histogram adjustment* technique. This method assumes that the difference between the minimum possible value (zero) and the actual minimum value in each band is the contribution of atmospheric scattering. By subtracting the actual minimum value from each band, the histograms are shifted left so that zero values appear in the data, which somewhat minimizes the effects of atmospheric scattering. (See a reference remote sensing text for a more complete description and other more sophisticated and accurate atmospheric correction techniques.)

---

**Note:** See the section “Additional tips for Virtual Datasets” at the end of this chapter for more information on using a VDS for change detection.

---

## Open a new window and load a Landsat TM dataset

1 On the main menu, click the **New**  button.

2 On the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Shared_Data’ directory, then double-click on the image ‘Landsat_TM_year_1991.ers’ to load it.

Band of a 1991 Landsat TM image of San Diego displays.

5 Click the **Surface** tab, then select **greyscale** from ‘Color Table’ list.

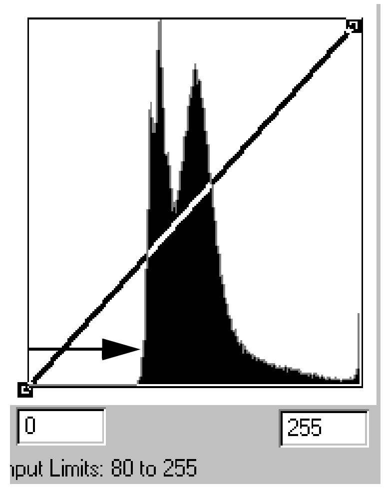
6 Click the **Layer** tab again.

## View and analyze the band 1 histogram

1 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button in the process diagram.

In the **Transform** dialog, examine the band 1 (visible blue) histogram. Notice the actual input limits are 80-255, so no values occur on the lower end of the possible 0-255 dynamic range. This gap between zero and the actual minimum value is considered to be the approximate contribution of atmospheric scattering to the signal received by the satellite sensor.

approximation of brightness added to band 1 values by scattering in the atmosphere




## View histograms and minimum values for other bands

1 Choose **B2:0.56_um** from the **Band Selection** list in the process diagram.

The histogram for TM band 2 (visible green) appears. Notice that its minimum value (about 27) is less than band 1, but still offset from zero.

2 Choose **B3:0.66_um** from the **Band Selection** list.

The histogram for TM band 3 (visible red) appears, and its minimum value is 22.

3 Choose **B4:0.83_um** from the **Band Selection** list.

The histogram for TM band 4 (near infrared) appears, and its minimum value is closer to zero (about 11).

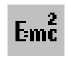
Atmospheric scattering in the visible wavelengths increases brightness in TM bands 1, 2 and 3. TM 1 (blue) is most affected because it senses the shortest wavelengths. (This is effect also noticeable in the blue band of natural color airphotos.) In contrast, the pixel values of the longer wavelength bands (near and mid-IR bands 4, 5 and 7) are reduced by absorption so their minimum values are at or near zero. In general, the shorter the wavelength band, the greater the offset from a pixel value of zero.

4 Choose **B1:0.485_um** from the **Band Selection** list.

By subtracting the minimum value from each band, you can perform a first-order correction for the effects of atmospheric scattering.

## Add a formula to automatically subtract the minimum value

One way to subtract the minimum value from all pixels in a dataset band is to use a formula such as **`input1 - 40`** (which subtracts 40 from each pixel value). However, this requires that you manually determine the minimum value, and type in the number, which will be different for each band. Here you will use a formula that simplifies this by subtracting the minimum value automatically.

1 Click the **Edit Formula**  button in the process diagram to open the **Formula Editor** dialog.

2 Edit the formula text to read:

```
input1 - RMIN(,R1,I1)
```

This formula tells ER Mapper to take the minimum value for band 1 and subtract it from all pixels in the dataset. (‘RMIN’ is the region minimum function that gets the minimum value of the dataset from statistics stored in the ‘.ers’ file. The ‘R1’ and ‘I1’ designations refer to a region and a band.)

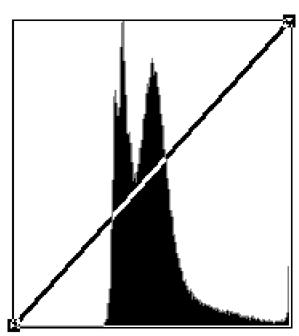
3 Click the **Apply changes** button to verify the formula syntax.

4 Click the **Inputs** button (above the Relations window), and select **B1:0.485_um** from the ‘INPUT1’ list (if it is not already selected).

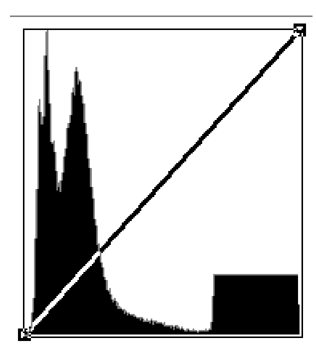
5 Click the **Regions** button (above the Relations window), and select **All** from the ‘REGION1’ list (if it is not already selected).

These settings tell the RMIN function to use the minimum value from band 1 calculated from statistics for the entire dataset (the ‘All’ region).

In the **Transform** dialog, notice that the band 1 histogram has shifted left to the origin, and the actual input limits are now 0-175. By subtracting the minimum value (80) from all pixels, you shift the histogram left so zero values now occur in the image data. This minimizes the effects of atmospheric scattering.



original histogram (min = 80)



adjusted histogram (min = 0)

**Note:** Before you can use this formula, you must have calculated statistics for your dataset, otherwise you will receive an error message. You can do this using **Process\Calculate Statistics**. It is recommended that you use a subsample setting of 1 so statistics are calculated from every pixel in the dataset (to ensure the true minimum value is recorded in the statistics).

6 Click **Close** on the **Formula Editor** dialog.

### Delete the transform and label the layer

1 From the **Edit** menu (on the **Transform** dialog), select **Delete this transform**.

ER Mapper deletes the post-formula transform from the layer. (This ensures that the new histogram adjusted data range will be saved with the Virtual Dataset.)

2 Click **Close** on the **Transform** dialog.

3 Change the label of the ‘Pseudo Layer’ to **`TM1 histo adjusted`** and press Enter or Return.

### Duplicate the layer five times

1 On the **Algorithm** dialog, click the **Duplicate**  button five times to create five copies of the original layer.

You now have five additional layers to perform the same histogram adjustment processing on Landsat bands 2-5 and 7. (You will skip TM band 6 since it is often not used.) Since they were copied from the first one, they already contain the adjustment formula and have the transform deleted.

### Change the band and label for the copied layers

1 Select the second layer, choose **B2:0.56_um** from the **Band Selection** list in the process diagram, then change the label to **`TM2 histo adjusted`**.

2 Select the third layer, choose **B3:0.66_um** from the **Band Selection** list, then change the label to **`TM3 histo adjusted`**.

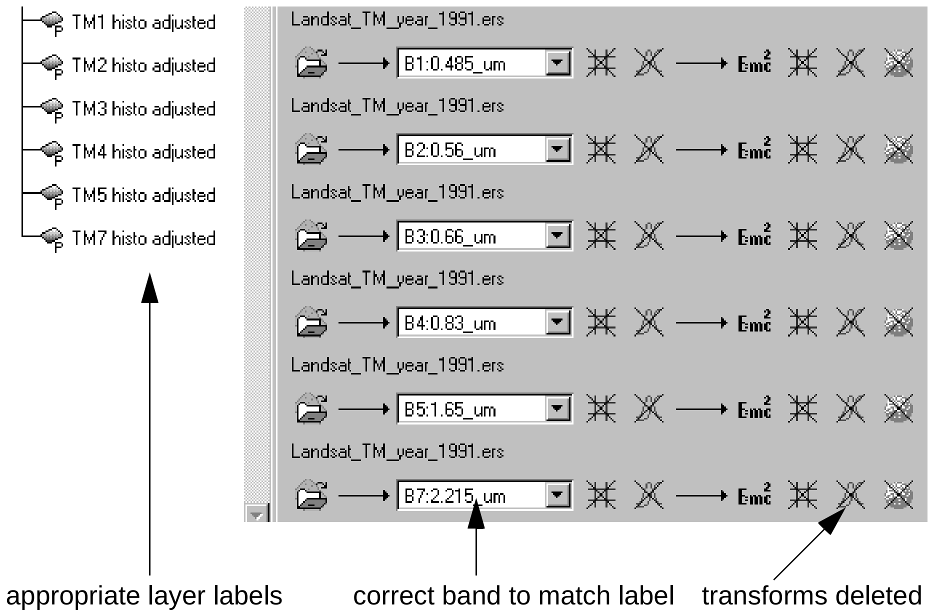
3 Select the fourth layer, choose **B4:0.83_um** from the **Band Selection** list, then change the label to **`TM4 histo adjusted`**.

4 Select the fifth layer, choose **B5:1.65_um** from the **Band Selection** list, then change the label to **`TM5 histo adjusted`**.

5 Select the sixth layer, choose **B7:2.215_um** from the **Band Selection** list, then change the label to **`TM7 histo adjusted`**.

6 Click the '[Ps]:Surface 1' icon in the layer list to show process diagrams for all six layers (if needed, make the **Algorithm** dialog taller to see all six.)

Your algorithm should look like this:




## Save the algorithm as a Virtual Dataset

1 On the main menu, click the **Save As** [icon] button.

2 In the **Files of Type:** field, select 'ER Mapper Virtual Dataset (.ers)'.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Miscellaneous' directory.

5 Open the 'Tutorial' directory.

6 In the **Save As:** text field, enter your initials followed by the text **`TM_hist_adjust_VDS`** and separate each word with an underscore (_).

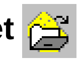
7 Click **OK** to save the Virtual Dataset, and **Yes** to removing the output transforms.

8 Bands 1-5 and 7 of the Landsat image have a histogram adjustment performed and are saved in a Virtual Dataset.

## Open a new window and load the VDS

1 Select **New** from the **File** menu to open a new, empty image window.

2 Drag it below the first one.

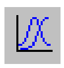
3 On the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.

4 From the **Directories** menu, select the **\examples** path.

5 Open the ‘Miscellaneous\Tutorial’ directory, then double-click on your ‘TM_hist_adjust_VDS.ers’ image to load and display it.

6 Click the **Surface** tab, select **greyscale** from the ‘Color Table’ list, then click the **Layer** tab again.

## View the haze corrected band 1 histogram

1 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits**  button in the process diagram.

2 In the **Transform** dialog, notice the band 1 histogram is shifted left to the origin and the band 1 minimum value is zero (in ‘Actual Input Limits’).

3 Select different bands to see their histograms and minimum values.

All bands should now have minimum values of zero, so they have had a first-order adjustment for the effects of atmospheric scattering. (A minimum value of zero may not always appear due to subsampling the data to the image window size, however the operation is still being performed correctly.)

---

**Tip:** You can use your histogram adjustment algorithm as a template to quickly apply the same processing to any other Landsat TM image. Just calculate stats for the TM image, load it into the algorithm, make sure the correct bands are selected, and save as a VDS.

---

## Close the image windows and Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Prepare an algorithm to be saved as a Virtual Dataset
- Compute a Tasseled Cap formula transform on a dataset, and save the resulting images in a “virtual” Tasseled Cap dataset
- Create a mosaic of three images, and save the algorithm as “virtual” image mosaic
- Create a Virtual Dataset referencing two images with different spatial resolutions, and use it to merge the two images
- Create a Virtual Dataset that performs a simple haze correction, so it can be used as input for subsequent quantitative or change detection processing

## Additional tips for Virtual Datasets

The following section contains additonal information about using Virtual Datasets, including creating and using them for multi-date change detection applications.

### Creating and editing VDSs

You can create Virtual Datasets manually (as you did earlier in this chapter), but ER Mapper also provides predefined algorithms you can use as templates to create common types of Virtual Datasets. All you need to do is open the template algorithm, load in your own datasets in layers as needed, then save them as a VDS.

These algorithms are stored in the ‘examples\miscellaneous\Templates\Virtual_Datasets’ directory. These include template algorithms to combine Landsat TM and SPOT Pan datasets, combine two Landsat TM images into a single VDS (different dates for example), and creating common transformations of DEM datasets (slope, aspect, etc.) and Landsat TM data (various ratios and index images).

Occasionally you will find it useful to edit a Virtual Dataset, for example change a formula or filter or add additional layers. To do this, open the VDS back into it's original algorithm using **File\Open from Virtual Dataset**. Then edit the algorithm as needed, and resave to a VDS using **File\Save As...**.

## Using Virtual Datasets for change detection

---

**Note:** A thorough discussion of multispectral change detection is beyond the scope of this workbook; refer to one of the reference texts in "Appendix B" for more information. Some general ideas are discussed following.

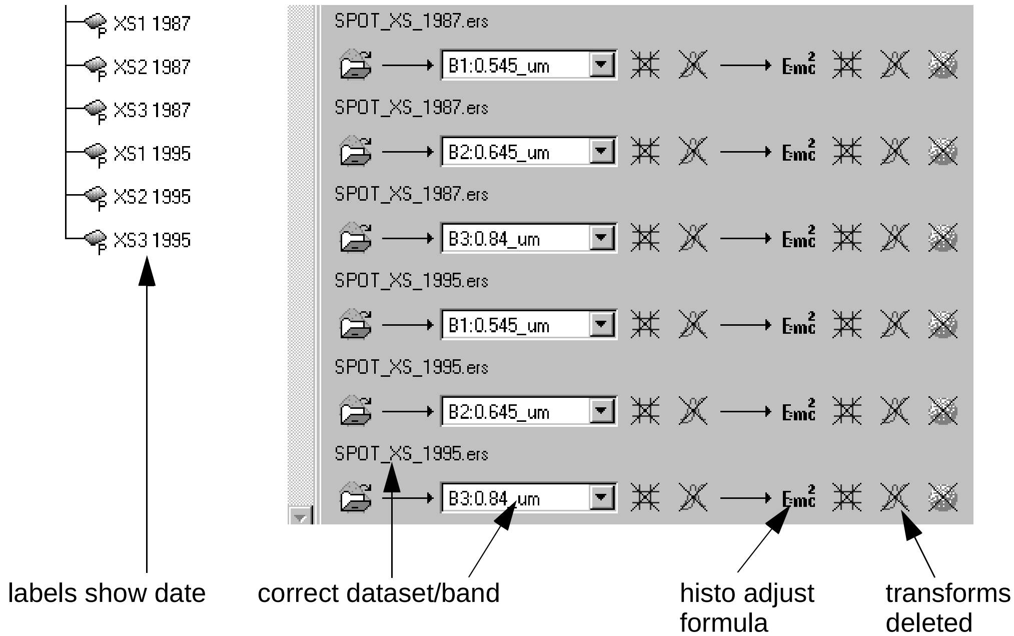
---

Virtual Datasets are also very useful for change detection applications, where you want to highlight and quantify changes between dates using two or more images of the same area acquired at different times. Many of the standard techniques for change detection require math operations to be performed between corresponding images of different dates such as image differencing and ratioing. (A simple technique using RGB was also discussed in the "Working with layers" chapter.) It is usually also desirable to normalize the histograms of images before performing change detection processing.

A simple overview of the steps involved in this follows:

- Create an algorithm that combines the two (or more) datasets. Use the example in section 3 that combines a SPOT XS and SPOT Pan image as a starting point. In addition, you should also normalize the histograms of the two datasets to account for differences in sun elevation, atmospheric scattering, and other factors. You can use the same histogram adjustment technique discussed in section 4 to accomplish this, and put it in the same algorithm.

For example, the following algorithm combines two SPOT XS datasets and performs a histogram adjustment on each band to normalize the value ranges of the two datasets:




Note that is is *very important* to make sure your layer labels are unique. For example, do not label the band 3 layers for both datasets simply “XS3” or they will become a single band in the VDS. Instead name them with the date to differentiate them, for example “XS3 1987” and “XS3 1995.”

- Save the algorithm as a VDS. (You could also create a new raster dataset using the same algorithm if desired, but a VDS will work for most applications and saves a great deal of disk space.)
- Load the VDS into an algorithm to compute changes between the two dates. For example, subtract band 1 of one date from band 1 of the other date (image differencing) using the formula **`input1 - input2`**. Or divide a band from one date by the same band from the other date (image ratioing) using the formula **`input1/input2`**. The resulting images show changes in brightness between the two dates, which can be changes in land use, crop development, or other features of interest.

# 15

# Algorithm wizards

This chapter shows you how to use ER Mapper's toolbars and algorithm wizards to automate the creation of many types of common image processing algorithms.

## About algorithm wizards

Up until now, you have learned to develop your own algorithms by loading datasets, creating algorithm layers, and modifying the process diagram in each layer. This is necessary so that you understand how ER Mapper works and how to apply the different types of processing functions.

However, ER Mapper also provides "image wizards" that let you develop algorithms quickly and easily with a few mouse clicks. A "wizard" is actually a set of instructions, or a macro, written in ER Mapper's batch scripting language. It guides you through the operations by prompting for required information and offering options for the type of algorithm you want to create. ER Mapper provides many types of image wizards, and you can also create your own custom wizards and toolbars.

With a bit of programming knowledge, you can create your own batch scripts and wizards. This gives you fast access to site specific functions and processing techniques, and also lets you give less sophisticated users access to these functions without the need for them to understand the processing in detail. (Use the existing scripts and *Customizing ER Mapper* documentation as a guide for creating your own.

**Tip:** The **99% Contrast Enhancement** button is actually a wizard that automatically adjusts the image contrast.

# Hands-on exercises

These exercises show you how to use ER Mapper wizards to automate the creation of several types of image processing algorithms.

***What you will learn...***

After completing these exercises, you can perform the following tasks in ER Mapper:

- Open a dataset directly (ER Mapper creates a simple display algorithm)
- Use wizards to create greyscale, RGB and mosaic algorithms
- Use wizards to create common displays of Landsat TM datasets

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Opening a dataset directly

***Objectives***

Learn to open a dataset directly and have ER Mapper automatically create a simple display algorithm for it.

Up until now, you have used the **File / Open** (or ) option on the main menu to open existing *algorithms* ('.alg' files) that were created and saved in the past. For fast viewing, however, you can simply open a dataset directly and have ER Mapper automatically create a simple algorithm based on the number of bands in the dataset, cell size and other characteristics.

## Open various sample datasets

1 On the main menu, click the **Open** button.

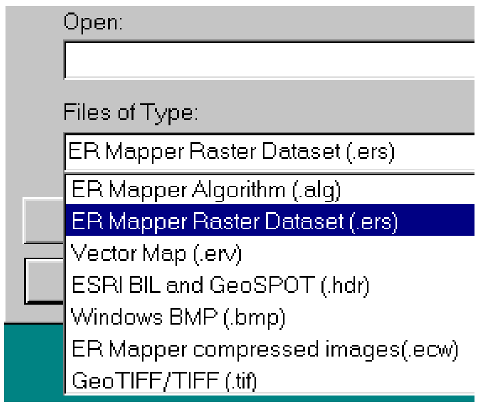
An image window and the **Open** dialog box appear. Drag the **Open** dialog next to the image window.

2 From the **Directories** menu (on the **Open** dialog), select the **\examples** path.

3 Open the 'Shared_Data' directory.

The **Open** dialog can be set to display files with certain extensions, or all files. In previous exercises, you have used the **Open** dialog to open algorithm (.alg) files.

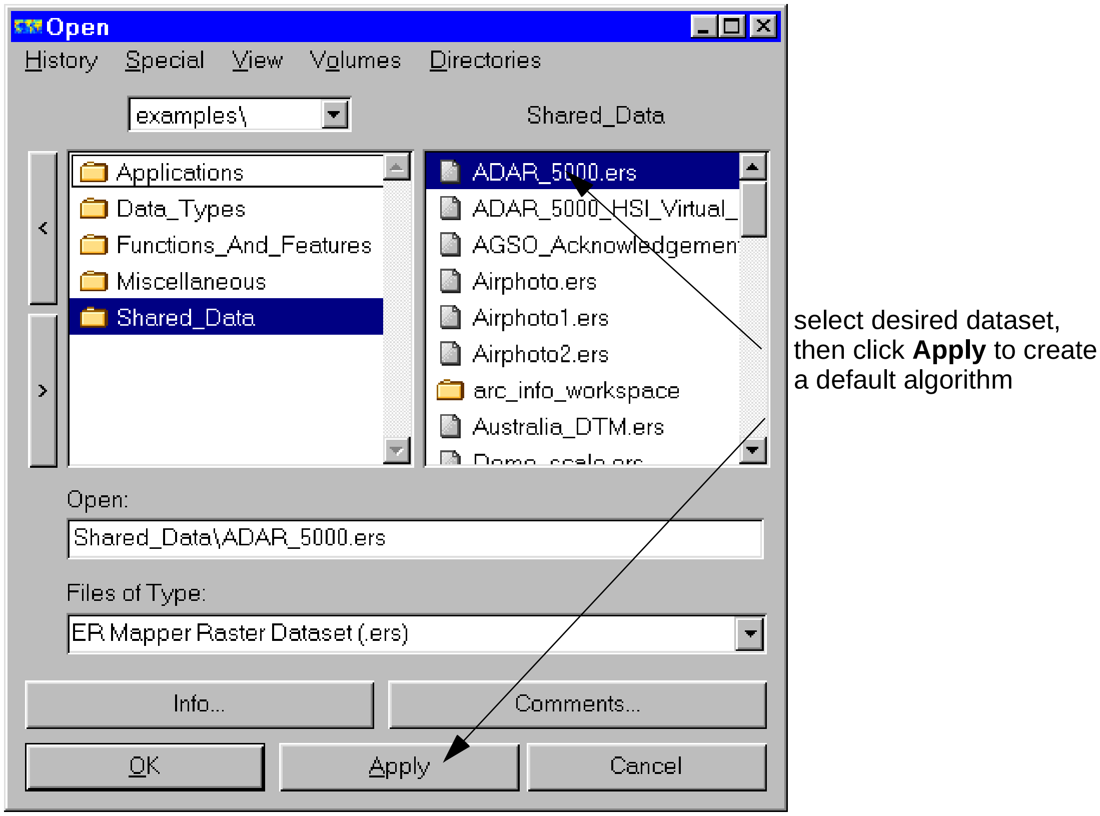
4 From the 'Files of Type' drop-down list, select **ER Mapper Raster Dataset (.ers)**.




The contents now show only files with ".ers" file extensions. Other file formats that can be opened directly are:

- ER Mapper Compressed Image (.ecw)
- Vector Map (.erv)
- Windows Bitmap (.bmp)
- ESRI BIL and GeoSPOT (.hdr)
- GeoTIFF/TIFF (.tif)
- JPEG (.jpg)
- USGS DOQQ (Grayscale)
- RESTEC/NASDA CEOS (.dat)

5 Click ***once*** on the ‘ADAR_5000.ers’ dataset to select it, then click **Apply**.




ER Mapper automatically loads the dataset and creates an RGB algorithm (since this dataset is a multiple-band image).

6 Click once on the ‘Digital_Terrain_Model_20m.ers’ dataset to select it, then click **Apply**.

ER Mapper loads the digital terrain dataset and creates a simple greyscale algorithm to display it.

7 Click once on the ‘Landsat_TM_23Apr85.ers’ dataset to select it, then click **Apply**.

ER Mapper loads the Landsat satellite image and creates a simple RGB algorithm that displays bands 3, 2 and 1.

8 Click once on the ‘SPOT_Pan_14Apr91.ers’ dataset to select it, then click **Apply**.

ER Mapper loads the SPOT Panchromatic satellite image and creates a simple greyscale algorithm (since this dataset has only one band). As you can see, opening datasets directly is a fast way to view many images quickly.

9 Close the image and Algorithm windows.

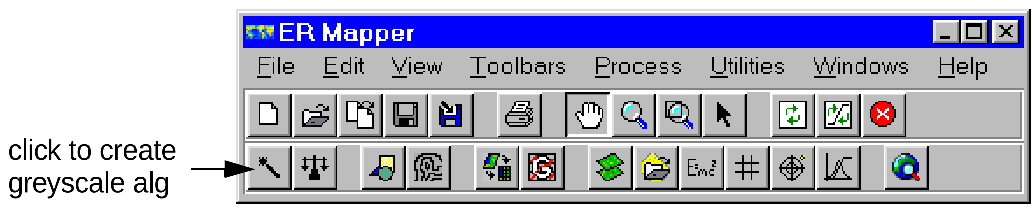
**Note:** If the dataset has one or two bands, ER Mapper creates a Pseudocolor greyscale algorithm for it. If the dataset has three or more bands, ER Mapper creates an RGB algorithm for it and displays the first three bands.

# 2: Using the Image Display and Mosaic Wizard

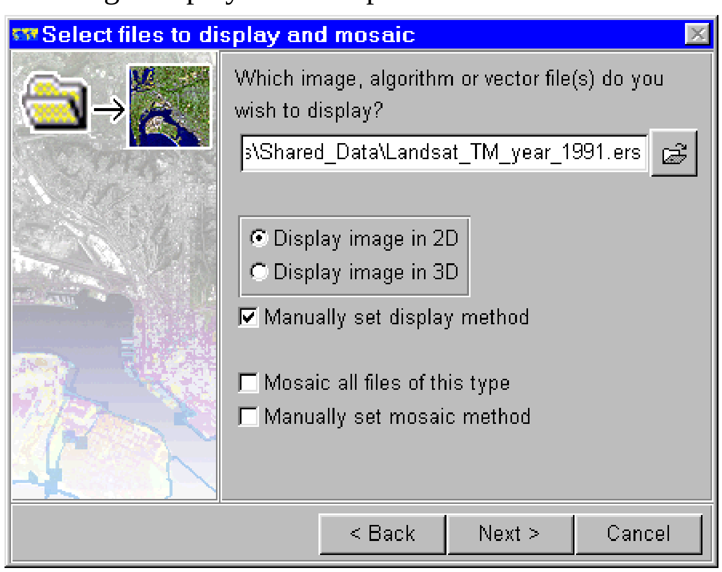
***Objectives*** Learn to use the Image Display and Mosaic Wizard to automate creation of greyscale, RGB and mosaic algorithms.

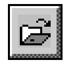
## Create a greyscale algorithm automatically

1 On the main menu, click the **Image Display and Mosaic Wizard** button.




The image Display Wizard opens.



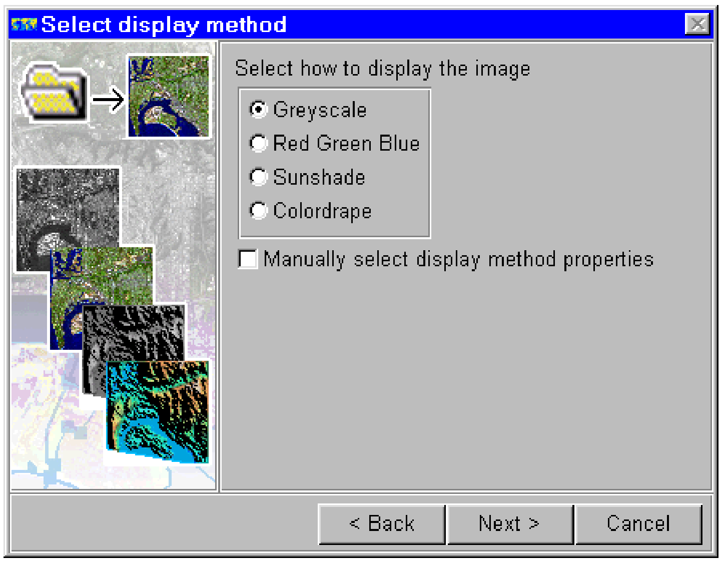
2 In the wizard page, click the  button.

3 From the **Directories** menu (on the **Select File** dialog), select the path ending with **\examples**.

4 Open the 'Shared_Data' directory, then double-click on the dataset 'Landsat_TM_year_1991.ers' to load it.

5 Select the **Display image in 2D** and **Manually set display method** options.

6 Click **Next>** to go to the **Select display method** wizard page.




7 Select the **Greyscale** option, and click on the **Next>** button.

ER Mapper creates a greyscale algorithm showing band 1 of the Landsat dataset. A 99% autoclip transform has been applied to enhance the contrast.

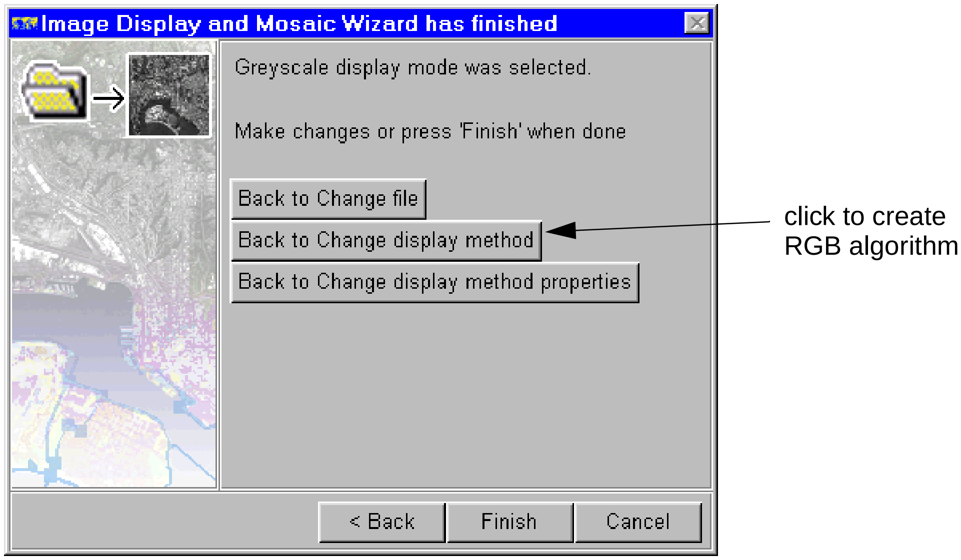
## Open the Algorithm dialog

1 From the **View** menu, select **Algorithm**.

The **Algorithm** dialog shows one Pseudo layer for the greyscale algorithm.

## View the same dataset as an RGB algorithm

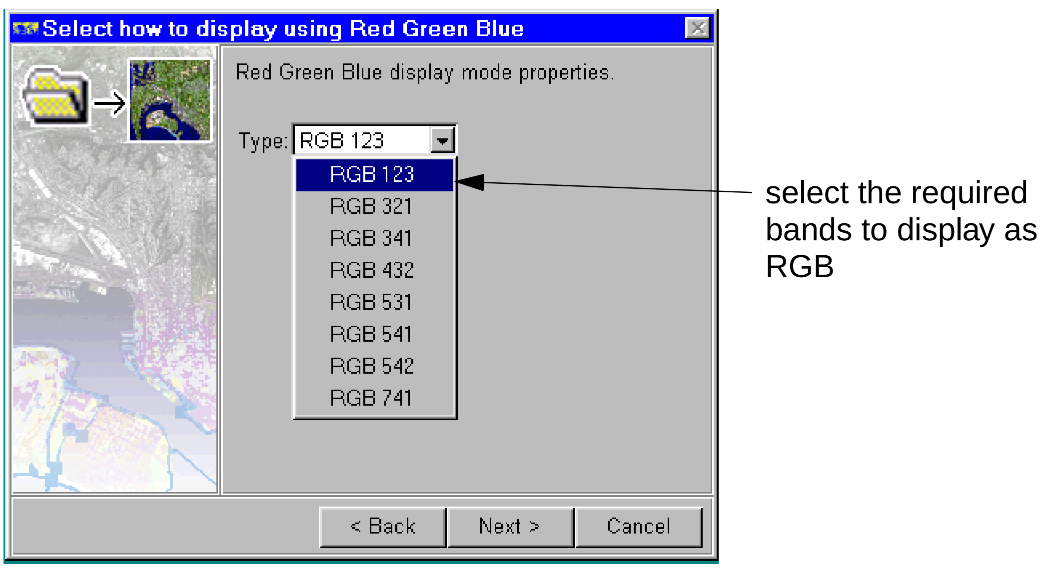
1 On wizard page, click the **Go back to Change display method** button.




The wizard will return you to the **Select display method** page.

2 Select the **Red Green Blue** and **Manually select display method properties** options, and then **Next>**.

3 Select 'RGB 123' in the wizard page.




This is to display band 1 of the image as Red, band 2 as Green and band 3 as Blue. There are a number of options that you can select.

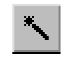
4 Click on the **Next>** button.

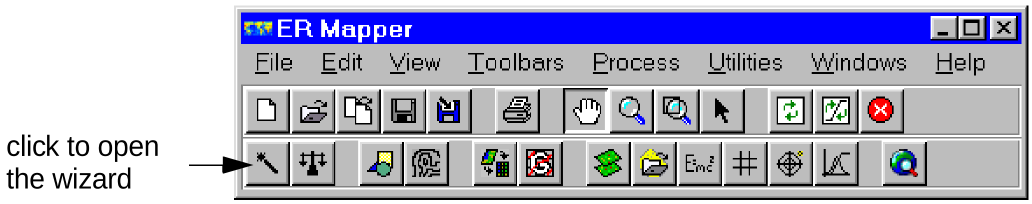
ER Mapper converts the greyscale algorithm to an RGB algorithm displaying bands 3, 2 and 1 of the Landsat dataset.

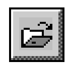
5 Click on the **Finish** button to close the wizard.

6 Select **Close** from the **File** menu to close the image window.

## Create a mosaic of three images automatically

1 On the main menu, click the **Image Display and Mosaic Wizard**  button.




2 In the wizard page, click the  button.

3 From the **Directories** menu (on the **Select File** dialog), select the path ending with **\examples**.

4 Open the ‘Applications\Airphoto\s3_Balancing’ directory, then double-click on the dataset ‘ADAR_Del_Mar_1.ers’ to load it.

5 Select the **Display image in 2D** and **Mosaic all files of this type** options, and then click on the **Next>** button.

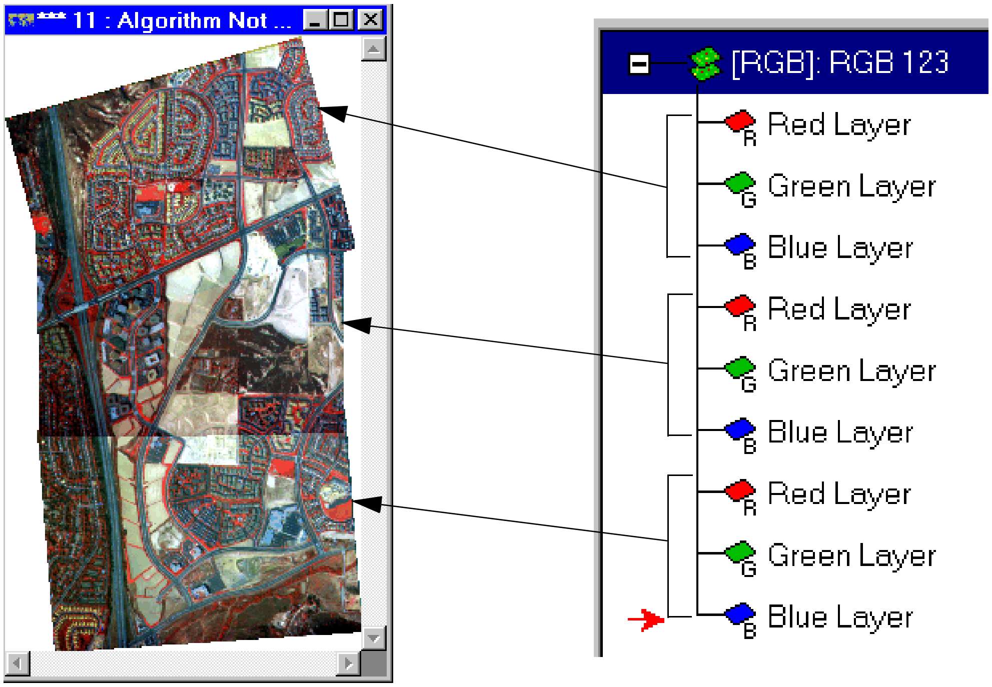
The wizard will look in the same directory for all images that can be mosaiced with the already loaded image. In this case the directory has two other image files, ‘ADAR_Del_Mar_2.ers’ and ‘ADAR_Del_Mar_3.ers’ which the wizard will add to the mosaic and display in the image window.

---

**Note:** It is possible to set the types of files that can be mosaiced and directories in which the wizard is to search by selecting **Manually set mosaic method** on the wizard page. refer to the *ER Mapper User Guide* for more information.

---

6 The Algorithm dialog will show the Red Green and Blue bands from the three mosaiced images:




7 Close the Algorithm dialog.

8 Click on the **Finish** button to close the wizard.

9 Select **Close** from the **File** menu to close the image window.

# 3: Using the Landsat TM image wizard

***Objectives*** Learn to use the image wizard designed to create common enhancements of Landsat TM satellite images.

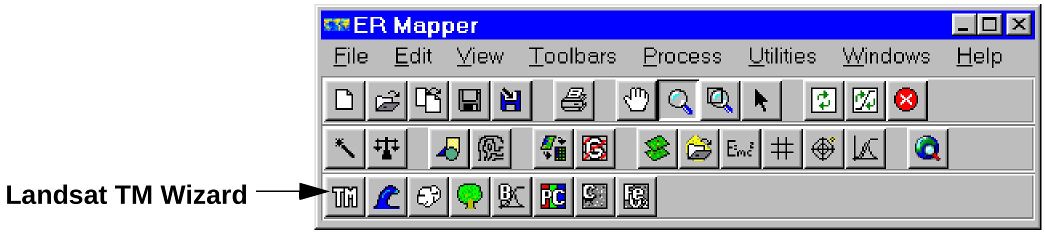
## Display the Remote Sensing toolbar

1 From the **Toolbars** menu, select **Remote Sensing**.

ER Mapper displays a third row toolbar buttons designed for creating images commonly used in satellite remote sensing.

## Start the Landsat TM image wizard

1 On the Remote Sensing toolbar, click the **Landsat TM Wizard** button.



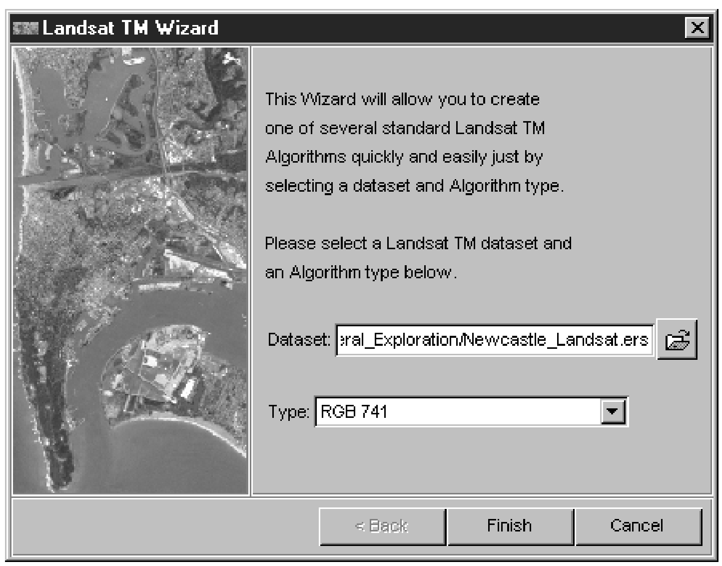

The **Landsat TM Wizard** dialog box opens. The wizard will prompt you for information it needs to build your algorithm.

2 Click the button next to the 'Dataset.'

3 From the **Directories** menu (on the **Select File** dialog), select the path ending with **\examples**.

4 Open the 'Applications\Mineral_Exploration' directory, then double-click on the dataset 'Newcastle_Landsat.ers' to load it.

5 From the 'Type:' drop-down list, select **RGB 741**. The dialog should now look like this:




## Create the RGB=741 algorithm

1 Click the **Finish** button at the bottom of the dialog.

ER Mapper executes the batch script and creates an RGB algorithm that displays bands 7, 4 and 1. A 99% autoclip transform is applied to each layer to enhance contrast. This is a Landsat image of the Newcastle area in southeastern Australia.

## Create a PC 123 in RGB algorithm

1 Click the **Landsat TM Wizard** button again.

2 Click the button next to the 'Dataset.'

3 On the **Select File** dialog, double-click on the dataset 'Newcastle_Landsat.ers' to load it.

4 From the "Type:" drop-down list, select **RGB Principal Components 123**.

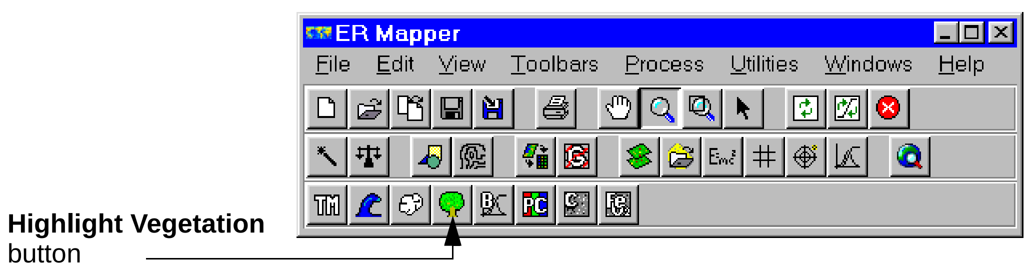
5 Click the **Finish** button.

ER Mapper opens a second image window and executes the batch script that creates an algorithm displaying Principal Components 1, 2 and 3 as an RGB image. (Drag the new window below the RGB 741 window to compare the two.) Principal Components images sometimes highlight subtle differences in vegetation, minerology or other features of interest that may not be apparent in simple RGB band combinations.

## Change the algorithm to display TM ratios

Some wizards can be used to automatically modify the current algorithm to change it to a different type of algorithm. If the wizard finds a dataset loaded into the current algorithm, it uses it. If there is no dataset, the wizard prompts for one.

1 On the Remote Sensing toolbar, click the **Highlight Vegetation** button.




The algorithm automatically changes to display a greyscale NDVI (vegetation index) image of the Landsat dataset.

## Hide the Remote Sensing toolbar

1 From the **Toolbars** menu, select **Remote Sensing**.

## Close the image windows and Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows, click the [X] **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Open a dataset directly (ER Mapper creates a simple display algorithm)
- Use the Image Display and Mosaic Wizard to create greyscale, RGB and mosaic algorithms
- Use wizards to create common displays of Landsat TM datasets

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# Thematic raster overlays

This chapter explains how you can create raster overlays in ER Mapper to display thematic data as solid or translucent colors over backdrop images. You will learn to use formulas, Classification layers, and other features. You can use these simple examples as the basis for developing more complex raster spatial modelling applications in ER Mapper.

## About thematic overlays

ER Mapper's algorithm processing approach allows you to interactively extract or derive data from multiple dataset bands (or from multiple datasets) and display the result in color over another image used as a backdrop. This type of display is commonly used to highlight areas meeting certain criteria in the context of a backdrop image used to show an overall view of an area. You have already used, for example, scattergrams to highlight certain ranges of data in color on an image.

The data for the color overlay can be derived interactively from a single image, or from multiple images when virtual datasets are used. For example, you could derive a sensitivity index based on slope and aspect from a DEM dataset and vegetation cover/type from a Landsat dataset, and display the result in color over a SPOT Panchromatic greyscale image used as backdrop. Any of the parameters can then be adjusted to modify the criteria.

# Hands-on exercises

These exercises give you practice using Classification layer types to display color overlays of thematic data, and setting transparency between images to aid analysis.

***What you will learn...***

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Display raster thematic data in solid color over images
- Use formulas to define criteria for displaying thematic color overlays
- Set transparency between two images to aid analysis

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Simple threshold overlays

***Objectives***

Learn to add a Classification layer to an algorithm to display a feature defined by a threshold in one band of a dataset. In this case, you will derive thematic information on water areas in a Landsat TM image and highlight them as a color overlay.

## Display a Landsat TM RGB algorithm

1 On the main menu, click on the **Open**  button.

An image window and the **Open** dialog box appear.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Data_Types’ directory, then open the ‘Landsat_TM’ directory.

4 Double-click on the algorithm named ‘RGB_321.alg.’

This algorithm displays an RGB color composite of bands 3, 2 and 1 of a Landsat TM image covering a portion of the San Diego, California metropolitan area. The dark areas in the lower portion are ocean.

5 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** dialog.

## Add a Classification layer and load the Landsat dataset

1 On the **Algorithm** dialog, open the **Edit** menu, select **Add Raster Layer**, then **Classification**.

A Classification layer is added to the algorithm layer list.

2 Click the **Load Dataset**  button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Landsat_TM_year_1985.ers’ to load it.

This is the same dataset loaded in the RGB layers of the algorithm. You will use a formula to define a threshold of one band of the image and display the result as a color overlay.

5 Turn off the classification layer by right-clicking on it and selecting **Turn Off.**

The classification currently covers the image with an all white layer. Turn it off for the moment to make the image visible.

## Determine the threshold value for ocean areas

Next you will use traverse extraction to determine a data threshold between land and ocean areas of the image using band 5 of the Landsat data. You will use this information to highlight the ocean areas in color using the Classification layer.

1 From the **View** menu, select **Traverse...**.

The **New Map Composition** and **Traverse** dialogs open.

2 On the **New Map Composition** dialog, make sure the ‘Vector File’ option is selected, then click **OK**.

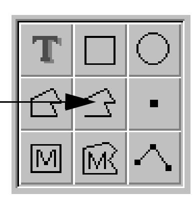
The **Tools** dialog and **ER Mapper** warning dialog appear.

3 Click **Close** on the **ER Mapper** warning dialog to close it. (This warning relates to use of the drawing tools for composing maps, but is not meaningful for this exercise.)

Position the **Traverse** dialog under the image window, and the **Tools** dialog to the right of the image window.

4 On the **Tools** dialog, click the **Poly Line**  button.

**Poly Line** button



5 As shown in the following diagram, define a traverse line starting from the dark ocean area at the bottom and extending through to the land areas beyond. (Click once at the start point, click once at the end point, then double-click to end the line definition.)

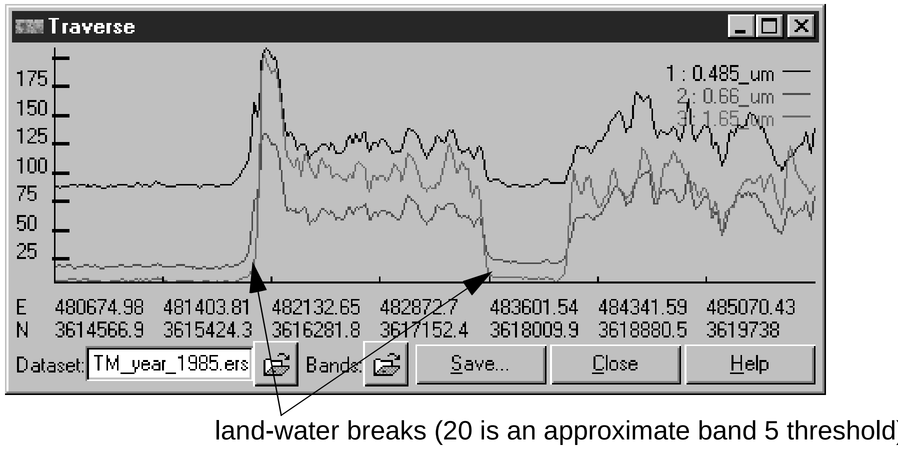
A profile line for band 1 appears inside the **Traverse** dialog.

6 On the **Traverse** dialog, click the **Bands:**  button.

7 On the **Traverse Band Selection** dialog, Ctrl-click on **B1:0.485_um**, **B3:0.66_um** and **B5:1.65_um** in the list to select them.

8 Click **OK** on the **Traverse Band Selection** dialog.

Profile lines for bands 1, 3 and 5 appear. The valleys in the lines are the ocean areas that typically have lower reflectance than land. Notice that TM 5 (mid infrared magenta line) has the biggest change in magnitude between the land and water areas (due to strong IR absorption). Any pixels with a value less than 20 in band 5 are considered water in this image, and 20 or greater are considered land.




---

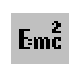
**Tip:** You could also use the **Cell Values Profile** feature under the **View** menu to determine this threshold.

---

9 Click **Close** on the **Traverse** dialog and the **Tools** dialog.

10 When asked to save the current annotation, click **No**.

## Define a formula to mask water from land

1 On the **Algorithm** dialog, click the **Edit Formula**  button in the process diagram.

2 In the **Generic** formula window, edit the formula text to read:

```
if input1 < 20 then 1 else null
```

This formula tells ER Mapper “if the image data values in the selected band are less than 20, then set the value to 1, else set it to null.”

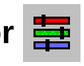
3 Click the **Apply changes** button to validate the formula.

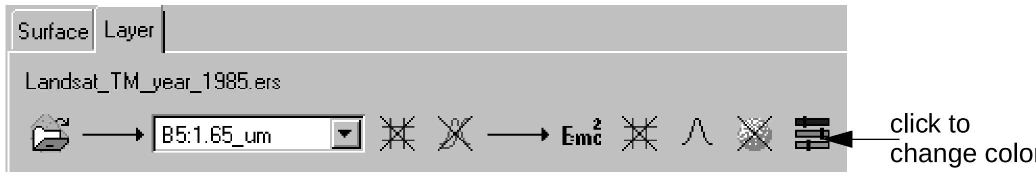
4 In the Relations window, select **B5:1.65_um** from the ‘INPUT1’ list.

The threshold formula now references band 5 of the Landsat dataset.

5 Click **Close** on the **Formula Editor** dialog.

## Choose an overlay color and name and display the image

1 In the process diagram, click the **Edit Layer Color**  button.




2 Choose a blue color, then click **OK** on the **Color** chooser dialog.

3 Change the Classification layer's label to **`water areas`** and press Enter or Return.

4 Turn on the classification layer by right-clicking on it and selecting **Turn On.**

The areas of ocean in the image are highlighted in a blue mask (areas where band 5 values meet the criteria of being less than 20). Other areas that do not meet that criteria are assigned the value null by the formula, so the color composite image created by the RGB layers "shows through" the blue mask in those areas.

---

**Note:** This is similar to the overlay technique you used earlier with the Scattergrams feature. When you define a region box on a scattergram, ER Mapper automatically creates a Classification layer and adds a formula to define the data limits of the box.

---

### Using multiple Classification layers

You may add additional Classification layers to display overlays in other colors meeting other criteria. Classification layers on top of the layer list take display priority over others below them. For example, if two Classification layers would cover overlapping areas based on the criteria you specify, the color of the layer on top covers the color in the layer below it where the two overlap. The color of the lower layer is only visible where there is no overlap. (Classification layers always cover other raster layer types, regardless of their position among the other layer types.)

# 2: Digital terrain aspect overlays

***Objectives*** Learn to create slightly more complex overlays that highlight specific ranges of aspect in a digital terrain model (DTM). Also learn to apply a pre-formula filter so the formula can operate on the filter output (aspect values in this case).

## Open the Australia colordrape algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu, select the **\examples** path.

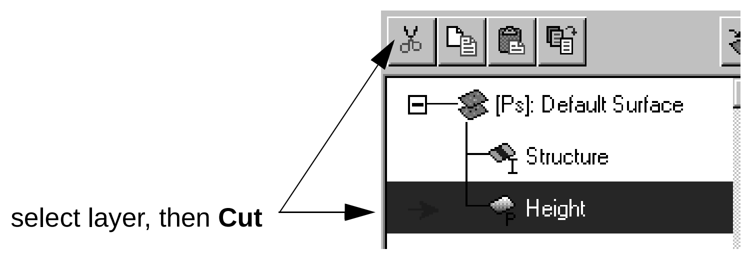
3 Open the 'Data_Types' directory, then open the 'Digital_Elevation' directory.

4 Double-click on the algorithm 'Australia_Colordrape.alg' to open it.

This algorithm displays a digital terrain model (DTM) of Australia as a colordrape image. Sun angle shading has been applied to the Intensity layer to create a "shaded relief" effect and elevation is shown in color in the Pseudo layer.

## Delete the Pseudo layer from the algorithm

1 Select 'Height' (Pseudo) layer in the algorithm, then click **Cut** .




The shaded relief image displays in greyscale. Next you will create a color overlay to highlight specific ranges of aspect of the terrain.

## Add a Classification layer and load the DTM dataset

1 On the **Algorithm** dialog, open the **Edit** menu, select **Add Raster Layer**, then **Classification**.

A Classification layer is added to the algorithm layer list.

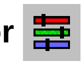
2 Click the **Load Dataset**  button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Australia_DTM.ers’ to load it. (Do *not* click **GO** yet.)

This is the same dataset loaded in the ‘Structure’ (Intensity) layer of the algorithm.

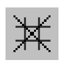
5 Turn off the classification layer by right-clicking on it and selecting **Turn Off.**

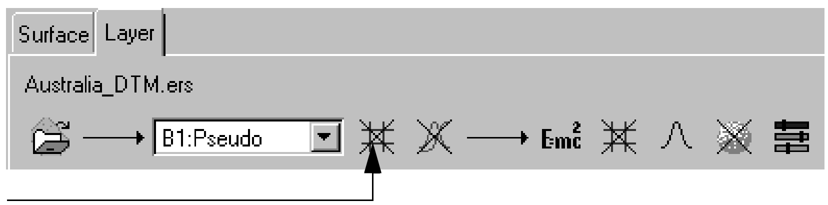
6 In the process diagram, click the **Edit Layer Color**  button.

7 Choose a red color, then click **OK** on the **Color** chooser dialog.

Next you will load a filter to calculate aspect from the DTM data, and then use a formula to display a specific range of aspects as a color overlay.

## Load a filter to calculate aspect from the DTM data

1 With the ‘Classification Layer’ selected, click the pre-formula **Edit Filter (Kernel)**  button.




pre-formula **Edit Filter (Kernel)** button

2 From the **File** menu (on the **Filter** dialog), select **Load...**.

3 From the **Directories** menu (on the **Load filter** dialog), select the **\kernel** path.

4 Open the ‘filters_DEM’ directory, then double-click on the filter ’aspect.ker’ to load it.

*Aspect* is a measure of the compass direction a topographic surface faces at a given point. Aspect is computed as a horizontal angle in degrees of azimuth from due north (which is zero degrees). The ‘aspect’ filter generates values ranging from 0 to 360 degrees . North-facing slopes have an aspect of 0 degrees, east-facing slopes 90 degrees, south facing slopes are 180, and west-facing slopes are 270.

5 Click **Close** on the **Filter** dialog.

Since your slope calculation is generated with a *pre-formula* filter, you can now use a formula to isolate a specific range of aspects for your thematic overlay.

## Enter a formula to show southeast to southwest facing slopes

1 On the **Algorithm** dialog, click the **Edit Formula**  button in the process diagram.

2 In the **Generic** formula window, edit the formula text to read:

```
if i1 > aspect1 and i1 < aspect2 then 1 else null
```

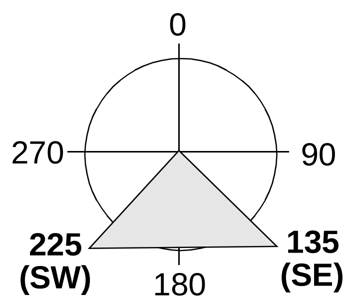
This formula tells ER Mapper "if the data values calculated by the aspect filter are greater than a variable named 'aspect1' and less than a variable named 'aspect2,' then set the value to 1, else set it to null."

3 Click the **Apply changes** button to validate the formula.

4 Above the Relations window, click the **Variables** button.

5 Change the value in the 'aspect1' field to **135** and edit the 'aspect2' value to read **225** and press Return or Enter.

The values 135 and 225 correspond to southeast and southwest on the 0-360 aspect scale, so the formula displays slopes facing between those two compass directions.




6 Turn on the Classification Layer by right-clicking on it and selecting **Turn on**.

Areas of the Australian continent with southeast to southwest facing slopes are highlighted in red.

## Change the formula to show northeast to southeast facing slopes

1 Change the value in the 'aspect1' field to **45** and edit the 'aspect2' value to read **135** and press Return or Enter.

Northeast to southeast facing slopes are highlighted in red. As you can see, these types of overlays and formulas provide very powerful and flexible tools for spatial modelling applications.

2 If desired, try different threshold values between zero and 360 for the 'aspect' variables in the formula to highlight different aspect ranges.

3 When finished, click **Close** on the **Formula Editor** dialog.

**Tip:** This is a very simple modelling application, but you can use this as a basis for more complex ones involving many variables and data from two or more datasets. Virtual Datasets are also very useful in modelling, for example create an “aspect” VDS that has N, NE, E, SE, etc. “bands” that are pre-computed, or link several datasets together so you can perform math operations on them as if they bands in a single dataset.

# 3: Transparency between images

***Objectives*** Learn to use the Transparency function to allow fast analysis and comparison of two or more different datasets covering a common area.

Earlier you learned how to control transparency between 3D surfaces. This feature is also very useful when viewing images in 2D.

## Display the shaded relief DEM algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Data_Types’ directory, then open the ‘Digital_Elevation’ directory.

4 Double-click on the algorithm ‘Realtime_Sun_Shade.alg’ to open it.

This algorithm displays a digital terrain model (DTM) of San Diego, California as a greyscale shaded relief image. Sun angle shading has been applied to the Pseudo layer to highlight terrain features in the area.

## Open a Landsat RGB algorithm as a second surface

To create transparency between different images, you must have each image as a different surface in the same algorithm (same as for 3D viewing).

1 On the main menu, select **Open into New Surface** from the **File** menu.

2 From the **Directories** menu, select the **examples** path.

3 Open the ‘Data_Types’ directory, then open the ‘Landsat_TM’ directory.

4 Double-click on the algorithm ‘RGB_741.alg’ to open it.

ER Mapper loads the Landsat RGB algorithm as a second surface in the current algorithm. Since the shaded DTM surface is above the RGB surface in the layer list, its image currently covers the RGB image where they overlap.

## Set transparency for the shaded relief image

1 Select the top surface ‘[Ps]:Surface 1’ in the algorithm.

Since the shaded relief image is on top of the RGB image, you must set transparency for it to see the RGB image underneath.

2 Click the **Surface** tab.

3 Set the ‘Transparency’ slider to its mid-point.

The two images are blended so colors from both are visible.

4 Adjust the ‘Transparency’ slider to various settings.

By shifting the transparency back and forth to different levels, you can quickly see how terrain features relate to surface cover shown in the RGB image. For example, you can see that the narrow canyons on the eastern and northern portions of the image contain natural vegetation (green in the RGB=741 band combination). This is a fast way to compare the two images.

---

**Tip:** It is also possible to add a third or fourth image, and set transparency between all of them. You must make the images (surfaces) on top of others partially transparent in order to images underneath. (You can also turn surfaces on and off to simplify fast comparison of many images.)

---

## Close all image windows and dialog boxes

1 Select **Close** from the **File** menu to close the image window.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Display raster thematic data in solid color over images
- Use formulas to define criteria for displaying thematic color overlays
- Set transparency between two images to aid analysis

# 17

# Vector data integration

This chapter explains how to use ER Mapper's vector annotation tools to draw annotation on your images using, text, polylines, polygons, and so on. It also explains how to display tabular (point location) data, link to and display existing vector data from GIS products, and generate contour lines and labels for an image.

## About vector annotation

Once you have created processing algorithms to aid analysis of your data, it is often helpful to draw interpretations on the image to communicate your results or recommendations. ER Mapper provides a complete set of vector annotation tools to let you draw text strings, polygons, lines, points and other objects. You can also set attributes such as color, line style, fill pattern and text rotation, and group objects and change their display order (move back and front). Your annotations are saved in a separate ER Mapper format vector file (.erv), and can be loaded and displayed over any other image as desired, or exported to other vector formats for use in other software products.

### About tabular data display

ER Mapper provides a utility to display tabular data over a backdrop image. Tabular data is usually used to plot point locations, for example hospitals, sample sites, or sitings of endangered species. Tabular data can be stored in an ASCII text file containing the X,Y values of the locations (in map coordinates), or can be extracted directly from a database product using an ER Mapper Dynamic Link.

### About GIS links

ER Mapper also has the capability to link directly to many external vector data formats, and display the data without the need for importing it first. This makes it easy to integrate vector data from a variety of software products and formats. You can, for example, link directly to AutoCAD DXF files or ARC/INFO coverages, and can edit vectors and save directly to the ARC/INFO coverage format.

### About vector contouring

ER Mapper also provides a feature to automatically create vector contours and labels from any source raster dataset. This can be an effective way to show elevations, levels of geophysical data, or other density measurements.

# Hands-on exercises

These exercises introduce you to many of the basic features of ER Mapper's annotation tools for drawing text, lines, and polygons on an image. You also learn to load and display external vector datasets such as AutoCAD DXF and ARC/INFO coverages, display tabular (point) data, and generate vector contours.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Add an Annotation/Map Composition layer to an algorithm
- Draw and modify attributes of vector objects such as text, lines and polygons
- Add layers to display tabular (point location) data
- Add layers to link directly to AutoCAD DXF files and ARC/INFO coverages
- Generate a vector contours overlay from a source raster dataset

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Creating vector annotation

***Objectives*** Learn to use ER Mapper's Annotation tools to draw interpretations and annotation objects such as lines, polygons, and text. Also learn to change the attributes (color, font, etc.) of annotation objects.

## Open a Landsat RGB algorithm

1 Click the **Open** button.

An image window and the **Open** dialog box appear.

2 From the **Directories** menu, select the **\example** path.

3 Open the 'Data_Types' directory, then open the 'Landsat_TM' directory.

4 Double-click on the algorithm 'RGB_741.alg' to open it.

This algorithm displays bands 7, 4 and 1 of the San Diego Landsat TM satellite image in RGB.

5 Drag the lower-right corner of the image window to make 50% larger.

6 Right-click on the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

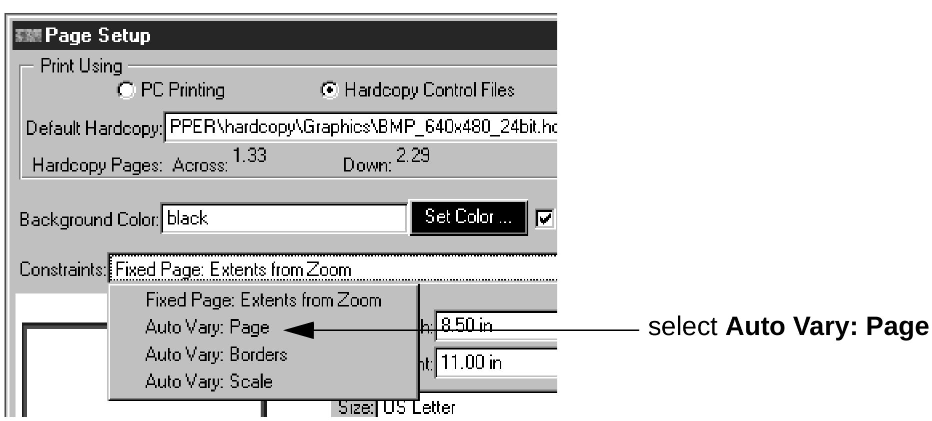
The image will resize to fit the enlarged window.

## Open the Page Setup dialog box

1 From the **File** menu, select **Page Setup**.

The **Page Setup** dialog box opens.

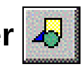
2 From the **Constraints** drop-down list, select **Auto Vary:Page**.



When creating annotation, it is recommended that you set the **Constraints** to something other than the default setting of **Fixed Page: Extents from Zoom**. (All the options on the **Page Setup** dialog are explained later in the “Composing Maps” chapter.)

3 Click **OK** on the **Page Setup** dialog.

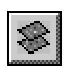
## Add a vector layer for map annotation

1 On the main menu, click the **Annotate Vector Layer**  button.


The **New Map Composition** dialog box opens to ask what type of annotation you want to create. You can create a vector file, raster regions or an ARC/INFO GIS coverage file. (You can also access this by selecting **Annotate Vector Layer** from the **Edit** menu.)

2 Make sure the ‘Vector File’ option is selected, then click **OK**.

ER Mapper opens the **Tools** dialog containing your drawing tools. Move the **Tools** dialog to the right of the image window.

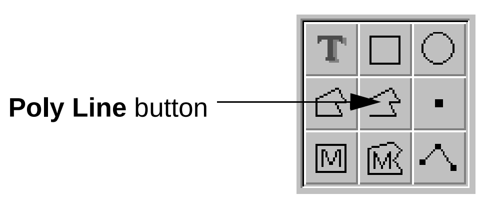
3 Click the **Edit Algorithm**  button.

Notice that a vector layer titled ‘Annotation Layer’ has been added to the layer list in the **Algorithm** dialog. This is the layer you will use to add your own annotation and items to the image.

4 Click **Close** on the **Algorithm** dialog.

## Draw a polyline to trace roads on the image

1 On the **Tools** dialog, click the **Poly Line**  button.



2 In the image, draw a line to trace a road by clicking once at each point, then double-clicking to end the line.

A line appears on your image to highlight the linear feature. Markers appear on the line at each node to indicate that the line is “selected.”

## View and modify the attributes of the polyline

1 On the **Tools** dialog, *double-click* on the **Poly Line**  button.

The **Line Style** dialog box opens to let you choose attributes for your polylines.

2 Click the **Set Color** button, choose any contrasting color, then click **OK** to close the **Color** chooser dialog.

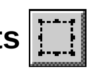
The line color on the image changes to your selected color.

3 Click the **Width** drop-down list and choose **3.0** to increase the line width.

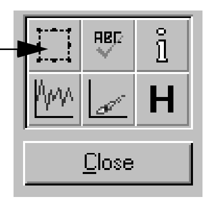
4 On the **Line Style** dialog, turn on the **Curved** option next to ‘Current Line.’

ER Mapper applies a spline function to the line to create smooth, rounded curves. This creates a more visually pleasing line and is especially helpful when tracing roads and other linear features.

5 Turn off the **Curved** option.

6 On the **Tools** dialog, click the **Edit Object Extents**  button.

**Edit Object Extents** button




The **Map Composition Extents** dialog opens to show information about the polyline object. It shows the line length in map units, and other attributes such as the number of vertices, geographic extents, and so on.

7 Click **Close** on the **Map Composition Extents** dialog.

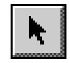
---

**Tip:** To draw a straight line with an arrowhead, use the **Poly Line**  tool to draw the line, then turn on the ‘Start’ or ‘End’ option under ‘Arrow at:’ in the **Line Style** dialog.

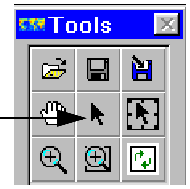
---

8 Click **Close** on the **Line Style** dialog.

## Modify the polyline nodes

1 On the **Tools** dialog, click the **Select/Edit Points Mode**  button, then click on the polyline you drew to select it.

**Select/Edit Points Mode** button



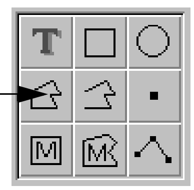

2 Drag any line node to a new location.

The line shape adjusts as you move the node. By dragging a node, you can reshape or fine tune a polyline (or polygon) as needed.

## Draw a shaded polygon around a feature

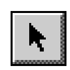
1 On the **Tools** dialog, click the **Polygon**  button.

**Polygon** button



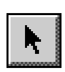
2 Draw a polygon around the feature of interest in the image by clicking once at each point, then double-clicking to close the polygon.

The polygon object appears surrounding the feature with the currently selected line attributes.

3 On the **Tools** dialog, click the **Select/Edit Points Mode**  button, then double-click on the polyline you drew to select it.

The **Line Style** dialog box opens to let you set polygon attributes.

---

**Tip:** You can quickly edit the attributes of any object by double-clicking on the object in the image window when the  or  select buttons are active.

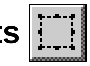
---

4 Click the **Set Color** button, choose a different color, then click **OK**.

5 Under **Fill Pattern**, click on one of the diagonal line fill patterns.

The polygon is filled with the diagonal shade pattern.

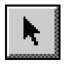
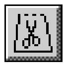
6 Click **Close** on the **Line Style** dialog.

7 On the **Tools** dialog, click on the **Edit Object Extents**  button.

The **Object Extents** dialog opens to show information about the polygon object, including the perimeter length and area.

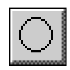
8 Click **Close** on the **Object Extents** dialog to close it.

---

**Tip:** To delete a node from an existing polyline or polygon, use **Select/Edit Points Mode**  and select it, click once on the node to delete, then click the **Delete Point**  button. To add a node, click the **Add Points Mode**  button, then click on the line to add a node at that point.

---

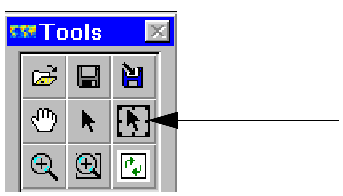
## Draw a shaded oval and move and resize it

1 On the **Tools** dialog, click the **Oval**  button.

2 Drag an oval shape inside the image and release.

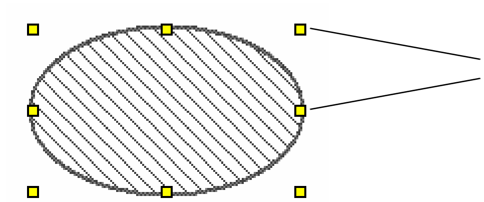
A shaded oval appears with the current attributes.

3 On the **Tools** dialog, click the **Select and Move/Resize Mode**  button.




**Select and Move/Resize Mode** button

**Select and Move/Resize Mode** lets you move and/or resize the selected object. Notice that the oval's selection handles change–now there are eight.



drag corner or side handle to resize or reshape object

4 Drag one of the corner or side handles to resize the oval.

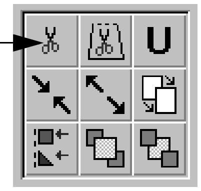
By dragging a handle, you can resize or reshape the object.

5 Point inside the oval, then drag it to a new location.

By dragging the object from the interior, you can move it on the image.

6 Click the **Delete Object** button to remove the oval object.

**Delete Object** button



---

**Tip:** To restore the last deleted object, click the **Undo Last Delete** button.

---

### Tips for selecting objects

ER Mapper’s annotation tool set provides two “select” tools for different tasks:

- Use the **Select/Edit Points Mode** button to select a polyline or polygon object when you want to move the individual line nodes, or select nodes.
- Use the **Select and Move/Resize Mode** button to select any annotation object when you want to move the entire object (drag from the center) or resize the entire object (drag one of the selection handles).
- To select multiple objects at once, choose the **Select and Move/Resize Mode** button. Then either drag a marquee box around all the objects, or select them one at a time by holding down the Shift key and clicking on them.

## Draw and modify a text string

1 On the **Tools** dialog, click the **Text Object** button.

The **Text Style** dialog box opens.

2 Inside the image, drag a box about one-half inch or 1cm tall.

Four selection handles appear when you release. (The box height determines the default text size.)

3 In the **Text Style** dialog, click in the **Text** field at the bottom to position the cursor, then type **`Pacific Ocean`**.

The text appears on the image as you type.

4 In the **Text Style** dialog box, select the following text attributes:

**Size: 36.0**

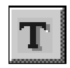
**Color:** white

**Font:** Postscript Stroke / **Helvetica-Bold**

The text object automatically updates on the image as you change the attributes.

5 Click the **Select and Move/Resize Mode**  button, then drag the text block by its center to the dark ocean area in the lower left.

## Draw and rotate a text string

1 Click the **Text Object**  button again, then drag a second text box in the image.

2 In the **Text Style** dialog, click in the **Text** field to position the cursor, then type `San Diego Bay`.

3 In the **Text Style** dialog box, select the following text attributes:

**Size: 24.0**

**Angle (deg): 315**

**Color:** white

**Font: Helvetica-Bold**

The text string rotates 315 degrees counter-clockwise, so it now points down toward the lower right. (Text strings rotate counter-clockwise around their origin in the upper-left corner.)

4 Click the **Select and Move/Resize Mode**  button, then drag the text block to the dark ocean area in the lower right.

Rotating text can help fit it to the shape or area of a feature.

---

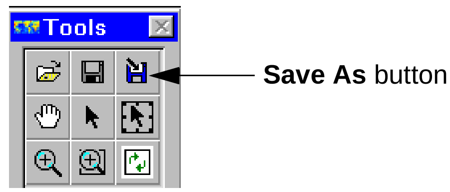
**Tip:** Text drawn as annotation can be set to automatically scale up or down proportionally at whatever size the image is printed (the **Fixed Text** option off), or always print at an exact point size (the **Fixed Text** option on).

---

5 Click **Close** on the **Text Style** dialog.

### Save the annotation to a file on disk

1 On the **Tools** dialog, click the blue **Save As** button.




The **Map Composition Save As** dialog opens.

2 Make sure the ‘Vector File’ option is selected, then click the button next to ‘Save to File.’

3 From the **Directories** menu (on the **Save Map Composition File** dialog) , select the **\examples** path.

4 Open the ‘Miscellaneous\Tutorial’ directory.

5 In the **Save As:** text field, type a name using your initials followed by the text **`annotation`** and separate each word with an underscore (_).

6 Click **OK** to validate the filename.

7 Click **OK** on the **Map Composition Save As** dialog.

Your vector annotation objects are saved to an ER Mapper format vector file (.erv) on disk. (To display this dataset again in the future, select **Annotation\Map Composition** from the **Edit\Add Vector Layer** menu on the **Algorithm** dialog, then load your vector dataset.)

8 Click **Close** on the **Tools** dialog.

# 2: Overlaying tabular data

***Objectives*** Learn to add a layer to an algorithm to display point data stored in a tabular format. (The examples used here are fire station locations, but they could just as easily be any other type of point data.)

### Open a SPOT Panchromatic greyscale algorithm

1 Click the **Open** button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Data_Types’ directory, then open the ‘SPOT_Panchromatic’ directory.

4 Double-click on the algorithm named ‘Greyscale.alg.’

The algorithm displays a SPOT Panchromatic satellite image of the San Diego, California area in greyscale.

## Display the GIS toolbar

1 On the main menu, select **GIS** from the **Toolbars** menu.

ER Mapper adds a third toolbar with buttons for quick access to common functions used for annotation and display of GIS vector data.

## Add a Tabular Data layer and load a sample dataset

1 On the **GIS** toolbar, click the **Show Tabular Data** button.


**Show Tabular Data** button

The **Tabular Dataset** dialog opens.

2 On the **Tabular Dataset** dialog, click the button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Data_Types’ directory, then open the ‘SPOT_Panchromatic’ directory.

5 Double-click on the dataset ‘San_Diego_Fire_Stations.tbl’ to load it.

6 Click **OK** on the **Tabular Dataset** dialog.

ER Mapper runs the algorithm and displays the location of each fire station as a white circle.

## Label the tabular layer and choose a color

1 On the main menu, select **Algorithm** from the **View** menu.

In the **Algorithm** dialog, notice that a vector layer titled ‘Table of Data as Circles’ has been added to the layer list. The process diagram for the tabular layer includes the **Dynamic Link Chooser** button to choose a different tabular dataset, and the **Edit Layer Color** button to change the color.

2 Change the ‘Table of Data’ layer’s label to **`fire stations`** and press Enter or Return.

3 In the process diagram, click the **Edit Layer Color** button.

4 Choose a red color, then click **OK** to close the **Color** chooser dialog.

### Creating table data files

To display the circles, ER Mapper is accessing data in an external ASCII text file with an Easting and Northing value for each location. You can create your own table data files for use in ER Mapper by converting your data into this simple ASCII text format and naming the file with a “.tbl” extension:

```
476129.7 3628371.7 0.2 Pacific Beach
480736.2 3626928.7 0.2 Bay Park
484024.5 3626720.5 0.2 Linda Vista
477368.8 3623305.3 0.2 Ocean Beach
477100.3 3620536.4 0.2 Pt. Loma
476781.4 3618157.3 0.2 Pt. Loma (naval reserv.)
```

Easting value — Northing value — value for circle size — text label

The first two fields (X,Y) must be in the same units as the raster dataset’s map projection (meters of Eastings and Northings for a UTM projection in this case).

# 3: Linking to GIS vector data

***Objectives*** Learn to use ER Mapper’s Dynamic Links feature to directly read and display data in an external format. In this case, you will display an AutoCAD DXF file of roads and an ARC/INFO coverage of waterways and drainage.

## Open the large scale SPOT Pan greyscale algorithm

1 On the main menu, click on the **Open** button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Applications\Land _Information’ directory, then double-click on the algorithm ‘SPOT_Pan.alg’ to open it.

This algorithm displays a SPOT Panchromatic satellite image of the greater San Diego, California area. The international border with Mexico is at the extreme southern (lower) part of the image.

## Add an AutoCAD DXF vector layer to the algorithm

1. On the **Algorithm** dialog, open the **Edit** menu, select **Add Vector Layer,** then **AutoCAD DXF**.

   An empty ‘DXF Link’ vector layer is added. This layer type lets you directly display vector datasets in AutoCAD DXF (‘.dxf’) format *without* having to import the files first into ER Mapper’s vector format (‘.erv’).

## Display a DXF vector file of roads

1. In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.
2. From the **Directories** menu (on the **DXF Link** dialog), select the **\examples** path.
3. Open the ‘Data_Types’ directory and then the ’AutoCAD_DXF’ directory’
4. Double-click on the file ‘Roads.dxf’ to load it.

   ER Mapper loads the dataset and establishes a link to the DXF file.

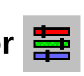
   First the raster image data is processed, then the vector roads data is displayed as a white overlay in the central part of the image. It might be difficult to see because it only covers a small part of the image.

## Zoom in to the extents of the vector dataset

1. Right-click in the image window, select **Quick Zoom**, then **Zoom to All Vector Datasets**.

   ER Mapper zooms in to the extents of the DXF file (first processing the raster data, then the vector data). Combining raster and vector data is useful for adding data from GIS and vector mapping applications to your images.

## Label the DXF layer and choose a color

1. Change the ‘DXF Layer’ label to **`San Diego roads`** and press Enter or Return.
2. In the process diagram, click the **Edit Layer Color**  button.
3. Choose a red color, then click **OK** to close the **Color** chooser dialog.

## Zoom out to the extents of the raster dataset

1. Right-click in the image window, select **Quick Zoom**, then **Zoom to All Raster Datasets**.

ER Mapper zooms back out to the full extents of the SPOT Pan satellite image.

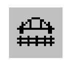
---

**Note:** The vector data is currently displayed with a DXF link, so it cannot be edited directly. To edit the data, you can import the DXF file using **Utilities/Import Vector and GIS formats** and create an ER Mapper format '.erv' vector file. The file can then be displayed in an Annotation/Map Composition layer and edited using ER Mapper's vector drawing tools. After editing, it can be exported back to DXF format if desired.

---

## Add an ARC/INFO coverage layer to the algorithm

1 On the **Algorithm** dialog, open the **Edit** menu, select **Add Vector Layer,** then **ARC/INFO Coverage**.

2 Click the **Dynamic Link Chooser**  button in the process diagram.

3 On the **ARC/INFO Chooser** dialog, click the  button next to the 'Workspace' field.

4 From the **Directories** menu (on the **ARC/INFO Workspaces** dialog), select the path ending with **\examples**.

5 Open the 'Shared_Data' directory.

6 Click ***once*** on the 'arc_info_workspace' directory to select it, then click **Select**.

The coverage is loaded into the **ARC/INFO Chooser** dialog.

---

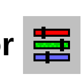
**Note:** When you link to ARC/INFO coverages, you must "select" the directory containing the coverages (the workspace) as shown above. Do *not* open the workspace directory directly.

---

7 From the drop-down list next to 'Coverage,' select **sandiegcst**.

8 From 'Line Width' list, select **1.0**.

9 Click **OK** on the **ARC/INFO Chooser** dialog to close it.

10 In the process diagram, click the **Edit Layer Color**  button.

11 Choose yellow, then click **OK**.

The San Diego coast and drainage data is displayed in yellow, then the red roads (from the DXF file) are drawn on top. As with raster layers, the order of vector layers in the algorithm determines which appear on top of others.

## Zoom in to the extents of both vector datasets

1 Right-click in the image window, select **Quick Zoom**, then **Zoom to All Vector Datasets**.

ER Mapper zooms in to the combined extents of the DXF file and the ARC/INFO coverage.

---

**Tip:** To zoom to extents of a specific dataset (raster or vector), select its layer in the algorithm, then select **Quick Zoom/Zoom to Current Dataset**.

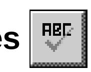
---

## Display the ARC/INFO coverage on top of the DXF file

1 Select the ‘ARC/INFO Layer’ in the algorithm, then click the **Move Up**  button.

The red DXF roads data draws first (since its layer is on the bottom), then the yellow ARC/INFO coast and drainage data draws on top where there is overlap.

---

**Tip:** You can also edit vectors and attributes in ARC/INFO coverages, and save the results directly back to the coverage format. To do this, click the **Annotate Vector Layer**  button in the process diagram and use the annotation tools to edit vectors as desired. Use the **Display/Edit Object Attributes**  button to edit attributes. When finished, save the annotation file with ‘ARC/INFO Coverage’ selected. You can then read the updated coverage directly in ARC/INFO. (Build and clean operations apply.)

---

## Close the image window

1 Select **Close** from the **File** menu to close the image window.

# 4: Overlaying contour lines and labels

***Objectives*** Learn to add a Contours layer to an algorithm to automatically generate contour lines and labels.

## Display the San Diego DEM in pseudocolor

1. On the main menu, click the **New** button.
2. In the **Algorithm** dialog, click the **Load Dataset** button in the process diagram.
3. From the **Directories** menu, select the **\examples** path.
4. Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Digital_Terrain_Model_20m.ers’ to load it.
5. Click the **Surface** tab, then select **pseudocolor** from the ‘Color Table’ list.
6. Click the **Layer** tab again.
7. Click on the post-formula **Edit Transform Limits** button in the process diagram.
8. From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

   The San Diego DEM dataset displays with the ‘pseudocolor’ color table. Low elevations display in blue, high elevations in yellow and red.

## Add a Contours layer to the algorithm

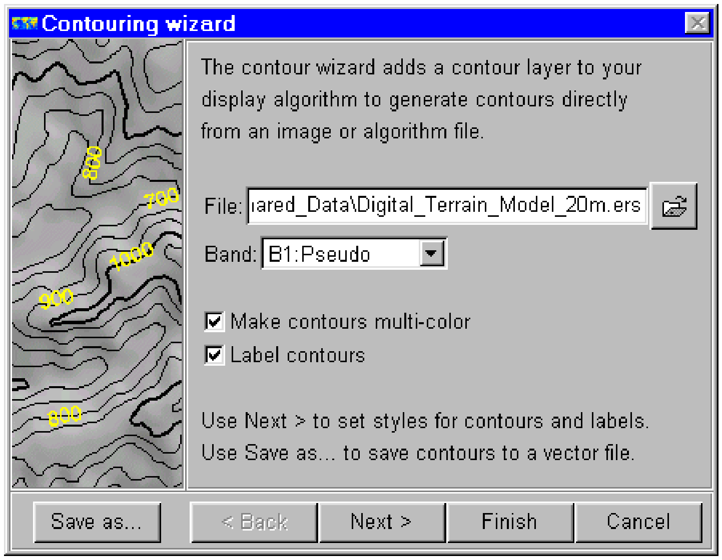
1. On the **Algorithm** dialog, open the **Edit** menu, choose **Add Vector Layer**, then choose **Contours**.

   A ‘Contours’ layer is added to the algorithm layer list.

## Specify the dataset and parameters for contouring

1. On the **Algorithm** dialog, click the **Dynamic Link Chooser** button in the process diagram.

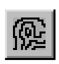
The **Contouring wizard** dialog opens. The ‘Digital_Terrain_Model_20m.ers’ dataset should already be selected in the **File:** field.




---

**Note:** Virtual datasets and algorithms can also be contoured.

---

You can also access the Contouring wizard by clicking on the **Contouring Wizard**  button on the **Common Functions** toolbar.


**Contouring Wizard** button

2 Choose the band to contour. (Digital_Terrain_Model_20m.ers has only one band)

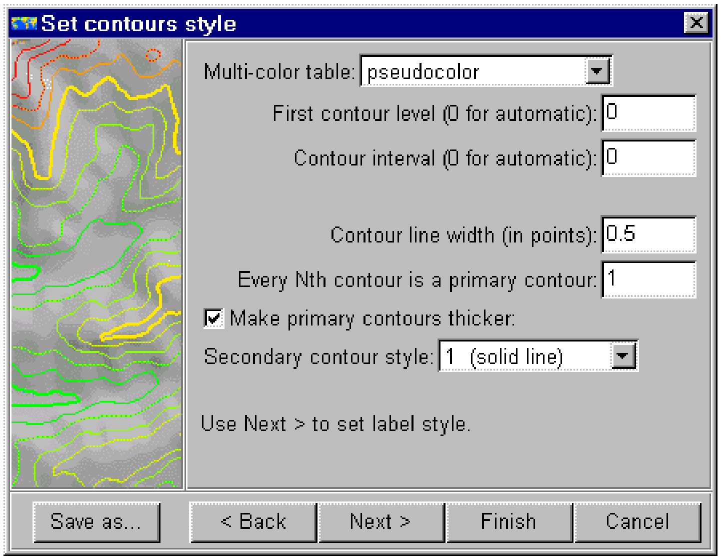
| | |
|---|---|
| **Band:** | Choose the image band to contour. Band 1 is chosen by default. |

3 Select the **Make contours multi-color** and **Label contours** options.

| | |
|---|---|
| **Make contours multi-color** | Select this option for the contour lines to have colors from a specified color table. Otherwise they will have a single color. |
| **Label contours** | Select this option if you want the contour lines to be labelled. |

4 Click on the **Next >** button to go to the **Set contours style** wizard page.

## Set contours style.




1 Select **elevation** from the drop-down list in the **Multi-color table** field.

2 Enter 10 for the **First contour level**, 30 for the **Contour interval**, and a **Contour line width** of 0.5 points.

3 Enter 4 for **Every Nth contour is a primary contour.**

4 Select the **Make primary contours thicker** option.

5 Select **Secondary contour style** number 17 from the list.

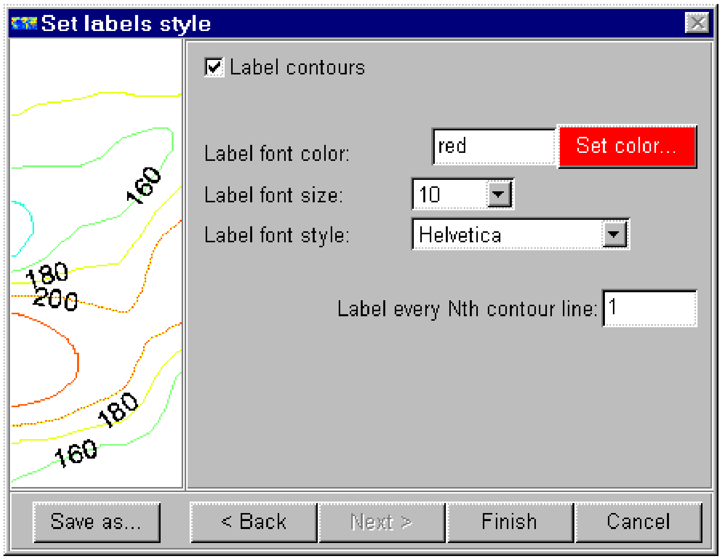
Every fourth contour line will be solid and thicker than the other lines, which will be dotted.

**Note:** If you leave the options as they are the default options will be used.

| | |
|---|---|
| **First contour level** | The value at which the first contour is drawn. If you leave the value as 0, ER Mapper will automatically choose a value. |
| **Contour interval** | The distance between contours. If you leave the value as 0 the step between contours will be automatically chosen by ER Mapper. |
| **Contour line width** | Specify the width of the contour lines in points. The default is 0.5 points. |
| **Every Nth contour is a primary contour** | The contour lines at the specified interval will be primary contours which you can specify to be thicker. Leave at the default value of 0 or 1 for no primary contours. |
| **Make primary contours thicker** | Select this option for primary contour lines to be thicker than the width specified in the **Contour line width** field.<br>This option has no effect if there are no primary contours; i.e you entered 0 or 1 in the **Every Nth contour is a primary contour** field. |
| **Secondary contour style** | Select the line style for secondary contours from the list.<br>Please note that you will only have secondary contours if you elected to have primary contours. Therefore ER Mapper will not use the secondary contour style if you entered a 0 or 1 in the **Every Nth contour is a primary contour** field. |

6 Click **Next** to go to the **Set labels style** wizard page.

## Set labels style




1 Select the **Label contours** option.,

The Label contours option should already be checked because you selected it in the first page of the wizard.

2 Leave the **Label font color**, **Label font size** and **Label font style** to the default values of red, 10 and Helvetica respectively.

3 Set **Label every Nth contour line:** to 2 so that every second line is labelled.

4 Click on **Finish** to exit the Contouring Wizard.

ER Mapper will redraw the image with contour lines.

---

**Note:** You could also have used the **Save as...** button in the Contouring Wizard to save the contours as an ER Mapper Vector Dataset (.erv) file. This is only necessary if you want to use the contours in some other applications. The ER Mapper **Contours** layer will re-draw the contours every time you run the algorithm.

---

## Close the image window and Algorithm dialog

1 Select **Close** from the **File** menu to close the image window.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Add an Annotation/Map Composition layer to an algorithm
- Draw and modify attributes of vector objects such as text, lines and polygons
- Add layers to display tabular (point location) data
- Add layers to link directly to AutoCAD DXF files and ARC/INFO coverages
- Generate a vector contours overlay from a source raster dataset

# 18

# Image geocoding

This chapter explains how to use ER Mapper to geometrically correct raw image data and rectify it to real world coordinate systems and map projections.

**Note:** To perform the following exercise as written, you will need to have a practice copy of the dataset 'Landsat_MSS_notwarped' in the 'tutorial' directory. The practice dataset is referred to as 'Landsat_practice' in the exercise. For information on creating the practice dataset, refer to Appendix A "System Setup" in this manual.

## About image geocoding

Whenever accurate area, direction and distance measurements are required, raw image data must usually be processed to remove geometric errors and rectify the image to a real world coordinate system. With satellite imagery, for example, these errors are introduced by factors such as roll, pitch and yaw of the satellite platform and curvature of the earth. In order to overlay or mosaic two images in ER Mapper, the images must be in the same coordinate system. The common coordinate system can be "raw" (uncorrected), or a real world map projection system.

A *ground control point* (GCP) is a point on the earth's surface where both *image coordinates* (measured in rows and columns) and *map coordinates* (measured in degrees of latitude and longitude, meters, or feet) can be identified. *Rectification* is the process of using GCPs to transform the geometry of an image so that each pixel corresponds to a position in a real world coordinate system (such as Latitude/

Longitude or Eastings/Northings). This process is sometimes called “warping” or “rubbersheeting” because the image data are stretched or compressed as needed to align with a real world map grid or coordinate system.

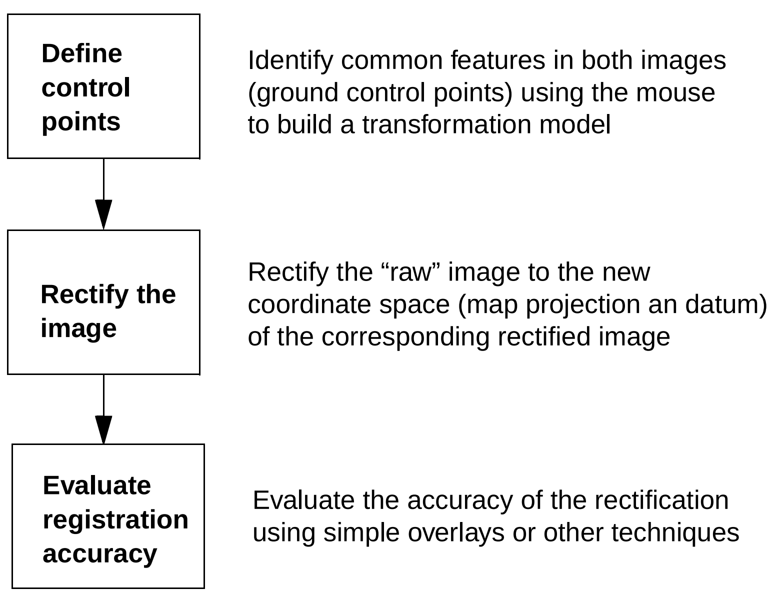
*Orthorectification* is a more accurate form of rectification because its takes into account sensor (camera) and platform (aircraft) characteristics. It is specifically recommended for airphotos. Orthorectification is covered separately in Chapter 26, “Image orthorectification”.

*Registration* is simply aligning two images so they can be overlaid or superimposed for comparison. In this case, the images do not have to be rectified to a map projection (they can both be in a “raw” coordinate system).

ER Mapper’s Rectification utilities are commonly used to perform four different types of operations:

- **Image to map rectification**–using polynomial (control point) or linear geocoding to rectify an image to a datum and map projection using GCPs.
- **Image to image rectification**–using polynomial (control point) or linear geocoding to rectify one image to another using GCPs.
- **Map to map reprojection**–transforming a rectified image from one datum/map projection to another.
- **Image rotation**–rotating an image any number of degrees.

In this exercise, you will use the Geocoding Wizard to perform an image-to-image rectification. A typical procedure for performing an image-to-image rectification is as follows:



# Hands-on exercises

These exercises give you practice using ER Mapper's Rectification features.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Choose common ground control points (GCPs) between two images
- Use options to modify the GCP display and edit GCPs
- Rectify a "raw" image to the chosen datum and map projection
- Evaluate registration accuracy using a red-green image overlay method

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

---

**Note:** It is *very important* to adhere to the following procedures exactly as written. Choosing GCPs can be a fairly complex procedure, and you will learn the basics best by following these exact steps the first time.

---

# 1: Choosing ground control points

***Objectives***

Learn how to use ER Mapper's Geocoding Wizard to identify common features in the two images, edit the points, and modify the GCP display.

## Create the FROM algorithm (the "raw" image)

Before performing an image-to-image rectification, you must first create an algorithm that displays the "raw" image you want to rectify.

1 Click the **Image Display and Mosaicing Wizard**  toolbar button.

An Image Wizard dialog box appears.

2 In the Image Wizard **Select files to display** window, click the file chooser  button in the **File to display:** field to open the file chooser.

3 In the directory 'examples\Miscellaneous\Tutorial', double-click on the image named 'Landsat_practice.ers'.

**Note:** if you have not already done so, you can create ‘Landsat_practice.ers’ by copying files ‘Landsat_MSS_notwarped’ and Landsat_MSS_notwarped.ers’ from the ‘examples\Shared_Data\’ directory and renaming them to ‘Landsat_practice’ and ‘Landsat_practice.ers’ respectively.

4 Select **Display image in 2D** and **Manually set display method**, and click on the **Next >** button.

5 In the **Select display method** window, select **Red Green Blue**.

6 Check the **Manually select display method properties** box.

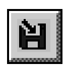
7 Click on the **Next >** button.

8 In the display mode properties box **Type:** field, select RGB 321 from the list.

9 Click on the **Next >** button.

10 The RGB composite with MSS1 (Blue), MSS2 (Green) and MSS3 (Red) is displayed.

11 Click on the **Finish** button to close the Image Wizard.

12 Click the **Save As**  toolbar button.

13 In the **Files of Type:** field, select ‘ER Mapper Algorithm (.alg)’.

14 From the **Directories** menu, select the path ending with **\examples**.

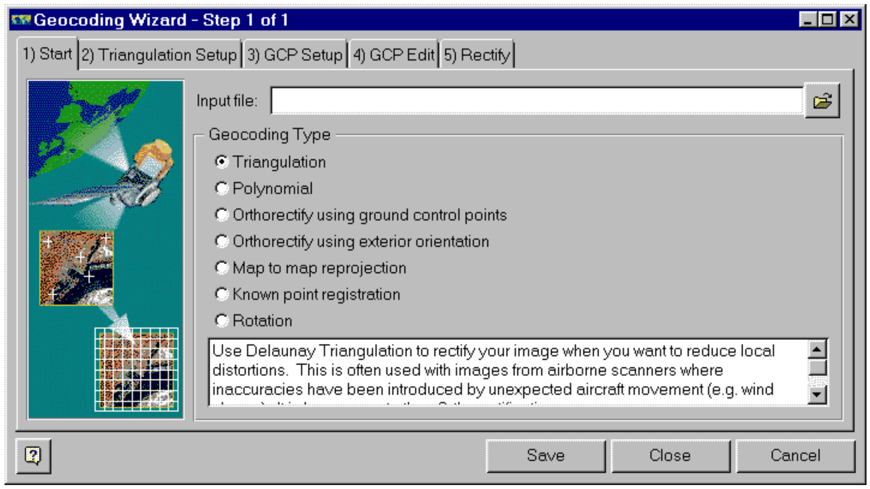
15 Open the ‘Miscellaneous\Tutorial’ directory, and save the algorithm with the name ‘Landsat_FROM_algorithm’ (use your initials at the beginning).

16 Close the image window using the window system controls:

## Remove existing Ground Control Points from the practice image

1 From the **Process** menu (on the main menu), select **Geocoding Wizard**.

The Geocoding Wizard dialog box will open with the **Start** tab selected.



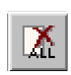

2 Click the **Load Algorithm or Dataset**  button in the **Input file:** field to open the file chooser.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 In the directory 'Miscellaneous\Tutorial,' double-click on your previously saved algorithm, 'Landsat_FROM_algorithm'.

5 Select **Polynomial** in the **Geocoding Type** box.

6 Select the **GCP Edit** tab.

7 Click the **Delete all GCPs**  button and, when asked to confirm the delete, click **Yes**.

8 Click on the **Save** button to save the changes to the practice image. If asked to confirm saving GCPs to disk click **Yes**.

## Set the Polynomial Order

1 Select the Geocoding Wizard **Polynomial Setup** tab.

2 Select **Linear** in the Polynomial Order box.

## Specify an image-to-image rectification and algorithm name

1 Select the Geocoding Wizard **GCP Setup** tab.

The **GCP Setup** tab lets you specify the name of a geocoded reference image.

2 In the **GCP Picking Method** box, select **Geocoded image, vectors or algorithm** option.

This tells ER Mapper you plan to pick corresponding points between two images on the screen (an “image-to-image” rectification).

3 Click the **Load Corrected Algorithm or Dataset** button.

4 From the **Directories** menu on the file chooser dialog, select the path ending with the text **\examples**.

5 Double-click on the ‘Data_Types’ directory to open it.

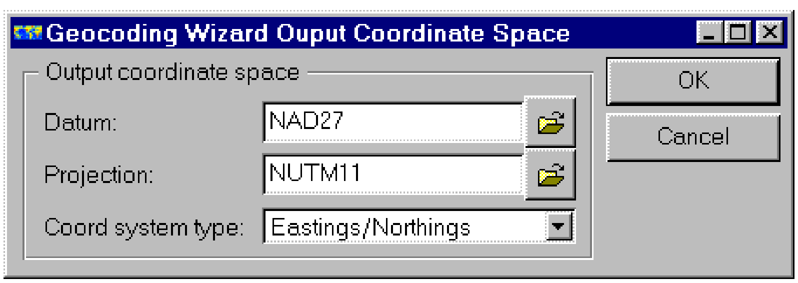
6 Double-click on the ‘Landsat_MSS’ directory to open it, then double-click on the algorithm ‘RGB_321.alg’ to load it.

This algorithm will be used to display the ‘CORRECTED’ image, which is the already rectified image containing coordinate information.

## Setup parameters for the image rectification

The **To geodetic datum**, **To geodetic projection** and **To Coordinates**, fields in the Output Coordinate Space box show the datum, projection and coordinate type for the output rectified file you will create. These parameters are included automatically from the ‘CORRECTED’ (rectified) Landsat image.

1 Click on the Change... button to open the **Geocoding Wizard Output Coordinate Space** dialog.




2 Click on the **Projection** chooser button.

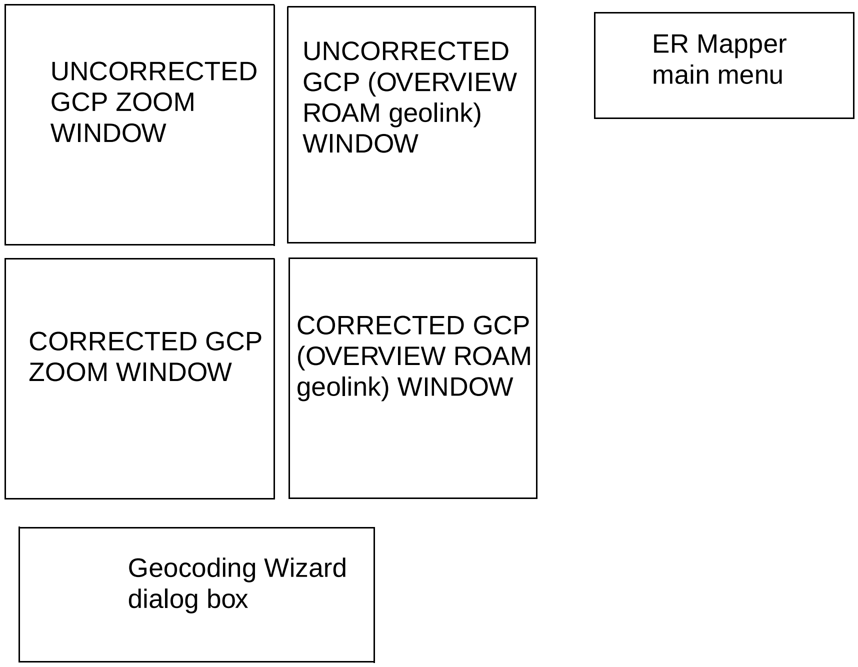
The **Projection Chooser** dialog opens showing available map projections (ER Mapper includes over 700 projections and you can add your own as well).

3 Click **Cancel** on the **Projection Chooser** dialog to close it.

4 Click **Cancel** on the **Geocoding Wizard Output Coordinate Space** dialog to close it.

5 Select the Geocoding Wizard **GCP Edit** tab.

ER Mapper opens several image windows and dialog boxes. You should see a screen setup similar to this one:




---

**Note:** If your system does not position the windows automatically, rearrange them as shown above before proceeding.

---

## Setup the image windows to pick the first four GCPs

When you first begin picking GCPs, your “raw” (unrectified) image contains no ground control points. You will begin by picking the first four control points using the CORRECTED and UNCORRECTED image windows. Once you have picked the first four GCPs, you can use the CORRECTED windows to quickly pick the remaining GCPs.

1 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** window.

2 Click inside the ’CORRECTED GCP ZOOM’ window to activate it.

3 In the **Algorithm** window, turn off the **Smoothing** option.

4 Click your right mouse button inside the ‘CORRECTED GCP ZOOM’ window, and select **Zoom to All Datasets** from the **Quick Zoom** menu.

   The ‘CORRECTED GCP ZOOM’ window zooms out to the full image extents.

5 Click inside the ‘UNCORRECTED GCP ZOOM’ image window to activate it.

6 In the **Algorithm** window, turn off the **Smoothing** option.

7 Click your right mouse button inside the 'UNCORRECTED GCP ZOOM' window, and select **Zoom to All Datasets** from the **Quick Zoom** menu.

The 'UNCORRECTED GCP ZOOM' window zooms out to the full image extents. You are now ready to pick your first GCP.

8 Click **Close** on the **Algorithm** window to close it.

---

**Note:** It is a good idea to turn off the **Smoothing** option on algorithms where you will pick ground control points. This makes it easier to see the locations of individual image pixels when you zoom in closely to areas.

---

## Pick a GCP in the upper-left part of both images

---

**Note:** Make sure the main ER Mapper menu is not hidden by the image windows–move it slightly if needed so you can easily access the toolbars.

---

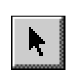
1 On the main menu, click the **ZoomBox Tool**  toolbar button.

2 Point to the 'UNCORRECTED GCP ZOOM' image window, and zoom in on a small area in the upper-left part of the image with well defined features (drag a zoom box).

3 Move the pointer over the 'CORRECTED GCP ZOOM' image window (notice the pointer is a  icon), and click once to activate the window.

4 In the 'CORRECTED GCP ZOOM' image window, drag a box to zoom in on the same geographic area you have displayed in the 'UNCORRECTED' window.

You have now zoomed to a common area in both images to pick a GCP.

5 On the main menu, click the **Pointer Tool**  toolbar button.

6 In the 'CORRECTED GCP ZOOM' window (which is active), click on a clearly identifiable feature in the image, such as a sharp boundary between red vegetation and white barren land.

ER Mapper marks the control point with green cross hairs, and the geographic location of that point appears in the Easting and Northing fields on the Geocoding Wizard **GCP Edit** dialog. (This dialog has many options you will learn more about later.)

7 Click once inside the 'UNCORRECTED GCP ZOOM' window to activate it.

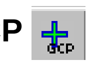
8 Click on exactly the same geographic feature in the 'UNCORRECTED GCP ZOOM' window. (It is important to be as accurate as possible).

ER Mapper marks the control point with cross hairs, and the image pixel location of that point in the raw image appears in the Cell X and Cell Y fields on the **GCP Edit** dialog. The location of each point is marked with a white "X" in each image with the number "1." You have now picked the first GCP.

## Pick a second GCP in the lower-left of both images

1 On the Geocoding Wizard **GCP Edit** tab, select **Auto zoom**.

The ZOOM windows will now automatically zoom into the point selected in the corresponding OVERVIEW ROAM windows.

2 On the Geocoding Wizard **Edit GCP** dialog, click the **Add new GCP**  button.

3 Click on a well defined feature in the 'UNCORRECTED GCP (OVERVIEW ROAM geolink)' window to select it.

The 'UNCORRECTED GCP ZOOM' window will zoom ito the selected point

4 Click once in the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window to activate it, then click on the same feature to select it as a GCP.

The 'CORRECTED GCP ZOOM' window will zoom ito the selected point

5 Use the two ZOOM windows to adjust the positions of the GCP.

You have now picked a second GCP in the image.

## Pick two more GCPs in the upper- and lower-right

1 Following the steps from the previous section, pick a GCP near the upper-right and lower-right corners of the images.

---

**Tip:** When picking the first four GCPs, it is best to pick them in the four corners of the image (if this is possible). This will make the **Calculate from point** function you will use next as accurate as possible. (In this case there was ocean in the lower-left, so you picked a point in the closest area possible.)

---

## Pick additional GCPs using the Corrected GCP Overview window

Once you have picked the first four GCPs, notice that ER Mapper now displays values in the 'RMS' field on the **GCP Edit** dialog. The Root Mean Square (RMS) error is a measurement of the accuracy of the GCP in this image expressed in the image's pixel size. (An RMS of 1.00 would be 80 meter positional error in the case of the Landsat MSS data used here.) If you have done an accurate job selecting the first four GCPs, the RMS should be one or less.

When an RMS can be calculated, ER Mapper can now use the coefficients generated from the first four points to "predict" the location of 'UNCORRECTED' (raw) points when you pick additional points in the 'CORRECTED' (rectified) image. This feature makes selection of the remaining points much faster and easier, and you will use it next.

1 On the main menu, click the **Set Pointer mode** button (if needed).

2 If needed, activate the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window by clicking in it.

3 On the Geocoding Wizard **Edit GCP** dialog, click the **Add GCP** button.

4 In the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window, click on a well defined feature near the center of the image.

   ER Mapper marks the control point with cross hairs, and enters the geographic location of GCP #5 in the TO Easting and Northing fields. The 'CORRECTED GCP ZOOM' window zooms into the point for you to adjust its position.

5 In the Geocoding Wizard **GCP Edit** dialog, click the **Calculate from point** button.

   ER Mapper automatically enters values in Cell X and Cell Y fields–this is the "predicted" location of GCP #5 in the FROM image.

   Notice that the new GCP #5 has an RMS error of zero. Since it's location is computed from the existing points, it adds no new information to the rectification model (and is therefore not yet a true GCP). Next you need to "fine tune" the location of the point in the ZOOM windows to make it a true GCP.

6 Click once in one of the ZOOM windows to activate it, then click on the GCP in the image. Adjust its position if necessary.

   ER Mapper repositions GCP #5 to the new position, and calculates an RMS value to display in the Geocoding Wizard **GCP Edit** dialog box.

   You have now picked a fifth GCP using the "predict FROM points" technique.

---

**Tip:** You can keep clicking in the UNCORRECTED AND CORRECTED ZOOM windows as many times as needed to refine the GCP location.

---

## Pick several other points spread throughout the images

1 Using the procedure in steps 2-6 above, pick several other GCPs well spread throughout the image (pick at least 10).

---

**Tip:** If the default magnification level in the ZOOM windows is too great or small for your taste, activate each window and use the **Zoom In** or **Zoom Out** options in the Quick Zoom menu to change the zoom factor by a fixed amount in both windows. That zoom factor is retained for subsequent points. (If you make a mistake, you can select **Previous Zoom** to fix it.)

---

## Try some other features on the Geocoding Wizard GCP Edit dialog

1 In the Geocoding Wizard **GCP Edit** dialog, click on any GCP number under the 'Name' column.

ER Mapper moves the crosshairs to highlight that point in all the 'OVERVIEW ROAM' and 'ZOOM' windows.

2 Turn off the **Auto Zoom** option at the bottom.

3 Click on any GCP number under the 'Name' column.

ER Mapper moves the crosshairs to highlight that point in the 'OVERVIEW ROAM' windows, but not the 'ZOOM' windows.

4 Click on the **Zoom to current GCP**  button.

ER Mapper zooms into the selected GCP in the "ZOOM' windows.

5 Select the number text for a GCP under the 'Name' column, and type a short name.

You can give GCPs text labels as well as numbers to help identify them.

6 Click on the text 'On' in the second column for any GCP.

The text changes to 'Off' and all the RMS errors are recomputed without including that GCP. (This is an easy way to see how the positional error of any GCP influences the RMS of the others. For example, turning off a GCP with a large RMS often reduces the RMS of the others.) This can be important when choosing which GCPs will be used for the final image rectification.

7 Turn off other GCPs to see the effect, but turn all on again when finished.

8 Click on the text 'Edit' in the third column for any GCP.

The text changes to 'No' and the "X" and number marking it in the image turns green. This effectively "locks" a GCP so it cannot be edited (that is, clicking in the image windows do not redefine it's position). This is useful when you have several very good GCPs and you to lock them to avoid accidentally changing them.

9 Turn on the **Errors** option.

The magnitude and direction of the calculated positional error are shown graphically by a line for each GCP on the image. (If you have very small RMS errors you may not see the error line, even if you increase the line length by a factor of 10 using the **x10** option.)

10 Turn on the **Grid** option.

A polynomial grid displays over all three image windows. This grid is a simple “preview” of the way in which the FROM (raw) image pixels will be reprojected onto the new coordinate grid of the TO image. (This grid is only an approximation, in reality the lines would be curved.)

11 Click **Save** on the **Geocoding Wizard** dialog. If asked confirm saving the GCPs to disk, click **Yes**.

# 2: Perform the image rectification

***Objectives*** Learn how to use the ground control points you selected to rectify the image to the selected datum and map projection.

## Specify output (rectified) image file

1 Select the Geocoding Wizard **Rectify** tab.

2 Click the file chooser  button in the Output Info box.

3 From the **Directories** menu, select the path ending with **\examples**.

4 Double-click on the ‘Miscellaneous\Tutorial’ directory to open it.

5 Enter the filename ‘Landsat_MSS_rectified’ (start with your initials), then click **OK**.

6 In the **Resampling:** in the Cell Attributes box select ‘Nearest Neighbour’.

The Cell Attributes box also lets you resample the output image to a different cell size (Output Cell width and height), and specify a null cell value.

7 Select **Display rectified image** to display the image after it is rectified.

## Create the output rectified image on disk

1 Click on the **Save file and start rectification** button.

ER Mapper opens a status dialog to indicate the progress of the rectification.

2 When the operation finishes, click **OK** of the successful completion dialog.

3 Click on the **Close** button to exit the Geocoding Wizard.

You have now rectified the uncorrected Landsat MSS image to correspond to the 1927 North American Datum (NAD27) and UTM zone 11 (NUTM11) map projection.

### Close all image windows and dialog boxes

1 Click on the Geocoding Wizard **Close** button.

2 Close all image windows using the window system controls:

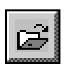
- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

3 Click **Close** on the **Algorithm** window to close it.

# 3: Evaluating image registration

***Objectives*** Learn a simple way to visually evaluate the registration of two images using an overlay technique. In this case, you will evaluate the registration of the raw image you rectified and the rectified MSS image supplied with ER Mapper.

### Load an existing RGB algorithm

1 Click the **Open**  toolbar button.

2 From the **Directories** menu, select the path ending with the text **\examples**

3 Double-click on the ‘Data_Types’ directory to open it.

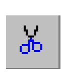
4 In the directory ‘Landsat_MSS,’ load the algorithm named ‘RGB_321.alg.’

This algorithm displays the rectified Landsat MSS image of San Diego provided with ER Mapper as an RGB image. You will use only the Red and Green layers for the comparison with your rectified image.

5 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** window.

### Load your rectified image into the Green layer

1 In the **Algorithm** window, click on the Blue layer to select it.

2 Click the **Cut**  button to delete the Blue layer.

3 Click on the Green layer to select it.

4 Click the **Load Dataset**  button in the algorithm process diagram.

5 From the **Directories** menu, select the path ending with **\examples**.

6 Double-click on the ‘Miscellaneous’ directory to open it.

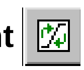
7 Double-click on the ‘Tutorial’ directory to open it.

8 Click once on the image ‘Landsat_MSS_rectified.ers’ to select it, then click **OK this layer only** button to load it into the Green layer. (The Red layer should still have the ‘Landsat_MSS_27Aug91’ image.)

9 Select **B3:0.75_um** from the Green layer’s **Band Selection** drop-down list.

(Band 3 is also loaded in the Red layer for the other image for direct comparison.)

## Display the two images to evaluate registration

1 Click the **99% Contrast Enhancement**  toolbar button.

This image combines two different images–one in the Red layer and one in the Green layer. If your images are well aligned the image appears yellow. If you see areas that are dominantly red or green, this indicates poor registration.

2 On the **Algorithm** window, turn off the **Smoothing** option.

3 On the main menu, click the **ZoomBox tool**  toolbar button.

4 Drag a zoom box over a very small area of the image that contains land and water.

Errors in registration appear as either red or green pixels because this is where the two image do not align perfectly. This is a very simple way to evaluate the registration of two images. If the RMS errors of your GCPs were generally less than one, you should not see more that one pixel offsets or registration errors.

## Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Choose common ground control points (GCPs) between two images
- Use options to modify the GCP display and edit GCPs
- Rectify a “raw” image to the chosen datum and map projection
- Evaluate registration accuracy using a simple image overlay method

## Additional information about rectification

The following contains additional information beyond the scope of this simple example that you may find helpful.

### RMS errors and the “Calculate FROM point” method

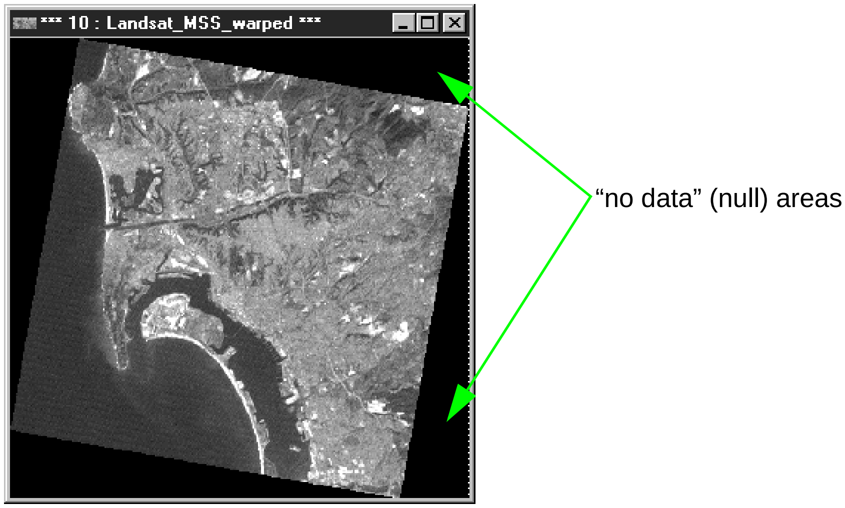
As mentioned previously, the RMS error and error bar features are meant to *alert you* to potential problem GCPs, *not* as an absolute indicator of a good GCP versus a bad one. As a general rule, if a GCP clearly lines up with the same feature in both images, that is *more important* than achieving a low RMS value.

The “Calculate FROM point” method of picking GCPs can be especially helpful when working with two very different “raw” and “reference” datasets. For example, you might try to rectify a SAR image to an optical satellite image like Landsat. In these cases, it may be difficult to visually find common features quickly on the two images by zooming in and out of areas using single ‘UNCORRECTED’ and ‘CORRECTED’ windows (the way you pick the first four points). By using the “Calculate FROM point” function, ER Mapper automatically puts you in the right neighborhood on the “raw” image so you can more easily look for the corresponding feature for the GCP.

### The Rectification Setup parameters

The Geocoding Wizard **5) Rectify** page contains several options to specify parameters for the rectification operation. These are described briefly below (see the *ER Mapper User Guide* manual and remote sensing texts for detailed information):

**Null cell value**–the value assigned to pixels that fall outside areas of actual data when the output dataset is created (default is that of the reference image). Typically these are along edges if the dataset is rotated during the rectification process.




**OUTPUT Cell width and Cell height (Cell size X, Cell size Y)** –The size of pixels in the output dataset (ground dimensions usually in meters). If your input (raw) dataset has a cell size specified, use the same value to give the output rectified dataset the same cell size, or change it to resample to a larger or smaller cell size.

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**Note:** If ER Mapper cannot determine the cell size of your “raw” dataset during import (and you do not specify it later), a default of 1.0 meters is used. Set this to a reasonable value for the type of image you are working with (for example 30 for Landsat TM). Otherwise you will needlessly create a *very* large dataset that contains redundant information.

---

**Resampling** –The method used to determine how pixel values in the input dataset are used to calculate new pixel values in the transformed grid of the output dataset (also called *intensity interpolation*). Nearest Neighbor (zero-order) resampling uses the pixel value closest to the coordinate location in the input image for the corresponding pixel value in the output image. Bilinear (first-order) resampling takes a distance-weighted average of the four nearest pixels, and Cubic convolution uses the 16 nearest pixels. Nearest Neighbor is preferred if maintaining the original pixel values (and thus subtle spectral information) is important. Bilinear and Cubic usually create “smoother” more pleasing output images, but also take more computation time.

**Rectification type**–The rectification technique for using GCPs to create a rectified output dataset. Polynomial uses polynomial equations to transform the raw dataset to the rectified output grid, it is best for reducing global distortion. Triangulated uses a mesh of triangles between each set of three GCPs, and does a linear rectification within each triangle (best for highly skewed data because it reduces local distortion). The Rotation and Map to Map Transformation options do not apply to control point rectifications (see “Reprojecting rectified images” later).

**Polynomial order**–The geometric coordinate transformation that relocates every pixel in the input (raw) dataset to its proper position in the output (rectified) dataset (also called *spatial interpolation*). The *order* is the highest exponent used in the polynomial equation, with Linear being first-order, Quadratic second-order, and Cubic third-order. In general, you should select the lowest order that gives an acceptable RMS. You must have at least 3 GCPs to perform a Linear rectification, 6 for Quadratic, and 10 for Cubic.

**Edit Extents...** button–Lets you rectify only a portion of the full “raw” dataset by entering Easting/Northing or Latitude/Longitude values. (This is a way to crop or subset part of an image during the rectification process.)

**Output Info** box–Lets you preview the dimensions and file size of the output rectified dataset before it is created. Use this to determine how much disk space the output file will occupy, or to determine how changing the Cell width/height affects the output file size.

## Reprojecting rectified images

If your dataset is rectified, you can reproject it into another coordinate system by using the Geocoding Wizard **Map to Map reprojection** option. If you want to merge or mosaic two images that are rectified to different map projections, for example, you would need to reproject one dataset into the other’s projection before that can be accomplished. ER Mapper can do this automatically in most cases, you simply need to specify the new datum and/or projection into which the dataset is to be transformed.

## Entering georeference information for “raw” datasets

Occasionally you may import a dataset into ER Mapper that has already been rectified to a datum and map projection, but ER Mapper was unable to read this information and assign it to the dataset. In this case, the dataset will appear to be “raw” in ER Mapper, and you must edit the header file to enter the correct information. Typically this information my be stored in a metafile associated with the actual data file you imported. (The ER Mapper ‘.ers’ file contains this information about the ER Mapper binary data file.)

To do this, click the **Load Dataset**  button and highlight the ‘.ers’ file, then click the **Info** button to display the current information. Then click the **Edit** button to open the **Dataset Header Editor** dialog. Use the **Coord Space** button to select the correct datum, projection and units. Use the **Raster Info** button to enter the correct cell size and registration point. (See the *ER Mapper User Guide* manual for details.)

**Note:** Simply changing the datum, projection, etc. information for a raw dataset does *not* rectify or change the geometry of the dataset. You should only do this for datasets that you *know* have already been rectified.

### Rectification of very large files

When rectifying very large datasets, make sure your system has sufficient swap file space or virtual memory available. If you cannot rectify a large file, try freeing up as much additional disk space as possible for virtual memory. In addition, most operating systems have limitations on the amount of addressable memory that can be used for file input/output operations. If you still cannot rectify the file because of this, consider subsetting the image into pieces and rectifying them separately.

# 19

# Unsupervised classification

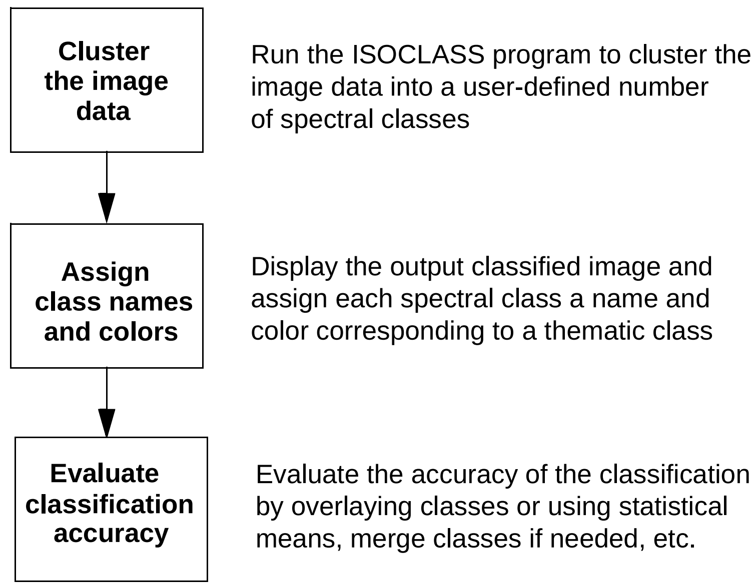
This chapter explains how use ER Mapper's ISOCLASS unsupervised classification feature to group multispectral image data into thematic information classes. You will learn to define clustering parameters, perform an unsupervised classification, and assign feature categories and colors to the classes.

## About unsupervised classification

Unsupervised classification is one of two methods used to transform multispectral image data into thematic information classes (supervised classification being the other). This procedure typically assumes that imagery of a specific geographic area are gathered in multiple regions of the electromagnetic spectrum, for example Landsat TM or SPOT XS multispectral satellite imagery. (Classification can also be effective for other types of imagery. Please refer to an appropriate reference text for complete information on classification.)

With *unsupervised* classification, the classification program searches for natural groupings or clusters of the spectral properties of pixels, and assigns each pixel to a class based on initial clustering parameters you define. Typically, you ask ER Mapper to group the image data into a specific number of spectral classes and give it parameters for when classes are to be split or merged as it searches for groupings in the image data. After the classification is completed, you assign each "spectral" class to a thematic information or feature class (such as water, urban, etc.) and a color for the class display. ER Mapper uses the ISOCLASS algorithm to perform clustering of the image data during an unsupervised classification. For information on how the ISOCLASS program works, refer to the *ER Mapper User Guide*.

A typical procedure for performing an unsupervised classification is as follows:




# Hands-on exercises

These exercises give you practice using ER Mapper's ISOCLASS Unsupervised Classification feature.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Specify clustering parameters and perform an unsupervised classification
- Assign colors and feature class names to the classified image
- Display a classified image using a Class Display layer
- Compare a classified image to a reference image

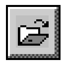
***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Clustering the image data

***Objectives*** Learn how to use ER Mapper's ISOCLASS unsupervised classification feature to group or cluster multispectral image data into several spectral classes in an output dataset.

## Display the Landsat image to be classified

1 Click the **Open**  button.

An image window and the **Open** file chooser appear.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Data_Types' directory, then open the 'Landsat_TM' directory.

4 Double-click on the algorithm 'RGB_741.alg' to open it.

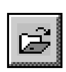
This displays bands 7, 4 and 1 of the Landsat TM image on which you will perform the unsupervised classification. (It is not necessary to display the image you want to classify, but you will use it for comparison later.)

## Open the Unsupervised Classification dialog box

1 From the **Process** menu, select **Classification**, then select **ISOCLASS Unsupervised Classification**.

The **Unsupervised Classification** dialog box opens. This dialog lets you specify the input raster dataset and bands to be used, the output dataset name, starting classes to be used, and parameters for clustering the image data.

## Specify the input dataset and bands to be used

1 Click the 'Input Dataset'  chooser button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Shared_Data' directory, then double-click on the image 'Landsat_TM_year_1985.ers' to load it.

4 Click the 'Bands to use'  chooser button.

The **Band Selection** dialog box appears to let you choose which bands in the dataset to use for the clustering operation.

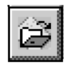
5 Drag through all seven bands listed to select them, then Ctrl-click on the band labelled **6:11.45_um** to *deselect* it.

Bands 1-5 and 7 should now be selected. (Since Landsat TM band 6 contains data in the thermal wavelengths, it is often not included in classifications.)

6 Click **OK** to close the **Band Selection** dialog.

Bands 1-5 and 7 now appear in the 'Bands to use' field.

## Specify a dataset name for the output classified image

1 Click the 'Output Dataset'  chooser button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Miscellaneous' directory.

4 Open the 'Tutorial' directory.

5 In the **Save As** field, type your initials followed by the text **`10_class_ISOCLASS`** and separate each word with an underscore (_).

6 Click **OK** to validate the filename.

## Specify the ISOCLASS clustering parameters

1 In the 'Maximum number of classes field,' enter the value **`10`** and press Return or Enter.

This tells ER Mapper to cluster the image data into a maximum of 10 spectral classes. (Note that this example is simplified, and you would typically choose a larger number of classes.)

All other default values on the dialog are appropriate for this simple exercise. ER Mapper will use bands 1-5 and 7 in the dataset, and will generate one starting class automatically (you could also use classes from another classified image to start with if desired). The clustering will finish when a maximum of 10 classes are created (although fewer are possible) and 98% of the clusters remain unchanged.

## Perform the unsupervised classification

1 Click **OK** on the **Unsupervised Classification** dialog to start the clustering process.

The **Processing Status** dialog box appears to show the progress. ER Mapper runs through several iterations to cluster the image data into classes, and splits and merges classes as specified by the parameters you entered.

When the 98% unchanged parameter has been reached, the classification finishes with 10 classes. ER Mapper then generates multivariate statistics for each class.

2 When the dialog appears indicating successful completion, click **OK**.

3 Click **Cancel** on the **Unsupervised Classification** dialog to close both.

The output of the classification is a single band dataset. Each pixel in the dataset has a value ranging from 1 to 10 (the number of classes that were generated). Next you will display the output image and assign class colors and names.

---

**Note:** If statistics have not already been generated for your input raster dataset, they will be generated first when you start the classification (which may take a few minutes depending on the dataset size).

---

# 2: Assigning colors and class names

***Objectives*** Learn how to view a classified image in a Classification Display layer, and assign colors and feature names to class numbers.

## Open a template algorithm to display a classified image

1 On the main menu, click the **New** button.

An new image window appears-drag it below the other window.

2 Click the **Open** button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Miscellaneous’ directory.

5 Open the ‘Templates’ directory, then open the ‘Common’ directory.

6 Double-click on the algorithm ‘Classified_data.alg’ to open it.

A classified image of San Diego displays. This is a template algorithm you will use to display the classified image you generated.

## Load the classified image you created

1 Click the **Edit Algorithm** button.

On the **Algorithm** dialog, notice that this algorithm has one layer of the type ‘Class Display.’ The Class Display layer is designed to display images created with ER Mapper’s classification functions.

2 Click the **Load Dataset** button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Miscellaneous’ directory.

5 Open the ‘Tutorial’ directory, then double-click on your ‘10_class_ISOCLASS’ image to load it.

The image initially displays in various shades of grey by default. Next you will create a color scheme for the classified image.

6 Click **Close** on the **Algorithm** dialog.

## Auto-generate a color scheme for the classes

1 From the **Edit** menu, select **Edit Class/Region Color and Name...**.

The **Edit Class/Region Detail** dialog box opens. This dialog lists each class in the dataset by number, and provides text fields for assigning names and a button to choose colors.

2 Enlarge the dialog until all 10 classes can be viewed at once.

3 Click the **Auto-gen colors...** button.

The **Auto-generate colors** dialog box opens. This dialog lets you automatically generate a color scheme for the classified image that simulates the colors of an RGB image display. By default, an RGB=321 band combination is chosen, but you will change it to an RGB=741 band combination.

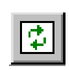
4 Change the ‘Red Band’ value to **7**, and the ‘Green Band’ value to **4**.

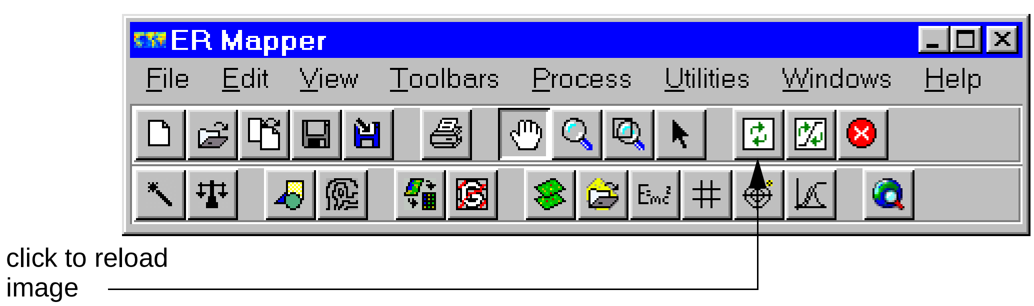
5 Click the **Auto-gen** button.

The new color assignments for each class appear in the **Set color...** buttons next to the class number in the **Edit Class/Region Details** dialog.

6 Click **Save** on the **Edit Class/Region Details** dialog, and when asked to overwrite the file click **Yes**.

The new color scheme for the classified image is now stored in the dataset header (‘.ers’) file.

7 Reload the image by clicking the **Refresh Image**  button on the **Standard** toolbar.



Note that the class color assignments make the image appear similar to the RGB=741 image in the other window. You can use the **Auto-gen colors** option to simulate the color scheme of any typical RGB band combination.

8 Click **Close** on the **Auto-generate colors** dialog.

---

**Note:** In order to display changes to the color scheme, you must save the changes and then reload the image (to re-read the updated header file with the new colors). The fastest way to reload the image is to click the **Refresh Image** button on the **Standard** toolbar.

---

## Close the Landsat TM RGB image window

1 Close the 'RGB_741' image window using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Move the 'Classified_data' image window to the upper-left on the screen.

## Find the class representing ocean and color it blue

1 From the **View** menu, select **Cell Values Profile**.

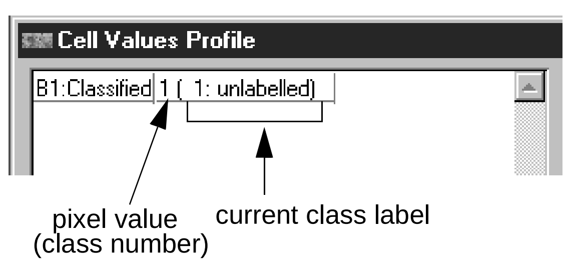
The **Cell Values Profile** dialog box appears. This will help you determine the class number of pixels in various areas of the classified image.

2 Turn on only the **Values** option.

3 On the main menu, click the **Pointer Tool** button.

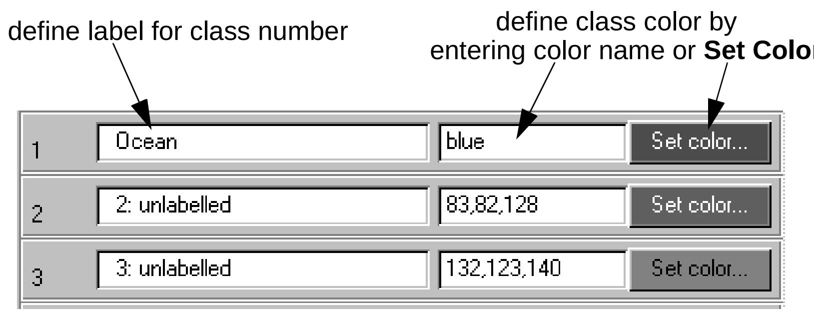
4 Drag the mouse through the dark areas near the bottom of the classified image, and note the values appearing in the **Cell Values Profile** dialog.

These are ocean areas that were generally grouped into class 1.



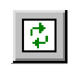
5 In the **Name** field for class 1 (on the **Edit Class/Region Details** dialog), change the text ‘1: unlabelled’ to **`Ocean/water`**.

6 Click the **Set color...** button for class 1, choose blue, then click **OK**.




As shown above, you can also set the class color by entering a color name and clicking Enter or Return.

7 Click **Save** on the **Edit Class/Region Details** dialog, and when asked to overwrite the file click **Yes**.

8 Reload the image by clicking the **Refresh Image**  button on the **Standard** toolbar.

The pixels assigned to class 1 (which you interpreted as ocean) are colored blue.

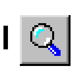
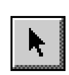
## Assign names and colors to the other nine classes

1 Assign names and colors as desired to the other nine classes in the image using the previous steps 4 through 6 (use the guide on the next page).

Generally you should use the **Cell Values Profile** dialog to determine the class number of a specific feature type on the image, and then fill in a name for the class and choose the desired color. This requires some subjective interpretation, and you should pan and zoom on different areas as needed.

Another way to do this is to pick a bright color for a class, save it, then click **GO** to see which areas are highlighted. This may help determine what feature class name to assign in the context of the other classes.

---

**Tip:** To zoom using the mouse, remember to set the mouse to **Zoom Tool**  to zoom, and back again to **Pointer Tool**  to view cell values.

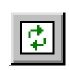
---

As a shortcut, the following class assignments are generally correct for this image (colors are purely subjective choices, choose any you prefer):

| Class | Name | Color |
|---|---|---|
| 1 | Ocean/water | blue |
| 2 | Beach/sandy soils | tan |
| 3 | Urban/industrial | magenta |
| 4 | Natural vegetation | dark green |
| 5 | Residential 1 | red |
| 6 | Residential 2 | pink |
| 7 | Mixed vegetation | light green |
| 8 | Parks/golf courses | green |
| 9 | Asphalt/tarmac | brown |
| 10 | Cement/barren land | white |

**Tip:** The current color values (numbers) are RGB values that represent a specific color. You can quickly change them to the colors above by typing the color name and pressing Return or Enter (without using the **Set Color** button).

2 When finished, click **Save** on **Edit Class/Region Details**, then **Yes** to overwrite the file.

3 Reload the image by clicking the **Refresh Image**  button on the **Standard** toolbar.

4 Click **Close** on the **Cell Values Profile** dialog.

5 Click **Close** on the **Edit Class/Region Details** dialog.

# 3: Overlaying classification results

***Objectives*** Learn how to display a Classified dataset using transparency over a reference image, and to use a formula and Classification layer to display individual classes.

## Open the Landsat TM 321 algorithm into a new surface

1 From the **View** menu, select **Algorithm** to open the **Algorithm** dialog.

2 From the **File** menu (on the main menu), select **Open into New Surface**.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Data_Types’ directory, then open the ‘Landsat_TM’ directory.

5 Double-click on the algorithm ‘RGB_321.alg’ to open it.

An algorithm (and it layers) are added as a second surface in the current algorithm. (This displays the Landsat TM image in “natural color”, or RGB=321.)

## Set transparency for the classified image

1 Select the top surface ‘[RGB]:Default Surface’ in the algorithm.

Since the classified image is on top of the RGB image, you must set transparency for it to see the RGB image underneath.

2 Click the **Surface** tab.

3 Set the ‘Transparency’ slider to its mid-point.

The two images are blended so colors from both are visible.

4 Adjust the ‘Transparency’ slider to various settings.

By shifting the transparency back and forth to different levels, you can quickly see how the natural color image underneath corresponds to the classes and colors of your classified image. This can be an effective way to compare the results of your classification to a reference image.

## Add a Classification layer to the Landsat image surface

1 Click the **Layer** tab in the **Algorithm** dialog to display the process diagram.

2 Right-click on the top surface ‘[RGB]:Default Surface,’ and select **Turn Off**.

The classified image’s surface is off, so it will not be displayed.

3 Select the lower surface ‘[RGB]:Landsat TM’ in the algorithm.

4 On the **Algorithm** dialog, open the **Edit** menu, select **Add Raster Layer**, then **Classification**.

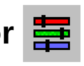
A Classification layer is added to the algorithm layer list.

5 Click the **Load Dataset**  button in the process diagram.

6 From the **Directories** menu, select the **\examples** path.

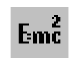
7 Open the “Miscellaneous” directory.

8 Open the ‘tutorial’ directory, then double-click on your ‘10_class_ISOCLASS.ers’ image to load it.

9 In the process diagram, click the **Edit Layer Color**  button.

10 Choose a yellow color, then click **OK** on the **Color** chooser dialog.

## Add a formula to display pixels in individual classes

1 On the **Algorithm** dialog, click the **Edit Formula**  button in the process diagram.

2 In the Generic formula window, edit the formula text to read:

```
if input1=1 then 1 else null
```

This formula tells ER Mapper “if pixels have a value of 1 (class 1) in the dataset, assign them a value of 1 for display, else assign them a value of null.”

3 Click the **Apply changes** button to validate the formula.

The ocean areas (class 1) display in yellow over the backdrop RGB image.

## Display other classes over the backdrop image

1 In the Generic formula window, edit the formula text to read:

```
if input1=4 then 1 else null
```

This will display class 4 in yellow.

2 Click the **Apply changes** button to validate the formula.

The natural vegetation areas (class 4) display in yellow over the backdrop RGB image. This is another way to help identify the feature class represented by a particular cluster (class number), or assess the accuracy of a classification.

3 (Optional.) If desired, edit the formula to display any other class number by changing **`input1=x`** to a value 1-10. Choose any color desired.

## Close the image window and Algorithm dialog

1 Close the image window using the window system controls:

- Select **Close** from the window control-menu.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Specify clustering parameters and perform an unsupervised classification
- Assign colors and feature class names to the classified image
- Display a classified image using a Class Display layer
- Compare a classified image to a reference image

## Additional information about classification

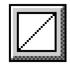
The following is additional information about classification that you may find useful.

### Including ratios, PCs or multiple datasets in a classification

It is also possible to include additional bands in the your input dataset for thematic or derived data such as band ratios, Principal Components (PCs), or other datasets. These additional "bands" may add information that will help make the classification more accurate. To do this, you can add additional layers to an algorithm that calculate the desired ratios, PC, etc., then save the algorithm as a Virtual Dataset or save it to a raster file on disk. Both supervised and unsupervised classification can use a Virtual Dataset as the input dataset.

For example, you can link Landsat TM, SPOT XS and SPOT Pan datasets of the same area in a Virtual Dataset, and run the classification on all three datasets at once. The output classified image will have the cell size of the highest resolution input dataset. (Using Virtual Datasets does significantly increase the time required to classify the image because two or more files must be read from at once. You can create a real raster dataset combining the images if this is a concern.)

If you are using ratios or other derived data as additional bands, you should rescale the data into a 0-255 range so it matches the normal range of the other data (usually 8-bit data with a 0-255 range). This is because the classification programs and parameters are setup for byte-scaled data, and will only work correctly on data that is within that range. For example, an NDVI image has a range from -1 to +1, so using ISOCLASS parameters designed for 0-255 data ranges do not take this smaller range into account.

To do this, open the **Transform** dialog, select **Limits to Actual**, then click the **Create default linear transform**  button. This does a linear rescaling of the data into a 0-255 range. (This means that layers for derived data will have transforms, while other layers with the raw data will normally have the transforms deleted because they are already scaled 0-255.)

## Using confusion matrixes to assess accuracy

ER Mapper also provides an option to generate a confusion matrix to compare the results of a classification to a reference dataset. The 'Reference Dataset' is either another classified image, or a set of ground truth samples. You can generate statistical comparisons such as Users and Producers accuracy and Kappa statistic to assess the accuracy of your classification compared to the set of reference data. To access this, select **View / Statistics / Confusion Matrix...** from the main menu. (See the *ER Mapper User Guide* for more information on confusion matrixes.)

The ground truth sample file must originate in an ASCII points format, and then be imported into ER Mapper using **Utilities / Import Vector and GIS formats / ASCII points with attributes** to create an ER Mapper '.erv' vector file. The format for an ASCII points file to be used as a reference dataset is as follows (use spaces to separate fields):

```
374500 2355400 2 water 9
```

| 374500 2355400 | 2 | water | 9 |
|---|---|---|---|
| X/Y coordinate of point (in EN or LL units) | class number | class label | additional info fields |

---

**Note:** The reference dataset must be precisely georeferenced to the classified image dataset. If the two datasets are not precisely georeferenced, confusion matrix errors may be due to misalignment between the reference and classified datasets, and not an inaccurate classification result.

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# 20

# Supervised classification

This chapter explains how use ER Mapper's supervised classification features to transform multispectral image data into user-defined thematic information classes. You will learn to define training regions, analyze training region statistics, and perform a supervised classification.

---

**Note:** To perform the following exercise as written, you will need to have a practice copy of the dataset 'Landsat_MSS_notwarped' in the 'tutorial' directory. The practice dataset is referred to as 'Landsat_practice' in the exercise. For information on creating the practice dataset, refer to Appendix A "System setup."

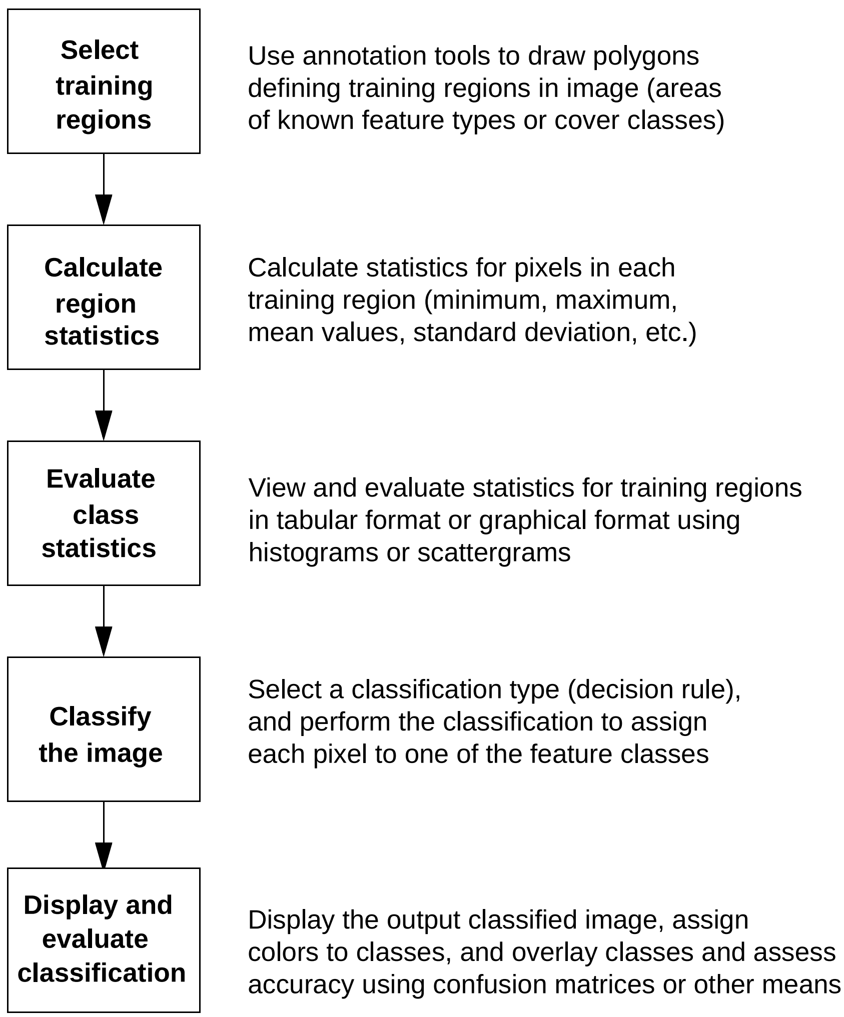
---

## About supervised classification

Supervised classification is one of two methods used to transform multispectral image data into thematic information classes (unsupervised classification being the other). This procedure typically assumes that imagery of a specific geographic are gathered in multiple regions of the electromagnetic spectrum, for example Landsat TM or SPOT XS multispectral satellite imagery. (Classification can also be effective for other types of imagery. Please refer to an appropriate reference text for complete information on classification.)

With *supervised* classification, the identity and location of feature classes or cover types (urban, water, wetland, etc.) are know beforehand through field work, analysis of aerial photographs, or other means. You typically identify specific areas on the multispectral imagery that represent the desired known feature types, and use the spectral characteristics of these known areas to “train” the classification program to assign each pixel in the image to one of these classes. Multivariate statistical parameters such as means, standard deviations, and correlation matrices are calculated for each training region, and each pixel is evaluated and assigned to the class to which it has the most likelihood of being a member (according to rules of the classification method chosen).

A simplified procedure for performing a supervised classification is as follows:



# Hands-on exercises

These exercises give you practice defining training regions and using ER Mapper's Supervised Classification features to perform a classification.

***What you will learn...***

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Draw polygons to define training regions for a supervised classification
- View statistics, histograms, and scattergrams for each training region
- Perform a supervised classification
- Display a classified image using a Class Display layer type

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Defining training regions

***Objectives***

Learn to use ER Mapper's vector annotation tools to define training regions (polygons) representing feature or land cover classes in an image.

### About regions

Regions are vector polygons that define an area of interest in an image. Regions can be used to process or display parts of an image separately from others, mask out parts of an image for mosaicing, define training sites for classification as you will do here, and other purposes. The definition of each region polygon is stored in the header file ('.ers' file) for the raster dataset.

## Open a Landsat MSS RGB algorithm

1 On the main menu, click the **Open**  button.

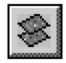
An image window and the **Open** dialog appear.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Data_Types' directory, then open the 'Landsat_MSS' directory.

4 Double-click on the algorithm 'RGB_321.alg' to open it.

This algorithm displays bands 3, 2 and 1 of a Landsat MSS satellite image of the San Diego, California area. You will use this algorithm to display the practice dataset you will use for the classification.

5 Click the **Edit Algorithm**  button to open the **Algorithm** dialog.

## Load the practice dataset into the RGB algorithm

1 On the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.

2 From the **Directories** menu (on the **Raster Dataset** dialog), select the **ERMAPPER\dataset** path.

3 Open the ‘tutorial’ directory, then double-click on the ‘Landsat_practice.ers’ dataset (the same dataset you used previously for the rectification exercise) to load it.

4 Make the image window about 50% larger. Right-click on the image and select **Zoom to all Datasets** from the **Quick Zoom** menu.

Next you will draw polygons on the image to define several feature classes.

## Add a vector layer for region definition to your algorithm

1 From the **Edit** menu (on the main menu), select **Edit/Create Regions**.

The **New Map Composition** dialog box opens. It shows the name of the raster dataset (‘Landsat_practice’) to which the region polygons will be added. Also, a vector layer titled ‘Region Layer (Outline)’ has been added to the algorithm.

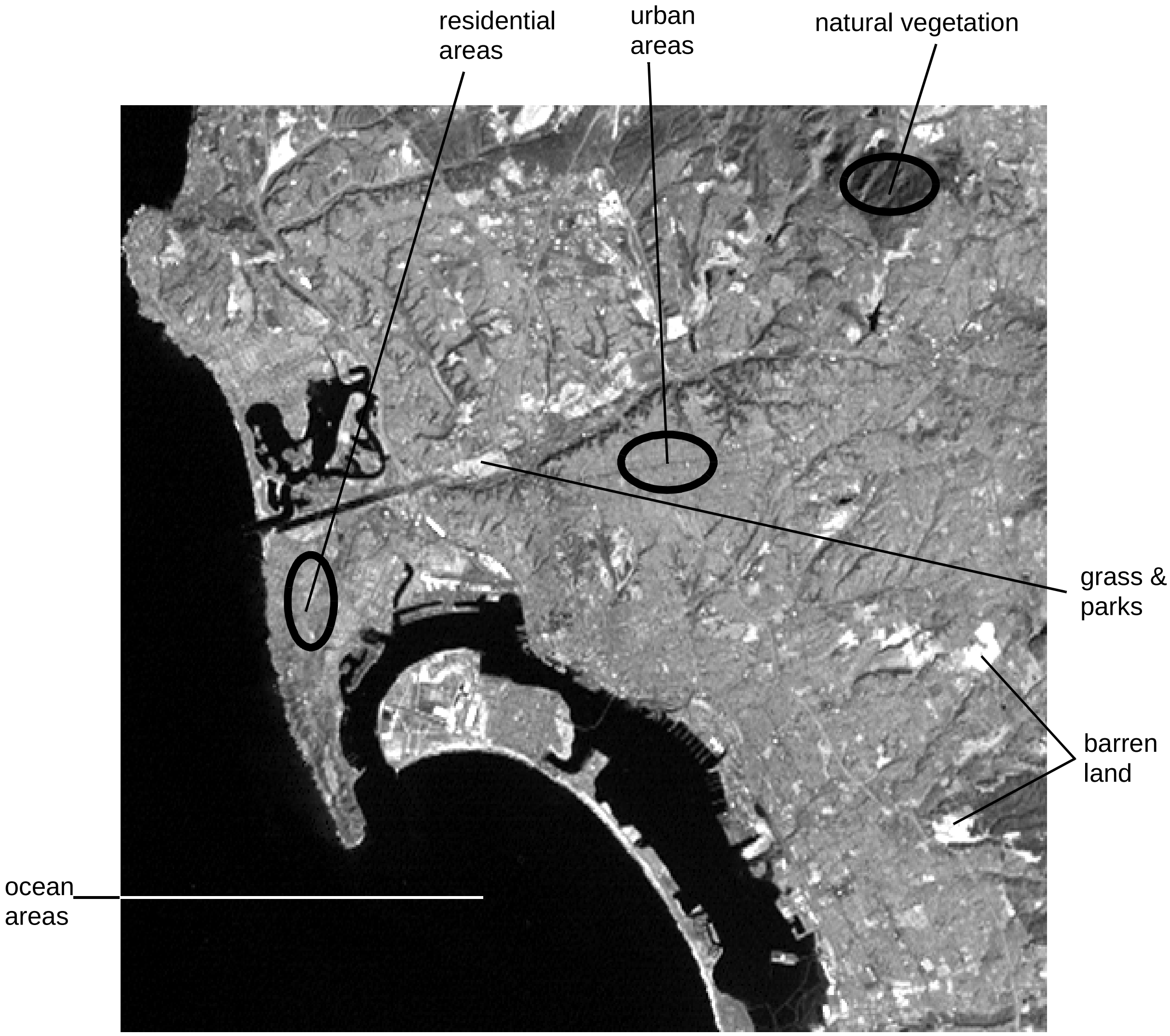
2 In the **New Map Composition** dialog, make sure the ‘Raster Region’ option is selected, then click **OK**.

ER Mapper opens the **Tools** palette dialog box containing your vector annotation tools. The ‘Raster Region’ option tells ER Mapper that the vector layer will be used to create regions for a raster dataset (for training site selection in this case).

3 Click **Close** on the **Algorithm** dialog.

## Define training regions on the image

1 Use the following diagram as a guide to help locate training regions in the image. You are asked to define these regions in the next steps.

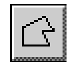


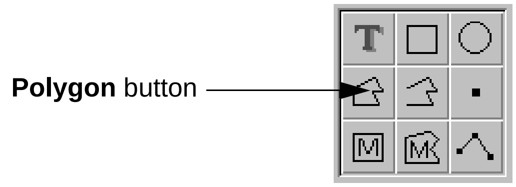

## Define a region to represent ocean areas

1 On the **Tools** palette dialog, click the **ZoomBox Mode**  button.

2 Zoom in on the lower-left quarter of the image by dragging a zoom box.

The large portion of dark blue area is ocean in this scene.

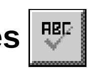
3 On the **Tools** dialog, click the **Polygon**  button.

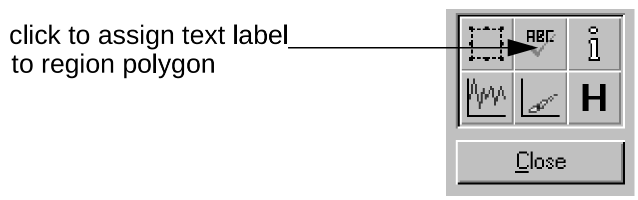



4 Draw a polygon in the ocean area by clicking once at each point, then double-clicking to close the polygon. (Make your polygon fairly large to get a good statistical sample.)

The polygon is selected by default when you close it. It is selected, so you can now give the polygon a color and text attribute.

5 On the **Tools** dialog, double-click the **Polygon**  button to open the **Line Style** dialog box.

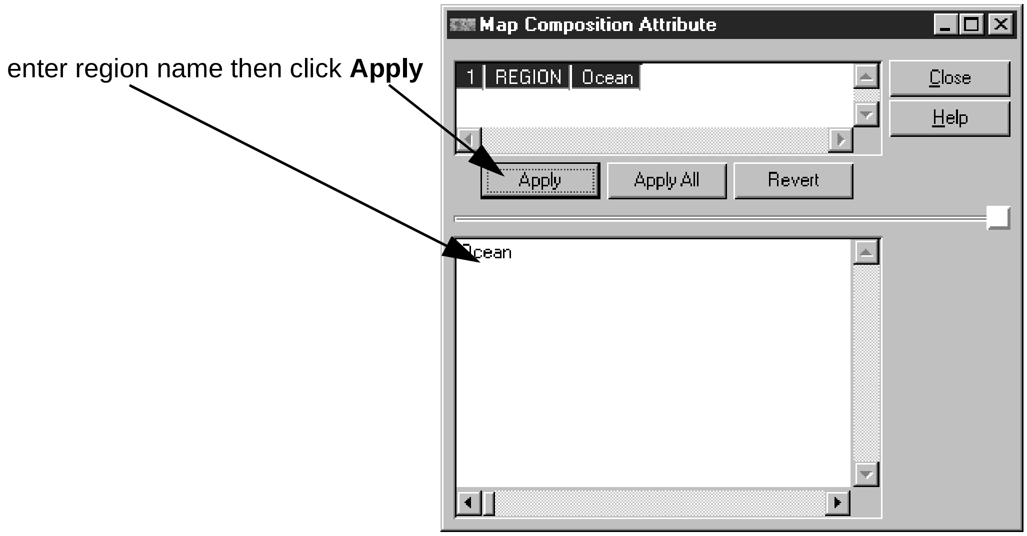
6 On the **Tools** dialog, click the **Display/Edit Object Attributes**  button.




Position the **Line Style** and **Map Composition Attribute** dialogs in a convenient area in the lower-right of the screen. Leave these dialogs open while you define regions so you can assign a color and name to each region as you go. (The colors you assign become the class colors in the output classified image.)

7 In the **Line Style** dialog, click the **Set Color** button, choose a medium blue color, and click **OK**.

8 In the **Map Composition Attribute** dialog, enter the text **Ocean** in the text field at the bottom, then click the **Apply** button.




The text "Ocean" is now defined as the name (text attribute) of the polygon.

You have now defined a training region representing ocean areas in the image. When you calculate statistics for this image later, the statistics for pixels inside this region will be used as a "signature" to classify other areas of ocean in the image.

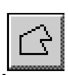
## Define a region to represent natural vegetation

1 From the **View** menu (on the main menu), select **Quick Zoom** and then **Zoom to All Datasets** to zoom out to the full image extents.

2 On the **Tools** palette dialog, click the **ZoomBox Mode**  button.

3 Zoom in on the upper-right quarter of the image by dragging a zoom box.

The dark brown areas at the top of the image are natural vegetation.

4 Click the **Polygon**  button, then draw a polygon to enclose an area of dark brown natural vegetation. (Click once at each point, then double-click to close the polygon.)

---

**Tip:** When defining polygons for training regions, try to include a good representative sample area (enclose at least 20 pixels if possible). The goal is to obtain a sample that accurately represents the statistical variation in the cover type. Do not include bordering areas of a different cover type (red or white areas in this case). If needed, you can adjust the polygon nodes precisely using the **Select/Edit Points Mode**  button after drawing it.

---

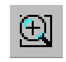
5 In the **Line Style** dialog, click **Set Color**, choose a dark green color, and click **OK**.

6 In the **Map Composition Attribute** dialog, enter the text **`Natural vegetation`** in the text field at the bottom, then click **Apply**.

You have now defined a training region representing natural vegetation.

## Define a region to represent grass and park areas

1 From the **View** menu (on the main menu), select **Quick Zoom** and then **Zoom to All Datasets** to zoom out to the full image extents.

2 On the **Tools** palette dialog, click the **ZoomBox Mode**  button.

3 Zoom in on one of the small, bright red areas (there is one in the river valley running east to west). Zoom in far enough so the bright red area fills most of the image window.

This is a golf course containing mostly irrigated grass areas that have high infrared reflectance (high band 3 values, so they appear red).

4 Click the **Polygon**  button and digitize a polygon around the border of the bright red area.

5 In the **Line Style** dialog, click **Set Color**, choose a bright green color, and click **OK**.

6 In the **Map Composition Attribute** dialog, enter the text **`Grass and parks`** in the text field at the bottom, then click **Apply**.

You have now defined a training region representing grass and park areas.

## Define a region to represent urban areas

1 From the **View** menu (on the main menu), select **Quick Zoom** and then **Zoom to All Datasets** to zoom out to the full image extents.

2 On the **Tools** palette dialog, click the **ZoomBox Mode**  button.

3 Zoom in on the greyish areas near the center of the image.

These are developed urban areas.

4 Click the **Polygon**  button and digitize a polygon around the border of the grey urban area (do not include red vegetated areas on the edges).

5 In the **Line Style** dialog, click **Set Color**, choose a grey color, and click **OK** to close the color chooser.

6 In the **Map Composition Attribute** dialog, enter the text **`Urban areas`** in the text field at the bottom, then click **Apply**.

You have now defined a training region representing urban areas.

## Define a region to represent residential areas

1 From the **View** menu (on the main menu), select **Quick Zoom** and then **Zoom to All Datasets** to zoom out to the full image extents.

2 On the **Tools** palette dialog, click the **ZoomBox Mode** button.

3 Zoom in on one of the pink areas in the northern part of the peninsula as shown in the previous diagram.

This area is primarily residential housing, so it has both buildings (houses) and vegetated areas (grass and trees).

4 Click the **Polygon** button and digitize a polygon around the pink areas described.

5 In the **Line Style** dialog, click **Set Color**, choose a pink color, and click **OK** to close the color chooser.

6 In the **Map Composition Attribute** dialog, enter the text **`Residential areas`** in the text field at the bottom, then click **Apply**.

## Define a region to represent barren land areas

1 From the **View** menu (on the main menu), select **Quick Zoom** and then **Zoom to All Datasets** to zoom out to the full image extents.

2 On the **Tools** palette dialog, click the **ZoomBox Mode** button.

3 Zoom in on the lower-right quarter of the image.

There are several areas of barren land here that appear white on the image (since they have high reflectance in all three MSS bands).

4 Click the **Polygon** button and digitize a polygon around the border of one of the barren white areas (do not include other areas on the edges).

5 In the **Line Style** dialog, click **Set Color**, choose a light brown color, and click **OK**.

6 In the **Map Composition Attribute** dialog, enter the text **`Barren land/cement`** in the text field at the bottom, then click **Apply**.

You have now defined six training regions representing ocean, natural vegetation, grass/parks, urban areas, residential areas, and barren land areas. The color you chose for each polygon will become the default color of that class in the classified image.

---

**Tip:** To define multiple polygons to be used as a single statistical region, assign all the polygons the same text attribute name. ER Mapper combines statistics for any regions with the same name automatically.

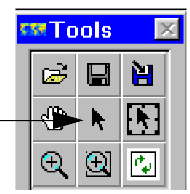
---

## Verify that each region polygon has a text label

1 From the **View** menu (on the main menu), select **Quick Zoom** and then **Zoom to All Datasets** to zoom out to the full image extents.

2 On the **Tools** dialog, click the **Select/Edit Points Mode**  button.

**Select/Edit Points Mode** button




3 Verify that each polygon has a text label assigned by selecting them one at a time and checking the label in the **Map Composition Attribute** dialog. (If any do not, enter the correct text label now.)

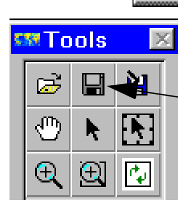
---

**Tip:** You can also use vector polygons created in a GIS or CAD product as regions in an ER Mapper dataset. First import the vector file to create an ER Mapper '.erv' file (**Utilities\Import**), then convert them to raster regions using the menu option **Process\Polygon<->Region Conversion**.

---

## Save the regions to the Landsat MSS practice dataset

1 On the **Tools** dialog, click the **Save File**  button.




**Save File** button

An **ER Mapper** information dialog appears asking you to confirm overwrite of the dataset.

2 Click **OK** on the **ER Mapper** information dialog.

A message window appears, and the region polygon definitions are added to the header file of the ‘Landsat_practice’ dataset. You can now calculate statistics for the pixels in each region.

---

**Note:** If region names such as ‘region0’ appear in the message window, this indicates that a polygon was added that did not have a text label. This may have been a mistake polygon that you did not delete or one you forgot to name. You can go back and fix this, then resave the regions again using **Save File** .

---

3 Click **Close** on the **ER Mapper** message dialog.

4 Click **Close** on the **Tools** dialog to close it and the attribute dialogs.

The image is redrawn with your polygons and text labels plotted next to them. (This is created by the ‘Region Layer (Outline)’ layer in the algorithm after you have defined and saved your regions.)

## Calculate statistics for the new regions

1 From the **Process** menu, select the **Calculate Statistics**.

The **Calculate Statistics** dialog box appears.

The ‘Landsat_practice’ dataset should be chosen by default because it is the dataset used in the current algorithm. (If it is not chosen, load it from the ‘tutorial’ directory).

2 Set the ‘Subsampling Interval’ to **1**.

3 Select the ‘Force Recalculate stats’ option (to calculate statistics again in case they have previously been calculated).

4 Click **OK** to start the statistics calculation.

5 When the operation finishes, click **OK** in the dialog indicating successful completion, then click **Cancel** on the **Calculate Statistics** dialog.

# 2: View training statistics

***Objectives*** Learn to view statistics for training regions in tabular format, view histograms of data values in the training class regions, and view class means and 95% probability ellipses over a scattergram.

## View tabular statistics for the training regions

1 From the **View** menu, select **Statistics**, then **Show Statistics**.

The **Statistics Report** dialog box appears. The ‘Landsat_practice’ dataset should be selected by default. You can choose to view statistics for selected regions or bands in the dataset, or for all regions and bands.

2 Click **OK** to display statistics for the all the regions you defined.

The **Display Dataset Statistics** dialog opens showing statistics for all your regions in all four Landsat MSS dataset bands.

3 Scroll through the list to view statistics for your training regions (make the dialog larger if needed).

The statistics for each region are listed in order by the region name, for example ‘Region: Barren land/cement.’ The stats show the number of pixels in the polygon (‘Non null cells’), the polygon area, minimum, maximum, and mean value in each band, and covariance and correlation matrices. Tabular statistics are an important way to analyze the spectral characteristics of your training regions.

(The last region listed named ‘All’ shows statistics for the entire dataset. This region is present in all datasets by default.)

4 When finished viewing statistics, click **Close** on the **Display Dataset Statistics** and **Statistics Report** dialogs.

## View a scattergram for the MSS dataset

1 From the **View** menu, select **Scattergrams...**.

The **Open Map Composition** and **Scattergram** dialogs open. The **Open Map Composition** dialog informs you that you already have region layer in your algorithm.

2 Click **OK** on the **Open Map Composition** dialog.

The **Tools** dialog opens and the **Scattergram** dialog automatically references the dataset in the active image window (‘Landsat_practice’). Your region polygons are shown on the image in their assigned color.

3 Click **Close** on the **Algorithm** dialog.

## Set the scattergram bands and limits

1 In the **Scattergram** dialog, click the **Setup** button.

2 In the **Scattergram Setup** dialog, select **B2:0.65** for the ‘X Axis’ field, and **B4:0.95_um** for the ‘Y Axis’ field.

3 Click the **Limits to Actual** button to set the X and Y axis limits to the actual data ranges of bands 2 and 4.

The scattergram for dataset bands 2 (reflected red) and 4 (reflected near IR) is redisplayed to fill the window. The wide dispersion of points in the scattergram indicates that the information in these two bands is not strongly correlated (they contain different information).

## Display mean and probability ellipses for training regions

1 In the **Scattergram Setup** dialog, turn on the ‘From current selection’ option.

This tells ER Mapper that you want to display the mean value and 95% probability ellipse for the currently selected region polygons in the image.

2 On the **Tools** dialog, click the **Select/Edit Points Mode**  button.

3 In the image, select the grey polygon defining your ‘urban’ training region.

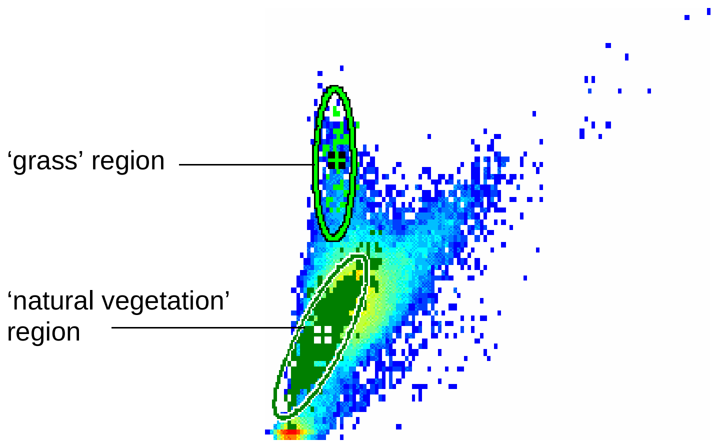
A grey ellipse appears over the scattergram showing the 95% probability threshold and mean value (the ellipse center point) for the ‘urban’ class in bands 2 and 4.

4 In the image, select the green polygon defining your ‘grass’ training region.

A green ellipse appears on the scattergram. As indicated, green vegetation shows a strong response in MSS band 4 (near infrared), but low response in band 2.

5 Hold down the Shift key, then click on the dark green ‘natural vegetation’ polygon in the image.

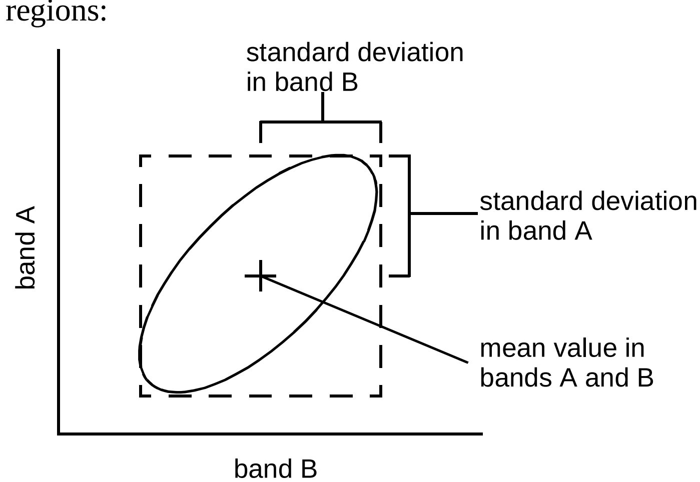
Ellipses for both the 'grass' and 'natural vegetation' regions appear on the scattergram, so you can easily compare them. As indicated, both have similar reflectance characteristics in band 2 (X axis), but are distinctly separable in band 4 (Y axis). Comparing region means and ellipses in a good way to evaluate the separability of your class signatures.




**Tip:** To select multiple polygons, hold down the Shift key while clicking.

## About the 95% confidence ellipse

The location and shape of the ellipse provide information about the spectral characteristics of your regions:



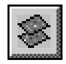

There is a 95% probability that any pixel within your region polygon actually falls inside the ellipse. It is therefore a good indicator of the spectral nature of the training region in the two selected bands, and allows comparisons to other regions. If ellipses for two regions overlap significantly, it indicates that those two regions have similar spectral characteristics in those two bands (but they may be separable using other bands).

## Close the scattergram dialogs

1 Click **Close** on the annotation **Tools** dialog to close it.

2 Click **Cancel** on the **Scattergram** dialog to close both dialogs.

## Add a Classification layer and load the Landsat dataset

1 Click the **Edit Algorithm**  button to open the **Algorithm** dialog.

2 Right-click on the 'Region Layer' and select **Turn Off**. (You no longer need it for this exercise.)

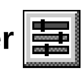
3 On the **Algorithm** dialog, open the **Edit** menu, select **Add Raster Layer**, then **Classification**.

A Classification layer is added to the algorithm.

4 Click the **Load Dataset**  button in the process diagram.

5 From the **Directories** menu, select the **\examples** path.

6 Open the 'Miscellaneous\Tutorial' directory, then double-click on the dataset 'Landsat_practice' to load it.

7 In the process diagram, click the **Open Color chooser**  button.

8 Choose a bright yellow color, then click **OK** to close the color chooser.

You can now use the Classification layer to display a training region in yellow on the image and show its histogram in any band.

## Enter a formula to display a region

1 Select the 'Classification Layer' in the algorithm, then click the **Edit Formula**  button in the process diagram.

2 In the Generic formula window, edit the formula text to read:

```
if inregion(region1) then input1 else null
```

This formula tells ER Mapper to process and display the data inside the region chosen as 'region1' in yellow on the image.

3 Click the **Apply changes** button.

4 Click the **Regions** button, then select **Grass and parks** from 'REGION1' drop-down list.

Your **Grass and Parks** region is displayed in yellow over the RGB image.

## View histograms for the Grass/Parks region

1. Click the post-formula **Open Transform Editor** button to open the **Transform** dialog box. Move it so it does not overlap with the image window or **Formula** dialog.
2. From the **Limits** menu, select **Limits to Actual**.

   The histogram for the pixels in band 1 of the training region ‘Grass/Parks’ appears in the histogram window.
3. In the **Formula** dialog, click the **Inputs** button, then select **B3:0.75_um** from the ‘INPUT1’ drop-down list.
4. From the **Limits** menu, select **Limits to Actual**.

---

**Note:** Since the data range is different for each band and region, you need to use **Limits to Actual** each time you change the band or region. Otherwise the new histogram may not fully display due to the limits set for the previous one.

---

The histogram for the pixels in band 3 of the training region ‘Grass and parks’ appears in the histogram window. The histogram provides information about the distribution and range of data values in your training regions. Ideally you want one main peak in the histogram. Bi-modal histograms (two peaks) indicate that your training region may encompass more than one feature class in that band.

## View histograms for the Urban areas region

1. Click the **Regions** button, then select **Urban areas** from the ‘REGION1’ list to highlight the ‘Urban areas’ region in yellow and generate a histogram.
2. From the **Limits** menu, select **Limits to Actual**.

   The band 3 histogram for the ‘Urban areas’ region appears in the **Transform** dialog.
3. If desired, view histograms for other region and/or band combinations using the steps listed previously.

   By changing the assignments in the Relations window, you can view a histogram for any band and region combination in the dataset.
4. When finished, click **Close** on the **Formula Editor** and **Transform** dialogs.
5. Click **Close** on the **Algorithm** dialog.

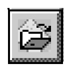
# 3: Classifying and evaluating the image

***Objectives*** Learn how to use the training region statistics to perform a supervised classification on the entire image that assigns each pixel to one of the six feature classes you defined.

## Open the Supervised Classification dialog box

1 From the **Process** menu, select **Classification**, then select **Supervised Classification**.

The **Supervised Classification** dialog box opens. The ‘Landsat_practice’ dataset is chosen as the default input dataset because it loaded in the active algorithm. The dialog also lets you choose which bands of the dataset to use for the classification, and the type of classification (or *decision rule*) to use.

2 Click the ‘Output Dataset’  chooser button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Miscellaneous\Tutorial’ directory.

5 In the **Save As** field, type your initials followed by the text **`max_like_class`** and separate each word with an underscore (_).

6 Click **OK** to validate the file name.

## Setup the classification type and parameters

1 Open the ‘Classification Type’ list to view the choices.

ER Mapper provides Maximum Likelihood Enhanced, Minimum Distance, Minimum Distance with a standard deviation, Parallelopiped, and Mahalanobis classifiers.

2 From the ‘Classification Type’ list, select **Maximum Likelihood Enhanced**, then **Maximum Likelihood Standard**.

3 Click the **Setup** button.

The **Supervised Classification Setup** dialog box opens. This dialog allows you to setup the options used for the classification, including which training regions to use (from this or other datasets), assigning class probabilities, and other options. By default, the six regions in your practice dataset are displayed. The options ‘Equal Prior Probability’ and ‘Generate Typicality’ are selected by default.

**Note:** For complete information on these options, see the *ER Mapper Reference* manual and remote sensing reference textbooks.

4 Click **Close** on the **Supervised Classification Setup** dialog.

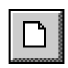
## Create the output classified image

1 Click the **OK** button to start the classification.

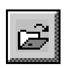
2 When it finishes, click **OK** on the dialog indicating successful completion. Then click **Cancel** on the **Supervised Classification** dialog.

The output of this classification is a two-band dataset. Band 1 is the classified image where each pixel has a value ranging from 1 to 6 for the class to which it was assigned. Band 2 is a typicality index indicating how closely a particular pixel matches a "typical" pixel for that class. (This was generated by selecting 'Generate Typicality' on the **Supervised Classification Setup** dialog.)

## Open a second window and template algorithm

1 On the main menu, click the **New**  button.

A second image window opens–drag it below the first window.

2 Click the **Open**  button.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Miscellaneous\Templates' directory, then open the 'Common' directory.

5 Double-click on the algorithm 'Classified_data.alg' to open it.

A classified image of San Diego displays. You will use this is a template algorithm to display your classified image.

## Load the classified image you created

1 Click the **Edit Algorithm**  button.

In the **Algorithm** dialog, notice that this algorithm has one layer of the type 'Class Display.' The 'Class Display' layer is designed to display images created with ER Mapper's classification functions.

2 Click the **Load Dataset**  button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Miscellaneous\Tutorial' directory, then double-click on the dataset 'max_like_class' you created to load it.

Each pixel in the original Landsat image is assigned to one of the six training classes you defined earlier. The class colors are those you defined for the training region polygons.

## View class name, colors and pixel values

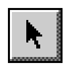
1 From the **Edit** menu (on the main menu), select **Edit Class/Region Color and Name**.

The **Edit Class/Region Details** dialog opens showing the name and color assigned to each class. If desired, you could change them here.

2 Click **Close** on the **Edit Class/Region Details** dialog.

3 From the **View** menu (on the main menu), select **Cell Values Profile**.

The **Cell Values Profile** dialog opens. Turn off the 'Signature' option.

4 Click the **Set Pointer mode**  button on the main menu, then click on areas in the classified image.

The Band 1 value is the class number to which the pixel was assigned. The Band 2 value is a typicality index that indicates how typical a pixel is of the class to which it was assigned (values 1-100, high values being typical and low values atypical).

5 Click **Close** on the **Cell Values Profile** dialog.

**Tip:** For information on creating a legend for the image showing the class names and colors, see the "Composing maps" chapter.

## Close the image windows and Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Draw polygons to define training regions for a supervised classification
- View statistics, histograms, and scattergrams for each training region
- Perform a supervised classification
- Display a classified image using a Class Display layer type

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# Raster to vector conversion

This chapter introduces you to the concept of raster to vector conversion and gives you practice using ER Mapper's raster to vector conversion features.

## About raster to vector conversion

Raster to vector conversion, sometimes called *vectorization*, allows you to convert data from a raster data structure to a vector data structure. For example, features or thematic classes defined by processing a satellite image can be converted to polylines and polygons, and then imported directly into a vector-based GIS product or used for further processing of raster data. Raster to vector conversion is a valuable feature for extracting timely information from satellite images, airphotos and other raster datasets to update vector-based information stored in GIS products.

With raster to vector conversion, ER Mapper analyzes the boundaries of the features you specify in a raster image, then traces polylines or closed polygons around the features. Typically you first need to perform some type of image processing to extract the features you are interested in, such as classification or thresholding to mask or highlight a particular feature. After vectorizing the features of interest, the output polylines or polygons are saved to an ER Mapper format vector file. They can then be converted to regions in a raster file, an ARC/INFO GIS coverage, or exported to other vector formats such as DXF.

# Hands-on exercises

These exercises give you practice creating algorithms to highlight a feature in a raster image, and then converting the feature to a vector representation. In this case, you will create vector polygons from classes in a previously classified image, and generate a binary land/water image and create a vector representation of the coastline.

***What you will learn...***

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Aggregate two or more classes into a single thematic class
- Generalize a classified image to remove isolated pixels
- Extract classes from a classified image and convert them to vector polygons
- Vectorize a binary land/water image to create polylines tracing the coastline

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Vectorizing a feature class

***Objectives***

Learn to prepare an algorithm displaying a classified image to extract and vectorize a feature class of interest, and perform the raster to vector conversion.

## Display a classified Landsat image

1 Click the **Edit Algorithm**  button.

An image window and the **Algorithm** dialog box appear.

2 On the main menu, click the **Open**  button.

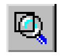
3 From the **Directories** menu, select the **\examples** path.

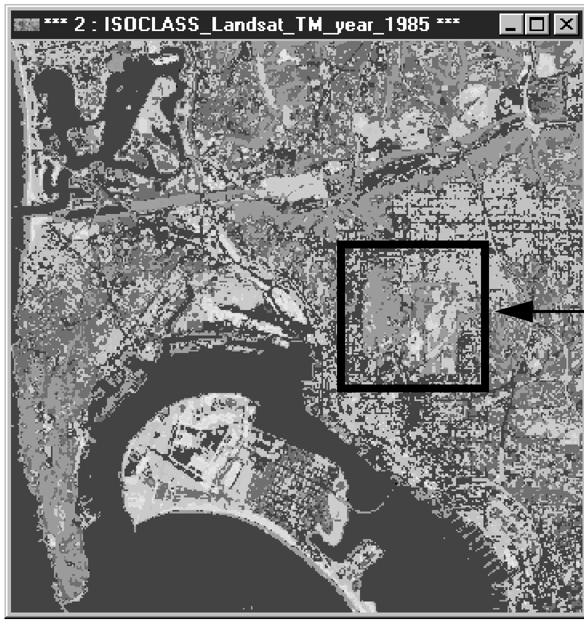
4 Open the 'Functions_And_Features' directory, then open the 'Classification' directory.

5 Double-click on the algorithm 'ISOCLASS_Landsat_TM_year_1985.alg.'

This algorithm displays a classified image of the San Diego, California area. There are 10 feature classes in this image representing water, vegetation types, barren land areas, and other feature classes.

## Zoom in on the Balboa Park park area near the center

1 Click the **ZoomBox Tool**  button on the main menu, then drag a box to zoom in on the green park area below:

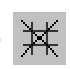



zoom in on park and surrounding area

This area is San Diego’s Balboa Park. Your zoomed image shows mostly green and light green pixels (vegetation) with some magenta pixels (developed areas) at the edges. You will create a vector representation of the vegetation areas.

## Apply a median filter to generalize the classification

Notice that the classification contains small, isolated groups of pixels within the larger single color areas. It is good idea to generalize the classification by incorporating these isolated pixels into the larger feature classes surrounding them before running raster to vector conversion. That way, you vectorize only the major features and minimize the number of small polygons that will be created.

1 In the **Algorithm** dialog, click the pre-formula **Edit Filter (Kernel)**  button.


pre-formula **Edit Filter (Kernel)** button

A formula will be used following the filter to extract certain classes from the generalized image.

2 On the **Filter** dialog, click the 'Filter filename' button.

3 From the **Directories** menu (on the **Load filter** dialog), select the **\kernel** path.

4 Open the 'filters_ranking' directory, then double-click on the filter 'median_5x5.ker' to load it.

This is a 5 by 5 median filter that assigns the center pixel the median values of all pixels in the 5 by 5 window. This and other filters such as 'majority.ker' are commonly used to generalize classified images.

The smaller, isolated pixels or clusters are incorporated into the surrounding dominant feature classes, which generalizes the classification.

5 Click **Close** on the **Filter** dialog.

## Enter a formula to aggregate the two vegetation classes

Notice that there are two vegetation classes in this part of the image shown in green (mostly natural vegetation) and light green (a golf course). For this exercise, you will aggregate these into one common class representing all vegetation before vectorizing them. (You could also vectorize each into its own polygons if desired.)

1 On the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.

2 In the Generic formula window, edit the formula text to read:

```
if input1=3 or input1=5 then 5 else input1
```

This formula tells ER Mapper "if pixels have a value of 3 (class 3) or 5 (class 5) in the dataset, assign them both a value of 5, else do not change them."

3 Click the **Apply changes** button to validate the formula.

Both vegetation classes are assigned the same value (5), so they both appear in the light green color. This light green area is the portion of the image you will convert to a vector representation.

4 Click **Close** on the **Formula Editor** dialog.

## Save the algorithm as a Virtual Dataset

To run the raster to vector conversion, you need to save the algorithm as a Virtual Dataset (VDS). The VDS will contain all your processing, including the zoomed area, the median filter, and the class aggregation formula. (You could also create a new raster dataset, but this is not necessary in this case.)

1 From the **File** menu (on the main menu), select **Save as...**.

2 In the **Save As...** dialog box, select ‘ER Mapper Virtual Dataset (.ers)’ in the **Files of Type:** field.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Miscellaneous’ directory.

5 Open the ‘tutorial’ directory.

6 In the **Save As:** field, type your initials followed by the text **`raster_classes_VDS`** and separate each word with an underscore (_).

7 Click **OK** to save the Virtual Dataset.

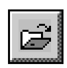
## Convert the raster cells to vector polygons

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens. This dialog contains options to vectorize specific bands or cell values in a dataset, to create polygons, polylines, or filled polygons, and to smooth (interpolate) vectors.

2 Click the ‘Input Raster Dataset’  button.

3 From the **Directories** menu, select the **\examples** path. Then open the ‘Miscellaneous\Tutorial’ directory and load your ‘raster_classes_VDS.ers’ dataset.

4 Click the ‘Output Vector Dataset’  button.

5 From the **Directories** menu, select the **\examples** path. Then open the ‘Miscellaneous\Tutorial’ directory and type your initials in the **Save As:** field followed by **`vegetation_polygons`** and click **OK**. (Separate each word with an underscore).

6 Change the ‘Cell Value’ field to read **5** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 5 in the Virtual Dataset (the aggregated vegetation areas from the classification). By default, ER Mapper will create vector polygons (because ‘Polylines’ is turned off).

7 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, then displays the number of vectors (polygons) created when the conversion is complete.

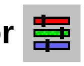
8 Click **OK** on the completion dialog, then click **Cancel** on the **Raster to Vector Conversion** dialog.

You have now created a vector file containing polygons representing the areas of vegetation on the classified image.

## Display the vector polygons over the classified image

1 In the **Algorithm** dialog, open the **Edit** menu, select **Add Vector Layer**, then **Annotation/Map Composition**.

An empty annotation layer is added to the algorithm.

2 In the process diagram, click the **Edit Layer Color**  button.

3 Choose a red color, then click **OK** on the **Color** chooser dialog.

4 Click the **Load Dataset**  button in the process diagram.

5 From the **Directories** menu, select the **\examples** path.

6 Open the 'Miscellaneous\Tutorial' directory, then double-click on your 'vegetation_polygons.erv' dataset to load it.

ER Mapper first processes the raster data, then draws the vector polygons in red. Notice that the vectors closely follow the outlines of the green areas on the image.

## Display the vector polygons alone

1 Right-click on the 'Class Display' layer and select **Turn Off**.

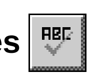
ER Mapper draws the vector polygons without the classified image backdrop so your can see them more clearly.

## View attributes of the vector polygons

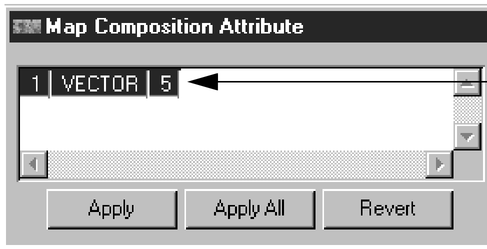
1 Select the 'Annotation Layer,' then click the **Annotate Vector Layer**  button in the process diagram.

The annotation **Tools** dialog opens.

2 On the **Tools** dialog, click the **Select/Edit Points Mode**  button, then click on one of the polygons to select it.

3 On the **Tools** dialog, click the **Display/Edit Object Attributes**  button.

The polygons are automatically assigned the class number (5) as an attribute during the raster to vector conversion. This attribute will be carried with them if saved to an ARC/INFO coverage, for example.




4 Click **Close** on the **Tools** dialog to close both dialogs.

# 2: Vectorizing a binary image

***Objectives*** Learn to prepare an algorithm that creates a binary image (land and water in this case), and perform the raster to vector conversion to extract a polyline defining the coastline. Also learn a fast way to use transforms to visually determine threshold values for binary images.

## Display a greyscale Landsat algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Data_Types' directory, then open the 'Landsat_TM' directory.

4 Double-click on the algorithm 'Greyscale.alg' to open it.

This algorithm displays band 1 of a Landsat TM satellite image of the San Diego, California area. This image contains an area of ocean in the lower part, and a recreational bay in the upper-left (Mission Bay). You will create a binary image to separate the land from the water, then vectorize the image to trace the coastline.

## Use the transform to find the land/water threshold

Binary images are often created to mask or isolate major features from each other. Land/water binary images are common because analysts are often only interested in working with one of the two features, and wish to mask out the other. A simple way to do this, when possible, is to define a data threshold to separate one feature from the other. One quick way to assess where the threshold might be is to create a binary transform line and adjust it.

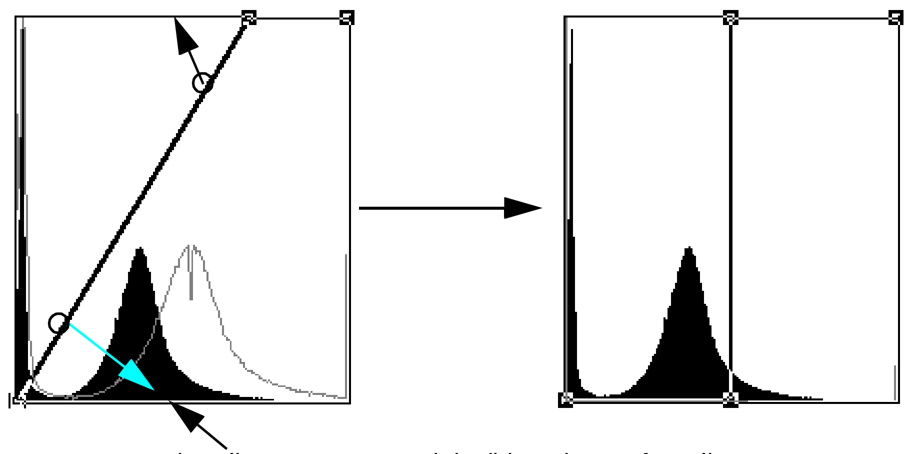
1 In the process diagram, select **B5:1.65_um** from the **Band Selection** list.

2 Click the **99% Contrast Enhancement** button.

ER Mapper displays band 5 (mid infrared) of the Landsat image. As you have seen in earlier examples, the IR bands are often good for delineating land from water due to strong IR absorption in water areas (so they appear dark in these bands).

3 On the **Algorithm** dialog, click the post-formula **Edit Transform Limits** button in the process diagram.

4 On the **Transform** dialog, create a straight up and down transform line by as shown below:



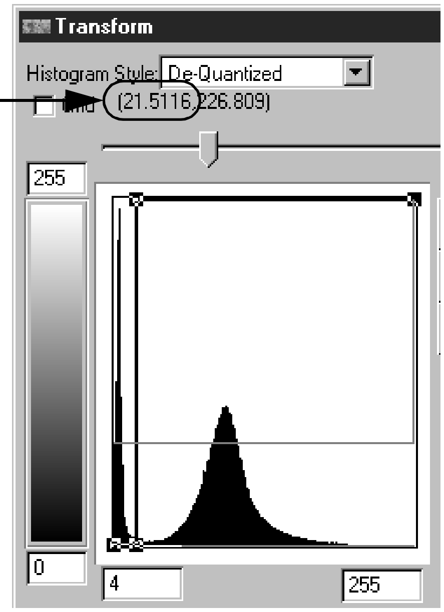

The image displays in only black and white. (All pixels in the histogram to the right of the line are mapped to white, and all to the left are mapped to black.) This is a bi-modal histogram (two peaks), one for water on the far left and the other for land areas in the middle.

5 Adjust the slider above the histogram left and right to change the threshold of the binary image.

The binary image threshold changes as you move the slider.

6 Move the slider to the position the line as shown below, then point to the line to view the X,Y values above the histogram.

X (data) value at line position
(approximate land-water threshold)




The X value of the line position in the histogram is the approximate threshold between land and water in this image (about 20).

---

**Tip:** This technique is a fast way to visually experiment with thresholds for any type of binary image, including ratios, Principal Components, and so on.

---

## Enter a formula to mask land from water

Once you have determined the threshold, you can use a formula to create true binary image that recodes all the pixels into only two values. For ease of use, you will save this binary image as a Virtual Dataset, then vectorize the water value.

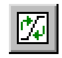
1 On the **Algorithm** dialog, click the **Edit Formula**  button in the process diagram.

2 In the Generic formula window, edit the formula text to read:

```
if input1 <= 20 then 1 else 2
```

This formula tells ER Mapper “if pixels in the input1 band (band 5) have a value less than or equal to 20, assign them a value of 1, else assign all others a value of 2.” This formula recodes each pixel in the image to a value of 1 or 2 (a binary image).

3 Click the **Apply changes** button to validate the formula.

4 Click the **99% Contrast Enhancement**  button.

The binary image again displays, this time created by the formula.

5 Click **Close** on the **Formula Editor** dialog.

## Save the binary algorithm as a Virtual Dataset

In the **Transform** dialog, notice that the ‘Actual Input Limits’ are 1 to 2. This is the result of the formula that recodes the band 5 values into 1 (water) or 2 (land).

1 On the **Transform** dialog, open the **Edit** menu, then select **Delete this transform**.

The transform you used previously to display the binary image is deleted to prevent rescaling the data in the Virtual Dataset. (Only the value range 1-2 created by the recoding formula will be saved to the VDS.)

2 Click **Close** on the **Transform** dialog.

3 On the main menu, click the **Save As**  button.

4 In the **Save As** dialog box, select ‘ER Mapper Virtual Dataset (.ers)’ in the **Files of Type** field.

5 From the **Directories** menu, select the **\examples** path.

6 Open the ‘Miscellaneous’ directory.

7 Open the ‘Tutorial’ directory.

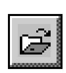
8 In the **Save As:** field, type your initials followed by **`binary_image_VDS`** and separate each word with an underscore (_).

9 Click **OK** to save the Virtual Dataset.

## Convert the raster cells to vector polylines

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens.

2 Click the ‘Input Raster Dataset’  button.

3 From the **Directories** menu, select the **\examples** path. Then open the ‘Miscellaneous\Tutorial’ directory and load the ‘binary_image_VDS.ers’ dataset you just created.

4 Click the ‘Output Vector Dataset’  button.

5 From the **Directories** menu, select the **\examples** path. Then open the ‘Miscellaneous\Tutorial’ directory and type your initials in the **Save As:** field

followed by **`vector_coastline`** and click **OK**. (Separate each word with an underscore).

6 Change the value in the 'Cell Value' field to **`1`** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 in the Virtual Dataset (the water areas in the image).

7 Turn on the 'Polylines' option (to create polylines instead of polygons).

8 Turn on the 'Smooth' option (to smooth the polylines using interpolation).

9 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, and number of vectors (polylines) created when the conversion is complete.

10 Click **OK** on the completion dialog, then click **Cancel** on the **Raster to Vector Conversion** dialog.

You have now created a vector file containing polylines representing the coastline (land/water boundary) in the Landsat TM image.

## Display the vector polylines over the Landsat image

1 Click the **Open**  button.

2 From the **Directories** menu, select the **\examples** path.

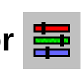
3 Open the 'Data_Types' directory, then open the 'Landsat_TM' directory.

4 Double-click on the algorithm 'RGB_321.alg' to open it.

This is bands 3, 2 and 1 of the same Landsat image used to create the binary VDS.

5 In the **Algorithm** dialog, open the **Edit** menu, select **Add Vector Layer**, then **Annotation/Map Composition**.

An empty annotation layer is added to the algorithm.

6 In the process diagram, click the **Edit Layer Color**  button.

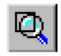
7 Choose a yellow color, then click **OK** on the **Color** chooser dialog.

8 Click the **Load Dataset**  button in the process diagram.

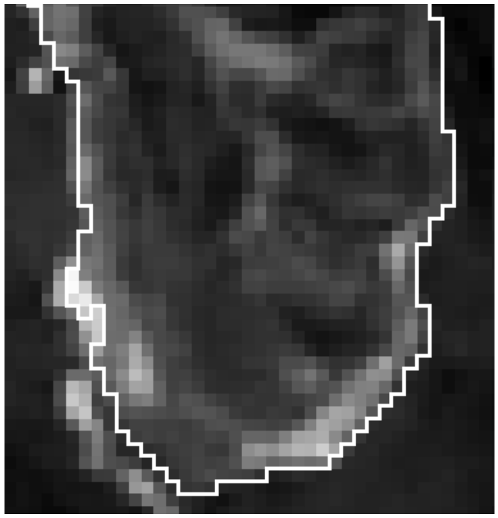
9 From the **Directories** menu, select the **\examples** path.

10 Open the 'Miscellaneous\Tutorial' directory, then double-click on your 'vector_coastline.erv' dataset to load it.

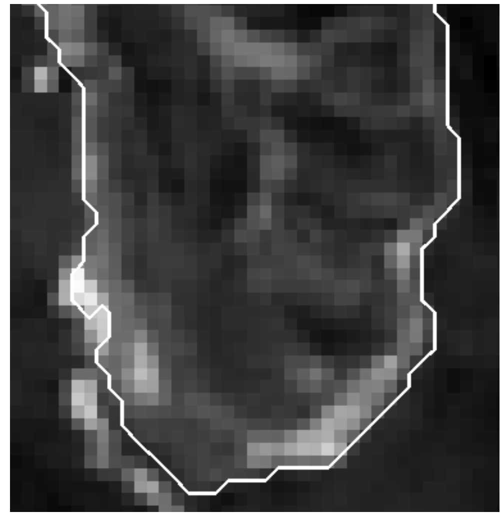
ER Mapper first processes the raster data, then draws the vector polylines in yellow. The vectors closely follow the land/water interface in the image.

11 Click the **ZoomBox Tool**  button, then zoom in to a coastal area.

The ‘Smooth’ option interpolates the vectors to give them a less jagged, smoother appearance. If ‘Smooth’ is off, the vectors exactly follow the pixel shapes.



with Smooth off



with Smooth on

## Close the image window and Algorithm dialog

1 Select **Close** from the **File** menu to close the image window.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Aggregate two or more classes into a single thematic class
- Generalize a classified image to remove isolated pixels
- Extract classes from a classified image and convert them to vector polygons
- Vectorize a binary land/water image to create polylines tracing the coastline

# 22

# Composing maps

This chapter explains how to use ER Mapper's Page Setup and Map Composition tools to create top quality cartographic image maps. You will learn about setting up a page size and extents for your map, how to add map objects such as coordinate grids, scale bars, north arrows, and considerations for printing to hardcopy devices.

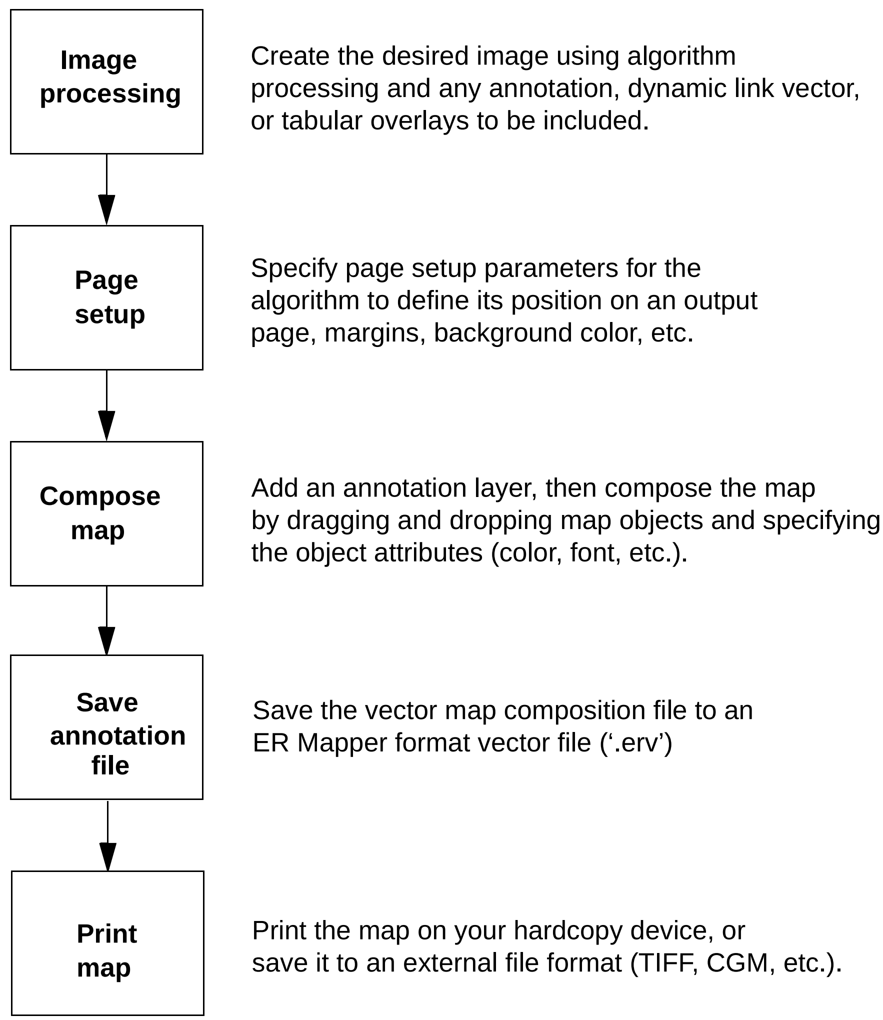
## About map composition

ER Mapper provides a complete set of map composition tools that let you easily transform images into top quality image maps. Your maps can include common map objects such as coordinate grids, scale bars, classification legends, north arrows, and more. You can use the annotation tools to draw lines, text, shaded polygons, and other vector objects. Your maps can also include other layers to add vector data from GIS systems, tabular data, or other external data.

ER Mapper's map composition also has an open design and is user-extendable. You can add your own Postscript map objects to ER Mapper's map object library, such as company logos or north arrows, include external files and text, and many other types of data. You can also modify the default attributes of map objects and save them under your own unique names for later use.

To add map objects to your images, you first add an **Annotation/Map Composition** layer to your algorithm. (The same type of layer you use to draw annotation or display an ER Mapper format vector file.) You then drag and drop the desired objects onto your image and specify their size and attributes.

The following diagram shows the general procedure for creating and printing a map in ER Mapper:



# Hands-on exercises

These exercises give you practice setting up an algorithm to create a map, defining Page Setup parameters, and composing the map by adding map objects and other annotation.

***What you will learn...***

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Define Page Setup parameters for an algorithm
- Add an Annotation/Map Composition layer for map objects
- Position and size map objects (grids, scale bars, etc.) on your map
- Specify color and other attributes for annotation and map objects

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Setting up the page

***Objectives***

Learn to use ER Mapper's Page Setup options to define the position of an image on an output page, and specify other options such as map scale, borders and background color.

## Open a Landsat and SPOT Pan merge algorithm

ER Mapper provides you with two ways of setting up a page. You can either use the **Page Setup** dialog box or the **Page Setup Wizard**. Both methods achieve the same results, but the Page Setup Wizard leads you sequentially through the required parameters. The Page Setup dialog box method is described here.

1 Click on the **Open**  button.

An image window and the **Open** dialog box appear.

2 Open the 'Functions_And_Features' directory, then open the 'Data_Fusion' directory.

3 Double-click on the algorithm named 'Brovey_Transform.alg.'

This algorithm merges bands 5, 4 and 1 of a Landsat TM dataset with a high resolution SPOT Pan dataset to create an enhanced "natural color" composite. The image covers the San Diego, California area. This is the image you will use as the basis for your map.

**Note:** The Brovey transform algorithm uses a Virtual Dataset containing the Landsat and SPOT images as input, then uses a color normalization formula to enhance the Landsat color data and merge it with the SPOT Pan. You can also merge images using the IHS (Intensity Hue Saturation) merge technique, RGBI colordraping, and others. (In the 'Data_Fusion' directory, see the algorithm 'Landsat_TM_and_SPOT_Pan_IHS_merge.alg' for an IHS example.)

## Display the Annotation toolbar

1 From the **Toolbars** menu, select **Annotation**.

A third row of toolbars buttons is added to the main menu. These give you quick access to functions often used when creating maps and annotation.

## Specify Metric or Imperial units of measure

1 On the main menu, select **Preferences** from the **Edit** menu.

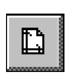
The **Preferences** dialog opens providing **General**, **Datasets, 3D Options**, and **Advanced** tab pages.

2 Select the **General** tab page (if needed), then select either 'Metric (mm)' or 'Imperial (inches)' from the **Display Units** list (whichever you prefer).

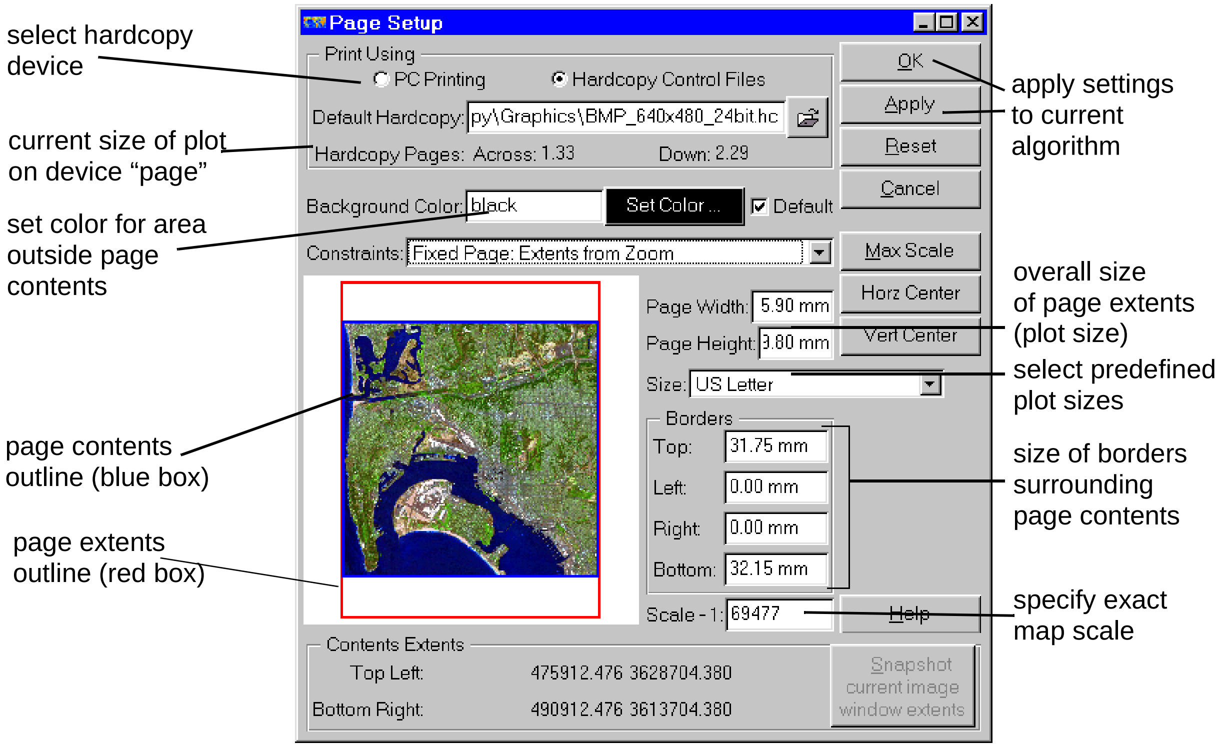
3 Click **Close** on the **Preferences** dialog.

All values regarding the plot size, margin sizes and other page setup and printing parameters will be displayed in the units of measure you selected.

## Open the Page Setup dialog box

1 From the **File** menu, select **Page Setup...** (or click the **Setup Algorithm Page Size**  button on the Annotation toolbar).

The **Page Setup** dialog box opens. This dialog provides controls for you to position your image on an output page, specify border sizes and map scaling, background color and more.

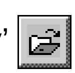



All algorithms have a default print size of 8.5 by 11 inches (US Letter size). The output print area is the red box ("page extents"), and the size and position of the algorithm image within the print area is the blue box blue ("contents extents").

## Select the destination hardcopy device

It is helpful to select the hardcopy device you plan to print on before you create your map to get an idea of how large the plot will be when printed. (You can change this later is desired.)

1 Click the 'Hardcopy Control Files' option at the top of the **Page Setup** dialog.

2 On the **Page Setup** dialog, click the 'Default Hardcopy'  button.

The **Default Hardcopy** dialog opens to let you select a printer or file format.

3 From the **Directories** menu (on the **Default Hardcopy** dialog), select the **\hardcopy** path.

A list of directories for categories of hardcopy devices and file formats appears.

4 Open the 'HP' directory, then double-click on the entry 'HP_DesignJet_300dpi_A0.hc' to select it.

This device is now selected as your default printer.

(The HP DesignJet is a large format color inkjet plotter. The entry you selected is designed to tell the printer to print at 300 dots per inch on an A0 size area of the device's plotting surface, which is approximately 33x46 inches or 84x118 cm.)

## Specify how the page or map contents can be scaled

The 'Constraints' drop-down list lets you specify how various plot size parameters are adjusted when you change others. Typically you need to decide what is most important for your map: a fixed page size, fixed borders, or a fixed map scale.

1 From the **Constraints** drop-down list, select **Auto Vary:Page**.

The outlines representing the page extents (red) and page contents (in blue) become the same size, and the 'Border' and 'Scale' fields are now editable.

**Auto Vary:Page** mode tells ER Mapper that it can automatically change the size of the image (page contents) to accommodate any changes you make to the map scale or the size of borders surrounding the graphic. (Other 'Constraints' options automatically change plot border sizes or map scale if other parameters are changed. See "Additional features of map composition" at the end of this chapter.)

## Specify the output map scale

1 In the 'Scale - 1:' text field, enter the value **`24000`** then press Enter or Return to validate.

ER Mapper sets the size of the page contents (the physical size of the satellite image) to print at 1:24,000 map scale. Since you selected **Auto Vary:Page** mode, the Page Height and Width values are automatically adjusted to show the actual size of the plot at 1:24,000 scale (24.6 by 24.6 inches or 625 by 625mm).

## Specify borders surrounding the page contents

Right now the page extents and page contents are the same size. Next you will add borders around the contents (the satellite image) so you have space to add a title, scale bar, coordinate grid, and other items on the sides.

1 In the text fields under 'Border,' enter the following values in the units you are using (press Enter or Return after each to validate):

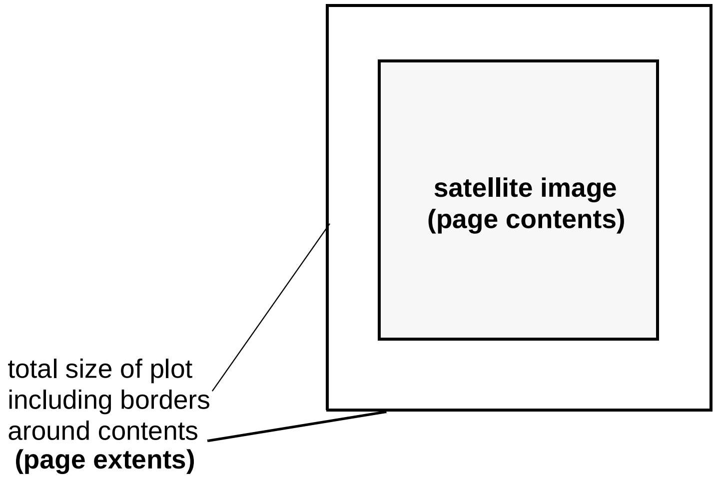
Top: **`80`** (mm) or **`3.15`** (inches)

Left: **`80`** (mm) or **`3.15`** (inches)

Right: **`80`** (mm) or **`3.15`** (inches)

Bottom: **`100`** (mm) or **`3.94`** (inches)

By adding borders, you increased the total plot size to 785 by 805mm or 30.9 by 31.6 inches. The blue outline shows the relative size and position of the page contents in the new, larger page. (The physical size of the page contents has *not* changed, it will still print at 1:24,000 scale).




**Tip:** After setting the desired map scale and border values, notice that the 'Hardcopy Pages Across' and 'Down' fields show the percentage of device's the A0 size print area that the plot will occupy (88% of the width of an A0 page in this case). If your total plot size (page extents) is larger than the selected print area of your device, these values will be greater than one. This means that ER Mapper would need to divide the plot and print each portion on a separate page in order to maintain your requested map size/scale. (The 'Down' value is zero in this case because this is a roll paper plotter so it has no meaning.)

## Set the background color to white

1 Select the text in the 'Background Color' field, type `white` and press Enter or Return.

ER Mapper sets the page background color to white (the areas of the page surrounding the page contents). If you will be printing on a device that has a white background, set the background color to white while you are composing the map to get a better idea of the final output. (You can use the **Set Color** button as well to choose any arbitrary background color. Black is often used for film output.)

## Save the algorithm with the Page Setup parameters

1 Click **OK** on the **Page Setup** dialog to apply your settings and close it.

ER Mapper redisplays the image with your borders and white background added around the outside.

2 From the **File** menu, select **Save As...** to save the algorithm under a new name.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Miscellaneous' directory.

5 Open the 'Tutorial' directory.

6 In the **Save As:** field, type your initials followed by the text **`San_Diego_map`** and separate each word with an underscore (_).

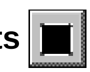
7 Click **OK** to save the algorithm, which now includes your page setup parameters.

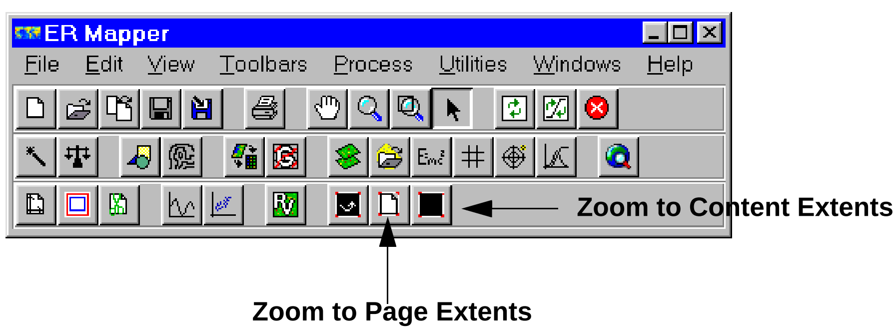
# 2: Defining map objects

***Objectives*** Learn to use ER Mapper's Map Composition tools to place and modify map objects such as scale bars, coordinate grids, north arrows, and others.

## Zoom to the contents and page extents

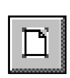
The Annotation toolbar provides two helpful buttons that let you quickly zoom to the contents extents (so you see only the image) or to the page extents (so you see the full plot area including any borders surrounding it).

1 On the Annotation toolbar, click the **Zoom to Contents Extents**  button.



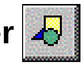

The image zooms in so that only the image (page contents) are displayed. This view is best for drawing annotation on the image itself.

2 Make the image window about 50% larger to increase the work area.

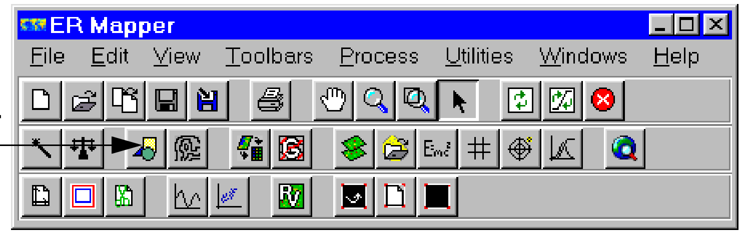
3 Click the **Zoom to Page Extents**  button.

The image zooms out to the extents of the page defined for the algorithm. This view is best for adding map composition objects to your page as you will do next.

## Add a vector layer for map composition

1 On the **Common Functions** toolbar, click the **Annotate Vector Layer**  button.

**Annotate Vector Layer** button



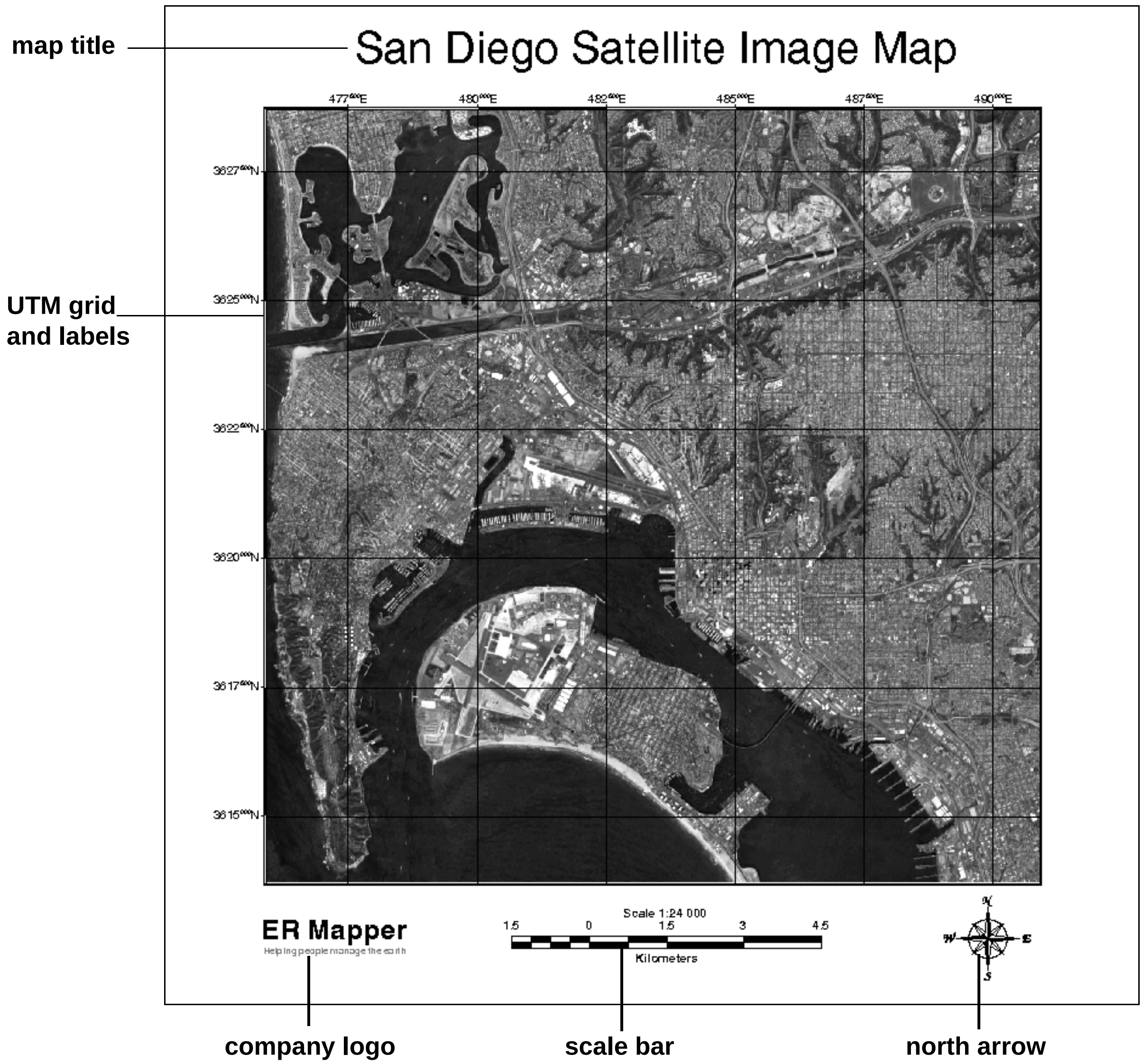

The **New Map Composition** dialog box opens to ask what type of annotation you want to create.

2 Make sure the ‘Vector File’ option is selected, then click **OK**.

ER Mapper opens the **Tools** dialog containing your drawing tools. Move the **Tools** dialog next to the right side of your image.

## Layout the types and positions of map objects

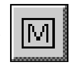
Before creating your map, it is a good idea to determine which types of map objects you want to use, and their relative sizes and positions on the page. In this exercise, you will create simple map with the following objects:

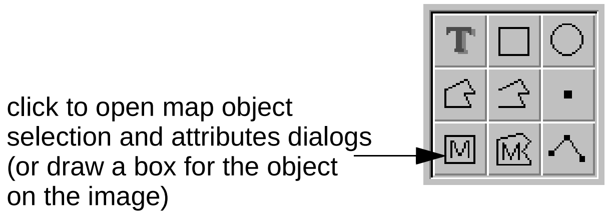



You will define these objects on the page in two ways:

- draw a bounding box and drag-and-drop the object into it; or
- drag-and-drop the object onto the page and resize it afterward

Use the diagram above as a guide for the size and position of bounding boxes for map objects you are asked to create in the next sections.

1 On the **Tools** dialog, click the **Map Rectangle**  button.

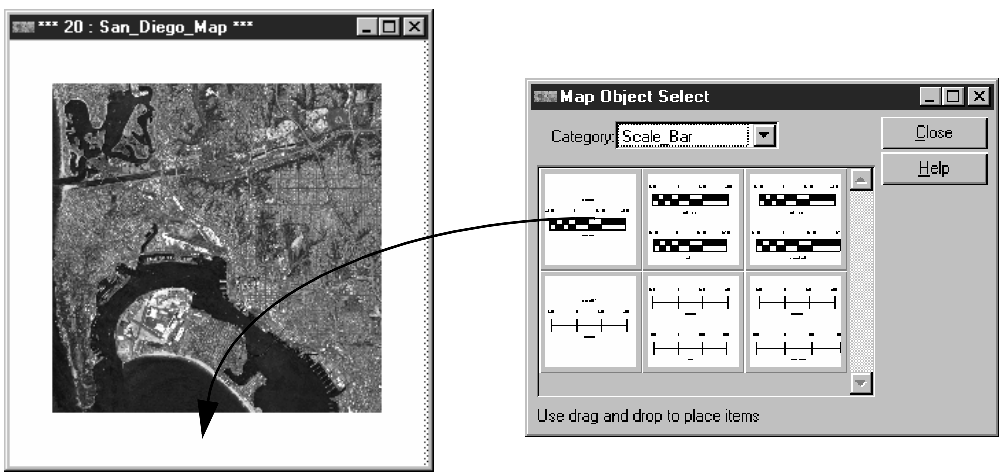



The **Map Object Select** and **Map Object Attributes** dialog boxes open (move them to the right side of the screen if needed). These dialogs let you drag and drop map objects onto your map page and specify attributes for the objects.

2 In the **Map Object Select** dialog, select **Scale_Bar** from the 'Category' drop-down list.

Icons for various types of scale bar map objects appear. The title of the object is shown in the status line at the bottom of the dialog when you point to it.

3 Point to the icon titled **Scale_Bar/Box**, then drag and drop it below the image.




The scale bar object is "dropped" onto the page and it draws a few seconds later. Notice that the scale bar is contained inside a box defined by selection handles at the corners. This is called the object *bounding box*, and it lets you control the size and position of the map object on the page. The default attributes for the scale bar appear in the **Map Object Attributes** dialog box.

4 In the **Map Object Attributes** dialog, select the following attributes for your scale bar:

Units: **Kilometers** or **Miles** (choose as desired)

Number of Divisions: **4**

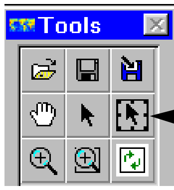
Left Align Scale Bar: **No**

Labels Font: **Helvetica-Bold**

Units Font: **Helvetica-Bold**

The scale bar object updates on the image as you change the attributes.

5 On the **Tools** dialog, click the **Select and Move/Resize Mode**  button.

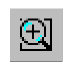


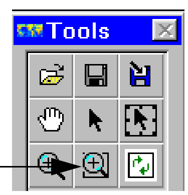

**Select and Move/Resize Mode** button

The scale bar object displays with nine selection handles at the corners so you can move or resize it as desired.

6 Center the scale bar below the image by dragging the object from the center, or resize the scale bar by dragging selection handles.

## Zoom in on the scale bar object

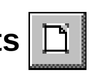
1 In the **Tools** dialog, click the **ZoomBox Mode**  button.




**ZoomBox Mode** button

2 Drag a zoom box around the scale bar object in the image window.

The scale bar shows the units, and map scale (set in the **Page Setup** dialog).

3 On the Annotation toolbar, click the **Zoom to Page Extents**  button.

The image again zooms out to the full extents of the page.

## Add a compass north arrow on the lower-right

1 In the **Map Object Select** dialog, select **North Arrow** from the 'Category' drop-down list.

Icons showing various types of north arrows appear.

2 Point to the compass north arrow (**North_Arrow/Compass**), and drag it to a position just right of your scale bar.

The north arrow object drops onto the page and draws a few seconds later.

3 On the **Tools** dialog, click the **Select and Move/Resize Mode** button.

4 Resize the north arrow object to make it smaller (drag a corner handle), then drag it into position under the image and right of the scale bar.

---

**Tip:** ER Mapper's north arrows are "smart" and will automatically rotate (if needed) to point to north on a rectified image.

---

## Add a company logo on the lower-left

1 In the **Map Object Select** dialog, select **Logo** from the 'Category' list.

Icons showing some sample company logos appear.

2 Point to the **ER Mapper** logo icon, and drag it into a position left of the scale bar.

The logo object drops onto the page.

3 Resize the logo object to make it smaller (drag a corner handle), then drag it into position under the image and left of the scale bar.

---

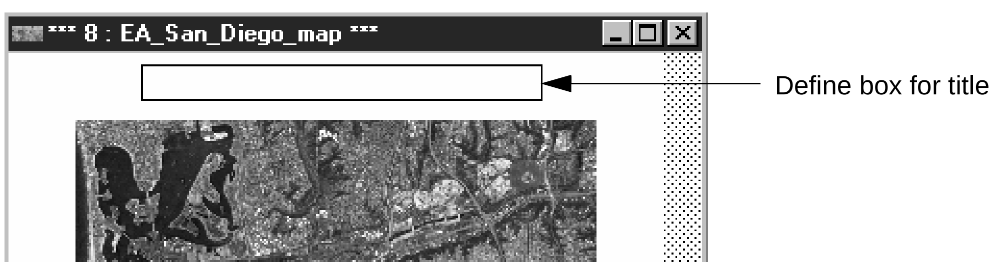
**Tip:** You can add your own company logos as Postscript files and access them from the standard Logos category used here.

---

## Add a main title above the image

1 On the **Tools** dialog, click the **Map Rectangle** button.

2 Drag a bounding box centered at the top of the image window.




3 In the **Map Object Select** dialog, select **Title** from the 'Category' list.

4 Point to the icon titled **Title/Scaling**, drag it into the bounding box you defined above the image.

(The title color is white by default, so it is not visible yet.)

**Note:** A bounding box must be selected before you can drag and drop an object into it (select it again if needed).

5 On the **Map Object Attributes** dialog, change the following text and attributes for your title:

Font Color: **black**

Title: **San Diego Satellite Image Map** (press Enter or Return afterward)

The title object automatically updates as you change the attributes.

## Define a UTM (Eastings/Northings) grid over the image

1 In the **Map Object Select** dialog, select **Grid** from the ‘Category’ list.

2 Point to the **Grid/EN** icon, and drag it onto the image.

The UTM grid map object draws with a default position and attributes. (A UTM grid shows coordinates in meters of Eastings and Northings.)

3 On the **Map Object Attributes** dialog, click the **Fit Grid** button.

ER Mapper resizes and positions the grid to fit exactly to the extents of the image on the page. (If desired, you could resize and position it manually.)

4 On the **Map Object Attributes** dialog, turn on the ‘Fast Preview’ option.

’Fast Preview’ tells ER Mapper *not* to update the object interactively as you change the attributes. (Since the grid is a more complex object, you will change all the desired attributes first, then refresh the object all at once to save time.)

5 On the **Map Object Attributes** dialog, select the following attributes for your grid:

**Grid Style: Full Grid**

**Grid Spacing X: 2,500 meters (2.5 km)**

**Grid Spacing Y: 2,500 meters (2.5 km)**

**Border Type: Check Ticks**

**Top labels orientation: Horizontal Right**

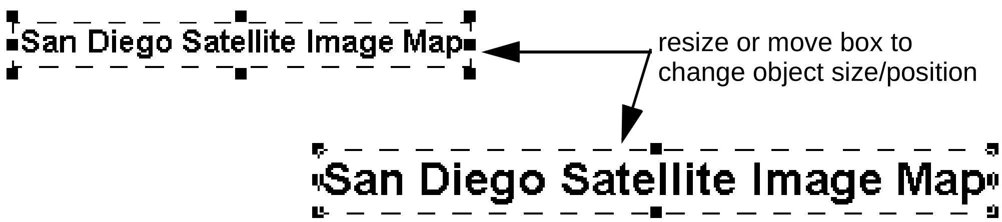
6 On the **Map Object Attributes** dialog, turn off the ‘Fast Preview’ option.

The grid map object is rendered again using the new attributes you defined. The ‘Check Ticks’ border type draws a collar around the map with black and white bars at the grid spacing intervals.

**Note:** The text size for the grid and scale bar labels appears small, but will be completely legible (12 point text) when printed at the 1:24,000 scale. To force the text to be larger, increase the ‘Min Labels Point Size’ and ‘Max Labels Point Size’ on the **Map Object Attributes** dialog when the object is selected.

## Adjust the size or position of any object

All of these map items are actually Postscript graphic files. To change the size or position of any object, select it, then move or resize its bounding box..




1 In the **Tools** dialog, click the **Select and Move/Resize Mode**  button.

2 Adjust the position or size of any object by selecting it, then moving or resizing it.

**Tip:** To select a map object, either click on a side (the bounding box area), or drag a selection marquee around a corner of the object (sometimes easier).

## Save the map composition file

1 On the **Tools** palette dialog, click the **Save File**  button.

The **Save Map Composition File** dialog box opens.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Miscellaneous\Tutorial’ directory.

4 In the **Save As:** text field, enter your initials followed by the text **`map_composition`** and separate each word with an underscore (_).

5 Click **OK** to save the annotation file to disk.

The annotation is saved in an ER Mapper format ‘.erv’ file, and it contains all the objects you defined, and their attributes, position and size on the page.

6 Click **Close** on the **Tools** dialog to close all three annotation dialogs.

**Tip:** See the section "Additional features of map composition" at the end of this chapter for more information on map objects and printing.

## Save the algorithm to update the changes

1 On the main menu, click the **Save** button.

2 When asked to confirm the overwrite, click **OK**.

This makes sure that the algorithm also includes your new annotation file in the future. You can now print your algorithm using the **Print** toolbar button or by selecting **Print** from the **File** menu.

## Hide the Annotation toolbar

1 Select **Annotation** from the **Toolbars** menu.

The Annotation toolbar buttons disappear from the main menu.

## Close the image window

1 Select **Close** from the **File** menu to close the image window.

Only the ER Mapper main menu should be open on the screen.

***What you learned...*** After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Define Page Setup parameters for an algorithm
- Add an Annotation/Map Composition layer for map objects
- Position and size map objects (grids, scale bars, etc.) on your map
- Specify color and other attributes for annotation and map objects

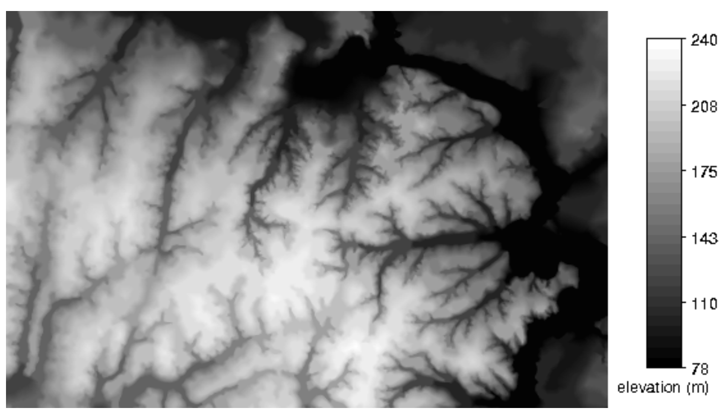
## Additional features of map composition

The preceding simple example covered only the basics of using ER Mapper's map composition, and following are some additional features and information. Refer to the chapter on creating maps in the *ER Mapper User Guide* for complete information.

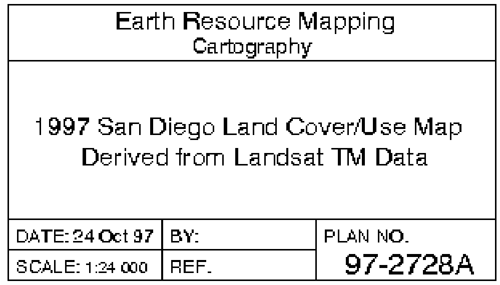
## Map object types and categories

The following section describes how map objects inherit attributes from other objects, and lists some other types of map objects you did not use in the previous example map.

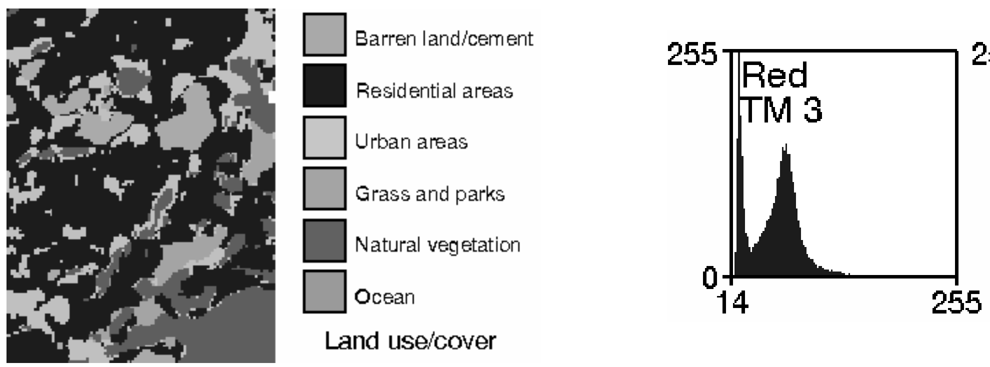
- If you drag an object into a selected bounding box that already contains an object, the old object is replaced by the new one. This is an easy way to try several north arrows, for example.
- Objects that are dragged and dropped to replace a current object automatically inherit any common attributes from the previous object. For example, if you have a red north arrow in a bounding box and then drag in a scale bar object, the scale bar automatically inherits the red color (since both objects have the “Color” attribute in common).
- You can modify the default attributes of map objects and save them under your own names(using **Save As** on the **Map Object Attributes** dialog.
- You can plot objects from external files like TIFF, EPS, or Targa using the category **Image** on the **Map Object Select** dialog.
- You can import text directly from ASCII text files and plot it on your map page using the category **Text** on the **Map Object Select** dialog.
- You can plot other algorithms you’ve created as map objects on the page using the category **Algorithm** on the **Map Object Select** dialog. (See the section “Plotting inset images” following for more information.)
- You can plot “z-scale” color bars that show how image colors are mapped to data values using the category **ZScale** on the **Map Object Select** dialog.



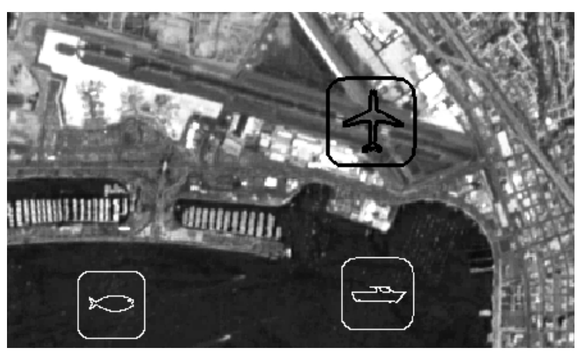
- You can plot title blocks showing project information using the category **Title_Block** on the **Map Object Select** dialog.



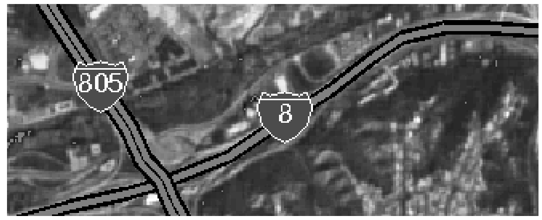

- You can plot legends showing classification colors and class names, histograms, and other legend types using the category **Legend** on the **Map Object Select** dialog.




- You can plot many standard map symbols using the categories **Map_Symbols** and **Symbols** on the **Map Object Select** dialog.



- You can plot special line styles and highway symbols for roads using the category **Road_Maps** and **Symbols** on the **Map Object Select** dialog.




To use the road line styles, select the **Map Polygon**  button, digitize the road, then drag-and-drop one of the road line style objects into the selected polygon.

## Page setup constraints options

In the previous simple example, you chose the 'Auto Vary:Page' option, although you could have chosen others as well. The Constraints options you can use are summarized briefly below:

- **Fixed Page:Extents from Zoom**–This is the default setting for all new algorithms, where the contents scale and borders are taken from the current zoom extents of the algorithm. For map making purposes, Extents from Zoom is not recommended because it can effect line thickness and text sizing.
- **Auto Vary:Page**–This mode allows ER Mapper to automatically vary the page size to account for any changes made to the map scale or page borders. This mode is easiest, for example, to print a map at an exact scale with any size borders without constraining it to a specific page size. If you want to place map objects outside the image (page contents) area, enter the desired border sizes to create space for them. (This is a good initial choice when you are prompted to change the mode when using the annotation tools.)
- **Auto Vary:Borders**–This mode allows ER Mapper to automatically vary the page borders to account for any changes made to the map scale or page size. This mode is most useful for printing at both an exact map scale and exact plot size.
- **Auto Vary:Scale**–This mode allows ER Mapper to automatically vary the map scale to account for any changes made to the page size or page borders. This mode is useful, for example, for printing an image at various sizes when exact map scale is not important.

## Page relative and map relative objects

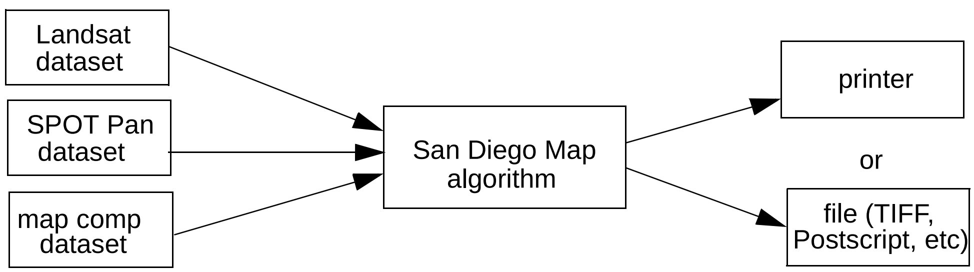
The vector map objects you defined in this exercise have their position and size specified relative to the page, rather than to map units (such as Latitude Longitude). This allows you to create standard map sheets with objects that remain in a fixed area of the page, regardless of how the page is scaled or the extents of the datasets used in the page contents are changed.

You can also specify the position of map objects in geographic coordinate units. The position of each object is “locked” to a particular geographic location relative to the image. This is what you want when tracing a vector to follow a road on your image, for example.

To specify a map object as map unit relative, turn off the ‘Page Relative’ option on the **Map Object Attribute** dialog box. The page relative attribute can be assigned either before or after the object is dragged-and-dropped onto the page. See the *ER Mapper User Guide* for more information.

## Printing your map

When you want to print your final map algorithm (using **File/Print** or the **Print**  button), ER Mapper asks for the name of the algorithm. When the print operation begins, ER Mapper automatically locates, processes and renders all the datasets used in the algorithm into one final print image. In this case, your map algorithm uses three datasets–a Landsat raster dataset, a SPOT raster dataset, and a vector map annotation dataset (which you created).




Since the map algorithm is made of several layers (and datasets), you can easily change it. For example, to print the image without the map objects overlay, simply turn off that layer in the algorithm, resave it, and print it.

You also have the option of printing using the Windows® driver for your device instead of the ER Mapper device drivers that ship standard with the software. To print using a Windows® printer, select the ‘PC Printing’ option on the **Page Setup** or **Print** dialog boxes.

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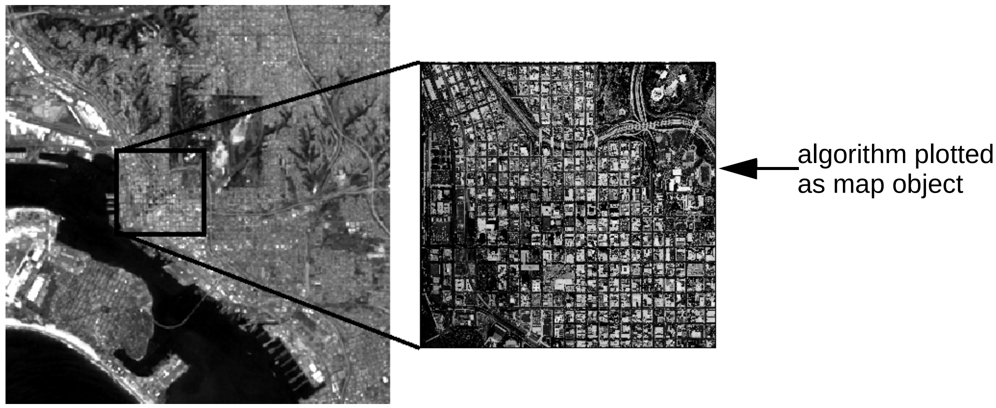
**Note:** If your algorithm is in the active image window and you select to print, ER Mapper automatically makes a temporary copy of it and loads it tnto the **Print** dialog. This lets you print the current algorithm, not just the last saved version.

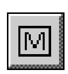
---

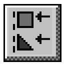
## Plotting inset images

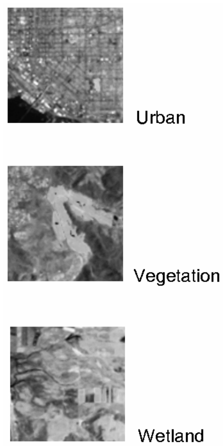
To create maps with several images on them, you can add existing algorithms as map objects. This is a good way to add inset images to a map, or create small “thumbnail” images for use as legends.




Follow these general steps to add an inset image to a map:

- Zoom to the area of interest in the inset image and save the algorithm.
- Add a new annotation layer for the inset image to the map algorithm. (It is recommended that you plot inset images in their own separate annotation layer because they do not redraw as fast as simpler map objects).
- Geolink the map sheet image window to the inset window, so the image map zooms to the same area as the algorithm to be inset. Use the annotation tools to draw a box around the zoomed area on the map window. Then zoom out to the page extents again. You should now have a box on the image that marks the area to be shown in the inset image.
- Click the **Map Rectangle**  button, then draw a bounding box on the map algorithm where you want the inset image to go.
- Load the inset algorithm as a map object. In the **Map Object Select** dialog, select the category **Algorithm** and drag the icon into the selected bounding box for the inset image. In the **Map Object Attributes** dialog, select the name of the algorithm to be loaded into the bounding box. Turn off ‘Fast Preview’ to display the algorithm in the bounding box on the image.
- If desired, draw lines to connect the marker box on the image to the inset image.

To create legend showing several “thumbnail” images, create and save an algorithm for each small image. You can then plot them using the category **Legend_Item/Algorithm** object. This also lets you place a text label next to each thumbnail image for the legend. (To help align the bounding boxes, you can use the **Align Object**  button on the **Tools** dialog.)



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# Image orthorectification

This chapter explains how to use the ER Mapper Geocoding Wizard to geometrically correct raw image data and orthorectify it to real world coordinate systems and map projections.

## About orthorectification

Orthorectification corrects local and global distortions in an image by adjusting for camera characteristics, platform positions and terrain details.

The camera characteristics, derived from a camera calibration report, are stored in a camera file for use by the Geocoding Wizard.

The terrain details are supplied in the form of a DEM. If the terrain is relatively flat, you can use an average height value.

In the case of Advanced Orthorectification, the platform position is determined by exterior orientation values which describe the exact position of the aircraft at the time the image was taken, and how this relates to the image. The following parameters are specified:

| | |
|---|---|
| **Attitude omega** | The tilt angle (roll) of the aircraft; i.e. the rotation about the X axis (direction of travel). |

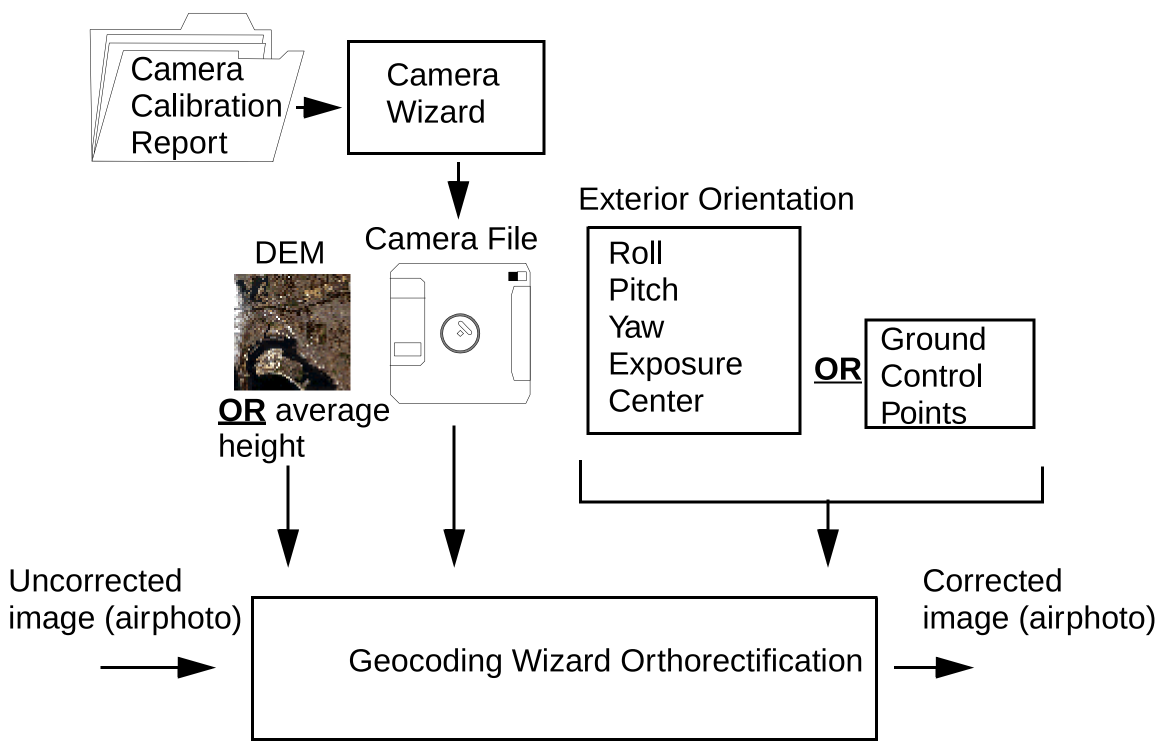
| | |
|---|---|
| **Attitude phi** | The swing angle (pitch) of the aircraft; i.e the rotation about the Y axis. |
| **Attitude kappa** | The azimuth angle (yaw)of the aircraft; i.e the rotation about the Z axis. |
| **Exposure center XYZ** | The co-ordinates of the exposure center of the image. |

If the exterior orientation parameters are not known, you have to specify about 4 to 6 GCPs for the Geocoding Wizard to compute them.

To use Orthorectification you must have the following information available:

- Camera file containing camera calibration information
- DEM file (You can enter an average height if the terrain is relatively flat)
- Exterior orientation (Only for Advanced Orthorectification. Otherwise you must select GCPs)
- GCPs referenced by their XYZ coordinates.

The diagram below illustrates the required inputs for orthorectification.



# Hands-on exercises

These exercises give you practice using ER Mapper's Geocoding Wizard to orthorectify an image.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Use the Geocoding Wizard to orthorectify an airphoto
- Use the Camera Wizard to create a Camera File from a calibration report
- Locate fiducial marks on an airphoto
- Pick suitable Ground Control Points (GCPs)

***Before you begin...***

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

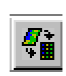
In these exercises you will use the Geocoding Wizard to orthorectify an airphoto image of San Diego taken in 1997. The example images are used with permission from Aerial Fotobank.

# 1: Orthorectify an airphoto using GCPs

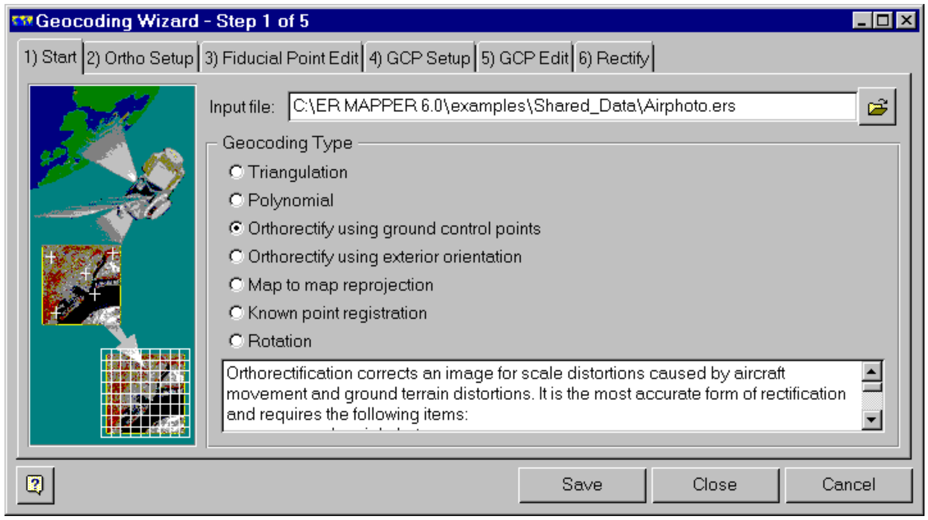
***Objectives***

Learn how to use ER Mapper's Geocoding Wizard to orthorectify an airphoto.
Use the Camera Wizard to create a Camera File with given calibration parameters.
Select Ground Control Points

## Open the Geocoding Wizard

1 Click on the **Ortho and Geocoding Wizard**  button in the **Common Functions** toolbar.

The Geocoding Wizard will open with the **1) Start** tab selected.




2 Click the **Load Algorithm or Dataset**  button in the **Input file:** field to open the file chooser.

3 From the **Directories** menu, select the path ending with the text **\examples**.

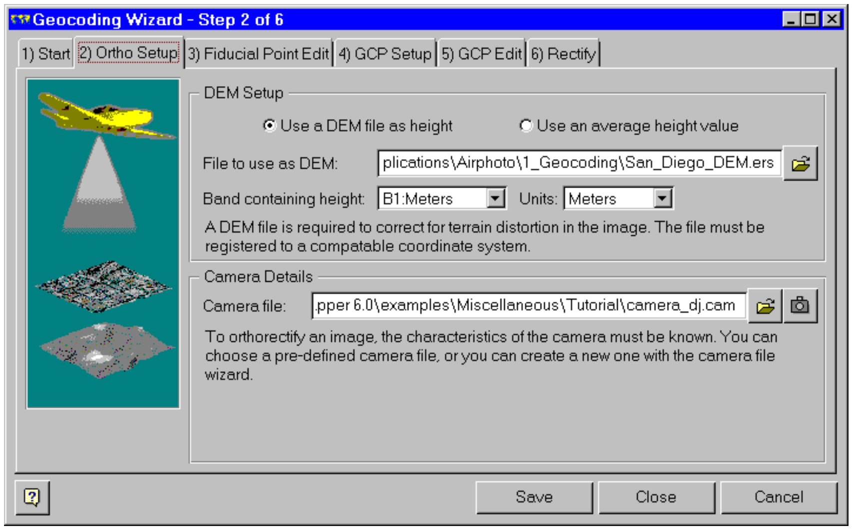
4 Select the directory 'Applications\,Airphoto\1_Geocoding' and then double-click on 'San_Diego_Airphoto_34_not_rectified.ers' to select it.

5 Select the Geocoding Wizard **Orthorectify using ground control points** option.

In this example, you do not have exterior orientation parameters which provide information on the position of the platform or aircraft. Instead, you will pick GCPs so that the wizard can compute the exterior orientation parameters. If these parameters were available, you would have chosen the **Orthorectify using exterior orientation** option.

6 Select the **2) Ortho Setup** tab.

## Enter terrain and camera details




This tab allows you to enter the terrain details in the form of a DEM or as an average height value. Obviously, using a DEM would produce a more accurate result. However, if the terrain is relatively flat, you can enter an average value. In this example you will enter the name of a DEM file.

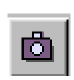
You supply the camera details to the Geocoding Wizard in the form of a camera file. If the applicable camera file does not exist, you can use the Camera Wizard to create one.

1 Select the **Use a DEM file as height** option in the **DEM Setup** box.

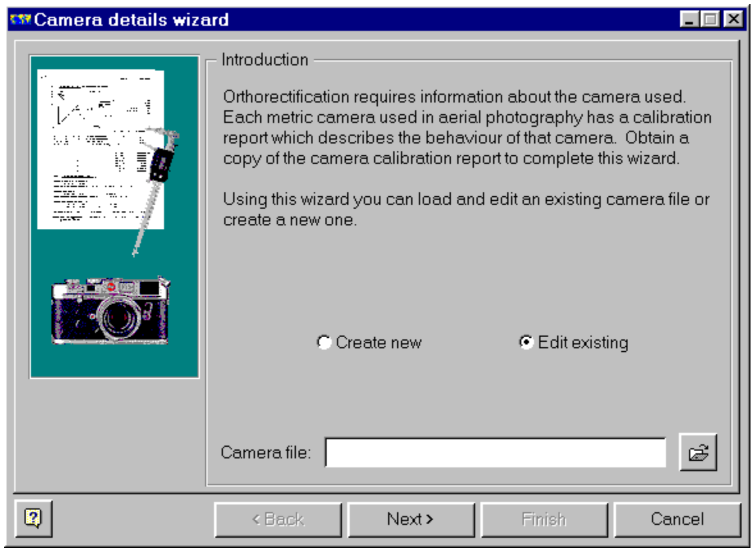
Notice that the DEM Setup box changes according to the option that you choose. Because you selected the **Use a DEM file as height** option, the DEM Setup box displays a file and a band chooser for you to select the DEM file and the required data band.

2 Click on the **Load input DEM File**  button to open the file chooser.

3 Select the file ‘San_Diego_DEM.ers’ from the ‘examples\Applications\,Airphoto\1_Geocoding’ directory and click on the OK button to return to the Geocoding Wizard.

4 Click on the **Camera Wizard**  button to open the Camera Wizard dialog.

## Create a Camera file

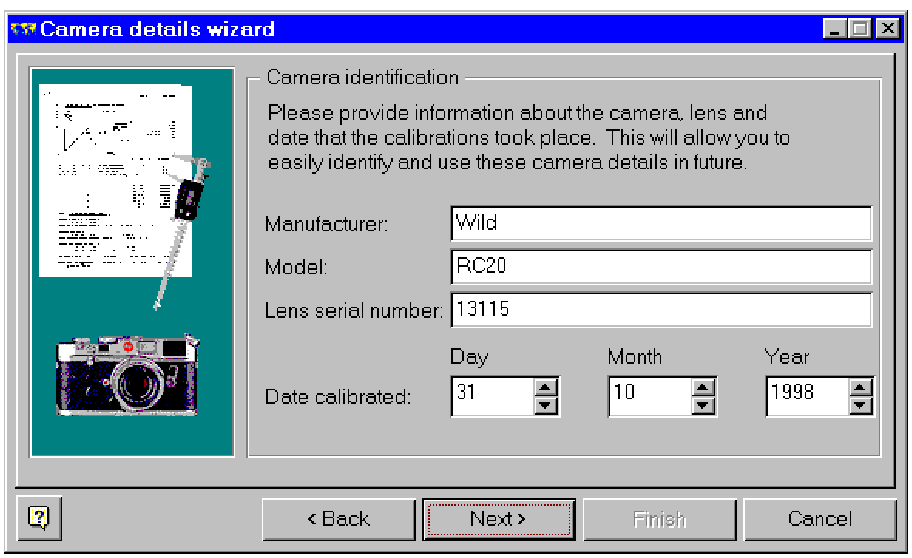



The Camera Wizard creates a Camera file for the Geocoding Wizard to use. It does this by providing a number of dialog boxes for you to enter camera calibration information. You normally get this information from a camera calibration report. If you do not have a valid calibration report for the camera that was used to take the image, you can use a generic report for that camera model. This could result in a some inaccuracies.

1 Click on the **Create new** option to create a new Camera File.

You could edit an existing Camera File, in which case the wizard provides you with the **Camera file:** field and chooser to enter the name of the existing file.

2 Click on the **Next>** button to go to the Camera identification page.



The information you enter here is not used by the Geocoding Wizard. Therefore it can be omitted. It is, however, a good idea to include it because it is a means of identifying the camera and the calibration report in the future.

3 Enter the following information in the applicable fields:

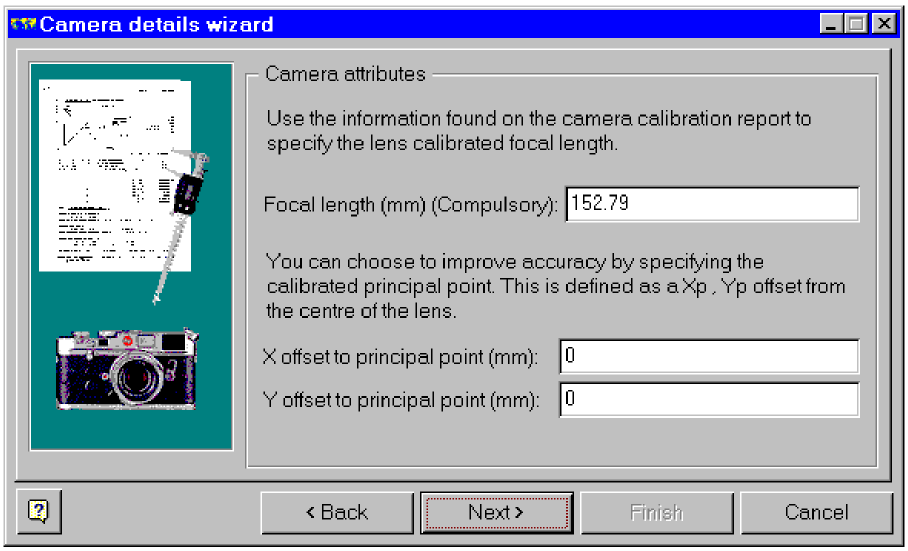
**Manufacturer:** Wild

**Model:** RC20

**Lens serial number:** 13115

**Date calibrated:** Day: 31 Month:10 Year: 1998

4 Click on the **Next>** button to go to the ‘Camera attributes page’.




Use this page to enter information on the focal length of the camera lens. The Camera Wizard uses this information, so it must be entered. In addition, you can enter information on the position of the Principal Point relative to the lens center as a measure of lens distortion. Any distortion in the lens would cause the principal point to be offset from the lens center.

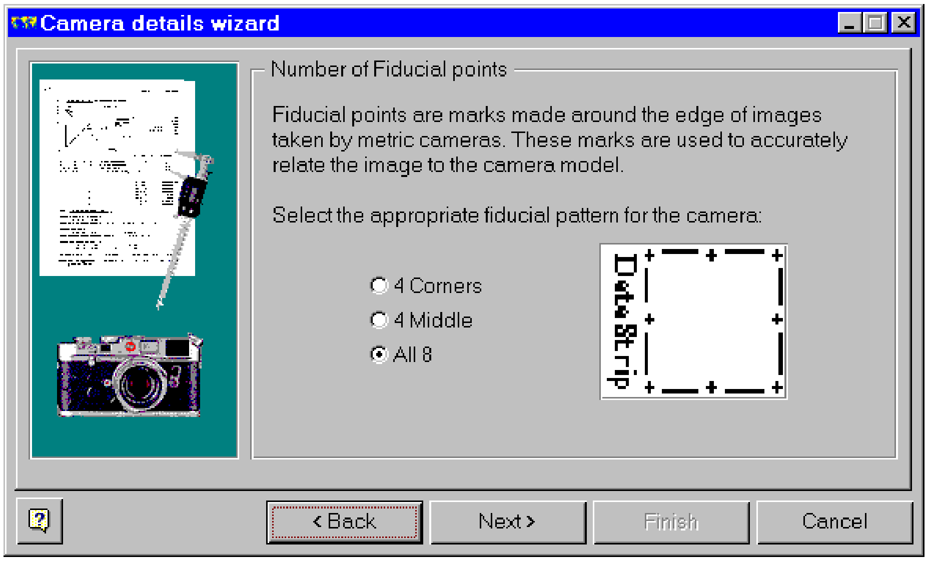
5 Enter the following information in the applicable fields:

**Focal length:** 152.793

**X offset to principal point:** 0

**Y offset to principal point:** 0

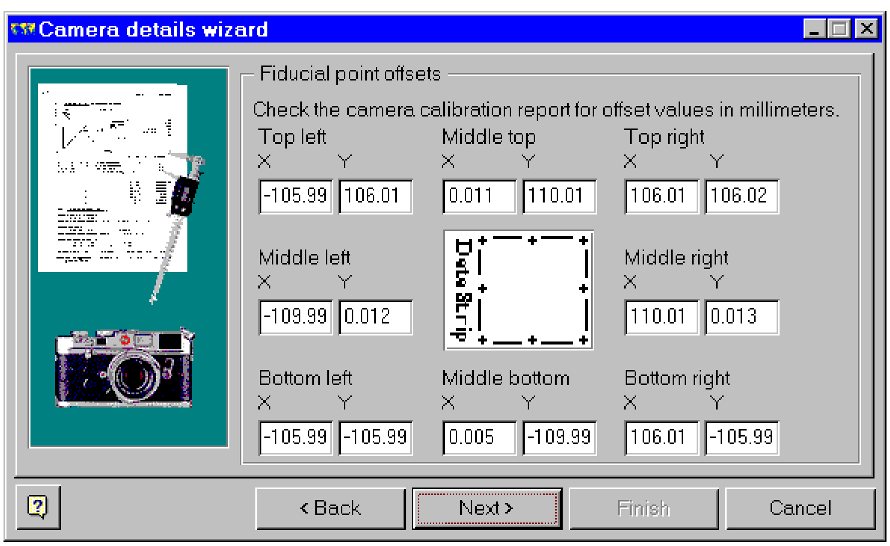
6 Click on the **Next>** button to go to the 'Number of Fiducial points' page




Aerial photography cameras insert Fiducial marks around the edges of the airphoto images. The Geocoding Wizard uses the positions of these marks to relate the image to the camera model. Different cameras insert these marks in different places on the image. Use this page to specify where the camera has placed the Fiducial marks. If you specify four Fiducial marks where the camera has, in fact, inserted eight, the Geocoding Wizard will only take into consideration the four you specified.

7 Select the **All 8** option; indicating that the Fiducial points are on the four corners and the middle of edges of the image.

8 Click on the **Next>** button to got to the 'Fiducial point offsets' page.

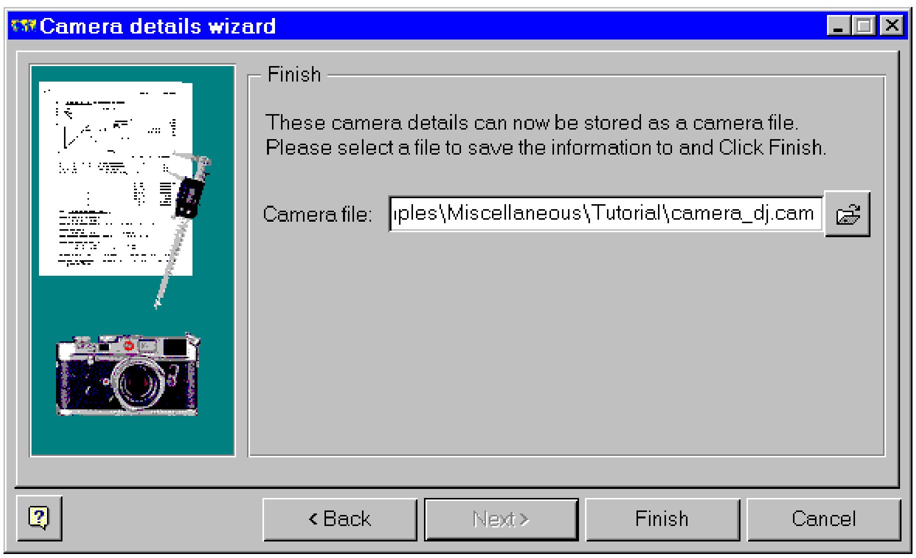



This page enables you to specify the positions of the fiducial points relative to the principal point.

9 Enter the following values in the applicable fields:

| | |
|---|---|
| **Top left** | X:-105.99 Y:106.01 |
| **Middle top** | X: 0.011 Y: 110.01 |
| **Top right** | X:106.01 Y:106.02 |
| **Middle left** | X:-109.99 Y: 0.012 |
| **Middle right** | X:110.01 Y: 0.013 |
| **Bottom left** | X:-105.99 Y:-105.99 |
| **Middle bottom** | X:-0.005 Y: -109.99 |
| **Bottom right** | X:106.0l Y:-105.99 |

10 Click on the **Next>** button to go to the 'Finish' page.




11 Click the **Save** button in the **Camera file:** field to open the file chooser to select a directory and file name to which to save the new camera file.

12 From the **Directories** menu, select the path ending with the text **\examples**.

13 Select the directory 'Miscellaneous\Tutorial,' and then enter '**camera_*<your initials>***' in the **Save as:** field.

14 Click on the **OK** button to return to the Camera Wizard.

The file name and directory you entered should now be displayed in the **Camera file:** field.

15 Click on the **Finish** button to return to the Geocoding Wizard.

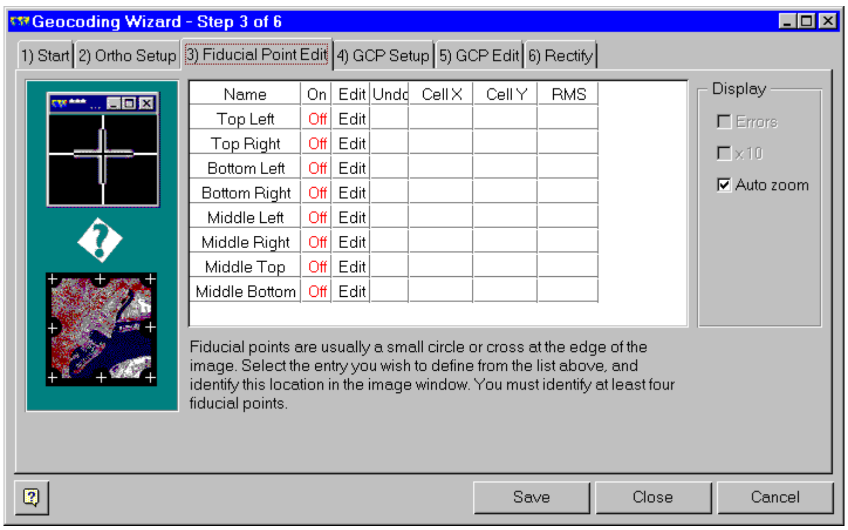
16 Click the **Load Camera File** button in the Geocoding Wizard **Camera file:** field to open the file chooser.

17 From the **Directories** menu, select the path ending with the text **\examples**.

18 Select the directory 'Miscellaneous\Tutorial,' and then double-click on the 'camera_<*your initials*>' file you saved.

19 Click on the **3) Fiducial Point Edit** tab.

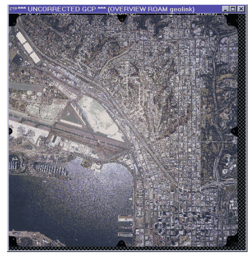
## Edit the fiducial points




This wizard page enables you to enter the locations of the fiducial points on the image into ER Mapper.

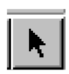
ER mapper opens two image windows one in OVERVIEW ROAM mode, and the other in ZOOM mode.

ZOOM



OVERVIEW ROAM

1 Select the **Auto zoom** option. This causes the ZOOM window to automatically zoom to the selected fiducial mark.

2 Select the **Pointer Tool**  on the **Standard** toolbar.

3 On the table, select 'Top Left' in the 'Name' column.

4 In the OVERVIEW ROAM window, click on the Fiducial mark on the top left corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

5 On the table, select 'Top Right' in the 'Name' column.

6 In the OVERVIEW ROAM window, click on the Fiducial mark on the top right corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

7 On the table, select 'Bottom Left' in the 'Name' column.

8 In the OVERVIEW ROAM window, click on the Fiducial mark on the bottom left corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

9 On the table, select 'Bottom Right' in the 'Name' column.

10 In the OVERVIEW ROAM window, click on the Fiducial mark on the bottom right corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

11 On the table, select ‘Middle Left’ in the ‘Name’ column.

12 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the left side of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

13 On the table, select ‘Middle Right’ in the ‘Name’ column.

14 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the right side of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

15 On the table, select ‘Middle Top’ in the ‘Name’ column.

16 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the top the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

17 On the table, select ‘Middle Bottom’ in the ‘Name’ column.

18 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the bottom of the image.

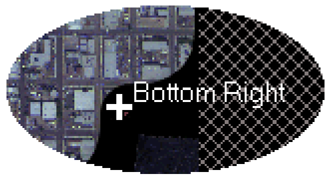
The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

After selecting the fiducial markers, the table on the **Fiducial Point Edit** tab should be similar to what is shown below.

| Name | On | Edit | Undo | Cell X | Cell Y | RMS |
|---|---|---|---|---|---|---|
| Top Left | On | Edit | Undo | 211.13 | 322.41 | 0.23 |
| Top Right | On | Edit | Undo | 5221.11 | 322.26 | 0.13 |
| Bottom Left | On | Edit | Undo | 202.80 | 5333.18 | 0.31 |
| Bottom Right | On | Edit | Undo | 5213.25 | 5333.81 | 0.26 |
| Middle Left | On | Edit | Undo | 112.59 | 2827.72 | 0.15 |
| Middle Right | On | Edit | Undo | 5311.96 | 2827.56 | 0.34 |
| Middle Top | On | Edit | Undo | 2716.12 | 227.64 | 0.20 |
| Middle Bottom | On | Edit | Undo | 2707.95 | 5428.11 | 0.13 |

The RMS column should show values of less than 1.00.

The image window should now have all the fiducial points labelled.

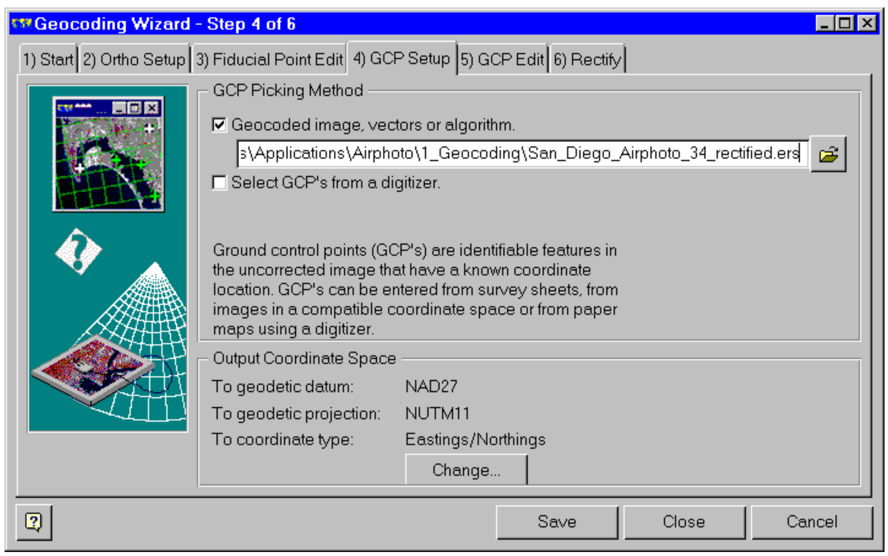



19 If necessary, select the **Errors** option, and adjust the position of the selections in the direction of the indicated errors.

The x10 option enlarges the error markers for a more accurate indication.

20 Click on the **4) GCP Setup** tab.

## Setup Ground Control Points

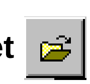



The **GCP Setup** tab lets you specify the way that you want to choose control points. Control points may be entered manually, chosen from a reference image, chosen from a digitizing tablet, or chosen using a combination of these three methods.

In this exercise, you will use a previously orthorectified reference image to locate GCPs.

1 In the **GCP Picking Method** box, select **Geocoded image, vectors or algorithm** option.

This tells ER Mapper you plan to pick corresponding points between two images on the screen.

2 Click the **Load Corrected Algorithm or Dataset**  file chooser button.

3 Choose 'ER Mapper Raster Dataset (.ers)' in the **Files of Type:** field.

4 From the **Directories** menu on the file chooser dialog, select the path ending with the text **\examples**.

5 Double_click on the 'Applications' directory to open it.

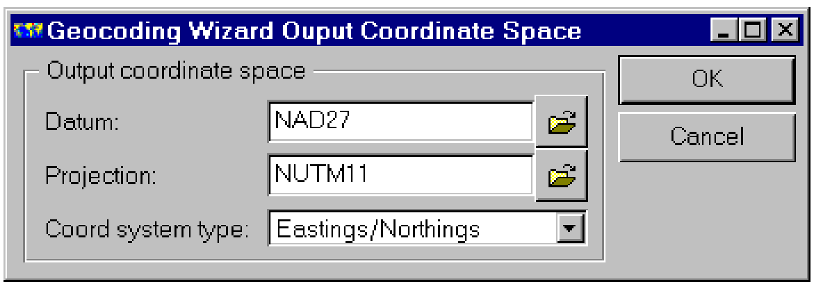
6 Double-click on the 'Airphoto\1_Geocoding' directory to open it, then double-click on 'San_Diego_Airphoto_34_rectified.ers' to load it.

This is the already rectified image containing coordinate information.

## Setup parameters for the image rectification

The **To geodetic datum**, **To geodetic projection** and **To Coordinates**, fields in the Output Coordinate Space box show the datum, projection and coordinate type for the output rectified file you will create. These parameters are included automatically from the 'CORRECTED' (rectified) airphoto image.

7 Click on the **Change...** button to open the **Geocoding Wizard Output Coordinate Space** dialog.

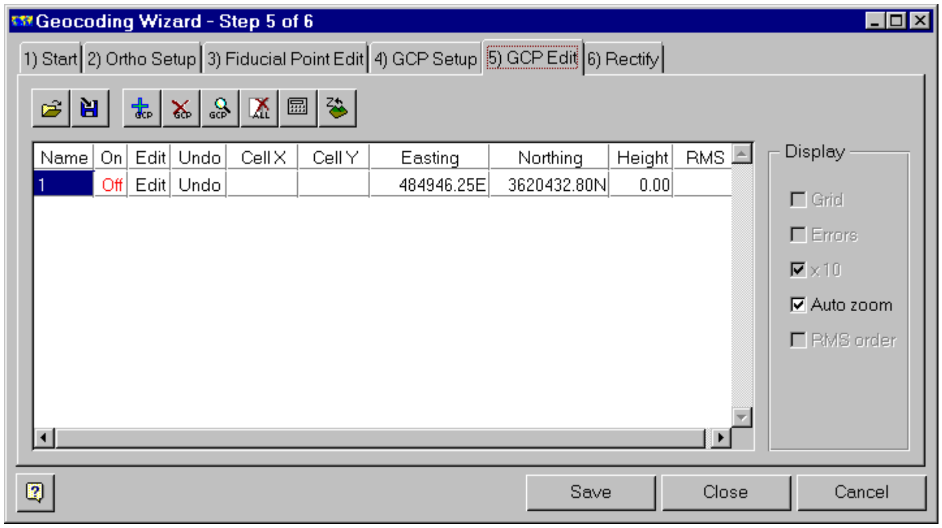



8 If necessary, change the settings to what is displayed above.

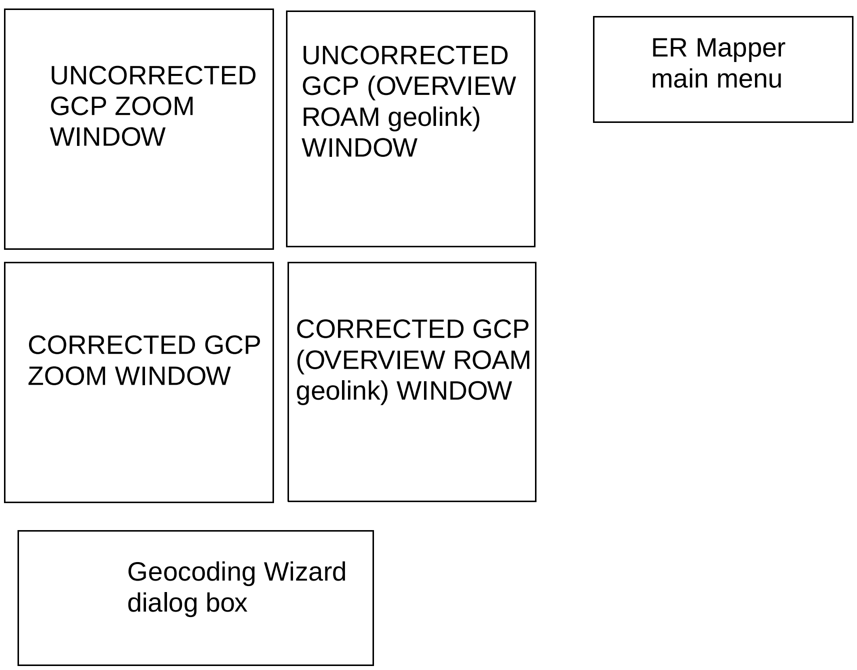
9 Click **OK** on the **Geocoding Wizard Output Coordinate Space** dialog to close it.

10 Select the Geocoding Wizard **5) GCP Edit** tab.

## Edit Ground Control Points




ER Mapper opens several image windows and dialog boxes. You should see a screen setup similar to this one:




**Note:** If your system does not position the windows automatically, rearrange them as shown above before proceeding.

### Pick a GCP in the upper-left part of both images

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**Note:** Make sure the main ER Mapper menu is not hidden by the image windows–move it slightly if needed so you can easily access the toolbars.

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1 On the Geocoding Wizard **GCP Edit** tab, select **Auto zoom**.

The ZOOM windows will now automatically zoom into the point selected in the corresponding OVERVIEW ROAM windows.

2 Click on a well defined feature in the 'UNCORRECTED GCP (OVERVIEW ROAM geolink)' window to select it.

The 'UNCORRECTED GCP ZOOM' window will zoom ito the selected point

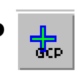
3 Click once in the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window to activate it, then click on the same feature to select it as a GCP.

The 'CORRECTED GCP ZOOM' window will zoom ito the selected point

4 Use the two ZOOM windows to adjust the positions of the GCP.

You have now picked a GCP in the image.

### Pick a second GCP in the lower-left of both images

5 On the Geocoding Wizard **Edit GCP** dialog, click the **Add new GCP**  button.

6 Click on a well defined feature in the 'UNCORRECTED GCP (OVERVIEW ROAM geolink)' window to select it.

The 'UNCORRECTED GCP ZOOM' window will zoom into the selected point

7 Click once in the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window to activate it, then click on the same feature to select it as a GCP.

The 'CORRECTED GCP ZOOM' window will zoom ito the selected point

8 Use the two ZOOM windows to adjust the positions of the GCP.

You have now picked a second GCP in the image.

9 Following the above steps, pick another four GCPs near the upper-right, lower-right and middle of the images.

The more GCPs you pick the lower the possibility of errors. For orthorectification you need at least six.

## Try some other features on the Geocoding Wizard GCP Edit dialog

1 In the Geocoding Wizard **GCP Edit** dialog, click on any GCP number under the ‘Name’ column.

ER Mapper moves the crosshairs to highlight that point in all the ‘OVERVIEW ROAM’ and ‘ZOOM’ windows.

2 Turn off the **Auto Zoom** option at the bottom.

3 Click on any GCP number under the ‘Name’ column.

ER Mapper moves the crosshairs to highlight that point in the ‘OVERVIEW ROAM’ windows, but not the ‘ZOOM’ windows.

4 Click on the **Zoom to current GCP**  button.

ER Mapper zooms into the selected GCP in the “ZOOM’ windows.

5 Select the number text for a GCP under the ‘Name’ column, and type a short name.

You can give GCPs text labels as well as numbers to help identify them.

6 Click on the text ‘On’ in the second column for any GCP.

The text changes to ‘Off’ and all the RMS errors are recomputed without including that GCP. (This is an easy way to see how the positional error of any GCP influences the RMS of the others. For example, turning off a GCP with a large RMS often reduces the RMS of the others.) This can be important when choosing which GCPs will be used for the final image rectification.

7 Turn off other GCPs to see the effect, but turn all on again when finished.

8 Click on the text ‘Edit’ in the third column for any GCP.

The text changes to ‘No’ and the “X” and number marking it in the image turns green. This effectively “locks” a GCP so it cannot be edited (that is, clicking in the image windows do not redefine it’s position). This is useful when you have several very good GCPs and you to lock them to avoid accidentally changing them.

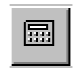
9 Turn on the **Errors** option.

The magnitude and direction of the calculated positional error are shown graphically by a line for each GCP on the image. (If you have very small RMS errors you may not see the error line, even if you increase the line length by a factor of 10 using the **x10** option.)

10 Turn on the **Grid** option.

A polynomial grid displays over all three image windows. This grid is a simple “preview” of the way in which the FROM (raw) image pixels will be reprojected onto the new coordinate grid of the TO image. (This grid is only an approximation, in reality the lines would be curved.)

11 Click the **Add new GCP**  button and select a point on the CORRECTED image.

12 Click on the **Calculate uncorrected point**  button. The wizard will automatically position the corresponding GCP on the UNCORRECTED image. Use the ZOOM windows to adjust the GCP position.

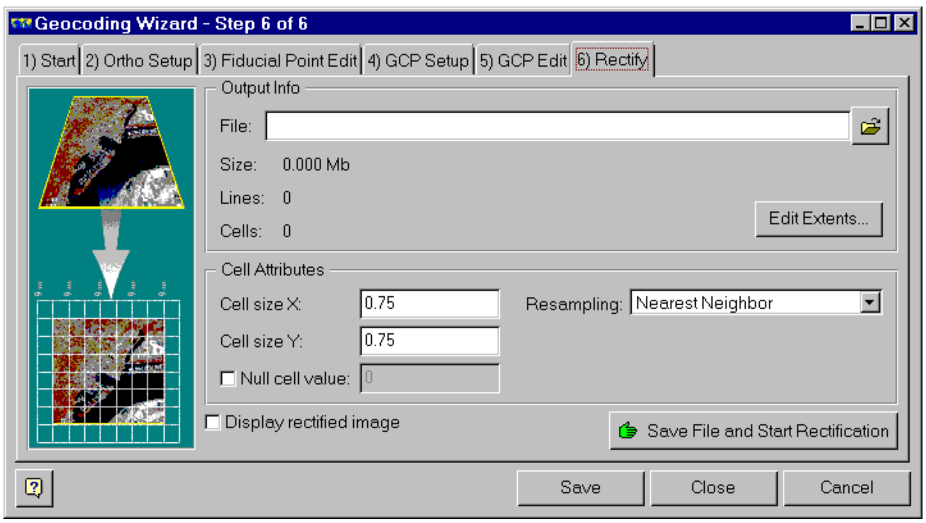
This facility is available once you have positioned four points.

13 Click **Save** on the **Geocoding Wizard** dialog. When asked confirm saving the GCPs to disk, click **Yes**.

This will save the geocoding information into the header file of the UNCORRECTED image.

14 Select the Geocoding Wizard **6) Rectify** tab.

## Rectify the image



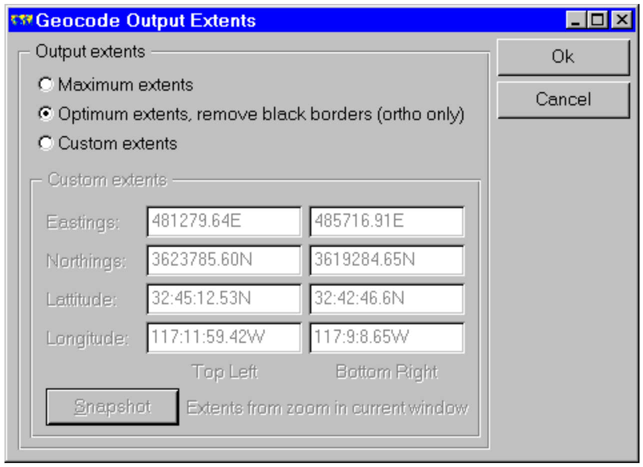

1 Click the file chooser  button in the **Output Info** box.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the 'Miscellaneous\Tutorial' directory to open it.

4 Enter the filename '`Airphoto_orthorectified`' (start with your initials), then click **OK**.

5 Click on the **Edit Extents...** button to open the **Geocode Output Extents** dialog box.




This dialog allows you to specify how much of the orthorectified image you want to save. You have three main options:

**Maximum extents**: Saves the whole image including any portion not visible in the currently active image window.

**Optimum extents**: Automatically calculates the extents of airphotos to exclude the black edges around them.

**Custom extents**: Allows you to specify the top left and bottom right coordinates of the area to be included. If you click on the **Snapshot** button ER Mapper will automatically select the extents of the visible part of the image in the currently active image window.

6 Select the **Optimum extents** button to remove the black edges.

7 Click on the OK button to return to the Geocoding Wizard.

8 In the **Resampling:** in the Cell Attributes box select ‘Nearest Neighbour’.

The Cell Attributes box also lets you resample the output image to a different cell size (Output Cell width and height), and specify a null cell value.

9 Click on the Save button to save the orthorectification parameters in the ‘San_Diego_Airphoto_34 _not_rectified.ers’ header file.

You will use this in the next exercise.

10 Select **Display rectified image** to display the image after it is rectified.

11 Click on the **Save file and start rectification** button.

ER Mapper opens a status dialog to indicate the progress of the rectification.

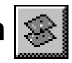
12 When the operation finishes, click **OK** of the successful completion dialog.

13 Click on the **Close** button to exit the Geocoding Wizard.

You have now rectified the uncorrected airphoto image to correspond to the 1927 North American Datum (NAD27) and UTM zone 11 (NUTM11) map projection.

14 Do not close the image window with the orthorectified image

## Evaluate the image orthorectification

1 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** window.

2 The Algorithm window shows the Red, Green and Blue layers of the orthorectified image '*<your Initials>*_Airphoto_orthorectified'

3 In the **Algorithm** window, click on the Blue layer to select it.

4 Click the **Load Dataset**  button in the algorithm process diagram.

5 From the **Directories** menu, select the path ending with **\examples**.

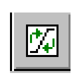
6 Double-click on the 'Applications' directory to open it.

7 Double-click on the 'Airphoto' and then on '1_Geocoding' directory to open it.

8 Click once on the image 'San_Diego_Airphoto_34 _rectified.ers' to select it, then click **OK this layer only** button to load it into the Blue layer. (The Red and Green layers should still have the '*<your Initials>*_Airphoto_orthorectified' image.)

9 Select **B3:Blue** from the Blue layer's **Band Selection** drop-down list.

## Display the two images to evaluate registration

1 Click the **99% Contrast Enhancement**  toolbar button.

This image combines two different images–one in the Red and Green layers and one in the Blue layer. If your images are well aligned the image appears normal. If you see areas that are dominantly yellow or blue, this indicates poor registration.

2 On the **Algorithm** window, turn off the **Smoothing** option.

3 On the main menu, click the **ZoomBox tool** toolbar button.

4 Drag a zoom box over a very small area of the image that contains land and water.

Errors in registration appear as either blue or yellow pixels because this is where the two images do not align perfectly. This is a very simple way to evaluate the registration of two images. If the RMS errors of your GCPs were generally less than one, you should not see more that one pixel offsets or registration errors.

### Close all windows

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.

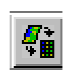
2 Click **Close** on the **Algorithm** window to close it.

# 2: Orthorectify an airphoto using Exterior Orientation

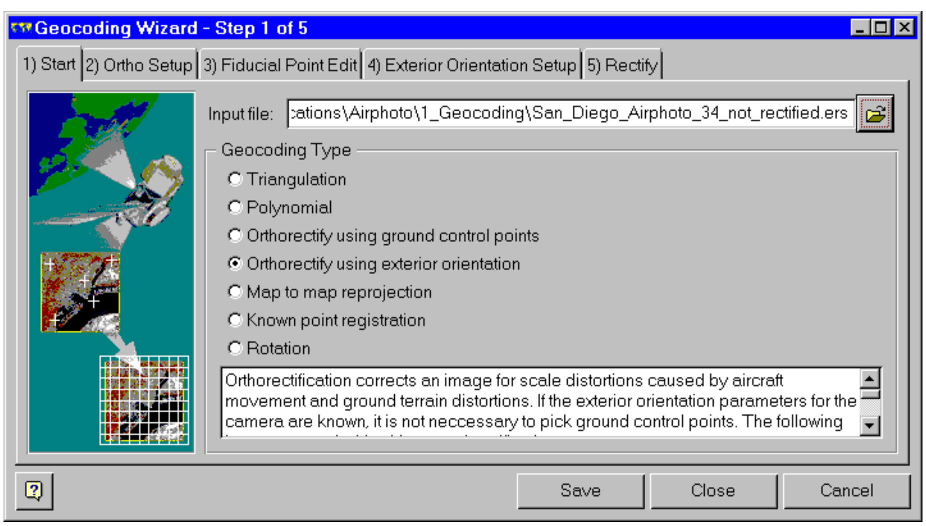
***Objectives*** Learn how to use ER Mapper's Geocoding Wizard to orthorectify an airphoto using Exterior Orientation parameters

In this exercise you will orthorectify the same image as in the previous exercise. This time, instead of using Ground Control Points, you will enter Exterior Orientation parameters which have been obtained from a photogrammetry, aerial triangulation or geoposition system external to ER Mapper. In the previous exercise you saved orthorectification parameters in the 'San_Diego_Airphoto_34_not_rectified.ers' file. This means that you will not have to re-enter them in this exercise.

### Open the Geocoding Wizard

1 Click on the **Ortho and Geocoding Wizard**  button in the **Common Functions** toolbar.

The Geocoding Wizard will open with the **1) Start** tab selected.



2 Click the **Load Algorithm or Dataset** button in the **Input file:** field to open the file chooser.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Select the directory ‘Applications\,Airphoto\1_Geocoding’ and then double-click on ‘San_Diego_Airphoto_34_not_rectified.ers’ to select it.

This is the same file as that you used in the previous exercise.

5 Select the Geocoding Wizard **Orthorectify using exterior orientation** option.

In this example, you enter exterior orientation parameters which provide information on the position of the platform or aircraft.

6 Select the **2) Ortho Setup** tab.

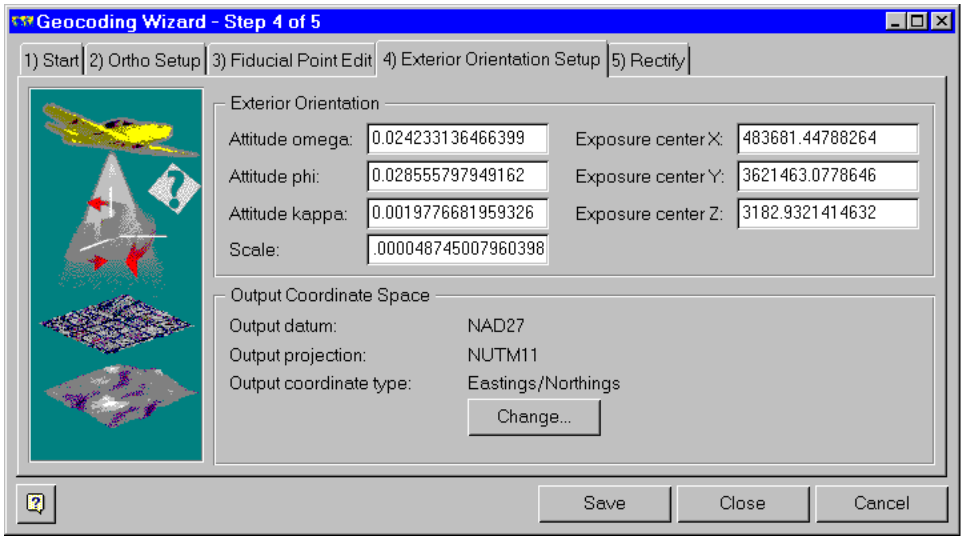
The fields in the Ortho Setup page should contain the information that you entered in the previous exercise because it was saved to the header file of the image being orthorectified.

7 Click on the **3) Fiducial Point Edit** tab.

The fields in the Fiducial Point Edit page should also contain the information you entered in the previous exercise.

8 Click on the **4) Exterior Orientation Setup** tab.

## Enter Exterior Orientation parameters




Exterior Orientation parameters contain information on the position of the platform or aircraft at the time the image was taken. You would have to obtain this data from a system external to ER Mapper. If these parameters are not available then you would use Ground Control Points as in the previous exercise.

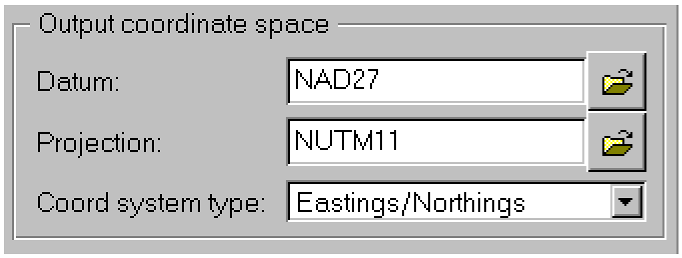
1 Enter the information in the relevant fields as shown in the table below:

| Field name | Description | Enter value |
|---|---|---|
| Attitude omega | The tilt angle (roll) of the aircraft; i.e. the rotation about the X axis (direction of travel). | 0.024233136466399 |
| Attitude phi | The swing angle (pitch) of the aircraft; i.e the rotation about the Y axis. | 0.028555797949162 |
| Attitude kappa | The azimuth angle (yaw)of the aircraft; i.e the rotation about the Z axis. | 0.0019776681959326 |
| Exposure center X | The X co-ordinate of the exposure center of the image. | 483681.44788264 |
| Exposure center Y | The Y co-ordinate of the exposure center of the image. | 3621463.0778646 |

| Field name | Description | Enter value |
|---|---|---|
| Exposure center Z | The Z co-ordinate of the exposure center of the image. | 3182.9321414632 |
| Scale | The scale of the image expressed as a decimal value. | 0.000048745007960398 |

2 Click on the **Change...** button to open the **Geocoding Wizard Output Coordinate Space** dialog.

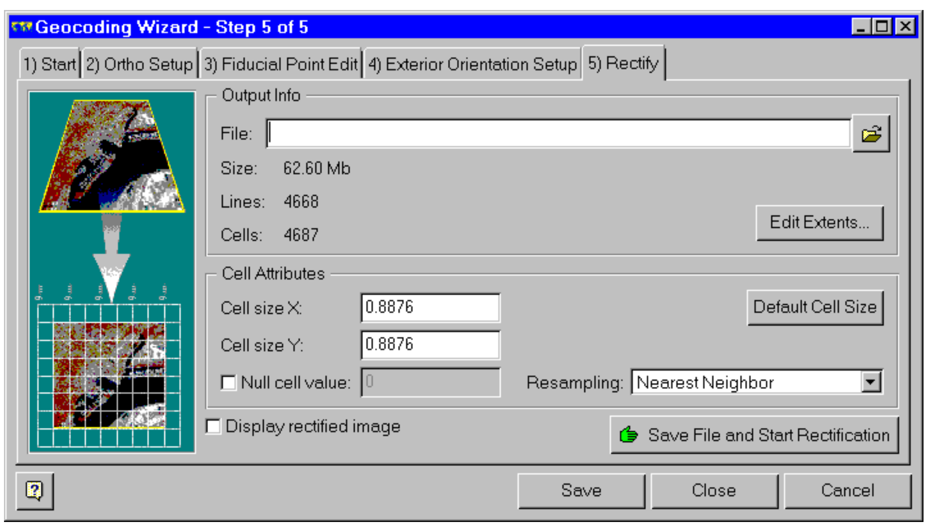
3 Enter the **Datum**, **Projection** and **Coord system type** as shown below




**Tip:** NUTM11 is a utm projection type.

4 Click on the **5) Rectify** tab.

## Rectify the image



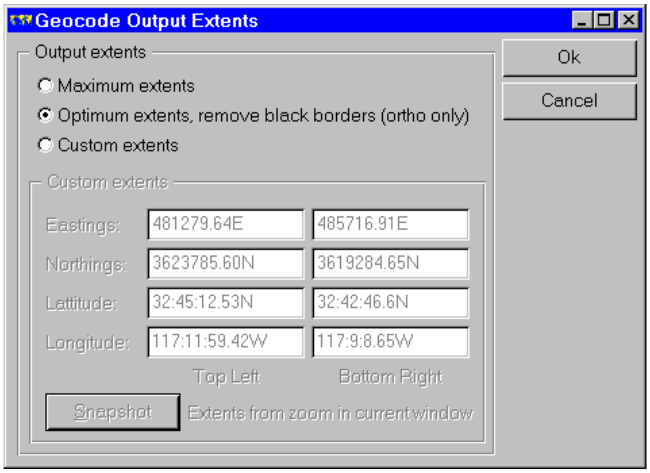

1 Click the file chooser  button in the **Output Info** box.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the 'Miscellaneous\Tutorial' directory to open it.

4 Enter the filename '**`Airphoto_orthorectified_advanced`**' (start with your initials), then click **OK**.

5 Click on the **Edit Extents...** button to open the **Geocode Output Extents** dialog box.




This dialog allows you to specify how much of the orthorectified image you want to save. You have three main options:

| | |
|---|---|
| **Maximum extents**: | Saves the whole image including any portion not visible in the currently active image window. |
| **Optimum extents**: | Automatically calculates the extents of airphotos to exclude the black edges around them. |
| **Custom extents**: | Allows you to specify the top left and bottom right coordinates of the area to be included. If you click on the **Snapshot** button ER Mapper will automatically select the extents of the visible part of the image in the currently active image window. |

6 Select the **Optimum extents** button to remove the black edges.

7 Click on the OK button to return to the Geocoding Wizard.

8 In the **Resampling:** in the Cell Attributes box select 'Nearest Neighbour'.

The Cell Attributes box also lets you resample the output image to a different cell size (Output Cell width and height), and specify a null cell value.

9 Click on the Save button to save the orthorectification parameters in the 'San_Diego_Airphoto_34 _not_rectified.ers' header file.

10 Select **Display rectified image** to display the image after it is rectified.

11 Click on the **Save file and start rectification** button.

ER Mapper opens a status dialog to indicate the progress of the rectification.

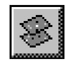
12 When the operation finishes, click **OK** on the successful completion dialog.

13 Click on the **Close** button to exit the Geocoding Wizard.

You have now rectified the uncorrected airphoto image to correspond to the 1927 North American Datum (NAD27) and UTM zone 11 (NUTM11) map projection.

14 Do not close the image window with the orthorectified image

## Evaluate the image orthorectification

1 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** window.

2 The Algorithm window shows the Red, Green and Blue layers of the orthorectified image ‘*<your Initials>*_Airphoto_orthorectified_advanced’

3 In the **Algorithm** window, click on the Blue layer to select it.

4 Click the **Load Dataset**  button in the algorithm process diagram.

5 From the **Directories** menu, select the path ending with **\examples**.

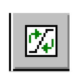
6 Double-click on the ‘Applications’ directory to open it.

7 Double-click on the ‘Airphoto’ and then on ‘1_Geocoding’ directory to open it.

8 Click once on the image ‘San_Diego_Airphoto_34 _rectified.ers’ to select it, then click **OK this layer only** button to load it into the Blue layer. (The Red and Green layers should still have the ‘*<your Initials>*_Airphoto_orthorectified_advanced’ image.)

9 Select **B3:Blue** from the Blue layer’s **Band Selection** drop-down list.

## Display the two images to evaluate registration

1 Click the **99% Contrast Enhancement**  toolbar button.

This image combines two different images–one in the Red and Green layers and one in the Blue layer. If your images are well aligned the image appears normal. If you see areas that are dominantly yellow or blue, this indicates poor registration.

2 On the **Algorithm** window, turn off the **Smoothing** option.

3 On the main menu, click the **ZoomBox tool** toolbar button.

4 Drag a zoom box over a very small area of the image that contains land and water.

Errors in registration appear as either blue or yellow pixels because this is where the two images do not align perfectly. This is a very simple way to evaluate the registration of two images. If the RMS errors of your GCPs were generally less than one, you should not see more that one pixel offsets or registration errors.

## Close all windows

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Use the Camera Wizard to create a Camera File
- Select fiducial markers on an airphoto image
- Use options to modify the GCP display and edit GCPs
- Enter Exterior Orientation parameters for advanced orthorectification.
- Use the Geocoding Wizard to orthorectify a “raw” airphoto image to the chosen datum and map projection.

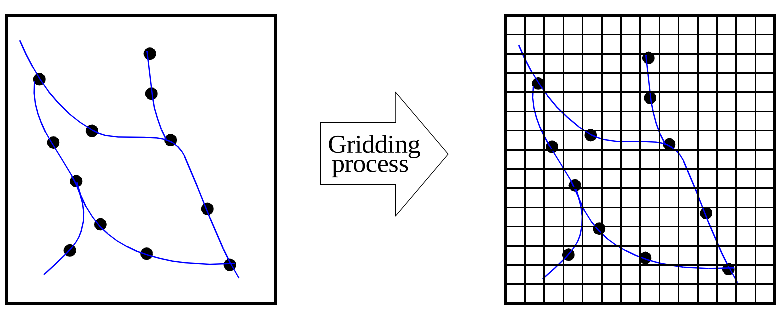
# 24

# Gridding

There are many instances where data is required to be in a regularly spaced grid, but is only available as samples taken at irregularly spaced locations. An example of this is a DEM which is required for orthorectification. Often, all that is available is a contour map or spot height measurements taken at different locations.

A gridding process will use irregularly spaced data to create a gridded raster image. It does this by laying a regularly spaced grid over the whole area and calculating a value for each cell in the grid. The accuracy of these calculations depends on the method used and the density and spacing of the input data.

The diagram below illustrates how a set of height measurements taken at different spots along a road network are used by a gridding process to create a gridded raster image of the whole area. As can be seen, there are large areas on the output where no input data is available.



The most common users of a gridding process would be cartographers or town planners using GIS or CAD applications, or anyone who has to orthorectify aerial photographs. Orthorectification requires a DEM which a gridding process can create from input data such as irregularly spaced spot height measurements and contour maps.

Geologists, mainly those in the mining industry, would use a gridding process to manipulate or “grid up” random geochemical samples.

Other uses could include monitoring pollution or population densities over a wide area by taking samples at arbitrarily spaced locations.

The ER Mapper Gridding Wizard creates regularly gridded raster files from a combination of any or all of the following types of data.

- Random line data
- Contour data, with faults, streamlines, ridgelines, and breaklines
- Random point data
- Regular line data
- Regularly gridded raster file

The output data is a raster (.ers) file with single or multiple bands containing regularly spaced grids.

ER Mapper supports two gridding techniques:

- Triangulation
- Minimum Curvature Under Tension

# Creating a gridded raster image

You can use the ER Mapper Gridding Wizard to generate a single or multiband raster image file from one or more input data sources. The input sources can be any of the following formats:

- Generic ASCII XYZ
- DXF
- USGS contour format (DLG-3)
- Any raster formats directly readable by ER Mapper (including .ers)
- ER Mapper .erv format

# Hands-on exercise

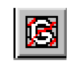
These exercises give you practice in using the Gridding Wizard to create a gridded raster image.

***Before you begin...***

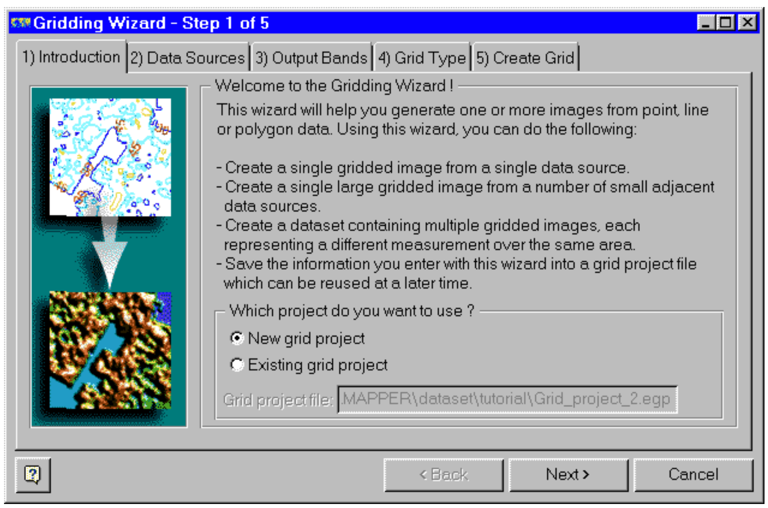
Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

# 1: Create a gridded image from text files

## Open the Gridding Wizard

1 Click the **Gridding Wizard** button on the Common Functions toolbar. 

The Gridding Wizard dialog opens with the **1)Introduction** tab selected.



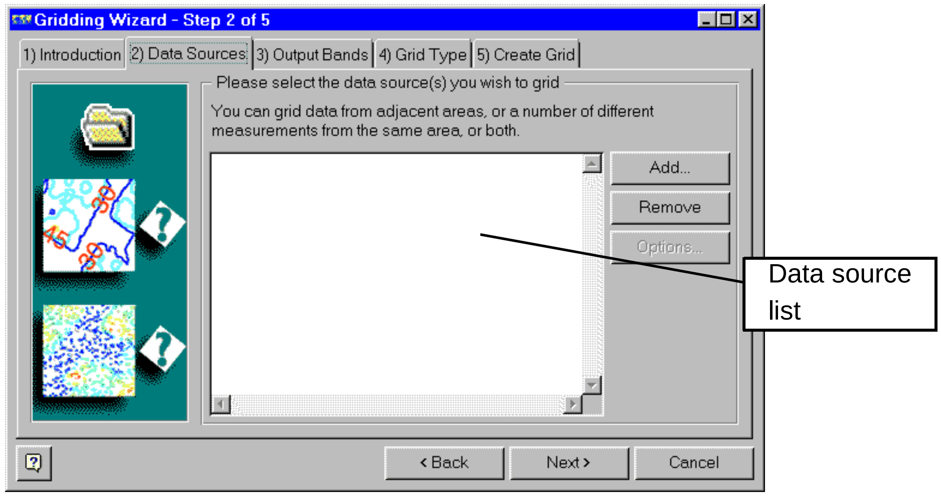

2 Select the **New grid project** option.

Notice that the **Grid project file:** field is grayed out. This is because you are creating a new project file. Therefore, you do not have to specify an existing one.

3 Click on the **Next>** button or select the **2) Data Sources** tab.

Both actions will take you to the next step by opening the Data Sources tab

## Select the input data source.




This tab allows you to enter one or more data sources for gridding. The data sources can be from the same or adjacent areas. For this example we are going to choose a number of text files as data sources.

The list of data sources should be empty because we have not yet entered any.

1 Click on the **Add...** button to enter a data source.

A file chooser dialog should open.

2 In the chooser dialog **Files of Type** field, select **AsciiXYZtext(.txt)**.

3 From the **Directories** menu, select the path ending with the text **\examples**

4 Double-click on the directory named 'Functions_And_Features' and then on the 'Gridding' directory.

The directory has four text files, supplied with the permission of the Geological Survey of Western Australia, that list geochemical sample readings at locations specified by Easting/Northing coordinates. An extract from the 'Peak_Hill_Al203.txt' file listing aluminum oxide sample readings is shown below

| #Easting | Northing | Al203 |
|---|---|---|
| 679346 | 7186699 | 11 |
| 675848 | 7182842 | 10.4 |
| 675882 | 7180203 | 7.22 |
| 680312 | 7182703 | 8.76 |

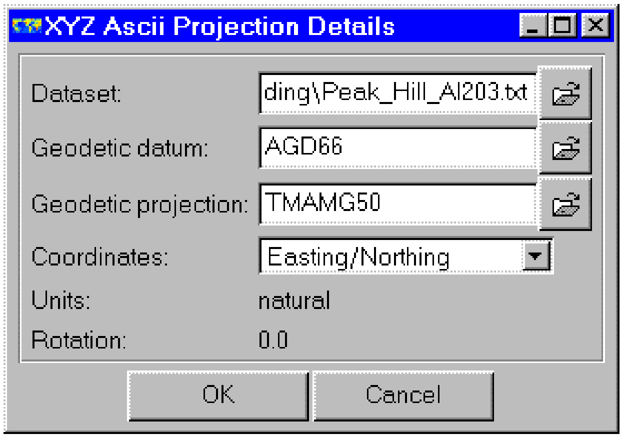
The information contained in the file is known as ASCIIXYZ data. The X Y components are the Easting/Northern coordinates of the locations, and the Z component is the aluminum oxide reading at each of the X Y locations.

The other three files are ‘Peak_Hill_CaO.txt’, ‘Peak_Hill_Fe203.txt’ and ‘Peak_Hill_MgO.txt’ which list traces of calcium oxide, copper oxide and magnesium oxide respectively.

In this exercise we will use the Gridding Wizard to create a gridded raster image with separate bands each showing overall concentrations of aluminum oxide, calcium oxide, copper oxide and magnesium oxide.

5 Click on the file named ‘Peak_Hill_Al203.txt, and then click **Apply**.

The Ascii Projection Details dialog box should open.




6 Check that the projection details are as shown above and then click on the OK button to return to the data source chooser.

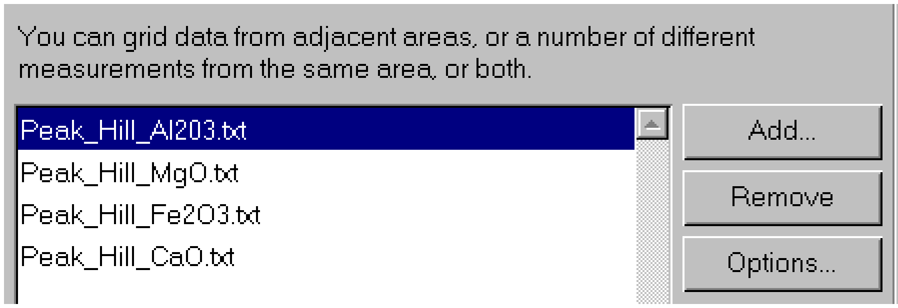
If the projection details are not as shown above, use the file chooser buttons  on the **Geodetic datum** and **Geodetic projection** fields to select ‘AGD66’ for the datum, and ‘TMAMG50’ from the ‘tranmerc’ projection list. Set **Coordinates** to ‘Easting/Northing’.

7 Repeat steps 5 and 6 to add the following files to the data source list:

- Peak_Hill_CaO.txt
- Peak_Hill_Fe203.txt
- Peak_Hill_MgO.txt

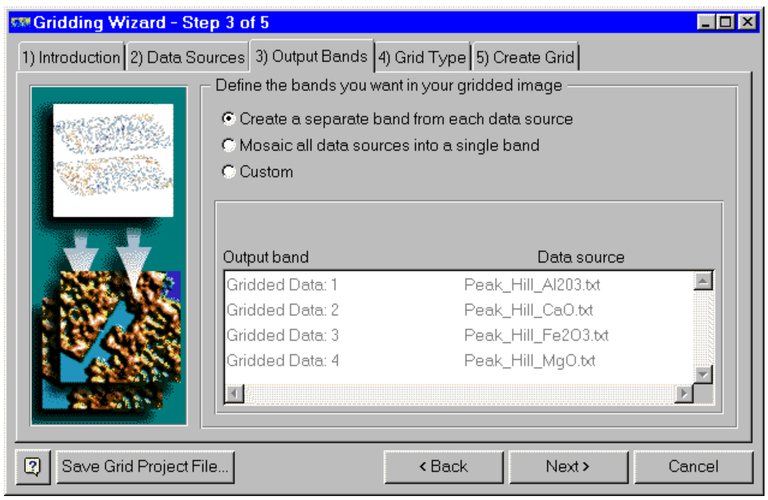
Click **OK** instead of **Apply** after selecting the last file.

The file names will appear in the source list box.




8 Click on the **Next>** button to go to the **3) Output Bands** tab.

## Define the output bands




The output gridded raster image can have one or more bands of information. The “Output Bands’ tab allows you to specify how the input sources are to be mapped to these output bands. There are three main options:

| | |
|---|---|
| **Create a separate band from each data source** | Each input source is allocated to a separate band. This creates an output gridded image with multiple bands as thematic overlays. |
| **Mosaic all data sources into a single band** | All the input sources are allocated, i.e. mosaiced, into a single band. This creates a single band output gridded image. |
| **Custom** | Enables the toolbar buttons for you to customize the output. You can specify the number of output bands and their descriptions, and then allocate individual or combinations of input sources to the output bands. |

1 Select the default option **Create a separate band from each data source.**

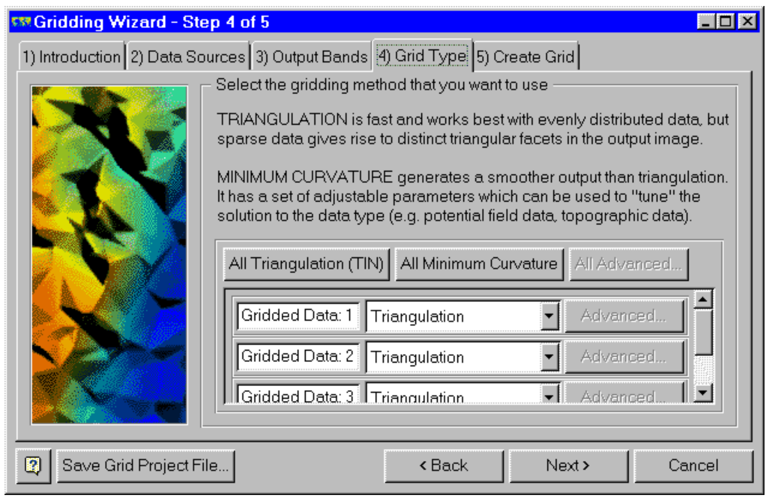
The list box will show:

| Output band | Data source |
|---|---|
| Gridded Data:1 | Peak_Hill.Al203.txt |
| Gridded Data:2 | Peak_Hill.MgO.txt |
| Gridded Data:3 | Peak_Hill_Fe203.txt |
| Gridded Data:4 | Peak_Hill.CaO.txt |

You will not be able to edit the entries in the list box.

2 Click on the **Next>** button to go to the **4) Grid Type** tab.

## Select the gridding method




There are two gridding methods available, viz. Triangulation and Minimum Curvature. Triangulation is simpler and works best with evenly distributed data. Minimum Curvature has a number of parameters which you can adjust to suit the input data.

The ‘Grid Type’ tab allows you to set the gridding method for the output bands collectively or individually.

We will set all the bands to Triangulation.

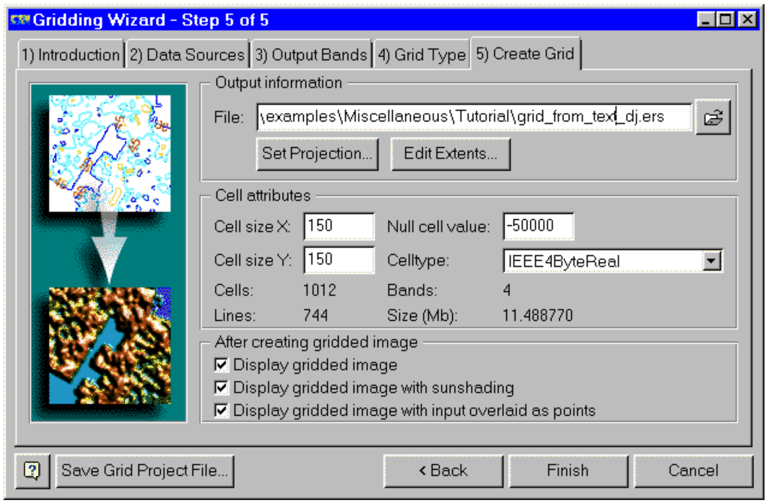
1 Click on the **All Triangulation (TIN)** button to set the gridding method to Triangulation.

You could also have selected Triangulation from the drop-down list next to each band description.

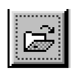
Notice that the **Advanced...** buttons are grayed out. This is because you do not have to set any further parameters for Triangulation.

2 Click on the **Next>** button to go to the **5) Create Grid** tab.

## Create the gridded image




The 'Create Grid' tab allows you to specify the file name and define the Extents, Projection and Cell attributes of the output gridded file. You can also select how you want the gridded image to be displayed.

1 Click on the File Chooser  button to open the **Gridding Wizard Output File** chooser dialog box.

2 From the **Directories** menu, select the path ending with the text **\examples**

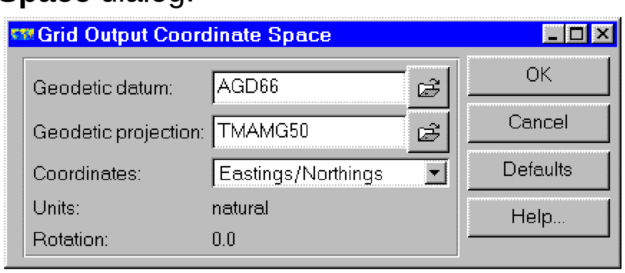
3 Double-click on the directory named 'Miscellaneous'.

4 Double-click on the directory named 'Tutorial.'

5 Enter '**`minerals_triangulated_grid_`*`<your initials>`***' in the chooser **Save as:** field, and click on the **OK** button.

The name with its path and a '.ers' extension will be inserted in the **File:** field of the 'Create Grid' tab. When you create the gridded image it will be saved to that file name.

6 Click on the **Set Projection...** button to open the **Grid Output Coordinate Space** dialog.

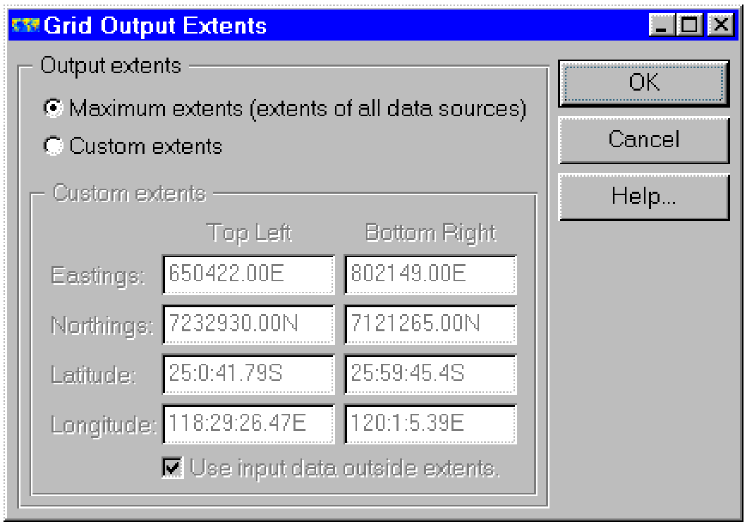


This dialog allows you to select a Geodetic datum, Geodetic projection and Coordinate type for the output gridded image. For this example we will use default values.

7 Click on the **Defaults** button to select the default values.

8 Click on the **OK** button to return to the Gridding Wizard.

9 Click on the **Edit Extents...** button to open the **Grid Output Extents** dialog box.




This dialog box allows you to specify the area to be included (extents) in the output gridded image. If you select the **Maximum extents** option, the output image will include the full extents of all the data sources. If you select the **Custom extents** option, you can then enter the top left and bottom right coordinates of the gridded image in the units you specified in the **Grid Output Coordinate Space** dialog. Generally this is in Eastings/Northings Longitude/Latitude or meters. This enables you to limit the extents of the gridded image to an area of interest.

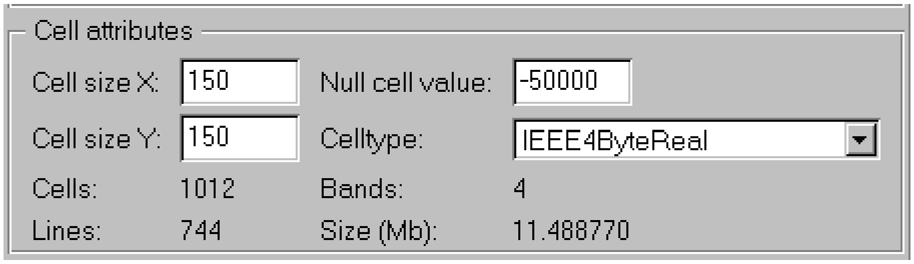
10 Select the **Maximum extents** option.

11 Click on the **OK** button to return to the Gridding Wizard.

12 Check that the number of cells and lines in the **Cell attributes** box show reasonable values.

13 If the size of the output file is larger than 12 Mb, increase the Cell size X: and Cell Size Y: values until the size is less than 12Mb.

Cell size values of 150 should result in the file size shown below




14 Select the following display option:

- Display gridded image with input overlaid as points

  You could also have selected the following options but, for the purpose of this exercise, we will just select the one:

- Display gridded image
- Display gridded image with sunshading

15 Select the **Save Grid Project File** button the open the chooser dialog.

All the grid data sources and settings you entered are stored in a project file which you can save and re-use.

16 From the **Directories** menu, select the path ending with the text **\examples**

17 Double-click on the directory named ‘Miscellaneous’.

18 Double-click on the directory named ‘Tutorial.’

19 Enter ‘**`grid_project_1_`*`<your initials>`***’ in the chooser **Save as:** field, and click on the **OK** button.

The project file is saved to the file name with a ‘.egp’ extension.

20 Click on the **Finish** button to generate the gridded image and close the Gridding Wizard

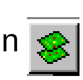
A Status dialog will indicate the progress of the gridding. On completion, ER Mapper will display an image window displaying the following algorithm;

- The gridded image in a pseudo layer and a grid datasource points vector layer.

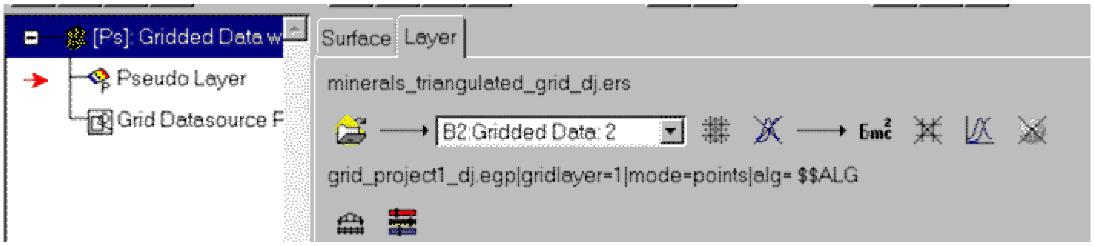
21 Click on the **Close** button to close the **Status** dialog.

## View an algorithm with the gridded image

1 Click on the image window title bar to make it active.

2 Open the Algorithm dialog by clicking on the **Edit Algorithm** button  on the Common Functions toolbar.

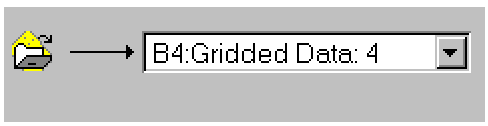
The algorithm has a surface with Pseudo and a Grid Datasource Points vector layer.




3 Select the Pseudo layer

This layer contains band **B1 Gridded Data:1** of the raster image you created. This displays the overall traces of aluminum oxide gridded from the 'Peak_Hill_Al203.txt' data source

4 Select bands B2 to B4.



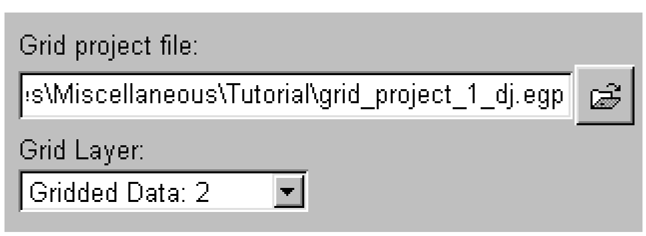

The image window will display the gridded trace of mineral associated with the band.

5 Select the Grid Datasource Points layer.

Notice that this layer is a Dynamic Link to the Project File you created. It shows point locations for the layer 1 (aluminum oxide) sample readings.

6 Click on the Dynamic Link Chooser  button in the layer process diagram to open the **Display grid datasource** points dialog box.

7 Select 'Gridded Data:2' from the **Grid Layer** drop-down list, and click on the **Finish** button to exit the dialog.




The image window will now show the point locations for the layer 2 (calcium oxide) sample readings.1

## Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

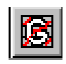
- For Windows, select **Close** from the window control-menu.

  Only the ER  Mapper main menu should be open on the screen.

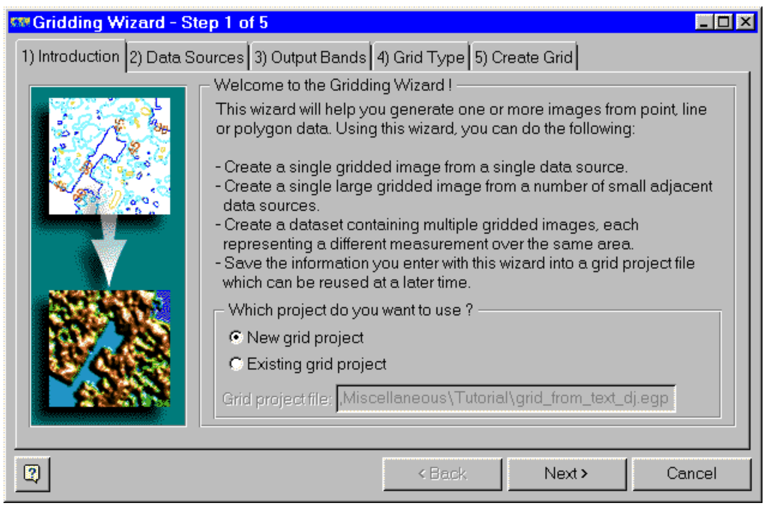
# 2: Create a gridded image using Minimum Curvature

In this exercise, we will create the same gridded image as we did previously. Instead of using Triangulation for all the bands we will now use Minimum Curvature for two of them. We will also gave the bands more meaningful names.

## Open the Gridding Wizard

1 Click on the **Gridding Wizard**  button on the **Common Functions** toolbar.

The Gridding Wizard dialog opens with the **1)Introduction** tab selected.




2 Select the **Existing grid project** option.

3 Select your previously saved 'grid_project_1_<*your initials*>.egp' project file from the '\examples\Miscellaneous\Tutorial' directory.

4 Click on the Gridding Wizard **Next>** button or select the **2) Data Sources** tab.

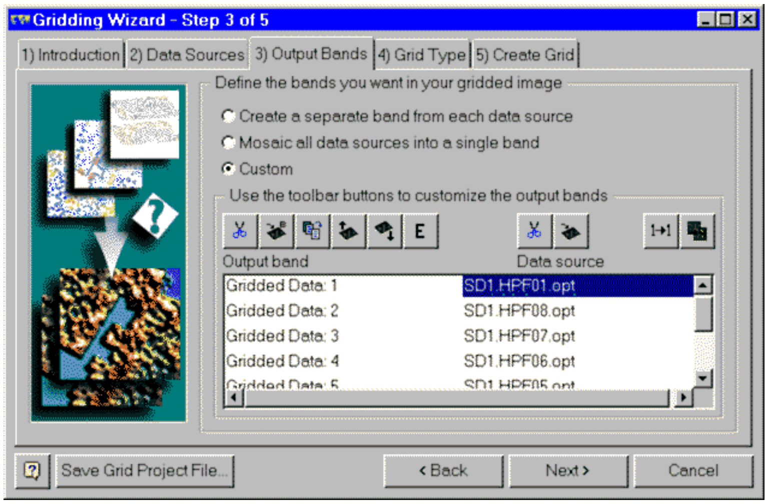
Both actions will take you to the next step by opening the 'Data Sources' tab

5 The list of data sources should show the four 'Peak_Hill' text files you selected in the previous exercise.

Leave the data sources unchanged.

6 Click on the **Next>** button to go to the **3) Output Bands** tab.

## Define the output bands




1 Select the option **Custom.**

This should already be the default selection because we are using an existing Project File. The toolbar buttons will now be visible.

We want to give the output bands more meaningful names.

2 Select the ‘Gridded Data:1’ entry under **Output band**.

3 Click on the **Edit output band description** E button.

The Edit band description dialog will open.

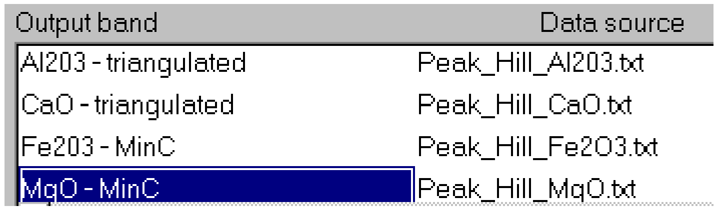

4 In the **Band description** field, enter the text “**`Al203 - triangulated`**”. Make sure that the ‘Peak_Hill_Al203.txt’ data source is allocated to this output band. If not, change the name accordingly.

5 Click on the **OK** button to return to the Gridding Wizard.

The Output band name will have changed to “Al203 - triangulated”.

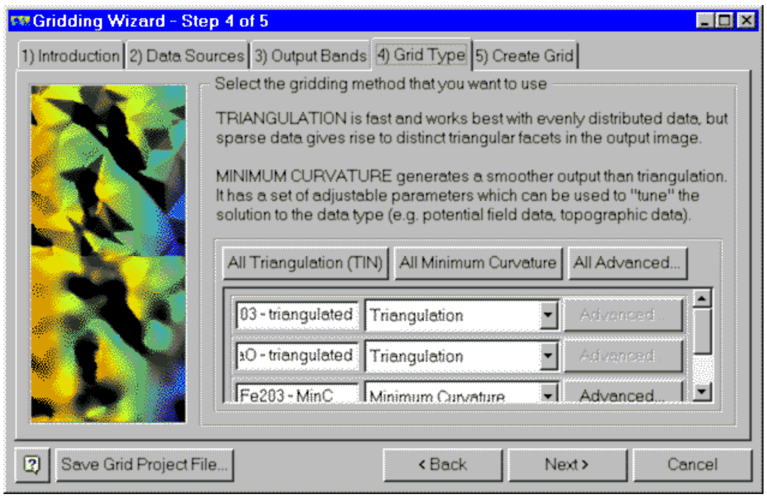
6 Repeat the previous two steps and rename the other bands, “CaO - triangulated”, “Fe203 - MinC” and “MgO - MinC”.

You should now have the following entries in the list:




7 Click on the **Next>** button to go to the **4) Grid Type** tab.

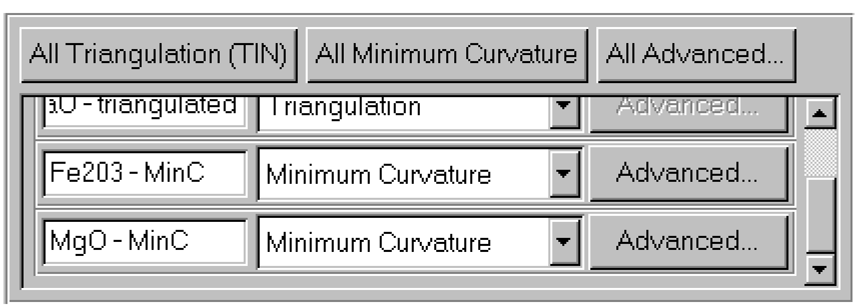
## Select the gridding method



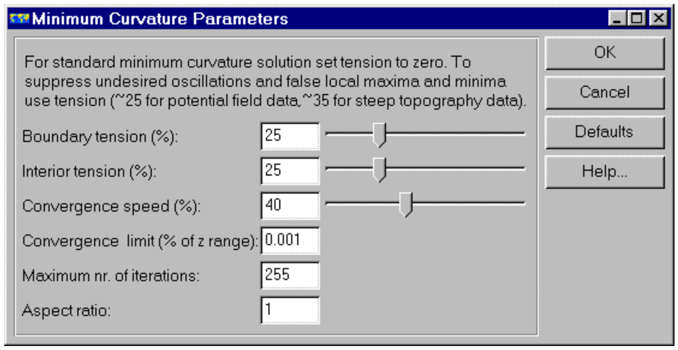

We will set two bands to Triangulation, and the others to Minimum Curvature.

1 Select **Triangulation** from the drop-down list next to 'Al203 - triangulated' and 'CaO - triangulated'.

2 Select **Minimum Curvature** from the drop-down list next to 'Fe203 - MinC' and 'MgO - MinC'.



3 Click on the **Advanced...** button next to the ‘Fe203 - MinC’ entry to open the **Minimum Curvature Parameters** dialog.




4 Use the sliders to set the **Boundary tension(%)** and **Interior tension(%)** to 25.

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**Note:** Leave the other settings at their default values. It is advisable not to change them unless you have a good reason fore doing so and you know what you are doing.

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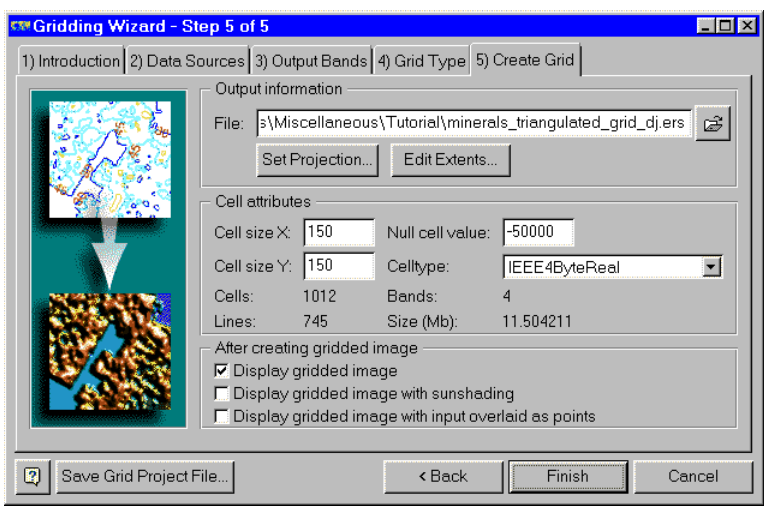
This will create the ‘Fe203 - MinC’ band with Minimum Curvature under tension, and the ‘MgO - MinC’ band with Minimum Curvature.

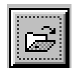
5 Click on the **OK** button to close the dialog and return to the Gridding Wizard.

6 Click on the **Next>** button to go to the **5) Create Grid** tab.

## Create the gridded image




The ‘Create Grid’ tab allows you to specify the file name and define the Extents, Projection and Cell attributes of the output gridded file. You can also select how you want the gridded image displayed.

1 Click on the File Chooser  button to open the **Gridding Wizard Output File** chooser dialog box.

2 From the **Directories** menu, select the path ending with the text **\examples**

3 Double-click on the directory named ‘Miscellaneous’ and then select the ‘Tutorial’ directory.

4 Enter ‘**`minerals_MinC_grid_`*`<your initials>`***’ in the chooser **Save as:** field, and click on the **OK** button.

The name with its path and a ‘.ers’ extension will be inserted in the **File:** field of the ‘Create Grid’ tab. When you create the gridded image it will be saved to that file name.

5 Select all the display options:

- Display gridded image
- Display gridded image with sunshading
- Display gridded image with input overlaid as points

The image will be displayed in three separate image windows.

6 Select the **Save Grid Project File...** button to open the chooser dialog.

All the grid data sources and settings you entered are stored in a project file which you can save and re-use.

7 From the **Directories** menu, select the path ending with the text **\examples**

8 Double-click on the directory named ‘Tutorial.’

9 Enter ‘**`grid_project_2_`*`<your initials>`***’ in the chooser **Save as:** field, and click on the **OK** button.

The project file is saved to the file name with a ‘.egp’ extension.

10 Click on the **Finish** button to generate the gridded image and close the Gridding Wizard

A status dialog will indicate the progress of the gridding.

On completion, ER Mapper will display three image windows displaying the following algorithms;

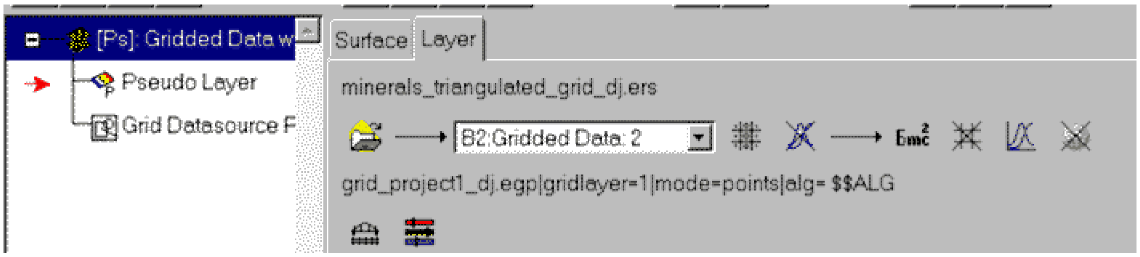
- The gridded image in a pseudo layer
- The gridded image in a pseudo layer and an intensity layer with sunshading on.
- The gridded image in a pseudo layer and a grid datasource points vector layer.;

## View an algorithm with the gridded image

1 Click on the ‘pseudo layer’ image window title bar to make it active.

2 Open the Algorithm dialog by clicking on the **Edit Algorithm** button on the Common Functions toolbar.

The algorithm has a surface with Pseudo layer.




3 Select the Pseudo layer

This layer contains band **B1:Al203 - triangulated** of the raster image you created. This displays the overall traces of aluminum oxide gridded from the ‘Peak_Hill_Al203.txt’ data source.

4 Select the B3:Fe203 - MinC band from the drop -down list.

The image window will now display the overall iron oxide traces gridded from the ‘Peak_Hill_Fe302.txt’ data source using the Minimum Curvature method.

## Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

  Only the ER  Mapper main menu should be open on the screen.

***What you learned...***

After completing these exercises, you know how to perform the following task in ER Mapper:

- Use the Gridding Wizard to create a multi-band gridded image from text files.
- Select some of the output bands to use Triangulated gridding, and others to use Minimum Curvature and Minimum Curvature under tension.

# Part Two - Enterprise Wide Imagery

# 25

# About this section

This section of the manual is intended to help explain the problems and solution to sharing imagery throughout your enterprise, and focuses on free software plug-ins provided by Earth Resource Mapping. The hands-on exercises in this document require that certain software and sample data be installed beforehand. Please read the introduction to each chapter for more information.

## Chapter contents

Most chapters in this section give you hands-on experience using the ER Mapper software plug-ins inside of the host application, such as ArcView GIS, MapInfo, Autodesk World, and office and word processing applications. In general, each chapter is independent of the others.

The emphasis is on learning and using the ER Mapper software plug-ins, not on teaching image processing and remote sensing concepts. For more detailed information on the principles of image processing or remote sensing for specific applications, please refer to the *ER Mapper Applications Manual*, or any of the text books available.

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# Enterprise Wide Imagery

*Enterprise wide imagery* is the concept of making imagery easily available and accessible to all users and software applications within your organization. This chapter explains how you can use free ER Mapper tools to overcome problems with using and sharing imagery. It also includes a short introduction to imagery, and an overview of the capabilities of the ER Mapper software.

## Using imagery within your organization

Many groups within an organization can benefit from the use of imagery such as aerial photographs and satellite images in their everyday work. These include departments such as engineering, marketing, mapping/GIS, graphics, publications and others. Because these groups use a wide range of software applications, it has been difficult to share imagery across an entire enterprise. Two primary reasons:

- **Incompatible file formats**–Images used by one group cannot be used by other groups because the file format is not compatible with their software.
- **Large file sizes**–Even when your software can read an image file's format, it often cannot process large image files. Large image files, such as airphotos, are increasingly demanded by clients to show high levels of detail and coverage of large geographic areas of interest.

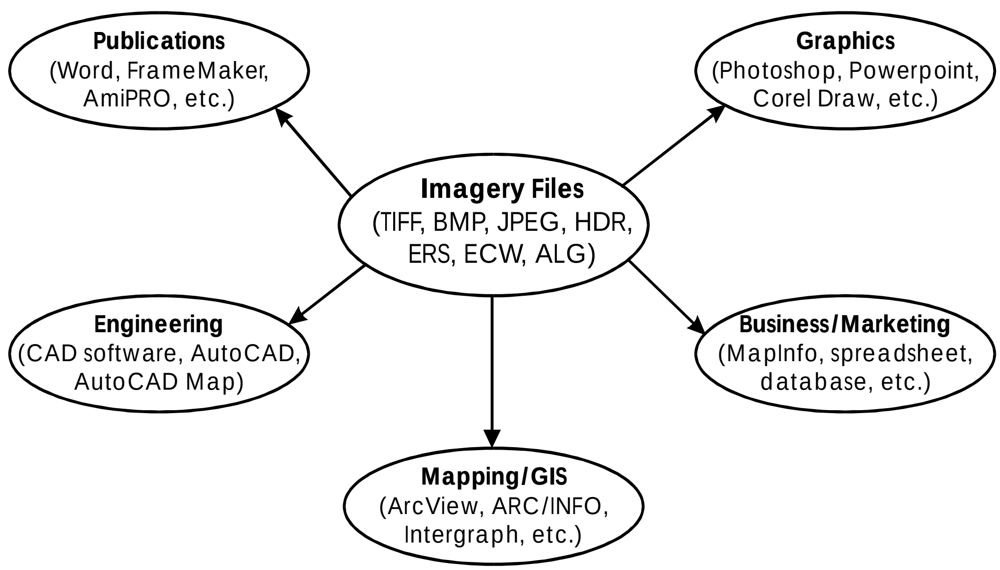
- **Images served over the Internet**–Images that you access over the internet have to retrieved via a browser and stored locally before you can use them in your software application. It would be far more efficient to be able to access images from within the software application by specifying their URL (Universal Resource Locator) as you would with an Internet browser like Internet Explorer.

  Now ER Mapper provides ***free software solutions*** to help you overcome these problems. Anyone who wants to use imagery can do so without having to convert between formats, reduce file sizes, learn complex imaging products, and so on.

# Enterprise wide imagery

*Enterprise wide imagery* is the concept of making imagery easily available and accessible to all users and software applications within your organization. These applications include desktop mapping and GIS products, graphics and presentation products, word processing products, database products, and others.

***Sharing Imagery Throughout an Enterprise***




ER Mapper's free imagery products provide solutions to the two main problems:

- **Incompatible file formats**–Images used by one group can now be used by all groups because ER Mapper's free solutions allow most products to read an industry standard set of imagery formats. For example, word processing or graphics applications can now directly display satellite images in their native formats.

- **Large file sizes**–ER Mapper’s free solutions allow your applications to read image files of virtually any size very quickly. Mosaics of aerial photographs, for example, often require 100’s of megabytes (even gigabytes) of disk space. ER Mapper’s solutions handle the underlying technology, so even simple word processors can display very large image files in a snap.
- **Images served over the internet**–ER Mapper 6.1 allows you to directly access images served over the internet by specifying their URL. The free plug-ins allow most other GIS and Office products to do the same.

# ER Mapper free imagery solutions

ER Mapper’s free Enterprise Wide Imagery solutions are tightly integrated software tools and plug-ins that let you share images throughout your enterprise.

- **ER Viewer**–A free image viewer that lets you view ER Mapper images and algorithms, TIFF and GeoTIFF files, Windows BMP, JPEG, Universal Data Format (UDF), ESRI BIL, and SPOTView image formats.
- **Imagery plug-in for Office users**–Users of office products (word processing, graphics, spreadsheets, etc.) can use ER Viewer’s OLE capabilities to directly display large imagery files quickly within their applications.
- **ER Mapper Imagery Extension for ArcView GIS**–A free extension that lets ArcView GIS users display ER Mapper format images and smart data algorithms.
- **MapImagery plug-in for MapInfo**–A free plug-in that lets MapInfo users display and enhance the same image formats supported by ER Viewer.
- **AutoCAD Map plug-in**–A free plug-in that lets AutoCAD Map users display the same image formats supported by ER Viewer.
- **Autodesk World imagery viewer**–Autodesk World lets users display any images supported by ER Viewer (this functionality is embedded in the World software).

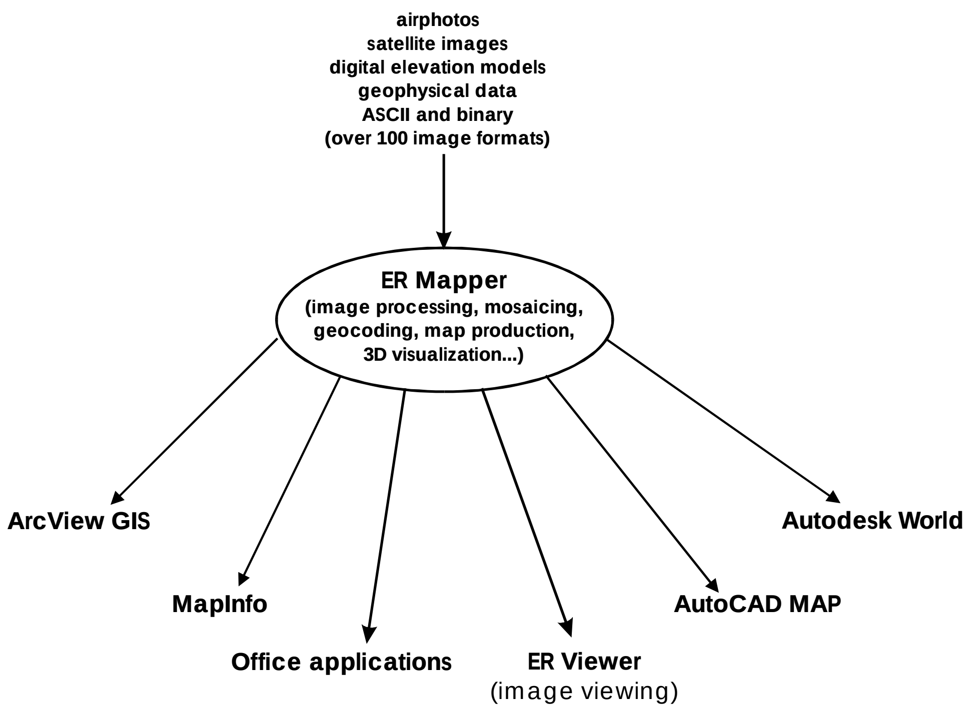
# Using ER Mapper for imaging

By using the plug-ins and tools in conjunction with ER Mapper, you gain access to the powerful capabilities of this leading integrated mapping and image processing application. ER Mapper can be used as a central depository for all image data, where it can be processed as needed before passing on to other applications in you organization via the plug-ins and tools.

Adding ER Mapper to your enterprise gives you capabilities to:

- Import and display over 100 different image formats

- Directly read TIFF, GeoTIFF, BMP, ER Mapper images and algorithms, ESRI BIL, SPOTView and Universal Data Format (UDF) imagery without the need for import or conversion
- Easily view the entire project area in one image–no limits on image file sizes
- Geocode and orthorectify imagery easily to precisely register with GIS vector data
- Automatically display, mosaic and color balance numerous images
- Combine imagery, vector and tabular data from any number of sources
- Create and edit vector data over imagery backdrops, and highlight features of interest and save them as vectors with ER Mapper's raster to vector conversion tools
- Use advanced image processing functions such as contrast enhancement, multispectral classification, vegetation indexes, color shaded reliefs, filtering, merging images, and many others.




ER Mapper can serve as a central hub for all the image data, so you can process and enhance images if needed before passing them onto other applications in your enterprise.

# ER Mapper image compression

ER Mapper also lets you create and distribute royalty-free compressed images using the patent pending ER Mapper ECW Compression facilities and the free plug-ins for other applications. You can now achieve significant compression ratios with no noticeable deterioration in image quality.

## Working with large images

When working with satellite imagery, airphotos, scanned topographical maps and other types of imagery, the size of image files can become very large. For example, it takes 3 terrabytes (3,000GB) of color imagery to take aerial photographs of typical city at 3 inch resolution. It takes 1.5TB (1,500GB) of color imagery to cover all of California at a resolution of one meter.

Compression of imagery offers several advantages including:

- reduced image file size
- faster access
- easier distribution
- the ability to work with imagery covering larger areas

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# Using ER Viewer

This chapter explains how to use the free ER Viewer application to display and analyze several types of image files. ER Viewer is a free Windows application that can be installed from the ER Mapper installation CD-ROM or downloaded from the ER Mapper website at www.ermapper.com.

## About ER Viewer

ER Viewer is a free, easy to use image viewing application featuring interactive roaming and zooming of very large image files. It also acts as an OLE server application to let you view images inside your favorite Windows applications.

ER Viewer offers unequalled stability and supports a wide range of image formats, including:

- Universal Data Format (UDF) images
- ER Mapper compressed and uncompressed images
- TIFF and GeoTIFF images
- Windows BMP images
- SPOTView images
- ESRI BIL (ARC/INFO and ArcView) images
- Smart Data ER Mapper algorithms

# Hands-on exercises

These exercises show you how to use ER Viewer to display image files and perform zooming, roaming and measuring distances.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ER Viewer and OLE-enabled Windows applications:

- Use ER Viewer to display images in several different formats
- Interactively zoom and roam images
- View geographic coordinates and measure distances on an image
- Print an image (optional)

***Before you begin...***

Before beginning these exercises, you must have installed ER Viewer on your system. You can download it free of charge from the ER Mapper web site at www.ermapper.com if needed.

---

**Note:** The following examples use image files supplied with ER Mapper as sample data. If it is not possible to install ER Mapper, you must have a sample TIFF or BMP image file to use for the exercises.

---

# 1: Using ER Viewer to display images

***Objectives***

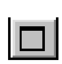
Learn how to use ER Viewer to display images, zoom and roam around the images, and measure distances on geocoded images.

## Start ER Viewer

1 Start ER Viewer by double-clicking the  icon on your desktop or selecting **Start/Programs/ER Mapper/ER Viewer**.

ER Viewer starts up and displays the Getting Started information dialog that contains basic instructions for using ER Viewer.

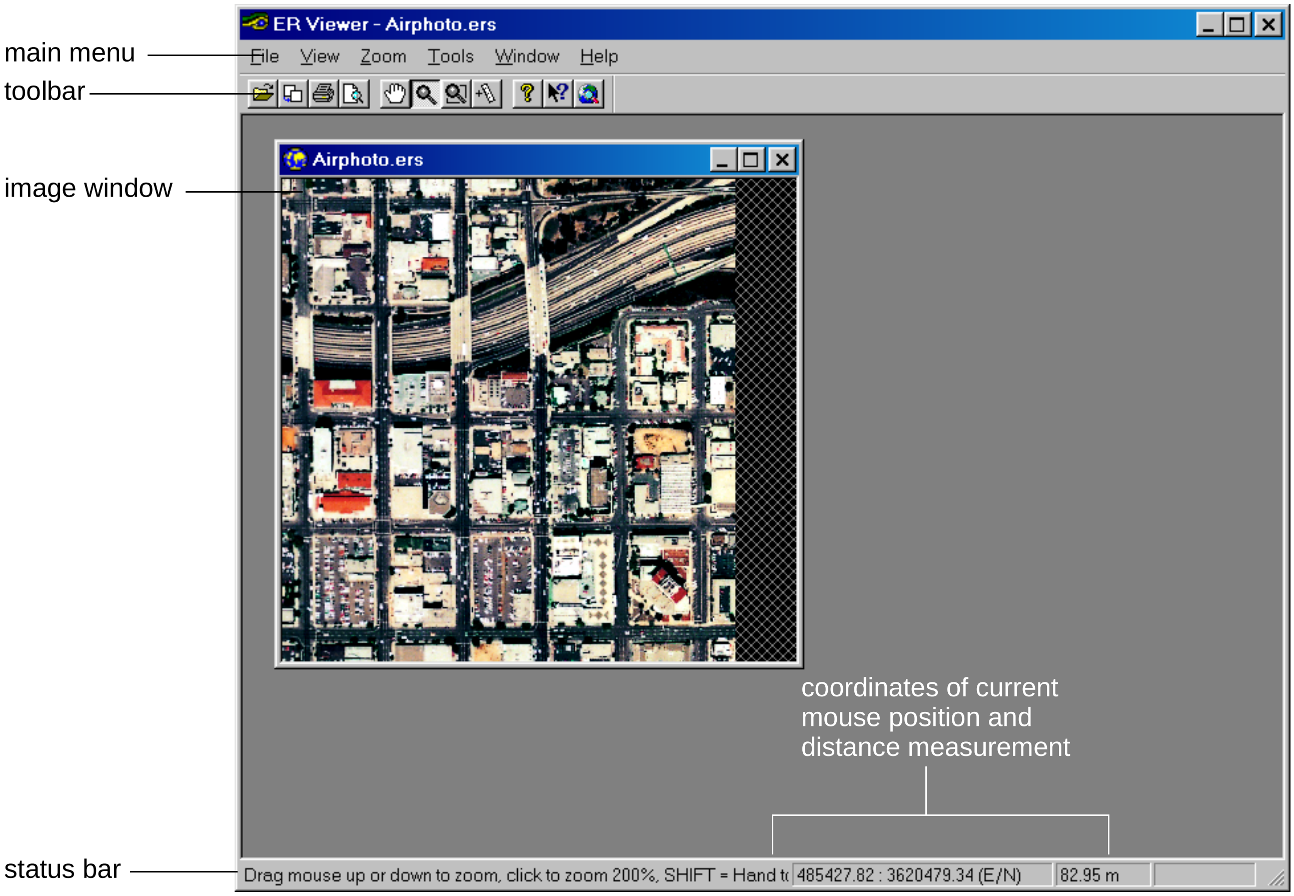
2 Click **Close** on the **Getting Started With ER Viewer** dialog.

3 Click the **Maximize**  button in the upper-right corner of the ER Viewer window (if it is not already maximized)

ER Viewer expands to fill your desktop.

## About the ER Viewer interface

The ER Viewer user interface has the following components:




---

**Tip:** To get help on using any ER Viewer component, click the **What's this?**  button then and click on the component of interest.

---

## Open an ER Mapper-format image file

1 Click the **Open**  toolbar button (or select **File > Open**).

2 On the **Open algorithm or image files** dialog, open the **Files of type** menu.

A list of image formats supported by ER Viewer displays. You can open ER Mapper-format images and algorithms, graphics formats like TIFF and BMP, satellite image formats such as GeoSPOT and ESRI BIL, and others.

3 Select the **All image files** option.

4 Navigate to the directory where ER Mapper is installed. Open the 'examples\Shared_Data' directory. Double-click on the file 'airphoto.ers.'

ER Viewer displays an aerial photograph of the San Diego, California area. (This file was previously imported and saved in ER Mapper '.ers' image file format.)

---

**Note:** If the ER Mapper sample data is not installed, navigate to a directory containing an image in TIFF, BMP or other supported format an open it instead.

---

## Enlarge the image window

1 Drag the image window by a corner to make it larger.

2 From the **Zoom** menu, select **Data Extents**.

The image expands to fill the new image window size.

## Use the Zoom Tool to zoom freely in and out

**1** Click the **Zoom Tool** button on the toolbar (or press **F6**).

2 Point to the center of the image, then drag downward to zoom in.

3 Point to the center of the image, then drag upward to zoom out.

By dragging up or down, you can zoom in or out by any amount. When you release the mouse, ER Viewer refreshes the image detail as needed.

## Use the Zoom Tool to zoom by fixed amounts

**1** From the **Zoom** menu, select **Data Extents**.

The airphoto image zooms out to show the entire image extents.

2 Click on the center of the image to zoom in.

The image zooms in to twice (200%) the previous magnification.

3 While holding down the Ctrl key, click the image center again.

The image zooms out to half (50%) of the previous magnification. With the **Zoom Tool** selected, clicking zooms in and Ctrl-clicking zooms out by fixed amounts.

## Use the Zoom Box Tool to zoom on an exact area

**1** From the **Zoom** menu, select **Data Extents**.

The image zooms out to show the entire image extents.

**2** Click the **ZoomBox Tool** button (or press **F5**).

3 Drag a box around the central portion of the image.

ER Viewer zooms in to display the area you defined with your box. Use the **ZoomBox Tool** tool to zoom in on an exact area of interest.

## Use the Hand Tool to roam around (pan) the image

**1** Click the **Hand Tool** button (or press **F7**).

2 Drag the airphoto within the image window.

ER Viewer roams (or pans) to display the adjacent area of the image. Use the **Hand Tool** tool to roam around and quickly view adjacent areas of the image.

---

**Tip:** When the **Zoom Tool** is selected, pressing Shift temporarily enables the **Hand Tool**.

---

## View geographic locations on the image

1 Without depressing the mouse, point to different locations on the image.

The geographic locations of the current mouse position are shown in the lower right part of the ER Viewer window. (Locations are shown in the units of the map projection. This airphoto is registered to the UTM coordinate system, so the locations are in meters of Easting and Northings.)

---

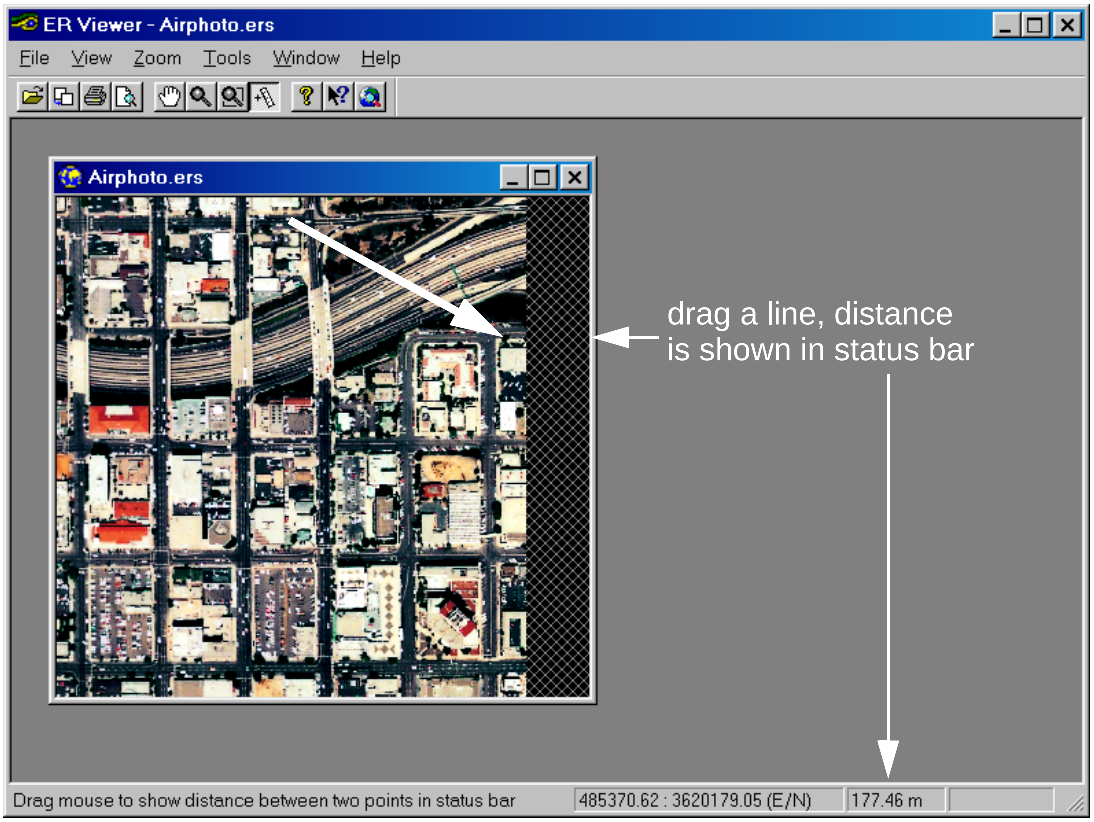
**Note:** Geographic locations only display when your image has been registered to a map projection. If your image in unregistered, the locations appear as row and column (cell) values instead.

---

## Use the Measure Tool to measure distances in the image

**1** Click the **Measure Tool** button (or press **F8**).

2 Drag a line between two points on the image.




ER Viewer shows the distance between the start and end points on the right side of the status bar.

3 While keeping the mouse button depressed, drag to different points on the image.

The distances are updated interactively as you move the mouse. As with locations, distances are shown in the units of the map projection (in this case meters).

---

**Tip:** Ctrl-Shift temporarily enables the **Measure Tool** when the **Zoom Tool**, **ZoomBox Tool** or **Hand Tool** is selected.

---

## Open a second ER Mapper image file

**1** Click the **Open** button.

2 Navigate to the directory where ER Mapper is installed. Open the directory ‘examples\Applications\Land_Information.’

---

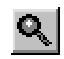
**Tip:** The ‘Automatically adjust contrast on dataset load’ option enhances the contrast of any image you open automatically. You should usually leave this option turned on.

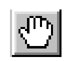
---

3 Double-click on the file ‘SPOT_XS_07Aug88.ers’ to display it.

ER Viewer displays a SPOT XS satellite of the San Diego, California area in a new image window. This is a color infrared image, so vegetated areas are shown in red tones.

4 Make the image window two times larger, then select **Zoom > Data Extents**.

**5** Zoom in to an area of interest using the **Zoom Tool**  or **ZoomBox Tool** .

**6** Pan or scroll the image as desired using **Hand Tool** .

## View properties of the image file

1 From the **View** menu, select **Properties**.

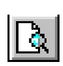
ER Viewer displays tab pages showing properties of the image file.

2 On the **Properties** dialog, click the **Registration** tab.

The geodetic datum, map projection, units and other georeferencing information about the image file is shown.

3 Click **Cancel** on the **Properties** dialog.

## Preview a hardcopy print of the image

**1** Click the **Print Preview**  button.

ER Viewer redisplays the image to show how it would be sized and positioned on your default printer. ER Viewer tries to center the image on the page and fill the printable area.

---

**Tip:** Only the area you zoomed into will be printed, so you can easily print any portion of a large image.

---

**2** Click **Close** or click the button on the image window.

The image redisplays in normal mode for zooming and roaming.

## Print of the image (optional)

**1** Click the **Print** button.

The Windows **Print** dialog for your default printer opens to let you select a printer, change the properties, and print the image.

**2** If desired, select the printer and properties, then click **OK** to print the image. Otherwise click **Cancel** to close the **Print** dialog.

## Close ER Viewer

**1** Click the **Close** button on the ER Viewer window (or select **File > Exit**).

***What you learned***

After completing these exercises, you know how to perform the following tasks in ER Viewer:

- Use ER Viewer to display images in several different formats
- Interactively zoom and roam images
- View geographic coordinates and measure distances on an image
- Print an image (optional)

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# Office applications (OLE)

This chapter explains how you can use your office software's OLE capabilities to easily display and manipulate large images inside Windows applications (without having to save the image as part of the file).

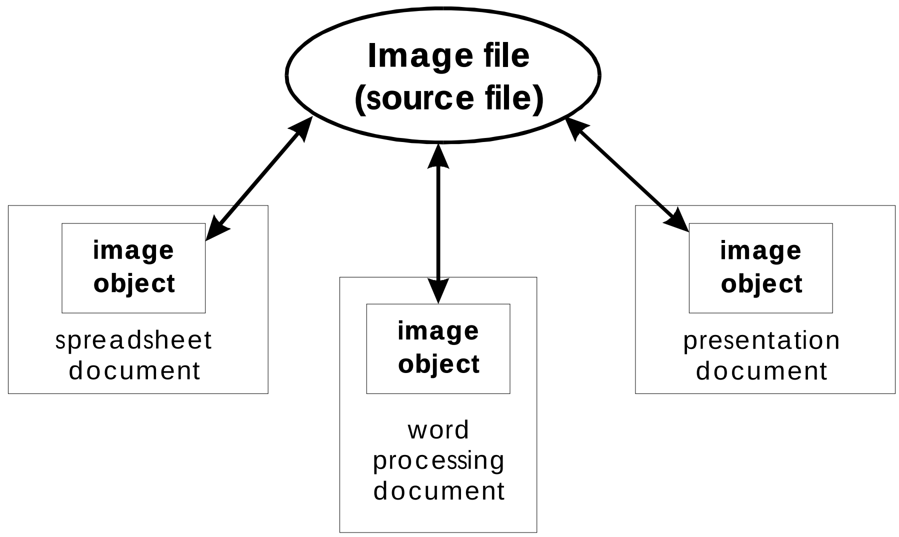
---

**Note:** To use the OLE capabilities described here, make sure you first install ER Viewer and perform the exercises in the previous chapter to become familiar with it. You can install ER Viewer from the ER Mapper installation CD-ROM or download it from the ER Mapper website at www.ermapper.com.

---

## What is OLE?

Many Windows applications support OLE–*Object Linking and Embedding*. OLE is a program-integration technology developed by Microsoft that lets you easily share information between programs. This capability allows you to insert an object (such as an image) into any OLE-enabled application. Most office applications running under Microsoft Windows support OLE.




With a *linked object*, information is created in one file (the *source* file) and inserted into another file (the *destination* file) while maintaining a connection or “link” between the two files. When you save the destination file (such as a word processing document), you save only the link to the source file and do not embed the image as part of the document.

For example, several different documents can display the same image, all via links to the single source image file. If the source image file is modified, the linked image objects in the destination files are also automatically updated to reflect any changes.

## Sharing image files using OLE

In addition to letting you view images, ER Viewer also acts as an OLE server application to let you view images inside your favorite Windows applications. Using ER Viewer’s OLE capabilities provides many advantages for sharing large image files throughout your enterprise, including:

- You can display image files much larger than the application itself is capable of displaying (for example a 500MB airphoto) since ER Viewer performs the processing (not the application where the image is displayed)
- Much faster display of large image files in documents, since ER Viewer performs the processing (not the application where the image is displayed)

- Word processing documents, spreadsheets, presentations, and other applications can all share a single copy of the original imagery files
- Documents can display images in many additional image formats not supported by the destination application, but that are supported by ER Viewer
- Images can be displayed in the application without having to permanently embed and save the image files as part of the document (so the documents remain small in size)
- You can access the power of ER Mapper Smart Data Algorithms to apply complex processing enhancements that create beautiful images interactively without changing the original image files

# Hands-on exercises

These exercises show you how to insert an image into another Windows application as a linked OLE object using ER Viewer as the source application.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in OLE-enabled Windows applications:

- Insert an image as a linked OLE object into another Windows application
- Edit the image object within the application using the ER Viewer toolbar
- Copy and paste an OLE image form one area to another

***Before you begin...***

Before beginning these exercises, you must have installed ER Viewer on your system.

---

**Note:** The following examples use image files supplied with ER Mapper as sample data. If it is not possible to install ER Mapper, you must have a sample TIFF or BMP image file to use for the exercises.

---

# 1: Using OLE to display images

***Objectives*** Learn how to use ER Viewer as an OLE server to display and edit large image files within OLE-enabled Windows applications.

In the past, it was usually necessary to embed large image files in word processing documents, spreadsheets or presentations in order to display and print them at full resolution. Since the image file was saved as part of the document, it created *very* large document files and the data could not be edited once it was inserted.

With Object Linking and Embedding (OLE), you can use ER Viewer as a powerful image viewing engine to display and edit large image files directly inside your Windows applications. This allows you to display images in many formats that cannot be read by the application itself, and also makes the document files much smaller because only a link to the image file is saved with the document.

The following example uses Microsoft Word as the example OLE-enabled application. You can use any other OLE-enabled word processing application if desired (WordPerfect, Framemaker, and so on).

## Start Microsoft Word (or other OLE-enabled word processor)

1 Start up the Word application on your system (or another OLE-enabled word processor).

2 Type the text **`San Diego Airphoto`** as the first line of your document, then press Enter to create a new line.

## Open the Windows Explorer

1 Open the Windows Explorer application (select **Start > Programs > Windows Explorer**).

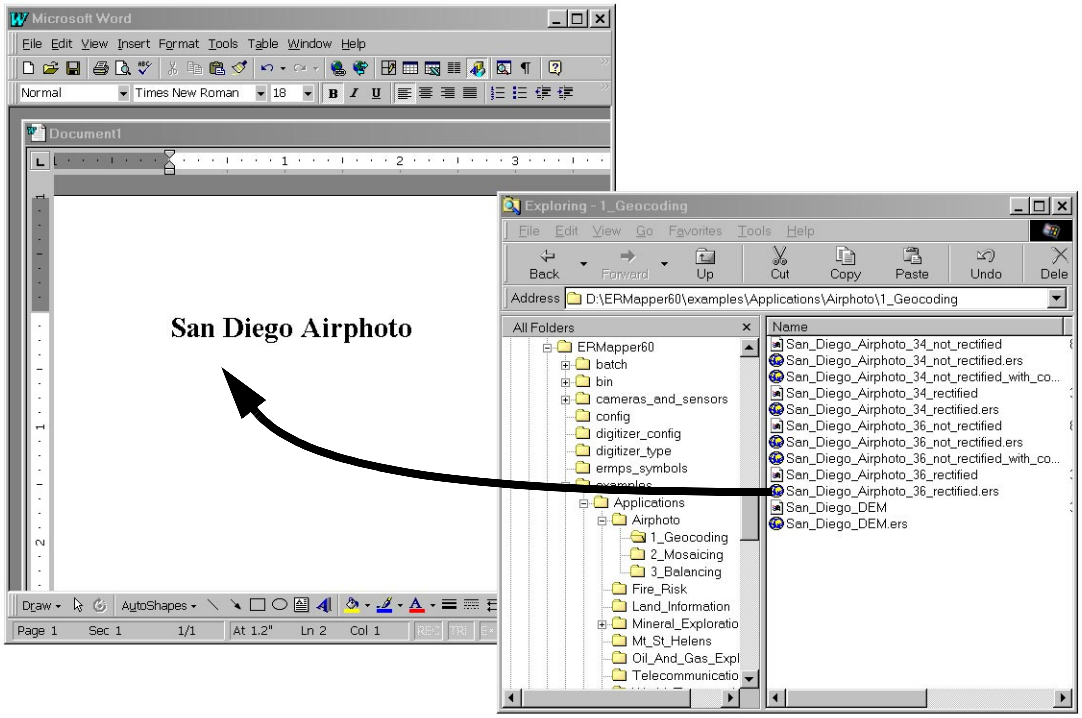
2 Open the ER Mapper installation directory. Then open the directory ‘examples\Applications\Airphoto\1_Geocoding.’

You should see a list of files beginning with ‘San_Diego_Airphoto.’

3 Move the Word application window and the Explorer window side by side (resize them if needed).

## Drag an image file into the Word document

1 Drag the file ‘San_Diego_Airphoto_36_rectified.ers’ from the Explorer window and drop it into the Word document window.




After a short time, the image file displays in your document.

2 In the word processor, click once on the image to select it, then drag the lower-right corner handle to make it much larger.

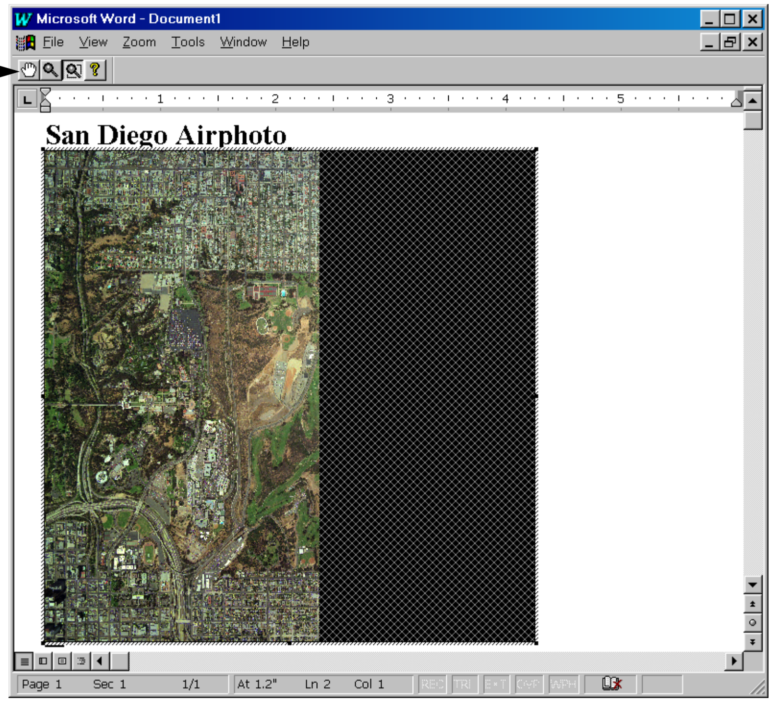
The image redisplays at the larger size. This image is a color aerial photograph of the San Diego, California area. The source image file is over 34MB in size.

## Zoom and roam using the ER Viewer toolbar

1 In Word, double-click on the image.

The word processor’s native toolbar changes to display the ER Viewer zoom and roam tools. When you double-click on a linked object, the object’s *server application* (ER Viewer) is temporarily enabled inside the container application (the word processor) so you can edit the object.

ER Viewer toolbar




2 Click the **ZoomBox Tool** button, then drag a box to enclose the area of white buildings in the lower central portion of the image.

3 ER Viewer zooms in to display the area you defined with your box.

4 Click the **Hand Tool** button, then drag the image.

5 ER Viewer roams (or pans) to display the adjacent area of the image.

## Return to the Word application

1 In the word processing document, click outside the image area.

The usual word processor toolbar and interface returns, and the image is updated to the new extents you defined.

## Drag and drop a second image into the document

1 Press Enter twice to create two new lines below the image, then type the text **`Mount St. Helens Volcano`**.

2 In the Explorer window, open the ER Mapper home directory, then open the directory examples\Applications\Mt_St_Helens.

3 Drag the file '2D_after_eruption.alg' from the Explorer window and drop it into the word processing document window.

After a short time, the image file displays in your document.

4 Click once on the image to select it, then drag the lower-right corner handle to make it larger.

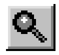
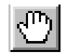
This is an image of the Mount St. Helens Volcano in the state of Oregon, USA after an eruption that blew out the central portion of the mountain. The image data from which this is created is a Digital Elevation Model (DEM) where each pixel value represents a terrain elevation. The special processing technique is called a "colordrape" that combines a color image that shows elevation with a shaded relief image that shows terrain features.

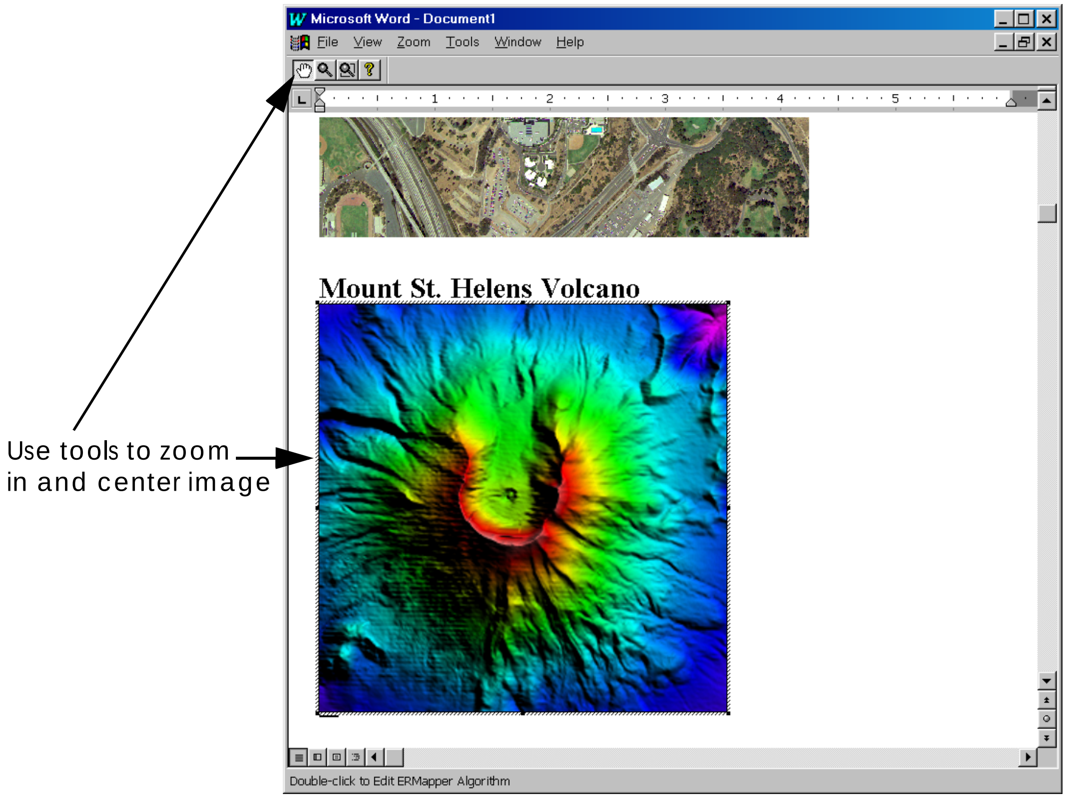
In this case, the image file you linked to is an ER Mapper Smart Data Algorithm (.alg). The algorithm file runs the ER Mapper processing engine in the background to interactively create the enhanced colordrape image from the original DEM image data.

**Tip:** Most OLE-enabled applications also let you insert a linked OLE object into a document using a menu command (as an alternative to the drag and drop method shown in the previous example).

## Zoom into and center the volcano image

1 Double-click on the inserted image to display the ER Viewer toolbar.

2 Use the **Zoom Tool**  to zoom in on the central portion of the image (the volcanic caldera), then use the **Hand Tool**  to drag the image and center it.




3 When finished, click outside the image to return to the word processing application.

## Copy and paste the volcano image

1 Click once on the volcano image to select it.

2 Press Ctrl+C (or select **Edit > Copy**) to copy it.

3 Press Enter twice to create two new paragraphs in your document.

4 Press Ctrl+V (or select **Edit > Paste**) to paste the volcano image into the new location.

It is sometimes useful to copy and paste OLE images from one part of your document to another. For example, you might insert an airphoto covering a large area, then copy and paste it to different parts of the document and zoom in to show different areas of interest.

## (Optional) Save your word processing document.

1 Save your document, then close the application.

---

**Note:** If you check the file size of your word processing document, it should only be about 1MB. Yet this document displays images that are created from almost 40MB of image files. This is one of the big advantages of OLE–you can display very large image files inside a document very quickly without having to embed the image files. (That is, images are not saved as part of the document, only the link to them is saved.)

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***What you learned***

After completing these exercises, you know how to perform the following tasks in OLE-enabled Windows applications:

- Insert an image as a linked OLE object into another Windows application
- Edit the image object within the application using the ER Viewer toolbar
- Copy and paste an OLE image from one area to another

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# ArcView GIS Users

This chapter explains how to use the free ER Mapper Imagery Extension for ESRI's ArcView GIS software. It also explains how to obtain and install the extension, and the additional imaging capabilities ArcView users can gain by using the extension in conjunction with ER Mapper.

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**Note:** You must have a licensed copy of ArcView GIS version 3.1 or greater to install and run the ER Mapper Imagery Extension. You do not need to have a copy of ER Mapper installed, but this is recommended to gain access to sample ER Mapper imagery and algorithms used in the following tutorial. (You can order the free ER Mapper installation CD-ROM from www.ermapper.com.)

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## About the ER Mapper Extension for ArcView GIS

As imagery data sources become more important for GIS applications, the need to efficiently process, enhance and display large image files also becomes more important. Earth Resource Mapping (developers of ER Mapper) provides a free extension (or "plug-in") that lets ArcView GIS users directly display ER Mapper imagery and algorithms. With the ER Mapper Imagery Extension, ArcView GIS users are no longer restricted by limited image handling capabilities. In addition, you can experience the full power of ER Mapper algorithms from within ArcView GIS, and give your vector GIS data real world meaning by presenting it over image backdrops.

## Using the extension with ER Mapper

By using the extension in conjunction with ER Mapper, ArcView GIS users gain access to the extensive capabilities of this powerful integrated mapping and image processing software, including:

- Import and display over 100 different image formats
- Directly read TIFF, GeoTIFF, BMP, ER Mapper images and algorithms, ESRI BIL, SPOTView and Universal Data Format (UDF) imagery without the need for import or conversion
- Easily view the entire project area in one image–no limits on image file sizes
- Geocode and orthorectify imagery easily to precisely register with GIS vector data
- Automatically display, mosaic and color balance numerous images
- Combine imagery, vector and tabular data from any number of sources
- Create and edit vector data over imagery backdrops, and highlight features of interest and save them as vectors with ER Mapper's raster to vector conversion tools
- Use advanced image processing functions such as contrast enhancement, multispectral classification, vegetation indexes, color shaded reliefs, filtering, merging images, and many others.

## How to obtain the ER Mapper Imagery Extension

You can obtain the free ER Mapper Imagery Extension from two sources:

- **The ER Mapper installation CD-ROM**–The extension can be installed as a separate component from the ER Mapper installation CD-ROM. (It is recommended that you also install ER Mapper to gain access to a wide variety of sample data and test drive the software in free evaluation mode to see what it can do for you.)
- **The ER Mapper web site**–You can download the latest version of the extension from the ER Mapper web site at www.ermapper.com. Navigate to the "free software" area and download the ArcView GIS plug-in.

# Hands-on exercises

These exercises show you how to use the ER Mapper Imagery extension for ArcView GIS.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in ArcView GIS using the ER Mapper Imagery Extension:

- Enable the ER Mapper Imagery Extension after starting ArcView GIS
- Display an ER Mapper image file (.ers) as an Image Data Source
- Display an ER Mapper algorithm file (.alg) as an Image Data Source
- Display a vector theme on an ER Mapper image

***Before you begin...***

Before beginning these exercises, you must have installed ArcView GIS version 3.1 or higher and the ER Mapper extension for ArcView on your system. These exercises use sample ER Mapper imagery and algorithm files from the ER Mapper installation CD-ROM. You may also follow the general procedures using your own ER Mapper imagery (.ers) or algorithm (.alg) files.

# 1: Using the ER Mapper extension

***Objectives***

Learn to enable the ER Mapper extension for ArcView and display ER Mapper imagery (.ers) files and algorithm (.alg) files.

## Start ArcView GIS

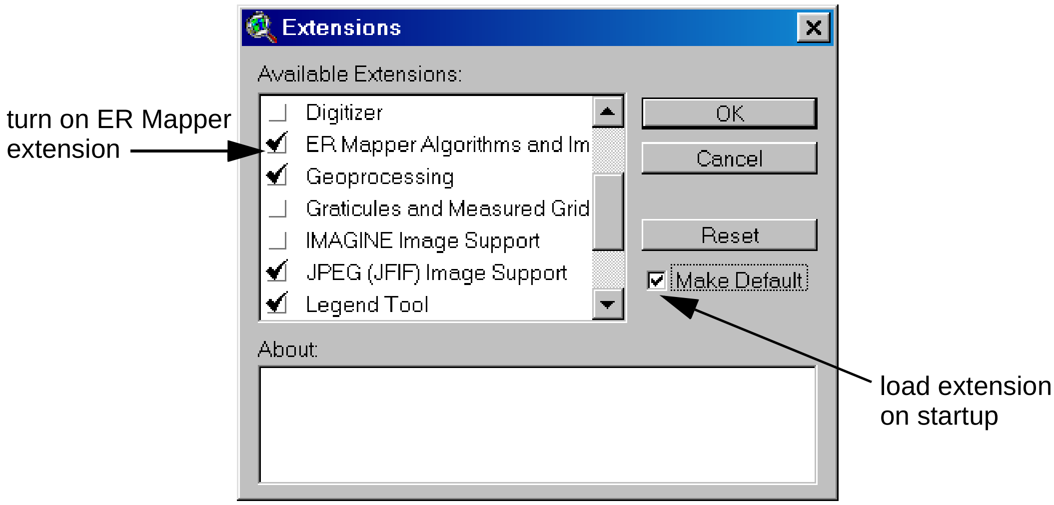
1. Start the ArcView GIS software on your system.
2. If the **Welcome to ArcView GIS** dialog appears, click **Cancel**.
3. Click the **Maximize** button in the upper-right corner of the ArcView GIS application window (if it is not already maximized)

   ArcView GIS expands to fill your desktop.

## Load the ER Mapper extension

1. From the **File** menu, select **Extensions...**.
2. On the **Extensions** dialog, click on the box next to 'ER Mapper Algorithms and Imagery' (a check mark should appear).

3 Turn on the 'Make Default' option, then click **OK**.




The ER Mapper Imagery Extension for ArcView GIS loads. You can now display ER Mapper algorithm and imagery files. Since you selected 'Make Default,' the extension will load automatically each time you start ArcView GIS.

## Open an ER Mapper-format (.ers) image file

**1** If the Project window is not open, select **File > New Project**.

**2** On the Project window, click **New** to open a View window. (It should titled 'View1'.)

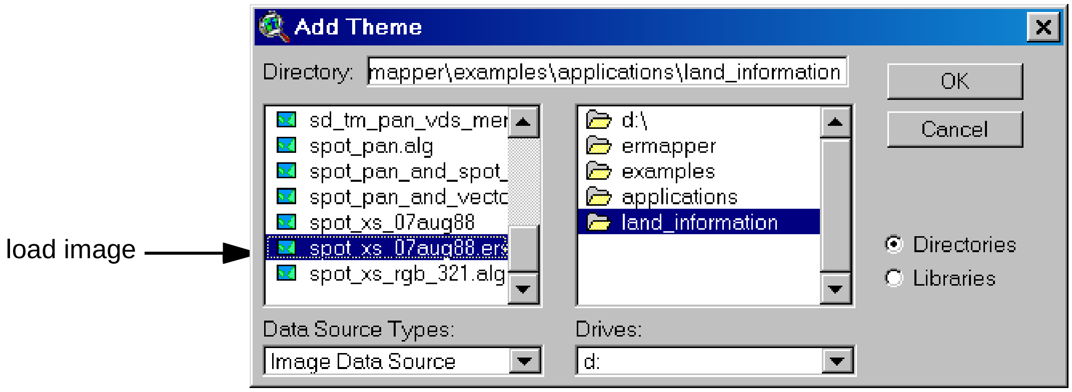
3 Click the **Add Theme**  button (or select **View > Add Theme**).

4 On the **Add Theme** dialog, select 'Image Data Source' from the 'Data Source Types' list. (ER Mapper imagery and algorithms are always image data sources in ArcView GIS.)

5 Double-click on the folder where ER Mapper is installed. Then open the 'examples\applications\land_information' folder.

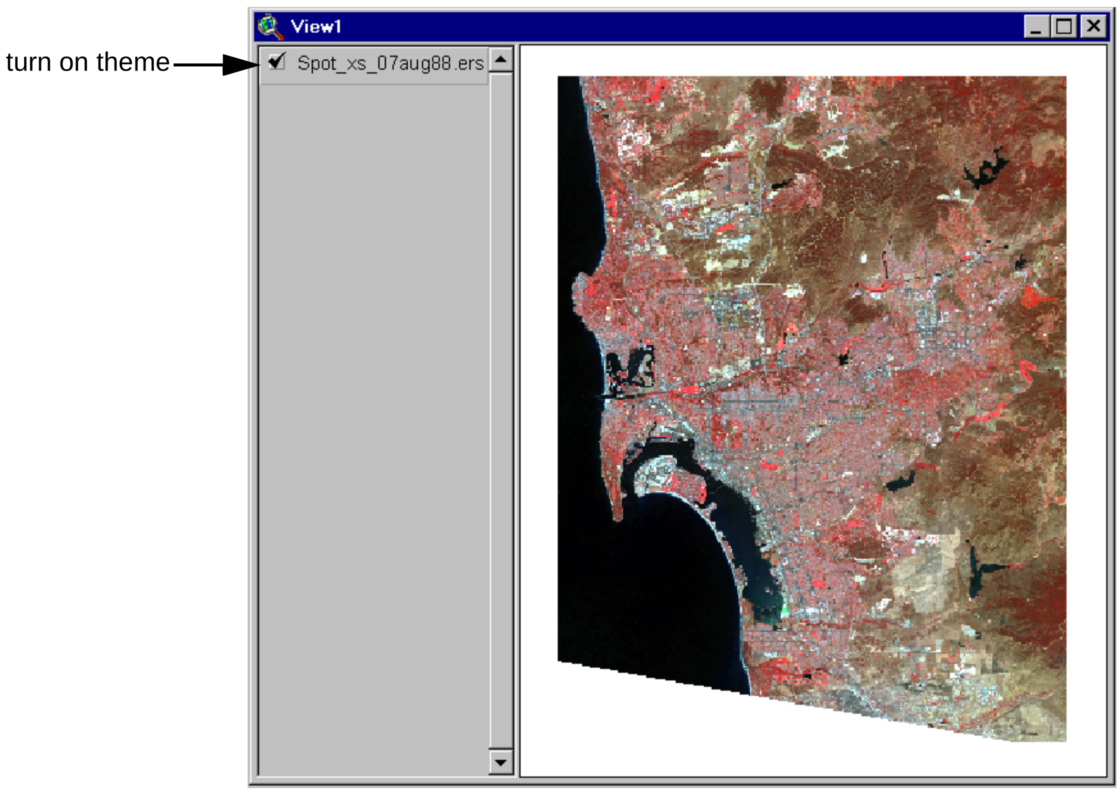
A list of ER Mapper imagery (.ers) and algorithm (.alg) files appears.

6 Scroll down to the bottom, then double-click on the file ‘spot_xs_07aug88.ers.’




7 Click the check box next to the ‘Spot_xs_07aug88’ theme to turn it on.

ArcView GIS displays a SPOT XS color satellite image of the San Diego, California area. This is a 3-band color infrared image, so vegetated areas appear in red tones.



This image file is in ER Mapper's native '.ers' imagery format. The extension enables ArcView GIS to read it as one of its native formats. (ER Mapper's imagery format is composed of a binary data file and an ASCII header '.ers' file similar to the '.hdr' files also used by ESRI products.)

8 Resize the 'View1' window to make the image larger.

## Zoom, pan and measure the image

1 Click the **Zoom In** tool, then drag a box over the central part of the SPOT image to zoom into it.

2 Click the **Pan** tool, then drag the image to view adjacent areas.

3 Click the **Measure** tool, then drag a line to view distances across an area.

The line length appears in the lower-left corner of the ArcView GIS dialog.

4 Move the mouse pointer around inside the image.

Geographic coordinates appear in the upper-right area indicating that the image is georeferenced. (In this case to the UTM projection, so units are meters of Easting and Northings.)

---

**Tip:** When you load an ER Mapper imagery (.ers) file, the contrast is automatically enhanced by the ER Mapper Imagery Extension (using a 99% linear contrast stretch). You can further adjust image contrast if desired using **Theme > Edit Legend**, however this is usually not necessary.

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## Open an ER Mapper algorithm (.alg) file

In ER Mapper, an *algorithm* is a list of processing steps or instructions ER Mapper uses to transform a raw imagery file into a final, enhanced image on your screen or printer. Algorithms let you define a "view" into your data that you can save, reload, and modify at any time. By using the ER Mapper Imagery Extension, you can display ER Mapper algorithms just like an other image data source.

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**Tip:** You need a license for ER Mapper to create algorithms, but you only need the free ER Mapper Imagery Extension to view them in ArcView GIS. This means that anyone using ER Mapper can create algorithms and send them to you for viewing.

---

1 From the **Edit** menu, select **Delete Themes**. When prompted to delete the theme ‘Spot_xs_07aug88.ers’ click **Yes**.

The theme is deleted from your view.

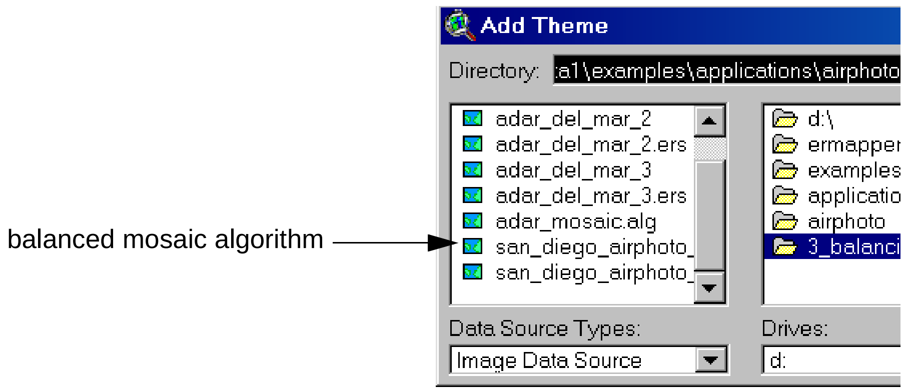
2 Click the **Add Theme**  button (or select **View > Add Theme**).

The files in the ‘land_information’ directory should be displayed.

3 Open the ‘applications\airphoto\3_balancing’ folder.

A list of ER Mapper imagery (.ers) and algorithm (.alg) files appears.

4 Scroll down to the bottom, then double-click on the file ‘san_diego_airphoto_34_36_balanced_mosaic.alg’ (the next to last file).




5 Click the check box next to the theme to turn it on.

ArcView GIS displays a mosaic of two orthorectified color airphotos of the downtown San Diego, California area. This image is created from an ER Mapper algorithm, so it has several processing enhancements applied to the two airphoto imagery (.ers) files used as input:

- brightness and color variations within each image are normalized to remove “hotspots” or light-to-dark variations across each photo
- the contrast and brightness of the two normalized images are then balanced to each other ensure uniform color and brightness across the mosaic
- the seam between the two images is feathered to ensure a smooth transition between the two images and make the mosaic truly “seamless”

6 Click the **Zoom In**  tool, then drag a box over the central part of the mosaic image to zoom into it.

7 Click the **Pan**  tool, then drag the image to view adjacent areas.

This example shows how you can access the power of ER Mapper algorithms to apply complex image enhancements and display them directly with ArcView GIS. This example uses only two airphotos, but you could just as easily display a mosaic algorithm containing 100's of megabytes (even gigabytes) of airphoto images.

## Add a second view to display a merged satellite image

1. Click the **Minimize** button on the 'View1' window to minimize it (or close it if desired).
2. On the Project window, click **New** to open a new View window. (It should be titled 'View2'.)
3. Click the **Add Theme** button (or select **View > Add Theme**).

   The files in the '3_balancing' directory should be displayed.
4. Open the 'examples\functions_and_features\data_fusion' folder.

   A list of ER Mapper algorithm (.alg) files appears. These algorithms all show different ways of merging (or "fusing") two different images into one.
5. Double-click on the file 'brovey_transform.alg.'
6. In the 'View2' window turn on the 'Brovey_transform' theme.

   ArcView GIS displays a color image of the San Diego, California area. This is a merge of a Landsat TM satellite image (bands 5, 4 and 2) and a SPOT Panchromatic satellite image. By merging the two types of data, you get the high spatial detail provided by the SPOT Pan image (10-meter resolution) with the multispectral color information provided by the Landsat TM image (seven bands at 30-meter resolution).

   The Brovey Transform is a mathematical way of combining the two images that also greatly enhances the color. Merging or fusion techniques like this are used to combine the strengths of different satellite sensors and create up-to-date views of the earth's surface.
7. Enlarge the 'View2' window to make the image larger.
8. Zoom in and pan to different parts of the image using the **Zoom In** and **Pan** tools.

   The image shows a high resolution, color-enhanced view of the area. As with the airphoto mosaic, the ER Mapper algorithm creates this image interactively from the two separate Landsat and SPOT satellite imagery files. (The Brovey Transform technique usually requires up to three intermediate image files to be created when using traditional imaging software, but ER Mapper performs the processing in real time from the two source images without creating intermediate files.)

9 Click the **Zoom to Full Extent** button (or select **View > Full Extent**) to zoom out to the full image extents again.

## Add a second theme (algorithm) showing thematic land cover

1 Click the **Add Theme** button (or select **View > Add Theme**).

The files in the ‘data_fusion’ directory should be displayed.

2 Open the ‘functions_and_features\classification_display’ folder.

3 Double-click on the file ‘isoclass_classification.alg.’

4 In the ‘View2’ window turn on the ‘isoclass_classification’ theme.

ArcView GIS displays a thematic color image of the same area of San Diego. Different colors correspond to different types of landuse in the area. This image was created from a 1985 Landsat TM satellite image using ER Mapper’s ISOCLASS unsupervised classification feature. Classification groups pixels with similar spectral values into classes that can represent different types of landuse or land cover.

5 Turn the ‘isoclass_classification’ theme on and off to compare it with the ‘brovey_transform’ merged satellite image theme.

Adding several themes showing different types of data or processing techniques as backdrop images can be very helpful to aid analysis of your vector GIS data.

## Add a third theme (algorithm) showing topography

1 Click the **Add Theme** button (or select **View > Add Theme**).

The files in the ‘classification_display’ directory should be displayed.

2 Open the ‘examples\data_types\digital_elevation’ folder.

A list of ER Mapper algorithm (.alg) files appears. These algorithms all show different ways displaying and processing digital elevation model (DEM) data files.

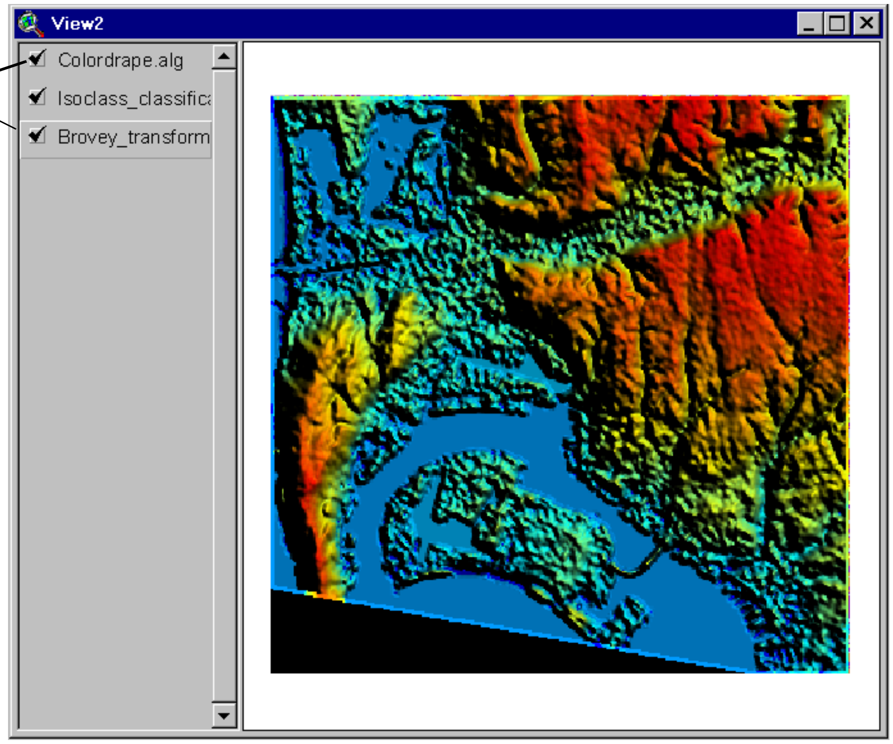
3 Double-click on the file ‘colordrape.alg.’

4 In the ‘View2’ window turn on the ‘Colordrape.alg’ theme.

ArcView GIS displays a color shaded relief (or “colordrape”) image of the same area of San Diego. Colors represent elevation (reds are highest) and the shading effect highlights topographic features such as hills and valleys. This image is illuminated from the northeast, so shadows appear on the southwest side of terrain features. ER Mapper has a built-in “realtime shading” feature that lets you interactively change the shading parameters without creating output files.

5 Turn the three themes on and off to compare them (if more than one is on, the top theme covers the others).

turn on any theme (drag and drop to reorder)




## Add a third view to display an image and vector data

1 If desired, click the **Minimize** button on the 'View2' window to minimize it.

2 On the Project window, click **New** to open a new View window. (It should be titled 'View3'.)

3 Click the **Add Theme** button (or select **View > Add Theme**).

The files in the 'digital_elevation' directory should be displayed.

4 Open the 'examples\shared_data' folder.

A list of ER Mapper image (.ers) and algorithm (.alg) files appears.

5 Double-click on the file 'airphoto.ers.'

6 In the 'View3' window turn on the 'Airphoto' theme.

ArcView GIS displays a color aerial photo of a small area near downtown San Diego, California.

## Overlay vector roads (in DXF format) on the airphoto

You can display any vector data such as shapefiles, coverages, and other supported vector formats on your ER Mapper image data. In this example, you will overlay a vector roads file of the corresponding area stored in DXF format.

1 From the **File** menu, select **Extensions...**.

2 Click on the box next to ‘Cad Reader’ (if not already turned on), then click **OK**.

This enables the CAD Reader extension, so ArcView GIS can now display DXF and DWG vector files.

3 Click the **Add Theme** button (or select **View > Add Theme**).

The files in the ‘shared_data’ directory should be displayed.

4 Open the ‘examples\data_types\autocad_dxf’ folder.

5 On the **Add Theme** dialog, select ‘Feature Data Source’ from the ‘Data Source Types’ list.

6 Double-click on the file ‘roads.dxf.’

7 In the ‘View3’ window turn on the ‘Roads.dxf’ theme.

ArcView GIS displays a vector roads coverage over the airphoto.

8 If desired, select ‘roads.dxf’ theme and change the vector color and line size to make them more visible. (Select **Theme > Edit Legend**, then double-click on the vector in the Symbol column).

9 Close the views by clicking the **Close** button on the view windows.

These simple examples show how you can use the power of ER Mapper algorithms showing various “views” of your image data, and display them directly inside ArcView GIS.

## Open a URL file

The ER Mapper extension enables you to open an ECW compressed image, served via an ER Mapper Image Web Server, inside arcview by specifying its URL. You can then zoom into and roam over this image in real time. The Image Web Server sends the compressed image blocks as they are requested.

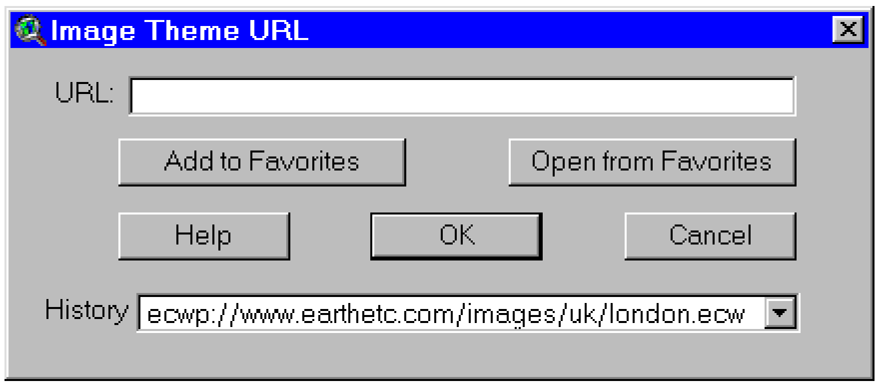
The extension includes the facility to store image URLs in a ‘Favorites’ list so that they can easily be accessed in later ArcView® sessions. You can also select URLs from a ‘History’ list that displays the last 20 URLs requested.

In order for you to do these exercises, the PC in which ArcView is installed must have access to an Image Web Server over the Internet or private intranet. In this example we will use the public ‘www.earthetc.com’ web site.

1 On the Project window, click **New** to open a new View window. (It should be titled ‘View1’.)

2 Click the **Add ECW Image Theme from an Image Web Server URL**  button (or select **View > Add URL Theme**).

This should open the **Image Theme URL** dialog box.




3 Enter the following URL in the **URL:** field.

**`ecwp://www.earthetc.com/images/world/gtopo30.ecw`**

This URL will access the gtopo30.ecw compressed image file at the Earth Resource Mapping www.earthetc.com web site. The protocol to be used is ECWP (Enhanced Compression Wavelet Protocol).

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**Note:** This step requires your PC to have Internet Access. If you are accessing another Image Web Server on a local network, you must change the URL accordingly.

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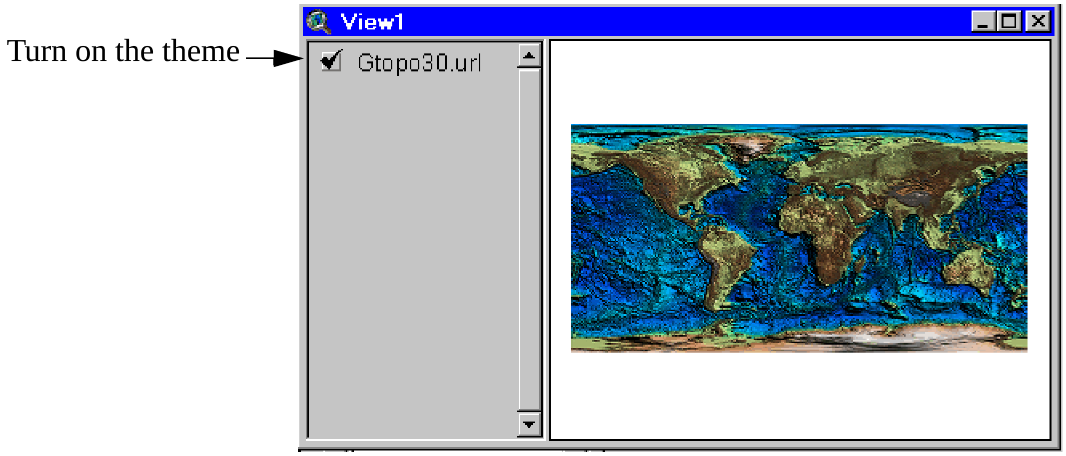
The 1 Km resolution image of the world was created by using the ER Mapper Image Display and Mosaic Wizard to mosaic 30 gtopo DTMs (Digital Terrain Maps). The resultant 2.8GB image was then compressed to 50 MB using ECW compression.

4 Click on the **OK** button.

The image will be loaded as theme via the Internet. If you have a slow connection to the Internet this step could take a few minutes. If your PC is not able to access the www.earthetc.com web site, it will display an error message.

5 In the ‘View1’ window turn on the ‘Gtopo30.url’ theme.

ArcView GIS displays the world image.




6 In the ‘View1’ window, select the ‘Gtopo30.URL’ theme and then select **Edit > Delete Themes** to remove the theme. Answer **Yes** to the **Delete Themes** query.

7 Click the **Add ECW Image Theme**  button (or select **View > Add URL Theme**) to reopen the **Image Theme URL** dialog box.

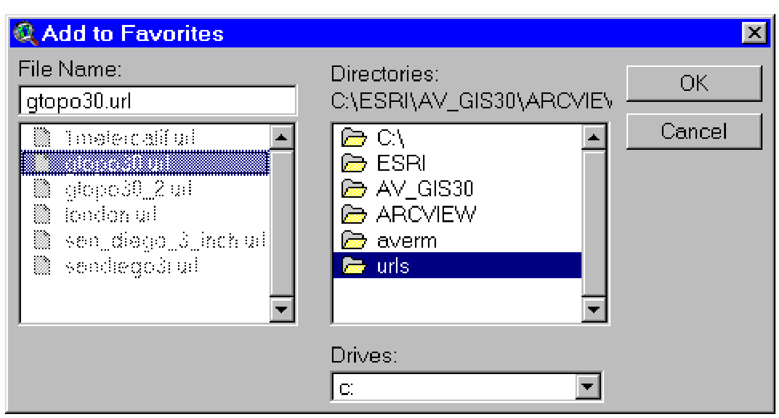
The **URL:** field should now be blank.

8 From the **History:** list select the ‘ecwp://www/earthetc.com/images/world/gtopo30.ecw’ entry.

The **History:** list contains the last 20 URLs entered. This saves you from having to type in the full URL to re-open a recently accessed image.

The **URL:** field should now contain the URL that you selected from the **History:** list. If you were to click on the **OK** button, it would re-load the image as a theme in the ‘View1’ window.

9 Click on the **Add to Favorites** button to open the **Add to Favorites** dialog box.



This box allows you to select a directory and file name to store URLs that you are likely to access again. The file names all have a .url extension.

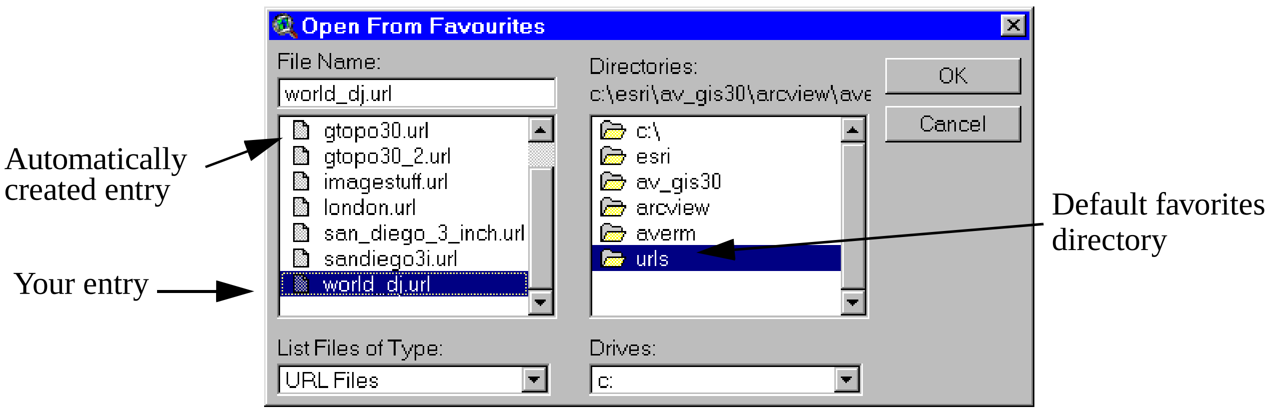
You should note that there is already a ‘gtopo30.url’ entry in the ‘arcview\averm\urls’ directory. The ER Mapper extension automatically creates these files in the default directory whenever you access a URL. The **Add to Favorites** facility is really only required if you want to save the URL to another directory and/or under another name.

10 Select the default directory, which should be ‘ARCVIEW\averm\urls’.

11 Enter **`World_`*<your initials>*`.url`** in the **File Name:** field and click on the **OK** button to return to the **Image Theme URL** dialog box.

12 Click on the **Open from Favorites** button.

This opens the **Open From Favorites** dialog box




13 Select the ‘arcview\averm\urls’ directory if it is not already selected.

14 Select the ‘World_*<your initials>*.url’ file which you previously added. There should also be ‘gtopo30.url file’ that was automatically created by the ER Mapper extension.

15 Click on the **OK** button to return to the Image Theme URL dialog.

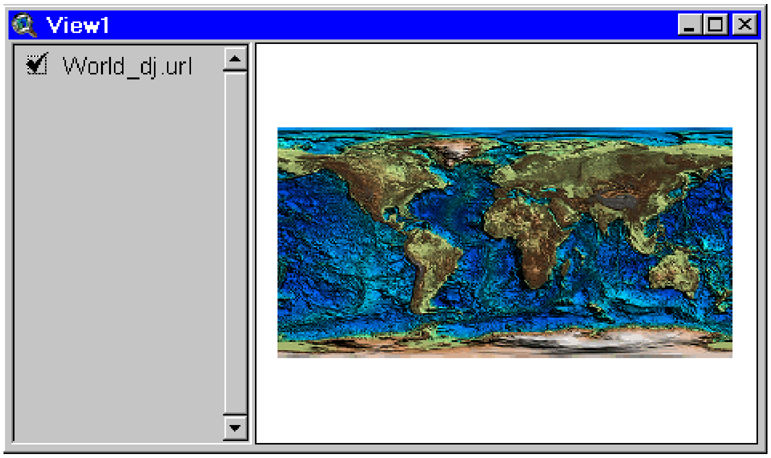
The URL: field should now contain he full URL .

16 Click on the **OK** button.

The image will be loaded as theme via the Internet. If you have a slow connection to the Internet this step could take a few minutes. If your PC is not able to access the www.earthetc.com web site, it will display an error message.

You should also note that the theme name is now the same as that you entered for the ‘Favorites’ file.

17 In the ‘View1’ window turn on the ‘World_*<your initials>*.url’ theme.




The same world image will open with the new theme name.

## Zoom, pan and measure the image

1 Click the **Zoom In** tool, then drag a box over the central part of the image to zoom into it.

2 Click on the **Refresh View** button to improve the image resolution.

---

**Tip:** If you are connected to the Internet via a slow link, you may have to click on the **Refresh View** button a number of times to get the best resolution. This is because ArcView® may display the image before it is fully downloaded from the server. The **Refresh View** button reloads the image with all new information that has been cached on the PC.

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3 Click the **Pan** tool, then drag the image to view adjacent areas.

4 Click on the **Refresh View** button to improve the image resolution.

5 Click the **Measure** tool, then drag a line to view distances across an area.

The line length appears in the lower-left corner of the ArcView GIS dialog.

## Close ArcView GIS

1 If desired, save your views as an ArcView project using **File > Save Project As....**

2 Close ArcView GIS by clicking the **Close** [X] button on the application window or selecting **File > Exit**.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in ArcView GIS using the ER Mapper Imagery Extension:

- Enable the ER Mapper Imagery Extension after starting ArcView GIS
- Display an ER Mapper image file (.ers) as an Image Data Source
- Display an ER Mapper algorithm file (.alg) as an Image Data Source
- Display a vector theme on an ER Mapper image
- Display an ER Mapper URL file (.ecw) as an Image Data Source.

# 30

# MapInfo Users

This chapter explains how to use the free MapImagery plug-in for MapInfo software to view ER Mapper imagery and algorithm files. (The free MapImagery plug-in is developed by GID Australia.) It also explains how to obtain and install the plug-in, and the additional imaging capabilities MapInfo users can gain by using the plug-in in conjunction with ER Mapper.

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**Note:** You must have a licensed copy of MapInfo version 4.5 or greater to install and run the MapImagery plug-in. You do not need to have a copy of ER Mapper installed, but this is recommended to gain access to sample ER Mapper imagery and algorithms used in the following tutorial. (You can order the free ER Mapper installation CD-ROM from www.ermapper.com.)

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## About the MapImagery plug-in for MapInfo

As imagery data sources become more important for GIS applications, the need to efficiently display, process and enhance large image files also becomes more important. GID Australia provides a plug-in that lets MapInfo users directly display ER Mapper imagery and algorithms. This plug-in uses the ER Mapper processing engine to display imagery within MapInfo.

Using the plug-ins, MapInfo users can choose from three levels of imagery support:

- **Level 1 (using the free MapImagery plug-in)**–By installing the free MapImagery plug-in, MapInfo users can directly display ER Mapper imagery and algorithms from within MapInfo. You can also use the plug-in to display other imagery formats directly supported by ER Mapper such as GeoTIFF, BMP, GeoSPOT and others.

- **Level 2 (using the commercial MapImagery plug-in)**–By installing the commercial version of MapImagery plug-in, MapInfo users add advanced image processing capabilities to MapInfo. These include contrast enhancement, convolution filtering, image mathematics functions, color lookup tables, and much more. The commercial version can also create ER Mapper algorithms. For information on the commercial version, contact GID Australia at their web site at www.gid.com. (GID Australia also makes other ER Mapper and MapInfo tools. See their website for information.)
- **Level 3 (using the free MapImagery plug-in with a licensed copy of ER Mapper)**–By purchasing a license for ER Mapper, MapInfo users can access the full range of high-level ER Mapper image processing functions, and display the images within MapInfo using the free or commercial MapImagery plug-in. ER Mapper provides functions for easily creating seamless, color balanced mosaics of many large image files such as airphotos. It also provides advanced image processing functions such as orthorectification, image reprojection, multispectral classification, color shaded reliefs, raster to vector conversion, image merging/ fusion, support for over 100 imagery formats and over 200 hardcopy printing devices, and much more.

## How to obtain the free MapImagery plug-in

You can obtain the free MapImagery plug-in from three sources:

- **The GID Australia web site**–GID Australia regularly updates the MapImagery plug-in and posts the latest version on their web site at www.gid.com. Navigate to the “products and services” area and download the free MapImagery plug-in.
- **The ER Mapper web site**–You can download the plug-in from the ER Mapper web site at www.ermapper.com. Navigate to the “free software” area and download the MapInfo plug-in.
- **The ER Mapper installation CD-ROM**–The plug-in can be installed as a separate component from the ER Mapper installation CD-ROM. (Note that this may not be the latest version. Check the GID Australia web site for the latest update.)

# Hands-on exercises

These exercises show you how to use the free MapImagery plug-in for MapInfo.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in MapInfo using the free MapImagery plug-in:

- Display an ER Mapper image file (.ers) as a MapInfo table
- Display an ER Mapper algorithm file (.alg) as MapInfo table
- Overlay MapInfo vector and tabular table data on an ER Mapper image

- Choose MapImagery setup options to control image display and printing

***Before you begin...*** Before beginning these exercises, you must have installed MapInfo version 4.5 or higher and the free version of the MapImagery plug-in on your system.

**Note:** These exercises use sample ER Mapper imagery and algorithm files from the ER Mapper installation CD-ROM. You may also follow the general procedures using your own ER Mapper imagery (.ers) or algorithm (.alg) files.

# 1: Open an ER Mapper image file

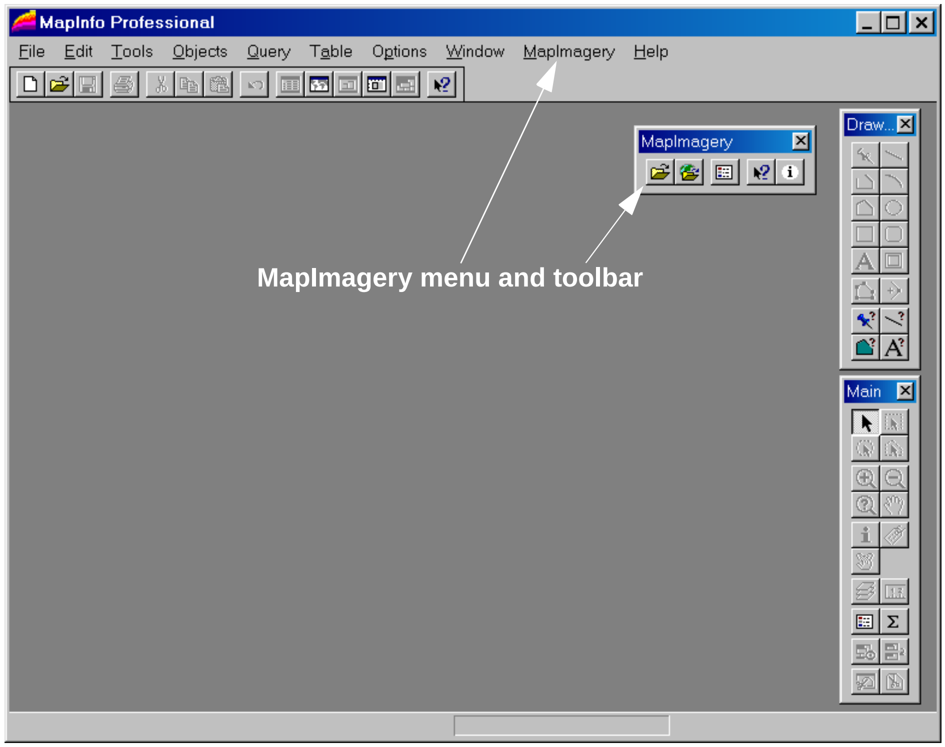
***Objectives*** Learn to use the MapImagery plug-in to display ER Mapper imagery (.ers) files and to zoom, pan and measure distances on the image.

**Note:** You can use the following procedure to open any image formats supported by MapImagery, including TIFF, Windows BMP, JPEG, SPOTView, ESRI BIL, and others. (Additional formats are added periodically, so make sure you are using the latest version of MapImagery.)

## Start MapInfo

1. Start the MapInfo software on your system.
2. If the **Quick Start** dialog appears, click **Cancel** on it.

In the MapInfo application window, you should see the MapImagery plug-in enabled as both a floating toolbar and menu:

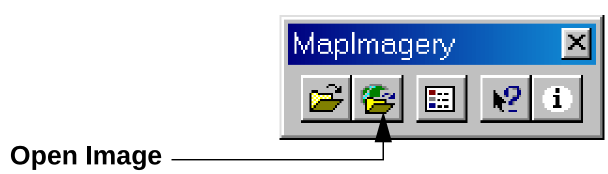



3 Click the **Maximize** button in the upper-right corner of the MapInfo application window (if it is not already maximized)

MapInfo expands to fill your desktop.

## Open an ER Mapper-format (.ers) image file

1 Click the **Open Image** button on the **MapImagery** toolbar (or select **MapImagery > Open Image**).




The option lets you open several types of imagery files directly inside MapInfo.

2 On the **Open Image Files** dialog, open the ‘Files of Type’ list.

A list of all the supported imagery formats displays. You can open ER Mapper imagery (.ers) and algorithm (.alg) files, as well as TIFF and BMP and compressed formats such as ER Mapper's compressed wavelet (.ecw), and JPEG. (Make sure the 'All Image Files' option is selected when closing the list.)

3 Double-click on the folder where ER Mapper is installed. Then open the directory 'examples\Applications\Land_Information.'

A list of ER Mapper imagery (.ers) and algorithm (.alg) files appears.

4 Scroll down to the bottom, then double-click on the file 'SPOT_XS_07Aug88.ers.'

5 If you see a message asking to overwrite the existing .alg file, click **Yes**.

The **Choose Algorithm Style** dialog appears. This lets you select how you want MapImagery to display the image.

6 Select the 'Automatic contrast stretching' option, then click **OK**.

7 If you see a message asking to overwrite the previous .tab file, click **Yes**.

The **MapImagery Projection** dialog appears.

8 Select the correct MapInfo projection items (as follows), then click **OK**:

- **MapInfo Category**–>Universal Transverse Mercator (NAD27 for US)
- **MapInfo Category Members**–>UTM Zone 11 (NAD27 for US)
- **MapInfo Units**–meters

MapImagery displays a SPOT XS color satellite image of the San Diego, California area in a new map window. This is a 3-band color infrared image, so vegetated areas appear in red tones. The spatial resolution (pixel size) is 20 meters.

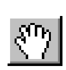
---

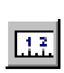
**Note:** When you open image or algorithm file, MapImagery creates a MapInfo table (.tab) file to allow correct coordinates and georeferencing. You may be prompted to overwrite this file; see "Table (.tab) files created by MapImagery" in part 3 in this chapter for details on when and why to do this.

---

## Zoom, pan and measure the image

1 Click the **Zoom-in**  button on the **Main** toolbar, then drag a box around the central part of the SPOT image to zoom in on it.

2 Click the **Grabber**  tool, then drag the image to view adjacent areas.

3 Click the **Ruler**  tool, then drag a line between two points on the image and double-click to end it.

The distance along the line is displayed in the pop-up **Ruler** dialog.

4 Select **Map > View Entire** Layer, then click **OK** on the pop-up dialog.

The image zooms out to the full extents of the SPOT satellite image.

### View geographic coordinates on the image

1 Select **Map > Options**.

2 On the **Map Options** dialog, select **degrees** or **meters** for 'Coordinate Units' (whichever you prefer).

3 Under 'Display in Status Bar,' click 'Cursor Location.' Then click **OK**.

4 Move the cursor around inside the satellite image.

Geographic coordinates appear in the Status Bar (lower-left area). The coordinates are in Latitude/Longitude (if you chose degrees) or meters of Eastings and Northings in the UTM projection (if you chose meters).

5 Select **File > Close All** to close all current tables (in case any others were also open).

## 2: Open ER Mapper algorithm files

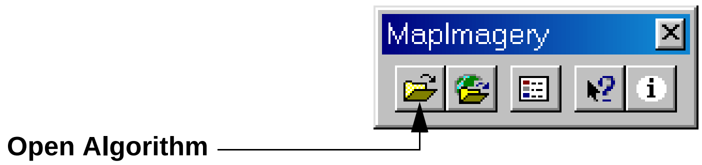
***Objectives*** Learn to use the MapImagery plug-in to display ER Mapper algorithm (.alg) files, and to add several images as different layers in your map.

### Open an ER Mapper algorithm (.alg) file

In ER Mapper, an *algorithm* is a list of processing steps or instructions ER Mapper uses to transform a raw imagery file into a final, enhanced image on your screen or printer. Algorithms let you define a "view" into your data that you can save, reload, and modify at any time. By using the MapImagery plug-in, you can display ER Mapper algorithms just like any other imagery file.

**Tip:** You can *create* algorithm files with ER Mapper or with the commercial version of the MapImagery plug-in. You only need the free MapImagery plug-into *view* algorithm files in MapInfo.

1 Click the **Open Algorithm** button on the **MapImagery** toolbar (or select **MapImagery > Open Algorithm**).




The files in the ‘Land_Information’ directory should be displayed.

2 Backup one directory (to ‘Applications’). Then double-click on the ‘Airphoto’ folder, then double-click on the ‘3_balancing’ folder.

A list of ER Mapper imagery (.ers) and algorithm (.alg) files appears.

3 Double-click on the ‘San_Diego_Airphoto_34_36_Balanced_Mosaic.ers’ file.

4 If you see a message asking to overwrite the previous .tab file, click **Yes**.

5 The correct MapInfo projection parameters are displayed, then click **OK**.

MapImagery displays a mosaic of two orthorectified color airphotos of the downtown San Diego, California area. This image is created from an ER Mapper algorithm, so it has several processing enhancements applied to the two airphoto imagery (.ers) files used as input:

- brightness and color variations within each image are normalized to remove “hotspots” or light-to-dark variations across each photo
- the contrast and brightness of the two normalized images are then balanced to each other ensure uniform color and brightness across the mosaic
- the seam between the two images is feathered to ensure a smooth transition between the two images and make the mosaic truly “seamless”

6 Click the **Zoom-in** button on the **Main** toolbar, then drag a box around the central area of the airphoto mosaic.

MapImagery applies the algorithm processing to the airphotos, then zooms in to display your area of interest.

7 Click the **Grabber** tool, then drag the image to view adjacent areas.

MapImagery applies the algorithm processing, then pans to display the adjacent area.

8 Select **File > Close All** to close all current tables (in case any others were also open).

This example shows how you can access the power of ER Mapper algorithms to apply complex image enhancements and display them directly within MapInfo. (Each one of these airphotos is over 30MB in size.) This example uses only two airphotos, but you could just as easily display a mosaic algorithm containing 100's of megabytes (even gigabytes) of airphoto images.

**Note:** When you have displayed an image and selected the projection information in MapInfo, MapImagery remembers this in the future. See "Choosing map projection information" in part 3 in this chapter for more information on how and when to select projections.

## Set the option to add multiple images to the current mapper

For this next example, you will add several images as layers in the same mapper window. MapImagery has setup options to make this easier.

1. Click the **MapImagery Options** button (on the **MapImagery** toolbar), or select **MapImagery > MapImagery Options**.
2. Click the **General** tab. Under 'When Opening an Algorithm Table' select the 'Add to Current Mapper' option. Click **OK**.

   This tells MapImagery to add new images to the same mapper, rather than open a new mapper each time.

## Open a merged satellite image algorithm

1. Click the **Open Algorithm** button on the **MapImagery** toolbar (or select **MapImagery > Open Algorithm**).

   The files in the '3_Balancing' directory should be displayed.
2. Backup to the 'examples' directory. Double-click on the 'Functions_and_Features' folder, then double-click on the 'Data_Fusion' folder.

   A list of ER Mapper algorithm (.alg) files appears. These algorithms all show different ways of merging (or "fusing") two different images into one.
3. Double-click on the file 'Brovey_Transform.alg.'
4. The correct MapInfo projection parameters are displayed, then click **OK**.

   MapImagery displays a color image of the San Diego, California area. This is a merge of a Landsat TM satellite image (bands 5, 4 and 2) and a SPOT Panchromatic satellite image. By merging the two types of data, you get the high spatial detail provided by the SPOT Pan image (10-meter resolution) with the multispectral color information provided by the Landsat TM image (seven bands at 30-meter resolution).

The Brovey Transform is a mathematical way of combining the two images that also greatly enhances the color. Merging or fusion techniques like this are used to combine the strengths of different satellite sensors and create detailed, up-to-date views of the earth's surface.

5 Use the **Zoom-in**  tool to zoom into the image. Then use the **Grabber**  tool to pan around inside it.

MapImagery applies the algorithm processing to merge the two image files, then displays your new area of interest.

The image shows a high resolution, color-enhanced view of the area. As with the airphoto mosaic, the ER Mapper algorithm creates this image interactively from the two separate Landsat and SPOT satellite imagery files. (The Brovey Transform technique usually requires up to three intermediate image files to be created when using traditional imaging software, but ER Mapper performs the processing in real time from the two source images without creating intermediate files.)

6 Select **Map > View Entire Layer**, then click **OK** on the pop-up dialog.

The image zooms out to the full extents of the merged satellite image.

## Add a second image (algorithm) showing thematic land cover

1 Click the **Open Algorithm**  button on the **MapImagery** toolbar (or select **MapImagery > Open Algorithm**).

The files in the 'Data_Fusion' directory should be displayed.

2 Open the 'examples\Functions_and_Features\Classification_Display' folder.

3 Double-click on the file 'ISOCLASS_Classification.alg.'

4 The correct MapInfo projection parameters are displayed, then click **OK**.

MapImagery displays a thematic color image of the same area of San Diego. Different colors correspond to different types of landuse in the area. This image was created from a 1985 Landsat TM satellite image using ER Mapper's ISOCLASS unsupervised classification feature. Classification groups pixels with similar spectral values into classes that can represent different types of landuse or land cover.

## Add a third image (algorithm) showing topography

1. Click the **Open Algorithm** button on the **MapImagery** toolbar (or select **MapImagery > Open Algorithm**).

   The files in the 'Classification_Display' directory should be displayed.

2. Open the 'examples\Data_Types\Digital_Elevation' folder.

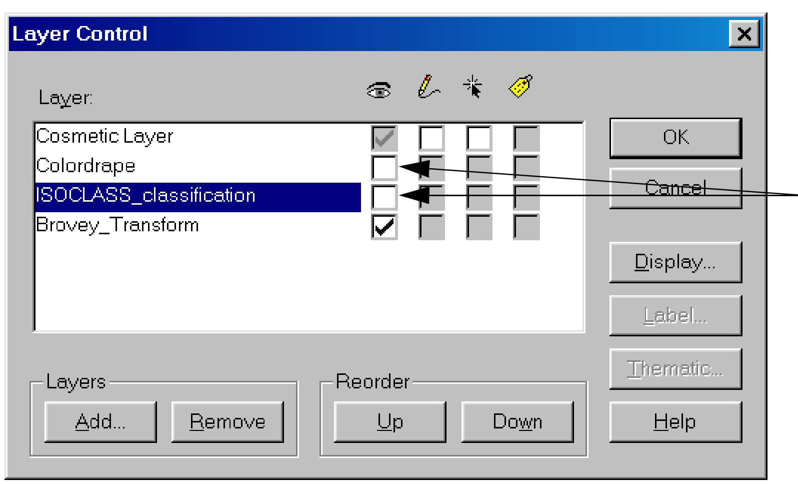
   A list of ER Mapper algorithm (.alg) files appears. These algorithms all show different ways displaying and processing digital elevation model (DEM) data files.

3. Double-click on the file 'Colordrape.alg.'
4. The correct MapInfo projection parameters are displayed, then click **OK**.

   MapImagery displays a color shaded relief (or "colordrape") image of the same area of San Diego. Colors represent elevation (reds are highest) and the shading effect highlights topographic features such as hills and valleys. This image is illuminated from the northeast, so shadows appear on the southwest side of terrain features. ER Mapper has a built-in "realtime shading" feature that lets you interactively change the shading parameters without creating output files.

## View the three images (layers) in the mapper

1. Click the **Layer Control** button on the **Main** toolbar (or select **Map > Layer Control**).
2. In the **Layer Control** dialog, turn off the Visible checkboxes for the 'Colordrape' and ISOCLASS_classification' layers, then click **OK**.




**Turn off Visible checkbox for layers**

   MapImagery redisplays the Brovey Transform algorithm.

3. If desired, repeat step 2 to view other images (turn on only the one you want, then click **OK**).

4 If desired, save your workspace using **File > Save Workspace**.

5 Select **File > Close All** to close any open tables.

# 3: Overlay MapInfo vector data

***Objectives*** Learn to overlay MapInfo vector and point table data on an ER Mapper algorithm image. In this case, you will display a world shaded relief image generated by an ER Mapper algorithm, then overlay MapInfo data of a Lat/Long grid, world capitals, and country borders.

## Open an ER Mapper world topography algorithm

1 Click the **Open Algorithm** button on the **MapImagery** toolbar (or select **MapImagery > Open Algorithm**).

2 Backup to the 'examples' folder, open the 'applications' folder, then open the 'World_Topography' folder.

A list of ER Mapper imagery (.ers) and algorithm (.alg) files appears.

3 Double-click on the 'World_Topography.alg' file.

4 If you see a message asking to overwrite the previous .tab file, click **Yes**.

5 Select the correct MapInfo projection items (as follows), then click **OK**:

- **MapInfo Category**–>Longitude / Latitude
- **MapInfo Category Members**–>Longitude / Latitude
- **MapInfo Units**–degrees

MapImagery displays a color shade relief image (a "colordrape") of the world. Colors of the land areas represent elevation (magenta are the highest, red are the lowest). Ocean areas are colored blue, and bathymetric features such as mid-ocean ridges are shown by the shading effect.

---

**Note:** When displaying data that is in a Longitude Latitude coordinate system, it is important to select 'degrees' as the map projection units. This lets you overlay any other data that is also stored in degrees.

---

## View Longitude Latitude coordinates on the image

1 Select **Map > Options**.

2 On the **Map Options** dialog, select **degrees** for 'Coordinate Units.'

3 Under ‘Display in Status Bar,’ click ‘Cursor Location.’ Then click **OK**.

4 Move the cursor around inside the satellite image.

Longitude Latitude coordinates appear in the Status Bar. (Negative Longitudes indicate the western hemisphere, and negative Latitudes indicate the southern hemisphere.)

## Overlay a Longitude Latitude coordinate grid

1 Select **File > Open Table**.

2 On the **Map Options** dialog, open the ‘WORLD’ directory (under the MapInfo ‘Data’ directory).

3 Double-click on the ‘GRID15.TAB’ file.

MapInfo overlays a Longitude Latitude grid (graticule) with a 15-minute grid spacing.

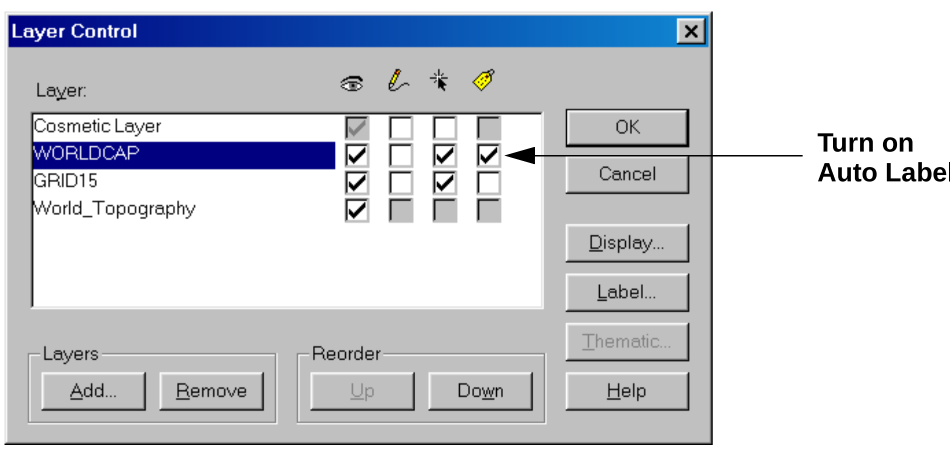
## Overlay a table of world capital cities

1 Select **File > Open Table**.

2 Double-click on the ‘WORLDCAP.TAB’ file.

MapInfo overlays the locations of world capital cities.

3 Click the **Layer Control**  button on the **Main** toolbar (or select **Map > Layer Control**). Turn on auto labelling, then click **OK**.




MapInfo redisplays the world map with labels (city names) plotted next to the symbols. (If desired, you can make the labels bigger, change fonts, and so on by selecting **Layer Control** again and clicking **Labels**...).

## Overlay a table of vector country borders

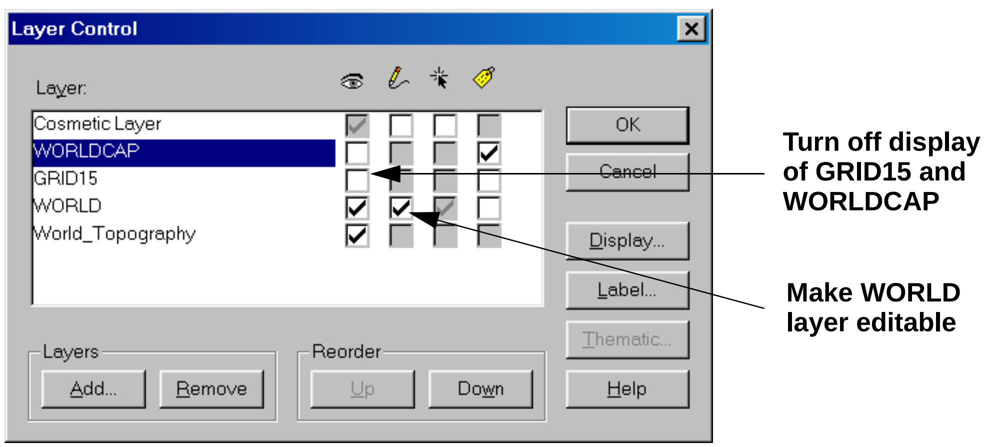
1 Select **File > Open Table**.

2 Double-click on the 'WORLD.TAB' file.

MapInfo overlays the borders of countries on the world map.

## Turn off the GRID15 and WORLDCAP layers

1 Click the **Layer Control** button again. Turn off the 'GRID15' and 'WORLDCAP' layers, make the 'WORLD' layer editable, then click **OK**.




MapInfo redisplays the map without the grid and capital cities layers.

## Make the Africa country border polygons transparent

1 Click the **Marquee Select** button on the **Main** toolbar, then drag a selection box around the continent of Africa.

MapInfo selects all the polygons in your selection marquee.

2 Click the **Region Style** button on the **Draw** toolbar (or select **Options > Region Style**).

3 On the **Region Style** dialog, select the 'Pattern' of 'None,' then click **OK**.

The selected region polygons redisplay without the fill pattern, so you can see the country borders in relation to the ER Mapper world topography image.

4 Click **Zoom-in** on the **Main** toolbar, then drag a box around the African continent to zoom in on it.

### Query the country data or go to other areas of the world

1. If desired, use the MapInfo query tools to get information about the countries, or follow the same steps as above to make country borders for other regions transparent.
2. (Optional.) Save your workspace using **File > Save Workspace**.

# 4: MapImagery settings and options

***Objectives*** Learn to understand the way MapImagery handles and displays imagery, and how to setup default options to control the way images are displayed and printed in MapInfo. (There are no exercises here, only information.)

## Table (.tab) files created by MapImagery

When you open an ER Mapper imagery or algorithm file (or any other supported format), MapImagery automatically creates a MapInfo table (.tab) file for the image. The table file contains information on the map projection, image extents, viewing resolution, and other information MapInfo needs to properly display the image. When you open an image or algorithm file that was already opened in the past, MapImagery prompts you to overwrite the previously created table file in case you have changed any parameters since then.

You would want to overwrite the existing table file in the following cases:

- You selected the wrong map projection information the first time. Click **Yes** to overwrite the existing table file for the image, and select the correct projection information for the future.
- You change the 'Supersampling Factor' on the **MapImagery Options** dialog's **Supersampling** tab. This option lets you manipulate the quality of images within MapInfo, but is also tied to the image extents and coordinates saved in the table file. If you change the supersampling factor, you must regenerate the table files for all imagery files you opened in the past. Click **Yes** to overwrite the existing table file for the image to update the supersampling setting. (If you do not overwrite the existing table file, your image will display but the map coordinates will be wrong, so this is very important.)

## Algorithm (.alg) files created by MapImagery

When you open an ER Mapper imagery (.ers) or other supported image file, MapImagery automatically creates an ER Mapper-format algorithm file for the image (in addition to a MapInfo table file). The algorithm file tells MapImagery how to display the image file, and is independent from the image file itself.

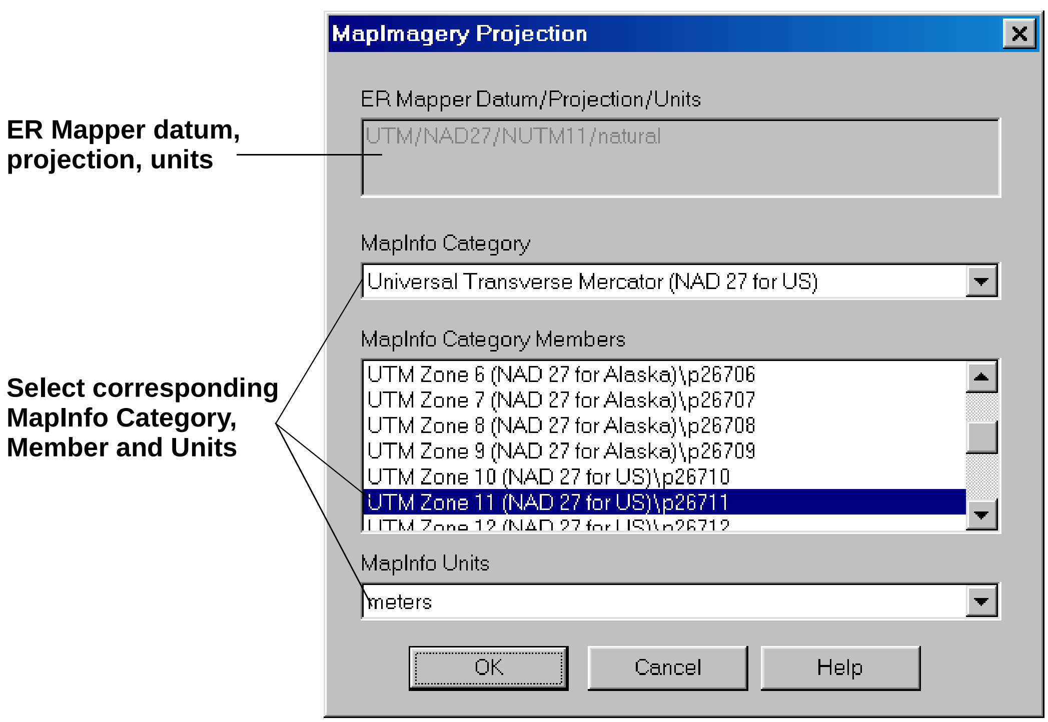
When you open an image file that was already opened in the past, MapImagery prompts you to overwrite the previously created algorithm file. You should do this if you want to change the contrast enhancement option you selected the first time you opened the image. Otherwise, you do not need to overwrite it.

## Choosing map projection information

When you open an ER Mapper or other image file for the first time, or when you choose to overwrite an existing table (.tab) file, you are presented with MapInfo projection options. These options let you choose the correct map projection and coordinate units, and these are important to make sure that georeferenced images display with correct coordinates in MapInfo.

Since the image often originated in ER Mapper, it usually has georeferencing information attached to it (stored in the .ers header file). You need to match the ER Mapper projection information to the equivalent information in MapInfo. Once you do this one time for a given projection type, MapImagery remembers this setting and will automatically set the MapInfo defaults for you when you open another image that has the same ER Mapper projection parameters.

To match the ER Mapper projection information to the MapInfo equivalent, examine the ER Mapper information at the top, then make the appropriate selections from MapInfo projection database:



## The Supersampling setting

When you open an ER Mapper or other image file, MapImagery processes and displays the image data at a predefined resolution. This is called *supersampling*, and is controlled by the 'Supersampling Factor' on the **MapImagery Options** dialog's **Supersampling** tab. For example, if you set supersampling to 8, then an 8x8 pixel area is displayed for every underlying pixel.

You should set the supersampling factor according to these guidelines:

- Use lower values to speed display of very large images, or mosaic algorithms containing many images. Lower values may not produce optimal hardcopy prints however.
- Use higher settings to improve detail in on the screen when smoothing is enabled in the ER Mapper algorithm, and when hardcopy printing from MapInfo.

## Contrast enhancement options

When you open an ER Mapper imagery (.ers) file and are prompted to create an algorithm for it, clicking **Yes** displays the **Choose Algorithm Style** dialog. This dialog lets you choose how contrast will be adjusted to improve the image presentation:

- **Create an algorithm with No contrast stretching**–This displays the image without enhancing the contrast. Use this option if you wish to view the image without enhancement or if your image is already contrast enhanced. Non-photographic images like digital terrain models (DEMs) may look better when displayed this way, or may look better with contrast stretching.
- **Create an algorithm with Automatic contrast stretching**–This displays the image with a linear contrast enhancement to improve color and brightness. Use this option for images that are not already contrast enhanced (like satellite images) or if your images look too dark or light or lack contrast using the no stretching option.

  The type of contrast enhancement applied is a linear contrast stretch that "clips" (or saturates) a certain percentage of brightest and darkest pixels at the high and low ends of the image histogram. The amount of clipping (percentage) is set in the **MapImagery Options** dialog's **Algorithm Generation** tab. A 99% clip applies a mild contrast enhancement that look good on many types of images. If the image still lacks contrast, choose 97.5. (The smaller the percentage the more contrast, but experiment for best results.)

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**Note:** The algorithm file contains the contrast enhancement settings, so the setting you choose is automatically applied to all images you open (if you choose to overwrite an existing algorithm file). If you have a problem image, try smaller percent values for that image, then set the default back to 99% so it is used in the future.

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## Close MapInfo

1 Close MapInfo by clicking the **Close** [X] button on the application window or selecting **File > Exit**.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in MapInfo using the free MapImagery plug-in:

- Display an ER Mapper image file (.ers) as a MapInfo table file
- Display an ER Mapper algorithm file (.alg) as MapInfo table file
- Overlay MapInfo vector and tabular table data on an ER Mapper image
- Choose MapImagery setup options to control image display and printing

# 31

# Autodesk World Users

This chapter explains how to use the capabilities of the Autodesk World software to display ER Mapper imagery and algorithm files as backdrops. This chapter covers steps similar to those described in the Autodesk World software documentation and help system.

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**Note:** You must have a licensed copy of Autodesk World 2.0 to run this tutorial. You do not need to have a copy of ER Mapper installed, but this is recommended to gain access to sample ER Mapper imagery and algorithms used in the following tutorial. (You can order the free ER Mapper installation CD-ROM from www.ermapper.com.)

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## About Autodesk World's ER Mapper image viewing engine

As imagery data sources become more important for GIS applications, the need to efficiently process, enhance and display large image files also becomes more important. Many projects require the analysis of vector GIS drawing data by presenting it over image backdrops that show a "real world" perspective. For example, you gain a better understanding of parcel ownership, tax zones, zip codes, and many other vector entities by overlaying them on an airphoto showing landuse and buildings.

Autodesk World incorporates the ER Mapper viewing engine, which lets you incorporate nearly any type of image data into your projects. These include aerial photographs, satellite images, digital elevation (topography) images and many more image types.

By incorporating the ER Mapper image viewing engine, Autodesk World users are not restricted by limited image handling capabilities as are some other GIS products. You can directly display ER Mapper imagery and algorithms, and image formats with location information such as GeoTIFF, ESRI/GeoSPOT HDR, and others. In addition, you can experience the full power of ER Mapper algorithms from within Autodesk World.

## Using Autodesk World with ER Mapper

By using Autodesk World in conjunction with a copy of the ER Mapper software, you gain access to the extensive capabilities of this powerful integrated mapping and image processing product, including:

- Import and display over 100 different image formats
- Use advanced image processing functions such as contrast enhancement, multispectral classification, vegetation indexes, color shaded reliefs, filtering, merging images, and many others.
- Directly read TIFF, GeoTIFF, Windows BMP, ER Mapper images and algorithms, ESRI BIL, SPOTView and Universal Data Format (UDF) imagery without the need for import or conversion
- Easily view the entire project area in one image–no limits on image file sizes
- Geocode, orthorectify or reproject imagery easily to precisely register with GIS vector drawing data
- Automatically display, mosaic and color balance numerous images
- Combine imagery, vector and tabular data from any number of sources
- Create and edit vector data over imagery backdrops, and highlight features of interest and save them as vectors with ER Mapper's raster to vector conversion tools

# Hands-on exercises

These exercises show you how to use the ER Mapper image display capabilities within Autodesk World.

***What you will learn...***

After completing these exercises, you will know how to perform the following tasks in Autodesk World:

- Insert an ER Mapper image into an Autodesk World drawing

- Enhance the image contrast and apply image smoothing
- Choose equivalent coordinate systems in Autodesk World and ER Mapper
- Insert an ER Mapper smart data algorithm into an Autodesk World drawing
- Stack and change the order of multiple images in a drawing
- Combine image and vector drawing data in a project

***Before you begin...***

Before beginning these exercises, you must have installed Autodesk World version 2.0 or higher on your system. These exercises use sample ER Mapper imagery and algorithm files from the ER Mapper installation CD-ROM. You may also follow the general procedures using your own ER Mapper imagery (.ers) or algorithm (.alg) files.

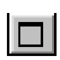
# 1: Inserting an ER Mapper image

***Objectives***

Learn to insert ER Mapper imagery (.ers) files into an Autodesk World drawing. (You can also use the following procedure to open any image formats directly supported by ER Mapper, including TIFF and GeoTIFF, Windows BMP, SPOTView, ESRI BIL, and others.)

The ER Mapper imagery (.ers) format stores image data in its “raw” form. That is, the imagery may not be processed or enhanced for best presentation. When you insert an ER Mapper image, Autodesk World gives you options to enhance the imagery as it is loaded and displayed.

## Start Autodesk World

1. Start the Autodesk World software on your system.
2. Click the **Maximize**  button in the upper-right corner of the Autodesk World application window (if it is not already maximized).

   Autodesk World expands to fill your desktop. You should start with a new project.
3. If you do not already have a new (empty) project open, start one by choosing **File > New**, then clicking **Blank Template**.
4. If the **Display Manager** window is open, close it.

## Set the coordinate system for the new project

All projects have an associated coordinate system. If you are beginning with an ER Mapper image that has location information as your “basemap,” you should choose the same coordinate system as the image for your project.

1 Choose **File > Properties**.

2 Click the **Coordinate System** tab, then click **Change....**

3 On the **Project Detail** dialog, select **UTM27-11** from the **Coordinate System** list.

This selection specifies a coordinate system using the NAD27 datum and the Universal Transverse Mercator (UTM) map projection (zone 11 in the northern hemisphere). The coordinate units are meters, so locations are defined in meters of Eastings and Northings.

4 Click **OK** on the **Project Detail** dialog, then click **OK** on the **Project Properties** dialog.

This coordinate system is now assigned to your project, and is the same one used by the ER Mapper images you will use in the upcoming examples.

## Insert an ER Mapper-format (.ers) image into the drawing

1 Choose **Insert > ER Mapper Image**.

2 On the **Insert ER Mapper Image** dialog, click the I**mage** tab, then click **Browse**.

3 Double-click on the folder where ER Mapper is installed, then open the ‘examples/Applications/Airphoto/1_Geocoding’ folder.

A list of ER Mapper algorithm (.alg) files appears.

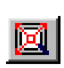
4 Turn off the ‘Bilinear Smoothing’ and ‘Contrast Stretching’ options. (These will be explained later).

5 Click on the ‘Files of Type’ list to view the different image formats.

You can insert ER Mapper algorithms (.alg) and datasets (.ers), as well as TIFF, BMP, ARC/INFO-GeoSPOT HDR, and others.

6 From the ‘Files of Type’ list, select **Datasets (*.ers)**.

7 Double-click on the file ‘San_Diego_Airphoto_34_rectified.ers.’

8 Click the **Zoom All**  button or choose **View > Zoom All**.

Autodesk World displays a color aerial photograph of the downtown San Diego, California area. This image has been *rectified* to the NAD27 datum and UTM zone 11 map projection, so it has geographic location information (true earth coordinates).

## Zoom in to a small area to see the pixel resolution

1 Click the **Zoom Window** button (or choose **View > Zoom Window**), then drag a very small box over part of the photo to zoom into it.

If needed, do this again until you can see the small square areas that comprise the digital image. These squares are called *pixels* (for picture elements), and are roughly equivalent to the smallest object you can see in the photo. In this image, each pixel is about 1 meter in diameter, which is termed “1-meter resolution.”

## Reload the image with smoothing and contrast enhancement

1 Choose **Insert > ER Mapper Image**.

2 This time *turn on* the ‘Bilinear Smoothing’ and ‘Contrast Stretching’ options.

3 From the ‘Files of Type’ list, select **Datasets (*.ers)**.

4 Click **Browse**, then double-click on the file ‘San_Diego_Airphoto_34_rectified.ers’ again to reload it.

The airphoto image redisplays with improved contrast and a “smoother” appearance.

- **Bilinear Smoothing** improves the display of zoomed images or large hardcopy prints by averaging the pixel values to remove the “blocky” look you saw previously when smoothing was not turned on. (You only see the effect of smoothing when you zoom into the pixel level.)
- **Contrast Stretching** generally improves the image color and presentation by increasing contrast between the light and dark areas. This option is recommended when inserting most image files, otherwise they may lack contrast or look too dark or light.

## Zoom in and out in the image

1 Click the **Zoom All** button or choose **View > Zoom All**.

The image zooms out to display the full extents of the airphoto.

2 Click the **Zoom Window** button (or choose **View > Zoom Window**), then drag a box over the central part of the photo to zoom into it.

3 Click the **Zoom In** or **Zoom Out** buttons, then click on the image to zoom in or out by fixed amounts.

4 When finished, click the **Zoom All** button or choose **View > Zoom All** to zoom out to the full image extents.

5 Once again, click **Zoom Window**, then drag a box over the central part of the photo to zoom into it.

## Pan (scroll) the image

1 Click the **Pan 2 Points** button (or choose **View > Pan**). Click on one point in the photo, then click on a second point.

The image pans (scrolls) in the direction and distance you defined by your two points. This is one way to view adjacent areas of an image.

2 Drag the scroll bars on the right or lower areas of the project window.

The image pans in the direction you drag the scroll bar.

## View geographic coordinates on the image

1 Choose **Tools > Format Options**.

2 Click the **Coordinate** tab, select **Latitude Longitude** from the ‘Display Type’ list, then click **OK**.

3 Point to various locations in the image.

The Latitude Longitude coordinates of the current cursor location appear in the status bar. (The format is decimal degrees, and negative longitudes indicate the western hemisphere.)

4 Choose **Tools > Format Options** again.

5 Click the **Units** tab, then select **m** from the ‘User Unit’ list.

6 Click the **Coordinate** tab, select **Projection Coordinate** from the ‘Display Type’ list, then click **OK**.

7 Point to various locations in the image.

The UTM map projection coordinates appear in the status bar. (The format is meters of Northings and Eastings in UTM zone 11.)

## Close the project

1 Choose **File > Close**.

When asked to save the contents or save changes, click **No**.

# 2: Inserting multiple coregistered images

***Objectives*** Learn to insert ER Mapper smart data algorithm (.alg) files into an Autodesk World drawing. Also learn to “stack” multiple images covering the same geographic area, and to turn images on/off and move them to the top of the display.

An ER Mapper *algorithm* is a list of processing steps or instructions ER Mapper uses to transform a raw image file into a final, enhanced image on your screen or printer. An algorithm does not contain the actual image data, but only stores references to it. (The actual image data is stored in ERS or other files.) When you insert an ER Mapper algorithm into an Autodesk World drawing, it follows the steps in the algorithm and displays the finished image accordingly.

**Note:** In order to precisely overlay multiple images (as you will do next), the images must have the same coordinate system information.

## Start a new project

1 Start a new project by choosing **File > New**, then clicking **Blank Template**.

## Set the coordinate system for the new project

1 Choose **File > Properties**.

2 Click the **Coordinate System** tab, then click **Change....**

3 On the **Project Detail** dialog, select **UTM27-11** from the **Coordinate System** list.

## Set the data viewing coordinate type

1 Choose **Tools > Format Options**.

2 Click the **Units** tab, then select **m** from the ‘User Unit’ list.

3 Click the **Coordinate** tab, select **Projection Coordinate** from the ‘Display Type’ list, then click **OK**.

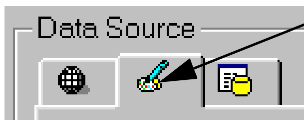
The display coordinates are now set to the units of the map projection (meters of Northings and Eastings in UTM zone 11.)

## Create drawing layers to display three different images

1 Choose **File > Data Manager**.

The **Data Manager** dialog lets you add and controls layers in your drawings.

2 Click the **Drawing Data** tab to view drawing layers




3 Right-click on ‘Drawing1’ then select **New Layer**.

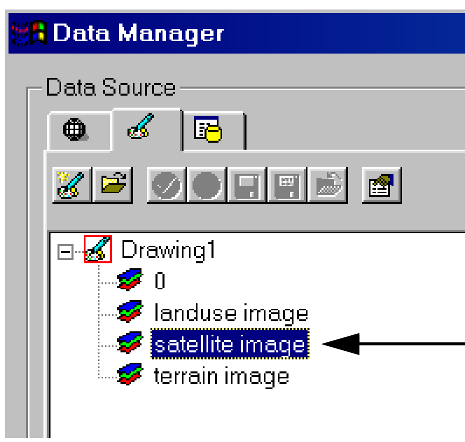
A new ‘Layer1’ is added in addition to the default ‘0’ layer.

4 Click on the ‘Layer1’ text and change it to **`satellite image`**.

5 Right-click on ‘Drawing1’ again, select **New Layer**, then name the new layer **`landuse image`**.

6 Right-click on ‘Drawing1’ again, select **New Layer**, then name the new layer **`terrain image`**.

You should have three new labelled layers (the order does not matter for now):




7 Click **Close** on the **Data Manager** dialog box.

## Insert an ER Mapper satellite image algorithm (.alg) file

1 Choose **Insert > ER Mapper Image**.

2 On the **Insert ER Mapper Image** dialog, click the **Image** tab, then click **Browse**.

3 On the **Insert Picture** dialog, select Algorithms (*.alg) from the ‘Files of Type’ list.

---

**Note:** When you insert an algorithm file, the Bilinear Smoothing and Contrast Stretching options are disabled because the algorithm file contains the contrast enhancement and other information.

---

4 Double-click on the folder where ER Mapper is installed, then open the 'examples/Functions_And_Features/Data_Fusion' folder.

A list of ER Mapper algorithm (.alg) files appears. These algorithms all show different ways of merging (or "fusing") two different images into one picture.

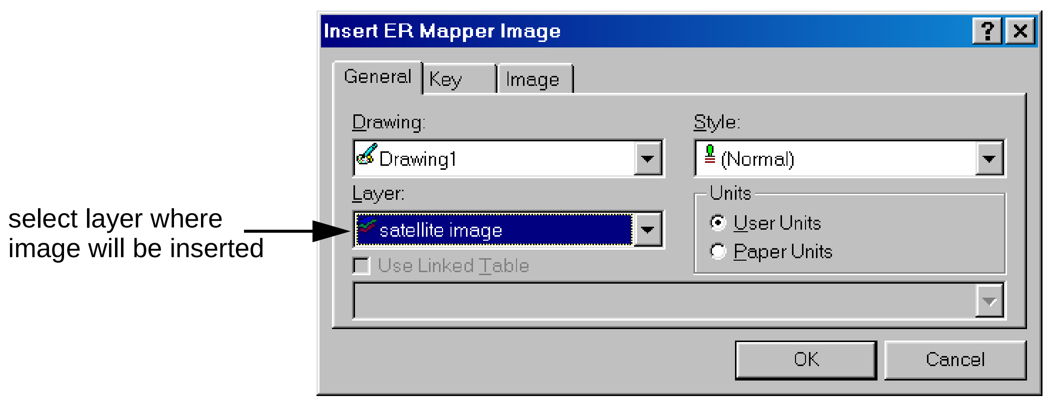
5 Double-click on the file 'Brovey_Transform.alg.'

---

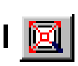
**Tip:** You need a license for ER Mapper to create algorithms, but you can insert and view them in directly in Autodesk World. This means that anyone using ER Mapper can create algorithms and send them to you for use in your projects.

---

6 Click **General** tab, then select **satellite image** from the 'Layer' list.




You can insert ER Mapper algorithms (.alg) and datasets (.ers), as well as TIFF, BMP, ARC/INFO-GeoSPOT HDR, and others.

7 Click **OK** to insert the image into the drawing layer, then click **Zoom All**  or choose **View > Zoom All** to display it.

Autodesk World displays a color image of the San Diego, California area. This is a merge of a Landsat TM satellite image (bands 5, 4 and 2) and a SPOT Panchromatic satellite image. By merging the two types of data, you get the high spatial detail provided by the SPOT Pan image (10-meter resolution) with the multispectral color information provided by the Landsat TM image (seven bands at 30-meter resolution).

The Brovey Transform is a mathematical way of combining the two images that also greatly enhances the color. Merging or fusion techniques like this are used to create to combine the strengths of different satellite sensors and create up-to-date views of the earth's surface.

8 Click **Zoom Window** (or choose **View > Zoom Window**), then drag a box over the central part of the image to zoom into it.

The image shows a high resolution, color-enhanced view of the area. The ER Mapper algorithm creates this image interactively from the two separate Landsat and SPOT satellite imagery files. (The Brovey Transform technique usually requires up to three intermediate image files to be created when using traditional imaging software, but ER Mapper performs the processing in real time from the two source images without creating intermediate files.)

9 When finished, click the **Zoom All** button or choose **View > Zoom All** to zoom out to the full image extents.

## Insert a second algorithm image showing thematic landuse

1 Choose **Insert > ER Mapper Image**.

2 On the **Insert ER Mapper Image** dialog, click the **Image** tab, then click **Browse**.

3 Double-click on the folder where ER Mapper is installed, then open the 'examples/Functions_And_Features/Classification_Display' folder.

A list of ER Mapper algorithm (.alg) files appears. These algorithms all show different ways of merging (or "fusing") two different images into one picture.

4 Double-click on the file 'Isoclass_classification.alg.'

5 Click **General** tab, then select **landuse image** from the 'Layer' list.

6 Click **OK** to insert the image into the layer and display it.

Autodesk World displays a thematic color image of the same area of San Diego. Different colors correspond to different types of landuse in the area. This image was created from a 1985 Landsat TM satellite image using ER Mapper's ISOCLASS unsupervised classification feature. Classification groups pixels with similar spectral values into classes that can represent different types of landuse or land cover.

## Insert a third algorithm image showing terrain and topography

1 Choose **Insert > ER Mapper Image**.

2 On the **Insert ER Mapper Image** dialog, click the **Image** tab, then click **Browse**.

3 Double-click on the folder where ER Mapper is installed, then open the ‘examples/Data_Types/Digital_Elevation’ folder.

These algorithms all show different ways displaying and processing digital elevation model (DEM) data files.

4 Double-click on the file ‘Colordrape.alg.’

5 Click **General** tab, then select **terrain image** from the ‘Layer’ list.

6 Click **OK** to insert the image into the layer and display it.

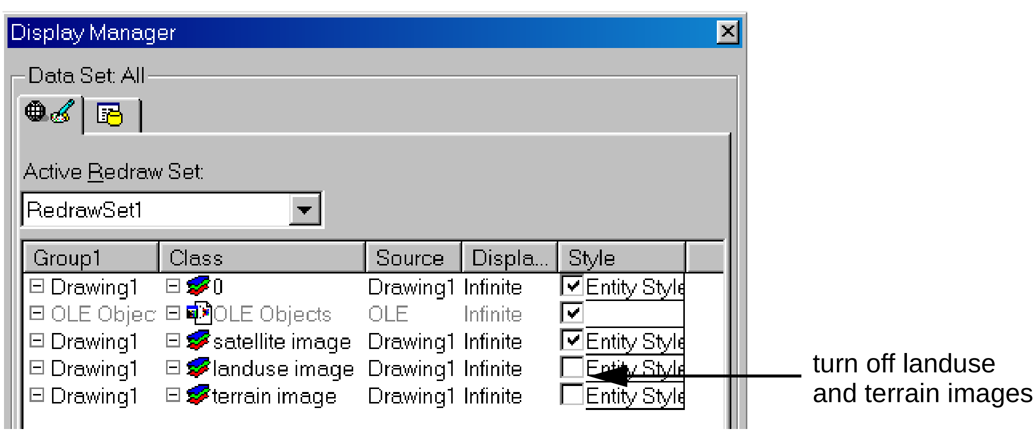
Autodesk World displays a color shaded relief (or “colordrape”) image of the same area of San Diego. Colors represent elevation (reds are highest) and the shading effect highlights topographic features such as hills and valleys. This image is illuminated from the northeast, so shadows appear on the southwest side of terrain features. ER Mapper has a built-in “realtime shading” feature that lets you interactively change the shading parameters without creating output files.

## View any of the three images

It is often helpful to “stack” multiple different types of images of the same geographic area (as you did here). Images are treated as CAD entities in Autodesk World, so you stack multiple images the same way you stack vector data–put each image on a separate layer and just turn the layers on and off. You can also control the redraw order (which image is on top) of the layers by dragging them around in the Display Manager to achieve the desired ordering.

1 Choose **View > Display Manager**.

2 In the **Display Manager** dialog, turn off the Entity Style checkboxes for the ‘landuse image’ and the ‘terrain image.’




3 Press **F5** (or select **View > Refresh View**).

The merged color satellite image displays.

4 In the **Display Manager**, turn off the ‘satellite image’ checkbox and turn on the ‘landuse image’ checkbox, then press **F5**.

5 View any of the three images by turning on its layer and turning the other two off, then pressing **F5** to refresh the view.

These simple examples show how you can use the power of ER Mapper algorithms to showing various "views" of your image data as backdrops for analysis of your vector data in Autodesk World.

## Close the project

1 If desired, save your project using **File > Save As...**.

2 Choose **File > Close** to close the project.

# 3: Combining image and drawing data

***Objectives*** Learn to use both image (raster) and drawing (vector) data in a project. In this example, you will overlay a network of roads on a small aerial photograph image.

---

**Note:** Before beginning, make sure the 'AutoCAD DXF' GDX driver has been added to Autodesk World. Consult your Autodesk World documentation or on-line help if needed to do this before continuing.

---

## Start a new project

1 Start a new project by choosing **File > New**, then clicking **Blank Template**.

## Set the coordinate system for the new project

1 Choose **File > Properties**.

2 Click the **Coordinate System** tab, then click **Change....**

3 On the **Project Detail** dialog, select **UTM27-11** from the **Coordinate System** list.

## Set the data viewing coordinate type

1 Choose **Tools > Format Options**.

2 Click the **Units** tab, then select **m** from the 'User Unit' list.

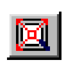
3 Click the **Coordinate** tab, select **Projection Coordinate** from the 'Display Type' list, then click **OK**.

The display coordinates are now set to the units of the map projection (meters of Northings and Eastings in UTM zone 11.)

## Create a drawing layer to display an airphoto image

1. Choose **File > Data Manager**.
2. Click the **Drawing Data** tab to view drawing layers.
3. Right-click on ‘Drawing1’ then select **New Layer**.
4. Click on the ‘Layer1’ text and change it to **`airphoto image`**.

## Insert an ER Mapper airphoto image into the drawing

1. Choose **Insert > ER Mapper Image**.
2. On the **Insert ER Mapper Image** dialog, click the **Image** tab, then click **Browse**.
3. From the ‘Files of Type’ list, select **Datasets (*.ers)**.
4. Double-click on the folder where ER Mapper is installed, then open the ‘examples/Shared_Data’ folder.
5. Double-click on the file ‘Airphoto.ers.’
6. Turn on the ‘Bilinear Smoothing’ and ‘Contrast Stretching’ options.
7. Click **General** tab, then select **airphoto image** from the ‘Layer’ list.
8. Click **OK** to insert the image into the layer and display it.
9. Click the **Zoom All**  button or choose **View > Zoom All**.

   Autodesk World displays a color aerial photograph of small part of the downtown San Diego, California area.

## Open a DXF drawing to overlay on the airphoto image

1. Choose **File > Data Manager**.
2. Click the **Drawing Data** tab, then click the **Open Drawing**  button.
3. From the ‘Files of Type’ list, select **Autodesk DXF File (*.dxf)**.

---

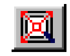
**Note:** If ‘Autodesk DXF’ does not appear as a filetype option, you need to install the AutoCAD DXF GDX driver.

---

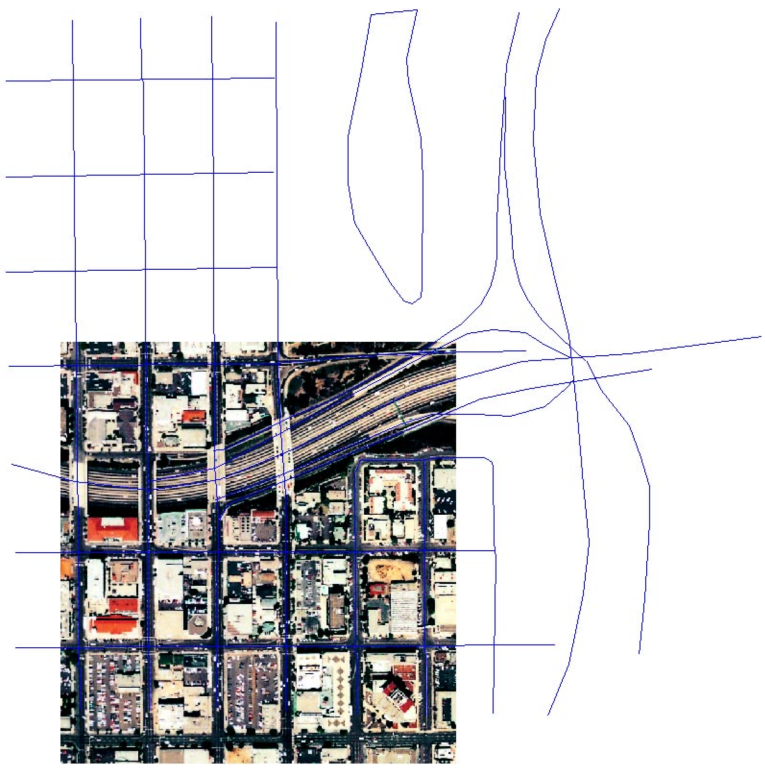
4. Open the ER Mapper ‘examples/Data_Types_AutoCAD_DXF’ folder.

5 Double-click on the file ‘Roads.dxf.’

The DXF file is added as a layer in your project.

6 Click **Close** on the Data Manager, then click the **Zoom All**  button or choose **View > Zoom All**.

Autodesk World displays a vector road network over the airphoto image. This is a very simple example of combining image and drawing (vector) data. This is the most common way you will be using the ER Mapper image handling capabilities within Autodesk World.



## Close the Autodesk World application

1 If desired, save your project using **File > Save As....**

2 Close Autodesk World by clicking the **Close**  button on the application window or selecting **File > Exit**.

***What you learned...***

After completing these exercises, you know how to perform the following tasks in Autodesk World:

- Insert an ER Mapper image into an Autodesk World drawing
- Enhance the image contrast and apply image smoothing

- Choose equivalent coordinate systems in Autodesk World and ER Mapper
- Insert an ER Mapper smart data algorithm into an Autodesk World drawing
- Stack and change the order of multiple images in a drawing
- Combine image and vector drawing data in a project

# A

# System setup

This appendix describes the steps needed to set up your system for students to perform the hands-on exercises in this manual.  There are three tasks:

- Installation of sample “application” datasets
- Copying files for supervised classification and rectification exercises
- Editing the sample file to remove existing GCPs for the rectification exercise

In order to carry out the following instructions, you should have some basic knowledge of copying files in Windows or UNIX and setting file permissions.

## Copying files to the ‘tutorial’ directory

The exercises for Supervised Classification and Image Rectification require that each student have their own copy of the dataset “Landsat_MSS_notwarped” under the name “Landsat_practice” in ER Mapper’s ‘tutorial’ directory. (The ‘tutorial’ directory is created automatically during the ER Mapper installation.) Follow these steps to create a copy of the header file and data file.

---

**Note:** Users must have **read and write** access to the practice dataset. Set the file permissions appropriately if needed.

---

### Copying files for Windows installations

1 Use the Windows Explorer to copy and rename the following files in the 'examples\Shared_Data' directory to the 'examples\Miscellaneaous\Tutorial' directory as indicated:

**Shared_Data\Landsat_MSS_notwarped.ers** *copy to* **Tutorial\Landsat_practice.ers**

**Shared_Data\Landsat_MSS_notwarped** *copy to* **Tutorial\Landsat_practice**

# Editing the practice file to remove GCPs

For the Rectification exercise, you will also need to set up an algorithm and delete existing Ground Control Points (GCPs) from the practice dataset. Follow these steps to do this:

1 From the **File** menu, select **Open**.

An image window and the **Open** file chooser appear.

2 From the **Directories** menu (on the **Open** dialog), select the **\examples** path.

3 Open the 'Data_Types' directory, then open the 'Landsat_MSS' directory.

4 Double-click on the algorithm 'RGB_321.alg' to display it.

You will load the practice dataset into this algorithm and save it under a new name.

5 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** dialog.

6 Click the **Load Dataset**  button in the process diagram (on the right).

7 From the **Directories** menu, select the **\examples** path.

8 Open the 'Miscellaneous\Tutorial' directory, then double-click on the 'Landsat_practice.ers' dataset to load it.

9 From the **File** menu, select **Save As...**

10 In the **Save As** dialog, select 'ER Mapper Algorithm (.alg)' for the **Files of Type** field.

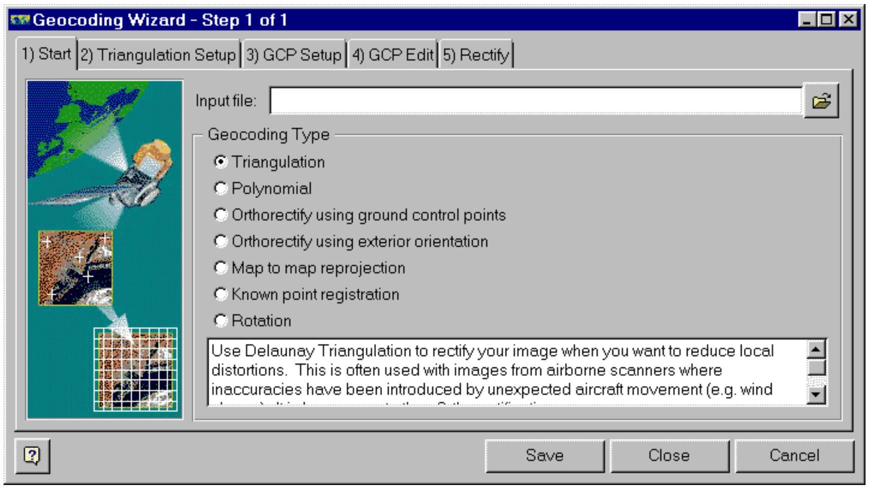
11 From the **Directories** menu (on the **Save As** dialog), select the **\examples** path.

12 Double-click on 'Miscellaneous' and then the 'Tutorial' directory to open it, enter the name '`Landsat_FROM_algorithm`' in the 'Save As' text field, and click **OK**.

You have now created the necessary algorithm for use

13 From the **Process** menu (on the main menu), select **Geocoding Wizard**.

The Geocoding Wizard dialog box will open with the **Start** tab selected.



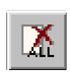

14 Click the **Load Algorithm or Dataset**  button in the **Input file:** field to open the file chooser.

15 From the **Directories** menu, select the path ending with the text **\examples**.

16 In the directory ‘Miscellaneous\Tutorial,’ double-click on your previously saved algorithm, ‘Landsat_FROM_algorithm.alg’.

17 Select **Polynomial** in the **Geocoding Type** box.

18 Select the **GCP Edit** tab.

19 Click the **Delete all GCPs**  button and, when asked to confirm the delete, click **Yes**.

20 Click on the **Save** button to save the changes to the practice image. If asked to confirm saving GCPs to disk click **Yes**.

21 Click **Close** on the **Geocoding Wizard** dialog to close it and the image windows.

You have now deleted the existing GCPs from the practice dataset. You may now make additional copies of the practice dataset for other users as needed.

B

# Reference texts

This appendix provides references to a range of image processing and remote sensing textbooks. These books will be very helpful to those new to image processing, or those who want to learn more about image processing techniques for specific earth science applications. Also refer to the *ER Mapper Applications* manual for examples and information about image processing for many earth science applications.


Avery, E. A., and G. L. Berlin. 1992. *Fundamentals of Remote Sensing and Airphoto Interpretation*, Macmillan Publishing Company, New York, N.Y, USA.

Cracknell, A. P., and L. W. B. Hayes. 1993. *Introduction to Remote Sensing*, Taylor & Francis Ltd, London, England.

Jensen, J. R. 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective (2nd Ed.)*, Prentice-Hall, Engelwood Cliffs, N.J, USA.

Lillesand, T. M., and R. W. Kiefer. 1991. *Remote Sensing and Image Interpretation*, John Wiley and Sons, Inc. New York, N.Y, USA.

Rees, W. G. 1990. *Physical Principles of Remote Sensing*, Topics in Remote Sensing, vol 1. Cambridge University Press, Cambridge, England.

Sabins, F. F. 1997. *Remote Sensing: Principles and Interpretation (3rd Ed.)*, W. H. Freeman and Co., New York,N.Y., USA.

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