

Technical Notes for *Bilko* Authors

Background Information

What can the *Bilko 3* software do?

Bilko provides a range of raster image processing functions including the following:

- the display and processing of digital images in a range of formats (e.g. GIF, BMP, HDF, GeoTIFF, N1, netCDF),
- standard tools for the analysis and manipulation of images (e.g. histograms, a range of stretches, palettes, transects, colour composites, scattergrams, filters, PCA, rectification and resampling, supervised and unsupervised classification),
- a simple but powerful interface (the Formula document) to allow you to create complex algorithms to combine sets of images using mathematical functions (e.g. algorithms for radiometric correction, sun glint removal, masking out land or sea, calculating vegetation indices).
- ability to extract a single parameter from many different files in one operation and connect these into time series for analysis

The software has been written from an educational perspective and is specifically designed to give students an **understanding** of how remotely sensed images are manipulated and analysed. Processes have as far as possible been kept transparent rather than being implemented as one-stop black-box routines. However, in recent years, *Bilko* is also increasingly used as a professional tool by scientists who occasionally need to use remote sensing in their work, but cannot justify investment in commercial systems.

What the *Bilko 3* software does not aim to do

The *Bilko* software currently does not support vector graphics and is not intended for use in GIS applications (although it does have a certain amount of GIS functionality – see Mini-lesson 4). It is intended primarily as a teaching tool and thus many specialist functions have been omitted to preserve simplicity. Many of these functions can be created using the Formula document facility.

Software development

Software developments in *Bilko* are driven by educational need. If a lesson is being produced which needs additional functionality, this is generally developed. Recent enhancements have included the addition of unsupervised and supervised classification functions for a lesson on classification.

Using this document

To make effective use of these *Technical Notes for Bilko Authors* you need firstly to become familiar with the *Bilko* image display and analysis software. The software has

an extensive, integrated, context-sensitive Help system which is a useful source of information but perhaps the best way to familiarise yourself with *Bilko* is by running through the 12 tutorials of the *Introduction to using the Bilko 3 image processing software* or the on-line *Introductory Tutorials* at <http://www.bilko.org/tutorial.php>. The *Introduction* guides you through most of *Bilko*'s functionality and the 12 tutorials broadly follow the guidelines on writing *Bilko* lessons and so will hopefully generate ideas about how you will structure your own lesson(s). You will need to set aside 6 to 10 hours of time to master the *Introduction*.

Before planning a lesson, you need to have become not only familiar with the functions available in *Bilko*, but also aware of the way in which the software emphasises the **learning** of remote sensing rather than providing 'black-box' solutions that obscure what is being done by the software. *Module 7*, which focuses on coastal management applications of remote sensing, provides example lessons that may be helpful in the lesson planning process.

Software development is lesson-driven with new features being added when lessons absolutely require them and the new functionality has clearly demonstrable **educational** usefulness. If you are likely to need additional functionality in order to develop lessons, you should contact the UNESCO-Bilko Project Secretariat at the following address:

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c/o Val Byfield
National Oceanography Centre
European Way
Southampton SO14 3ZH
United Kingdom
E-mail: bilko@noc.ac.uk
Website: <http://www.unesco.bilko.org/>

In compiling this information we have assumed that you have a reasonable knowledge of the applications of satellite and airborne imagery to coastal management, oceanography or other subject areas; this means you should be familiar with the satellite or airborne sensors used, their modes of operation and the types of image they produce. Several textbooks providing general or more specific information on remote sensing are listed below in Table 1.

Pedagogical aspects of writing *Bilko* lessons are covered in a separate document entitled *Guidelines for Bilko Authors*, which should be read in conjunction with these technical notes if you are intending to write a *Bilko* lesson.

Table 1. Key reference books on remote sensing listed in reverse order of date of publication.

Reference
Green, E.P., Mumby, P.J., Edwards, A.J. and Clark, C.D. (Ed. A.J. Edwards). (2000). <i>Remote Sensing Handbook for Tropical Coastal Management</i> . Coastal Management Sourcebooks 3. Paris: UNESCO.
Mather, P.M. (1999). <i>Computer Processing of Remotely Sensed Images: An Introduction</i> . Second Edition. New York: Wiley. (Includes CD-ROM).
Sabins, F.F. (1996). <i>Remote Sensing. Principles and Interpretation</i> . (Third Edition). San Francisco: Freeman.
Wilkie, D.S. and Finn, J.T. (1996). <i>Remote Sensing Imagery for Natural Resources</i>

- Monitoring: A Guide for First-time Users*. New York: Columbia University Press.
- Jensen, J.R. (1995). *Introductory Digital Image Processing. A Remote Sensing Perspective*. (Second Edition). Englewood Cliffs: Prentice-Hall.
- Richards, J.A. (1995). *Remote Sensing Digital Image Analysis: An Introduction*. (Second Edition). New York: Springer-Verlag.
- Lillesand, T.M. and Keifer, R.W. (1994). *Remote Sensing and Image Interpretation*. (Third Edition). New York: Wiley.
- Barrett, E.C. and Curtis, L.F. (1992). *Introduction to Environmental Remote Sensing*. (Third Edition). London: Chapman and Hall.
- Cracknell, A.P. and Hayes, L.W. (1990). *Introduction to Remote Sensing*. London: Taylor and Francis.
- Harrison, B.A. and Judd, D.L. (1989). *Introduction to Remotely Sensed Data*. Canberra: Commonwealth Scientific and Industrial Research Organisation.
- Open Universiteit (1989). *Remote Sensing. Course Book and Colour Images Book*. Heerlen: Open Universiteit. (Available from The Open University, Milton Keynes, UK as PS670 study pack).
- Curran, P.J. (1986). *Principles of Remote Sensing*. London: Longman.
- Maul, G. (1985). *Introduction to Satellite Oceanography*. Dordrecht: Martinus Nijhoff.
- Robinson, I.S. (1985). *Satellite Oceanography*. Chichester, Ellis Horwood Ltd.
- Stewart, R.H. (1985). *Methods of Satellite Oceanography*. University of California Press
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For information on the most recent developments in ocean and coastal remote sensing, the Space Agencies provide publicity material and technical specifications for new sensors. National Remote Sensing Agencies also provide information about the types of image data that they supply.

Given the diversity of the available data sources, detailed information on the digital formats of source images is too specific to be provided here and must be sought elsewhere. This technical information digest does however provide a checklist of the actions required to generate images for lesson purposes.

In the text that follows, image filenames refer to the images supplied in either *Module 7* or in the *Introduction to using the Bilko 3 image processing software*. All files are available from the *Bilko* website <http://www.bilko.org/>.

1. Selection of images

1.1. Choice of images to form the basis of a lesson

Any image in digital form is a potential candidate for use as lesson material. The primary criterion in selecting an image is that it should contain interesting features upon which the lesson can focus, or exemplify a particular technique of coastal or marine image analysis or interpretation. If several images are to be used in a single lesson they should have a logical relation to one another; they might, for example, show different channels (wavebands) of the same image¹, or a time series of images of the same area¹, or display the same area at different spatial resolutions. It is sensible to

¹ In such a case you might wish to open the images of each of the channels/times of interest in *Bilko*, connect them and save them as a SET, so that your students can easily open all at once.

restrict images to those whose analysis can confidently be unfolded within the context of the lesson.

Module 7 provides examples of coastal management related lessons based on studies of the Caicos Bank in the West Indies using Landsat MSS (80 m spatial resolution), Landsat TM (30 m resolution), SPOT XS (20 m resolution), SPOT Pan (10 m resolution), Ikonos multispectral (4 m resolution), scanned aerial photographs (2 m resolution) and Compact Airborne Spectrographic Imager data and Ikonos panchromatic data (1 m resolution). Many other types of imagery could be used. Also it can be very useful to include scanned or digital photographs in a lesson in a format that can be viewed by *Bilko* (e.g. GIF, BMP). These might be pictures of habitats, remote sensing instruments, survey aircraft, people ground-truthing, maps, etc.

1.2. Non-traditional images

Any two-dimensional dataset is capable of display in *Bilko*. Hence many other data products make suitable subjects for computer-based lesson material. Examples are: the vertical distribution of salinity and temperature along a transect, sampled using an undulating recorder; transects of velocity with depth derived from an acoustic doppler current profiler; and the output fields of ocean models.

2. Source data

Having selected images for your lesson, it is important to ensure that you have sufficient information to prepare them for use in *Bilko*. Useful questions to keep in mind are:

2.1. What is the origin of the image?

The date and time of acquisition, satellite and orbit number, geographical location are all necessary to provide unique identification of an image. Such information should be provided to the student in the *Background* section of the lesson.

If you have a geometrically corrected image, which is not in a format that can be read directly by *Bilko*, and wish to transfer its UTM (or other gridded coordinates) or latitude and longitude coordinates to *Bilko*, you will need to note the UTM coordinates of the top left pixel of the source image and pixel dimensions before exporting from your usual image processing package. If projections are important in the context of your lesson you may need to note additional information such as the UTM grid zone, spheroid, and datum used. However, note that at present *Bilko* does not explicitly deal with projections and cannot automatically convert between different geographical coordinate systems.

In *Bilko 3* coordinates relate to centre point of each pixel whereas in previous versions they related to the top-left corner of each pixel. This is the same convention as used by most commercial packages (e.g., ERDAS Imagine).

2.2. From which sensor does it come?

Most sensors utilise more than one waveband so, for them, the channel number must be quoted when specifying an image. When storing bands as separate files, suffixing image filenames by #01, #02, etc. to indicate channel/band number is recommended.

(Hierarchical data formats such as HDF, N1, netCDF, all of which can be read by *Bilko*, may contain multiple bands.)

2.3. Has the image been processed: if so, how?

The image may already have been calibrated, converted into oceanographic parameters such as sea-surface temperature or chlorophyll concentration, and may have been resampled onto a geometric grid different from that referred to in the raw sensor data. This information may be essential for interpreting the image and needs to be provided to the student in the *Background* section of the lesson.

2.4. How can the data be obtained?

It is important to identify an authentic supply route for image data. In this way you, or others working on your lesson, may be able to obtain further image data of the same type. This is especially important if the images being used have been obtained through informal professional contacts. A great deal of image data is now available free over the web for registered users. Indicating the URL (web address) where similar data can be obtained (free) can be immensely helpful to students or teachers using your lessons.

2.5. How is the source image stored?

Two aspects of image storage must be considered, its physical format and its logical format (file type). The types of logical file formats supported by *Bilko* are discussed further in section 5.1.

Image data are generally provided to the project on CD (or DVD), on floppy diskette (for very small images) or over the internet via FTP.

Note: If all you have is a hard copy (screen-dump or photograph) of a digital image display, you will need to refer this question back to the supplier of your hard copy to ensure that digital data are available.

3. Pre-processing

It is easier to use data in its existing form, but this may not be ideal for a lesson. You may have to change its form to make it more suitable for your students. Questions to have in mind are:

3.1. Are the data already in usable form or is some pre-processing of the image necessary to make it more suitable for teaching?

If your data are already in acceptable form, skip to Section 4.

3.2. Are raw data adequate?

Certain types of image data can be used in their raw form as counts from the sensor, and need not be processed. Lesson 3 in *Module 7*, which looks at radiometric correction, starts with a geometrically corrected image but with data that are raw DN values.

Be careful here. One aim of the UNESCO-*Bilko* project is to demonstrate the *quantitative* use of remote sensing. A calibrated, corrected image can be presented to

students as consisting of 125,000 *scientific measurements*, whereas a raw, uncalibrated image may be dismissed as no more than another *satellite picture*.

3.3. Should sensor calibrations be applied?

If the data of interest simply represent object counts or position measurements, sensor calibration may not be required. If they represent the values of physical quantities, calibration is likely to be essential. In Lesson 3 of *Module 7*, the initial part of the lesson involves converting raw DN values to spectral radiance values using calibration information supplied by the vendor. Remember that sensor counts can always be converted into radiance values or radiation temperatures using the calibrations supplied with raw-image data.

3.4. Are atmospheric corrections necessary?

A positive response to 3.3 normally suggests that atmospheric corrections should also be applied. For some oceanographic and most coastal management applications these corrections are essential. Most of the images used in *Module 7* have already been atmospherically corrected.

3.5. Is the image geolocated?

Establish whether it is possible to determine the geographical location corresponding to each pixel on the image. If it is, and you can read off the coordinates as UTM (Universal Transverse Mercator) or other gridded coordinates or as Latitudes and Longitudes then you can transfer these to *Bilko* (see section 2.1). You can also use a series of Ground Control Points (GCPs) to work out the coordinates of all the pixels in an image using *Bilko*'s rectification and resampling capabilities to geometrically correct image data. For images, which have been geometrically corrected in another package or are supplied with some level of rectification, if you know the geographical coordinates (Easting/Northing, Longitude/Latitude) of the top left pixel and pixel width and length you may apply the coordinate system once you have imported the image file to *Bilko* using the **Edit, Coords** function.

3.6. Is rectification necessary?

Rectification allocates data to a new coordinate grid and allows students to reference between locations on the ground/sea and pixels in the image and also allows explicit exploration of the scales of features or phenomena being studied. For coastal management applications, rectification is normally desirable. If rectification is a key part of a lesson it can be done in *Bilko*, if not it may be appropriate to pre-rectify the image so that the student can concentrate on other learning tasks.

3.7. Pre-processing of the data where functionality is missing

Where functionality is missing in *Bilko* or you do not want students to get bogged down in aspects of image processing which are perhaps secondary to the aims of a lesson and may detract from the key learning objectives, it may be appropriate to pre-process data and present students with before and after images and some brief description of the process undertaken. An example of such a workaround is given in the next paragraph.

In Lesson 3 of *Module 7* on radiometric correction, it was felt important that the student should be aware of 5S (or 6S) radiative transfer code and how it is used in

atmospheric correction. The actual code is not part of *Bilko*, so the lesson, having led the student through (i) converting raw DN values to spectral radiance and (ii) how to convert these to exo-atmospheric reflectances using *Bilko* Formula documents, introduced the student to what parameters can be input into the 5S model and what the outputs of the 5S model for the image were. The student then took the outputs of the 5S model, which was run on a Unix machine elsewhere, and completed the atmospheric correction by inputting these into a further Formula document. Although *Bilko* could not run one specific piece of radiative transfer code, the lesson lost almost nothing in terms of student understanding of the process of radiometric correction.

3.8. Copyright and permission to use image data for lessons

You should make sure that any image data used for lessons is not copyright to someone else or, if it is, that permission has been sought from the copyright owner to use the data. For data used for non-profit educational purposes this should not present a major problem and UNESCO will be happy to provide you with a standard letter to assist you in obtaining permission if this is needed.

4. Practical aspects of handling source-image files

There are two issues in transferring data from a source-image file to a PC. One relates to the structure of the data and the other to the physical systems involved in the transfer.

4.1. Are the required image data interleaved with images of other channels and/or with calibration data within the same file?

Whether your data are Band Sequential (BSQ) or interleaved (Band Interleaved by Line – BIL or Band Interleaved by Pixel – BIP), if they are not in a format which *Bilko* can read directly, you will need to export them as binary flat files from whatever proprietary image processing package you are using. For *Module 7*, all images were exported from ERDAS Imagine as flat binary files (*.bin* extension).

In Mini-lesson 6 there is an example of a 5 band BIL AVHRR image being imported into *Bilko* as a single binary flat file. This is then saved as five separate image files in *Bilko*'s proprietary *.dat* format and these five images then connected as a set so that they can be opened together in *Bilko* with the minimum of effort.

4.2. Assuming you now have single-channel image files or *Bilko* readable hierarchical files, what constraints must be applied to the dimensions of your image?

Ideally, try to keep images to be used in lessons to sizes not much larger than 800 columns x 600 rows of pixels, that is a size that can be readily viewed on standard PC monitor screens. Often larger images may be necessary for a lesson and *Bilko* can readily open a full Landsat, AVHRR or MERIS scene if needed. The golden rule is that images should be kept to dimensions that ensure that the size does not interfere with the lesson by (i) slowing down processing operations, (ii) making it cumbersome or slow for students to locate key areas of interest, (iii) distracting students from the phenomena/features of interest, or (iv) exceeding student disk quotas.

Monitors should have 24-bit colour resolution (or better), although 16-bit resolution (sometimes called 'High Color') is acceptable. Processing time will increase with image size and it should be borne in mind that some users may have relatively slow machines, which may struggle with very large file sizes. This type of consideration is now less important than it was as PCs are so much faster but unless there are good educational reasons for large file sizes, it is helpful to students to keep files reasonably small. The other issue that should be considered is that students may possess limited file storage space. This is commonly the case on networked systems. If you create a lesson that requires a student to save a 100 Mbyte file to her/his own disk space, you may find that relatively few can do this and thus that your lesson has a very limited uptake.

Many network systems may allow temporary file storage on the local hard drive (often in **C:\Temp** folder) and students/teachers will need to be alerted to how to utilise such space if very large files are to be saved.

4.3. In what digital form are the pixel count values stored?

Points you need to establish are:

- i. Is the file (a) formatted, or (b) an unformatted flat binary file?
- ii. If (a), what is the format? Are the numbers stored in signed or unsigned integer or real form?
- iii. If (b), what is the length of each individual pixel value in bits? It is likely to be 8 bits (1 byte), 16 bits (2 bytes) or 32 bits (4 bytes).
- iv. For multi-byte pixels, what is the byte order (big endian or little endian)? Motorola and Intel store bytes in a different order.

5. *Bilko* data formats

5.1. *Bilko* Image Files

Bilko can read and write image files in a wide range of formats: CompuServe 8-bit GIF format (**.gif**), unformatted binary flat files (**.bin**), Windows bitmap format (**.bmp**), ZSoft v. 5.0 pcx (**.pcx**) format, and *Bilko* data format (**.dat**). Coordinate data for 8-bit images can be stored in GIF format and for 8, 16 (unsigned) or 32-bit (IEEE float) images can be stored in *Bilko* proprietary data format (**.dat**).

Bilko 3 can also read in data in a range of other geocorrected and hierarchical structured data formats such as version 4 and earlier Hierarchical Data Format (**.hdf**), GeoTIFF (**.tif**), European Space Agency N1 (**.n1**), netCDF (**.cdf**) and *Bilko* can only save images for export in GeoTIFF format. However, if users feel this is important, saving to NetCDF (.nc) could also be implemented. Further technical details of these formats and URLs of websites with full specifications are given in Table 2.

In the *Introduction to using the Bilko 3 image processing software* the two AVHRR images (**AVHRR_Mulls#02.bmp** and **AVHRR_Mulls#04.bmp**) have been resampled as Windows bitmaps, whilst most other 8-bit images are stored as CompuServe GIFs. In *Module 7, Lesson 5* the images used are 16-bit unsigned integer files (2 bytes per

pixel) and are stored as *Bilko* **.dat** files, whereas in Lesson 6 the main images are 32-bit floating point *Bilko* **.dat** files.

When using Formula documents you quite often may need to specify the pixel format of the output images, with the output image often having a different format to the input image. An example is provided in Tutorial 10 of the *Introduction to using the Bilko 3 image processing software* where an 8-bit GIF image is converted to sea surface temperatures (SST) in degrees Celsius using a formula and the output needs to be floating point to display temperatures to nearest 0.01°C. Output image formats can be set either by using the menu options or by embedding statements in the Formula document.

Table 2. Details of file formats supported by *Bilko* 3.

File formats supported	Details of <i>Bilko</i> support
Bilko DAT (.dat)	Proprietary internal <i>Bilko</i> format.
Binary flat file (.bin)	Supports fixed length headers, 8, 16 and 32-bit signed and unsigned and 32-bit float (IEEE format) data in both Intel and Motorola byte order. Handles BSQ, BIL and BIP file formats.
Compuserve GIF (.gif)	Supports 1 to 8-bit data in interlaced or non-interlaced mode and multiple images (animated GIFs).
ENVISAT N1 (.n1)	Supports all MERIS, AATSR and ASAR data sets containing raster data sets. Based on the ENVISAT Product Reader API v2.0.2
ERDAS Imagine (.img)	Supports reading of image data, associated header information and classification tables (if present).
HDF v. 4 (.hdf)	Supports a wide range of 8, 16, and 32-bit signed and unsigned and 32-bit (IEEE format) data in 1, 2 and 3 dimensional formats. Based on HDF4.2r0
USGS MapGen (.dat)	Vector coastline data displayed as a bitmap. Available from http://www.ngdc.noaa.gov/mgg/shorelines/shorelines.html
netCDF (.nc)	Supports a wide range of 8, 16, and 32-bit signed and unsigned and 32-bit (IEEE format) data in 1, 2 and 3 dimensional formats. Based on netCDF v3.5.0
TIFF v. 6 (.tif)	Supports 1, 2, 4, 8, 16 and 32-bit signed and unsigned and 32-bit (IEEE format) data. It does not support YUV format. Based on Libtiff v3.6.0
Windows BMP (.bmp)	Supports 1, 4, 8 and 24-bit data types (uncompressed).
Z soft v. 5 PCX (.pcx)	Supports 8-bit data only.

5.2. Conversion of source files to *Bilko* files.

If the data are stored in a formatted file, which is not in any of the formats supported by *Bilko*, they should be saved in the proprietary software package in which they were created as one of the formats that can be read into *Bilko*. Most packages allow you to export in at least one of the supported formats or as binary flat files.

If exporting as a binary flat file make a note of the numbers of rows and columns in the original file and any geolocational data before exporting. If the image is georeferenced

to a grid (e.g. UTM, UK Ordnance Survey National Grid, etc.) you should note the coordinates of the upper left pixel of the image (often referred to as ULX: and ULY:), the pixel dimensions and, as a check so that you can make sure the coordinates are correct in *Bilko*, the coordinates of the lower right pixel of the image (LRX: and LRY:). The coordinates can be applied to the image in *Bilko* using the **Edit, Coords** function and saved with the image in Compuserve *.gif* (for 8-bit images) or *Bilko .dat* (for the full range of file formats supported by *Bilko*).

5.3. Copying data between *Bilko* and other packages via the Clipboard.

A useful feature of *Bilko* is the ability to copy image, transect, table and formula data to the *Windows* “clipboard” and then paste the data into *Microsoft Office* or other packages. This is best done using the **Paste Special** menu option. For example, box selections or transects in images can be copied and pasted to *Excel* or *Minitab* worksheets for statistical analysis, manipulation or plotting. However, you need to be aware that *Excel* allows you a maximum of only 256 columns of data, so image areas wider than this cannot be pasted successfully. Similarly the contents of rectification and other tables (e.g. outputs of PCA) in *Bilko* can be selected with **Select All** and then copied and pasted to *Excel* or *Word*. Tutorial 12 of the *Introduction to using the Bilko 3 image processing software* explores these options.

You can also copy ranges of *Excel* cells containing appropriate numerical data and paste these into *Bilko* images or rectification tables. This may be helpful in creating or modifying image datasets or rectification tables for lessons.

Transect data can be copied from transect documents or images and pasted to *Excel* or *Minitab*. This is particularly useful when using a stack of images as it allows you to use the functionality of *Excel* or *Minitab* to examine, compare, statistically analyse or plot the transect data in a series of bands or a time series taken in one waveband. Because of the 256 column limit in *Excel* and the likelihood that transects may well exceed this, transects are transposed so that they paste down the column rather than along the row when pasted in a worksheet.

If developing a formula document you can use a pre-existing one as a model and cut and paste working elements from one formula document to another via the clipboard. This reduces the risk of typing errors. The parser, which checks that formulae are syntactically correct, will often object if you copy part of a formula document and give you a “Syntax error” warning message, but the formula text you have copied is still passed to the clipboard and can be pasted where you wish.

Preparing rectification tables for use in lessons can be very time consuming and prone to copying errors. If GPS or other coordinate data are available in an *Excel* spreadsheet in a series of columns like the two examples below (one for UTM gridded data and one for latitude/longitude data expressed as decimal degrees), selections of cells in the first three or all five columns can be copied and pasted to blank rectification tables in *Bilko*.

Description	Easting	Northing	column	row
NW corner of airstrip tarmac	237125.0	2381302.0	123	41
SE corner of airstrip tarmac	238900.0	2381000.0	618	130
Crossroads 1 middle	239687.0	2381350.0	827	32
Crossroads 2 middle	240150.0	2380850.0	961	177

Coordinate pairs are combined into single columns on pasting into *Bilko*. Thus the rows above would appear as three columns in the rectification table:

Description	Master: Use Map (Gridded)	Slave: Aerial_sub...
<input checked="" type="checkbox"/> +GCP #000: NW corner of airstrip tarmac	(237125.0E, 2381302.0N)	(0123, 0041)
<input checked="" type="checkbox"/> +GCP #001: SE corner of airstrip tarmac	(238900.0E, 2381000.0N)	(0618, 0130)
<input checked="" type="checkbox"/> +GCP #002: Crossroads 1 middle	(239687.0E, 2381350.0N)	(0827, 0032)
<input checked="" type="checkbox"/> +GCP #003: Crossroads 2 middle	(240150.0E, 2380850.0N)	(0961, 0177)

Description	Latitude	Longitude	col	row
NE Cyprus - Cape Andreas	34.60664	35.70297	673	516
W Cyprus - Cape Arnauti	32.27767	35.09112	618	533
Dortyo - Turkey	35.78099	36.75890	704	479

Coordinate pairs are combined into single columns on pasting into *Bilko* and decimal degrees are converted to degrees, minutes and seconds in the rectification table. Thus, when pasted, the rows above would appear as three columns in the rectification table:

Negative latitude and longitude values in the spreadsheet can be used to denote

Description	Master: Mediterranean_coastline.gif	Slave: AVHRR_ID24979...
<input checked="" type="checkbox"/> +GCP #000: NE Cyprus - Cape Andreas	(034°36'23.90"E, 35°42'10.68"N)	(0673, 0516)
<input checked="" type="checkbox"/> +GCP #001: W Cyprus - Cape Arnauti	(032°16'39.60"E, 35°05'28.03"N)	(0618, 0533)
<input checked="" type="checkbox"/> +GCP #002: Dortyo - Turkey	(035°46'51.56"E, 36°45'32.03"N)	(0704, 0479)

latitu
des
south
of the
Equat

or or west of the Greenwich Meridian.

Being able to sort, add to, delete, etc. coordinate data in *Excel* and then transfer chosen selections to a *Bilko* rectification table considerably facilitate preparation of lessons involving geometric correction.

6. Useful information for potential authors

Module	A collection of lessons. A thematic module is a collection of lessons (usually around 6 to 10) focused around one theme (e.g., satellite, subject area, region).
Lesson	A focused learning experience dealing with a single main topic, which can be completed in 1-3 hours. An average student should be able to complete a lesson comfortably within 3 hours at the outside.
Mini-lesson	A short focused learning experience dealing with a single topic, which can normally be completed in 30 minutes to 1 hour.
Aims	The aims of a lesson indicate the broad aspirations you have for students who undertake the lesson and should flag up to both students and teachers (who are deciding which lessons they may wish to utilise) what, in global terms, your hopes are for the outcome of the lesson.
Objectives	Lesson objectives specify tasks that your students will, and subsequently should be able to, undertake as a result of studying the lesson. The lesson objectives indicate specific topics/concepts that students will be learning and developing their understanding of while working towards achieving the aims of the lesson.

UNESCO-Bilko	The programme/project name
<i>Bilko for DOS</i>	Modules 1 to 5 used DOS versions of <i>Bilko</i> . Three versions were released.
<i>Bilko for Windows</i>	Two 16-bit versions of <i>Bilko</i> were developed for Windows. Version 1 was developed for Windows 3.1 and was used with Module 6. For Module 7 this was further developed as <i>Bilko for Windows v. 2.0</i> which was designed to run on Windows 3.1, Windows 95 or Windows NT 4.0 or later.
<i>Bilko 3</i>	This is the current beta version of <i>Bilko</i> ; optimised for Windows 2000 and XP. This is a 32-bit programme and includes significantly more functionality than <i>Bilko for Windows v. 2.0</i> . It also runs happily under Windows 95, Windows 98 or Windows NT 4.0 and Windows 7. Some users have experienced difficulties with Windows Vista.
Web address	http://www.unesco.bilko.org/
E-mail addresses	bilko@noc.ac.uk specific queries on the <i>Bilko</i> project
Bitmaps	Available in the authors folder: http://www.bilko.org/authors/ <i>Bilko</i> logo bilko.bmp UNESCO logo unescoblack.tif, unescoblue.tif, unescowhilte.tif
