

# Best practice guidelines - digitising in ArcGIS

## Creating vector boundaries

These best practice guidelines are intended to provide the necessary information to creating digital boundaries using ESRI ArcGIS products. The tutorials provide information on how to create vector boundaries for Important Bird Areas. The process is the same for other types of data, although the associated attributes will differ.

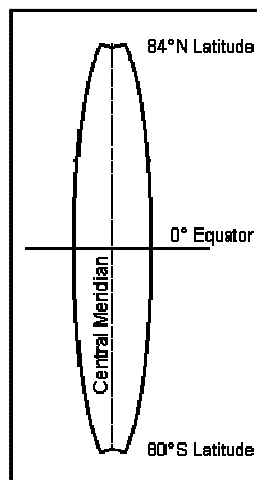
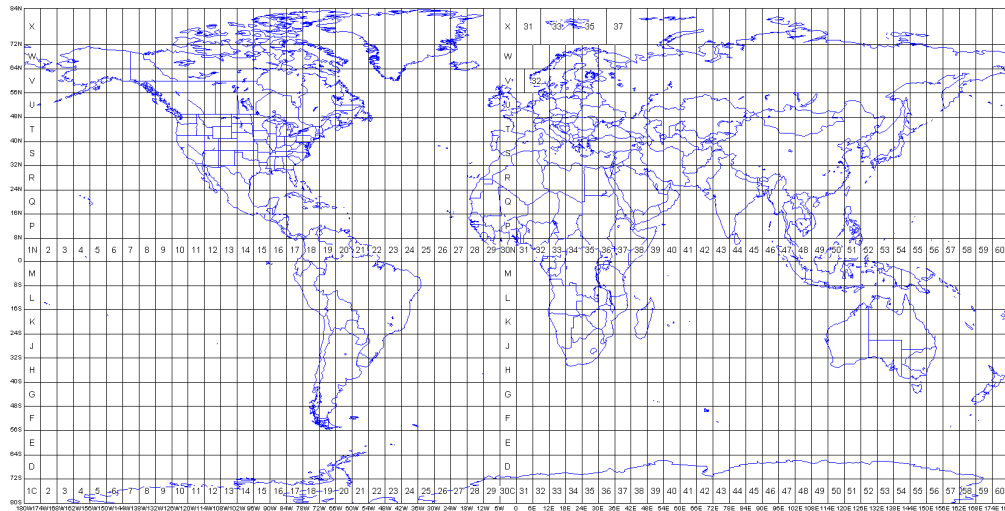
The process of creating vector boundaries within a geographical information system is called *digitising*. It is the creation of polygons, lines and point data. The process is not dissimilar to creating graphical objects in a computer graphics package such as CorelDraw, but what is fundamentally different is the use of a coordinate system to reference the objects to the Earth. It is usual to digitise features from a scanned topographical map, an aerial photograph or a satellite image. There are several important considerations that need to be addressed before the actual process of digitising can begin and these are listed below.

- Data collection

A wide variety of data can be collected to assist with digitising vector boundaries. Commonly used supplementary data are scanned maps (you must be aware and careful not to infringe upon copyright laws), and satellite imagery has become more easily obtainable from sources such as Landsat Geocover. Alternatively, Google Earth images can be saved (it is essential that you do not remove the Google Earth logo, this is needed to avoid breaking the licence agreement) and then georeferenced for your projects. You also have to mention Google Earth / Digital Globe as the source.

- Data preparation

Scanned maps, aerial photographs and images need to be georeferenced to “locate” them on the surface of the earth before you start work, otherwise your digitised data will not relate to the right location. You need to determine what projection you are going to need and use. A recommended projection for creating digital boundaries is the Universal Transverse Mercator (UTM) projection. The Universal Transverse Mercator projection is designed to provide a single grid system that can be applied to the surface of the earth. In this projection, the world is divided into 60 north-south zones, each covering a strip 6° wide in longitude. These zones are numbered consecutively beginning with Zone 1, between 180° and 174° west longitude, and progressing eastward to Zone 60, between 174° and 180° east longitude. The following image displays these zones.



You can envisage the preparation of the UTM projection by imagining the Earth as an orange. If you took a sharp knife and cut out two small circles at the poles (areas where this projection becomes illogical) and then cut straight north/south lines around the orange until there were 60 separate segments of peel – each of equal size.

Each of the slices of peel would then become the basis of a separate projection. The peel would be flattened out to form that projection and it is that flattening process that introduces some distortion. However the rather narrow strips used produce maps with relatively low levels of overall distortion. UTM is therefore a single grid co-ordinate system that applies to 60 separate projections that in total can be used to map almost the entire surface of the Earth.

The UTM projection is widely used within the GIS industry and is ideal as it allows areas to be calculated easily. A word of caution however, if a boundary extends into another zone you will need to use that specific UTM zone unless the boundary is within the 50km overlap (east/west) and 1km overlap (north/south) between zones. It is recommended that the reader becomes familiar with coordinate systems and projections before starting a GIS project.

- Scale

Scale greatly affects the accuracy of digitised boundaries e.g. the same digital boundary created using map at 1:5,000 and 1:100,000 scales will vary greatly in quality. In general, the more detail you can see, the greater the accuracy of the boundary. Decide on an appropriate scale and record this in a 'Quality' attribute - e.g. QuaRecID in the SitMapGlobal template attribute.

- Digitising quality

The process of digitising features can produce unwanted artefacts within the vector data structure such as self-intersecting polygons, one that crosses over itself (looking similar to a bow tie). It is highly recommended that these artefacts are avoided. "Bad topology" as these errors are called will cause problems later when you want to do analyses. It is a good idea to practice the process of digitising before working on final polygon data.

The following illustration provides an example of a self-intersecting polygon.



Notice the black arrows indicate the direction of digitising, note that in this example, the polygon intersects itself. It is these errors that cause problems later on when you need to analyse your data.

There are two tutorials included in this best practice guide:

1. Georeferencing an image
2. Digitising a polygon

## Tutorial 1

### Georeferencing a raster (scanned image) in ArcMap

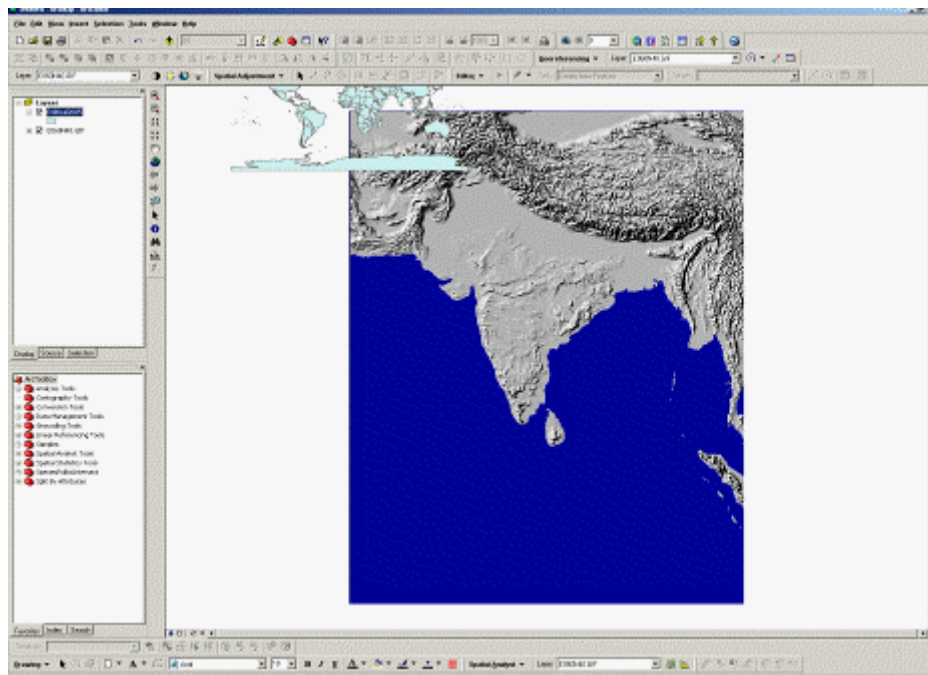
The objective is to align a raster data set (in most cases obtained from scanning an image) to a coordinate system so that it can be displayed and used in conjunction with other spatial data. This is commonly referred to as georeferencing or image registration.

Two data layers are used in this tutorial.

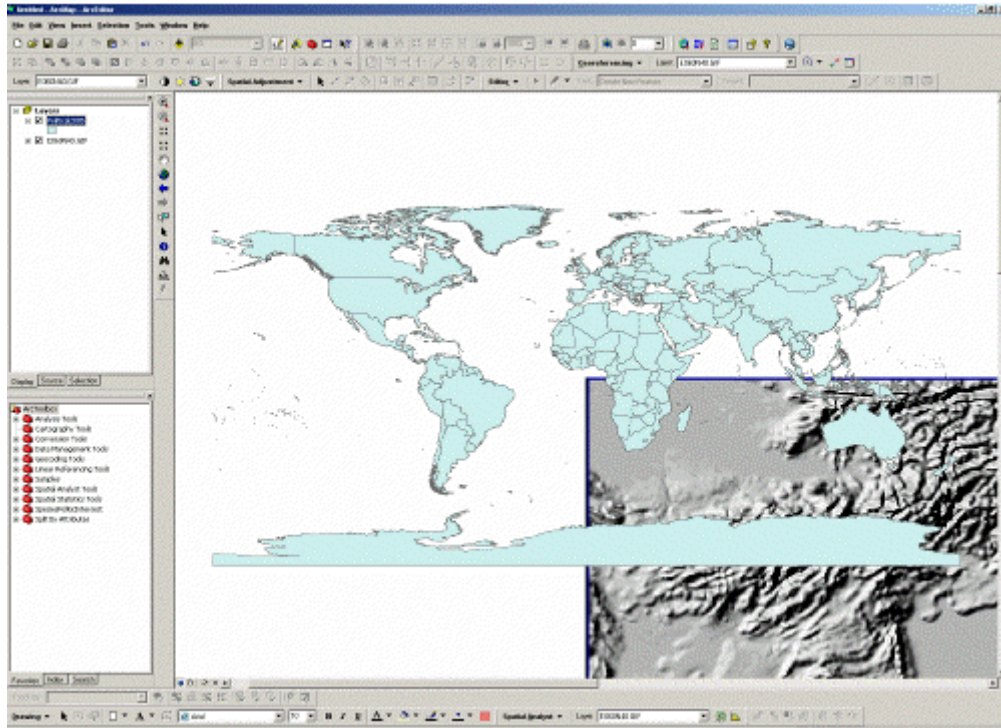
- A shaded relief image (unprojected)
- Political boundaries (geographic coordinate system)

#### Step 1. Open a new map document

- Open a new ArcMap document and add your data. Make sure you add a layer that is already georeferenced e.g. the Political boundaries – this will be your reference base for the scanned image.
- Click to the scanned image to make it visible.
- You will notice that it does not appear in the Data Frame. This is because the data is ungeoreferenced.
- Because these data layers do not share a common coordinate system they will not both be visible at the same time. To view the raster layer highlight it then right click *zoom to layer*. The layer is now displayed in the data frame window. If you hover over the image with the mouse you will see the coordinates are displayed as unknown units.



- Make sure the georeferenced base layer (Political boundaries) is on top by clicking and dragging it to the top of the table of contents. Highlight it and right click *zoom to layer*. This layer will now appear in the data frame window.



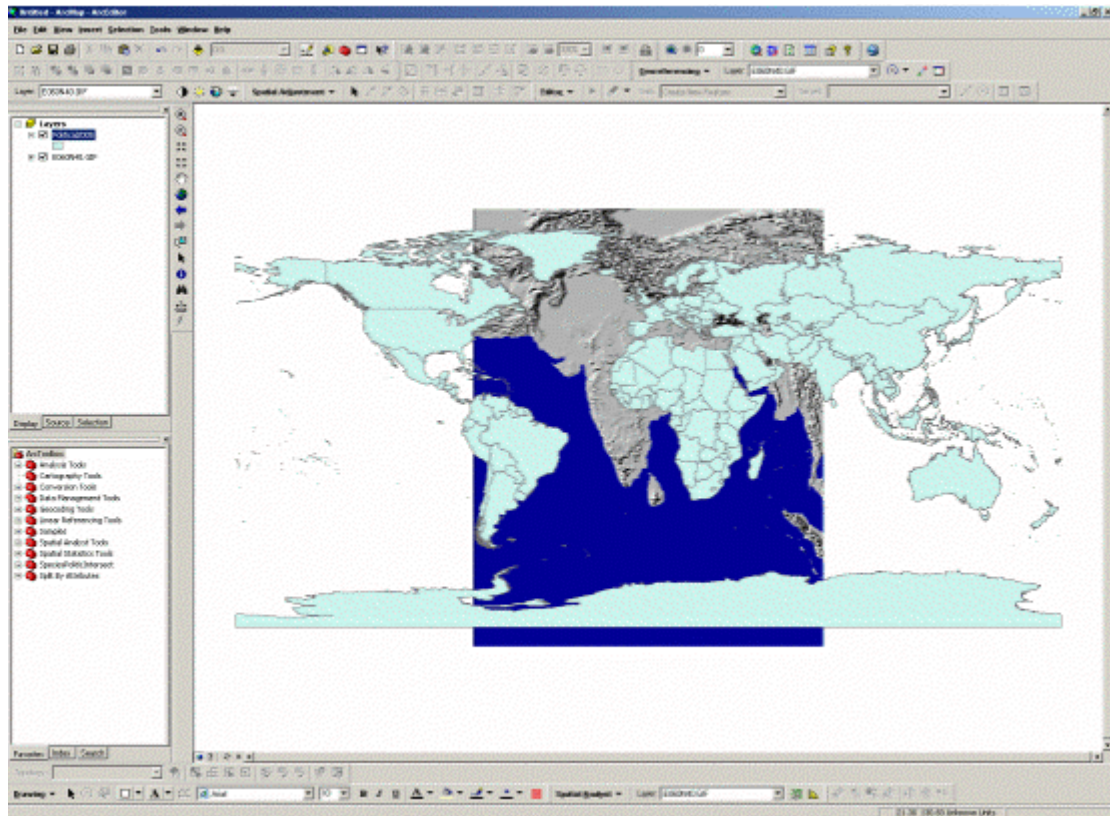
### Step 2. Opening the Georeferencing tool bar.

- The georeferencing tool bar is used to georeference and rectify maps. Choose *toolbars* from the *view* menu and check *georeferencing*.
- The *georeferencing* bar is now visible and available to use. It has a drop down menu and a number of control buttons. Take a look at the available options.

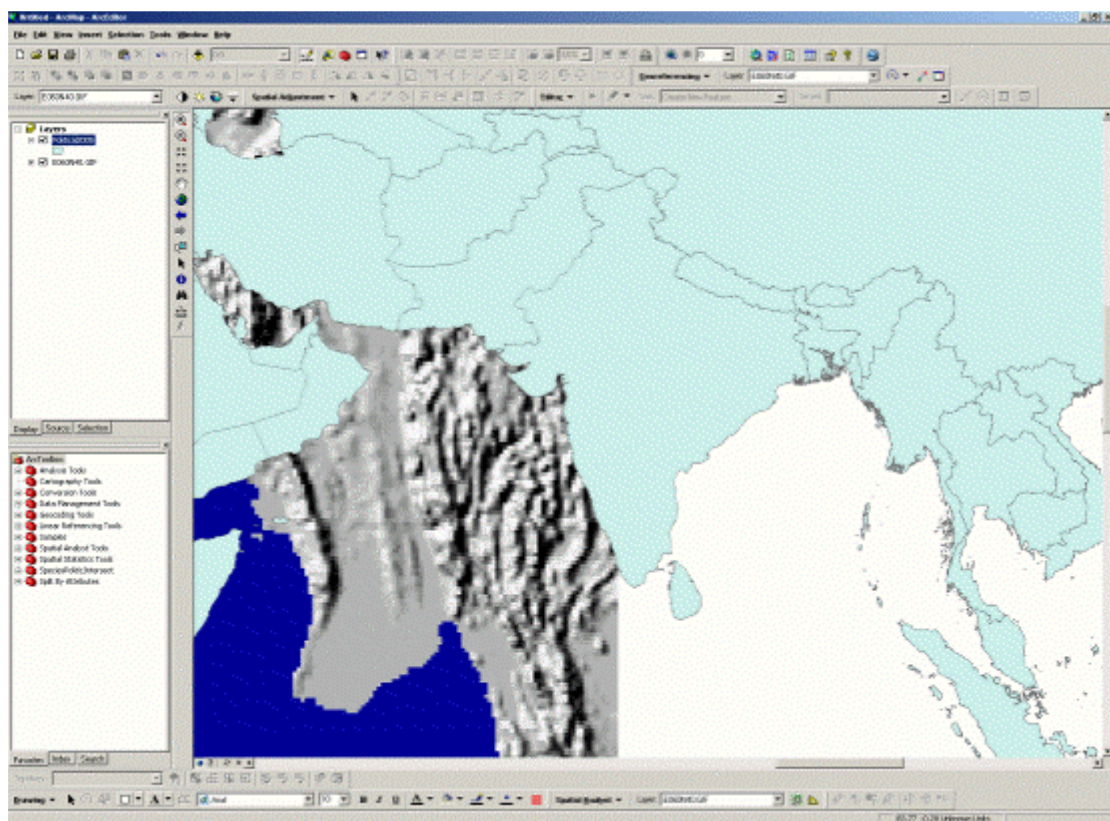
### Step 3. Aligning locations to the target layer

- Before you can start adding **Ground Control Points (GCPs)** and transforming you need to have both layers (target and source) displayed in the data frame window. Make sure the raster layer is active and choose *georeferencing*>*fit to display* from drop down menu. This will display the raster in the same area as the target layer.

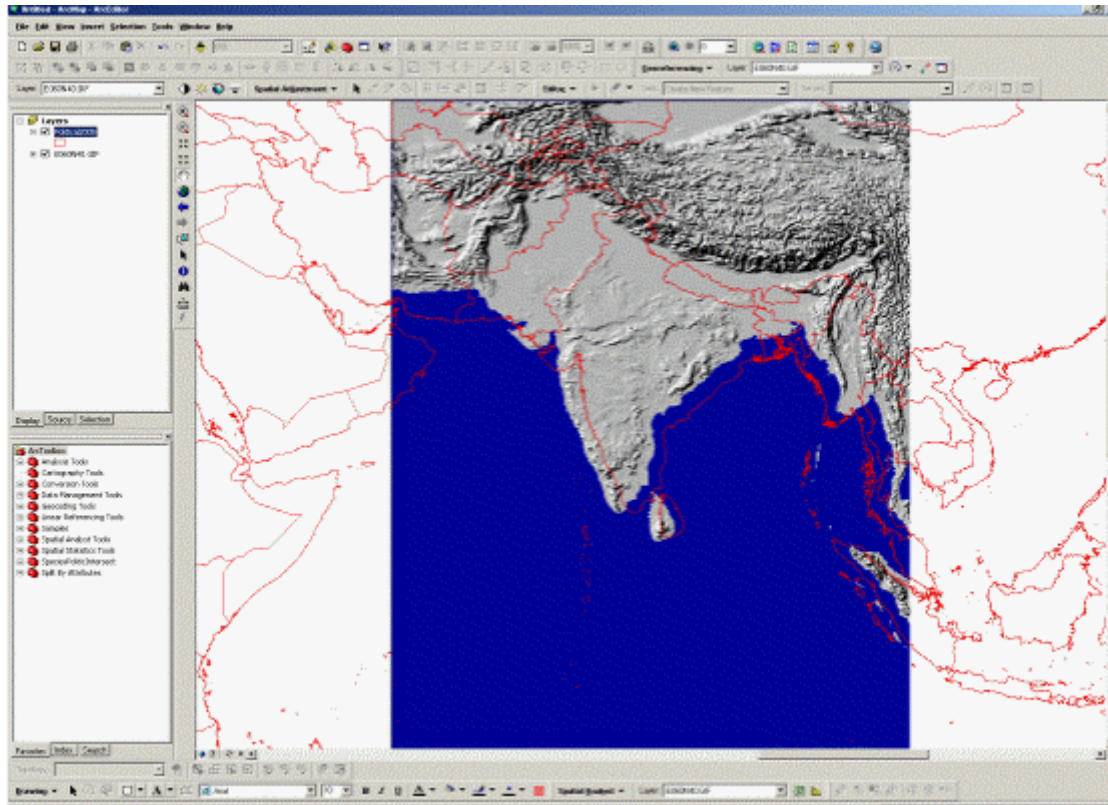




- Note: Even though the image is now displayed with the political data, can adjust this to match with the political area needed (in this example, we need to zoom to show India).




- Again, make sure the raster layer is active and choose *georeferencing>fit to display* from drop down menu. This will display the raster in the same area as the target layer. To make the process easier to view, adjust the symbology of the political layer to use no fill and an outline colour such as red.



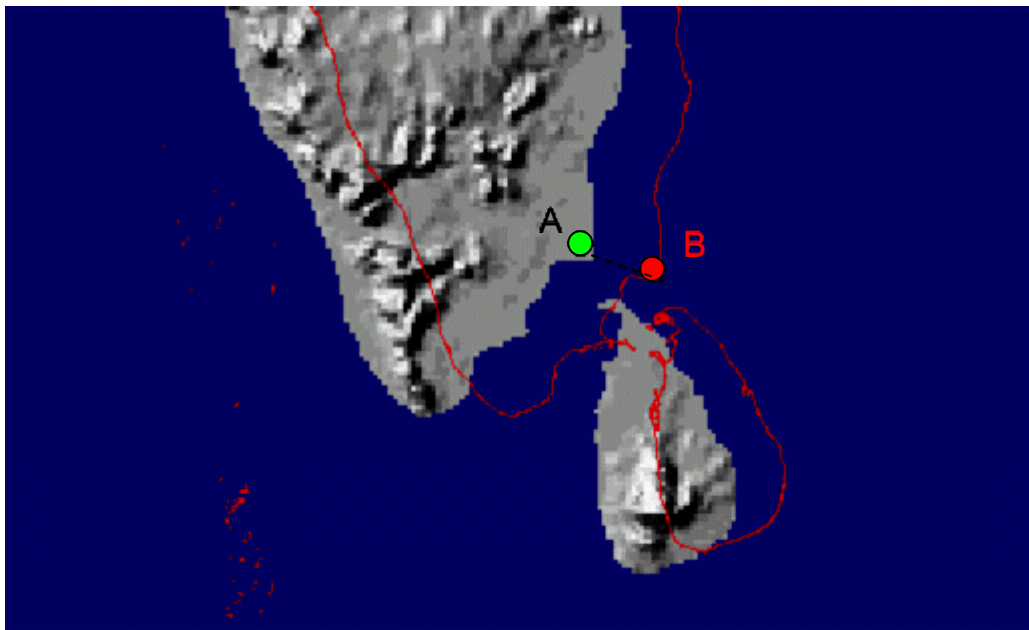
- Note: The layers are not far off matching but we will add GCPs to rectify the image.

#### Step 4. Adding control points

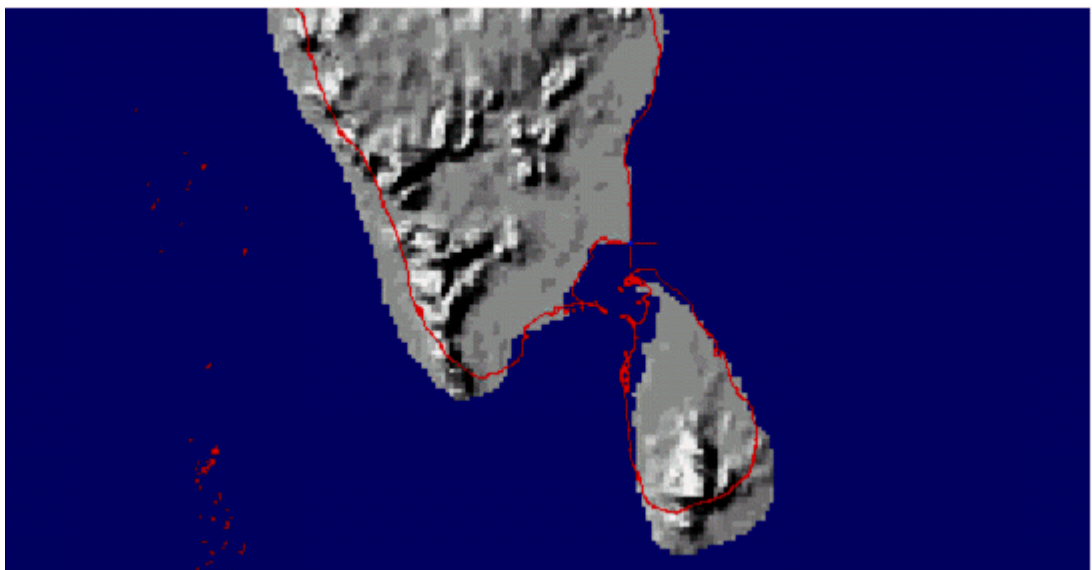
- The next stage is to identify identical features that are present in both layers to use as ground control points. In general, road intersections and human features such as building footprints don't change that much over time and as a rule make the best control points for your links. Features such as rivers and field boundaries are subject to change and are therefore not as reliable.
- Control points are always selected from the image (target) layer first and then linked to the corresponding feature in the base georeferenced (source) layer.
- When assigning control points it is best to be at a scale that enables accurate placement of the control points so make sure you are zoomed in close enough.
- Click on the add control points button in the georeferencing toolbar 

and then click on a feature in the target layer (Marked A on image below).

A coloured cross will appear on the map with a line attached. Identify the corresponding feature on the base map in this layer and if necessary zoom in. Next click on the control point button in the georeferencing tool bar and the attached line will reappear. Place the control point on the same feature on source layer that you used in the vector (target) layer (B). This will complete the first link between the two layers. The image below shows the location of these two GCPs.



These points are now coincident.




**Note:** Selecting Auto Adjust from the georeferencing drop down menu will automatically perform the transformation each time a new link is added. If

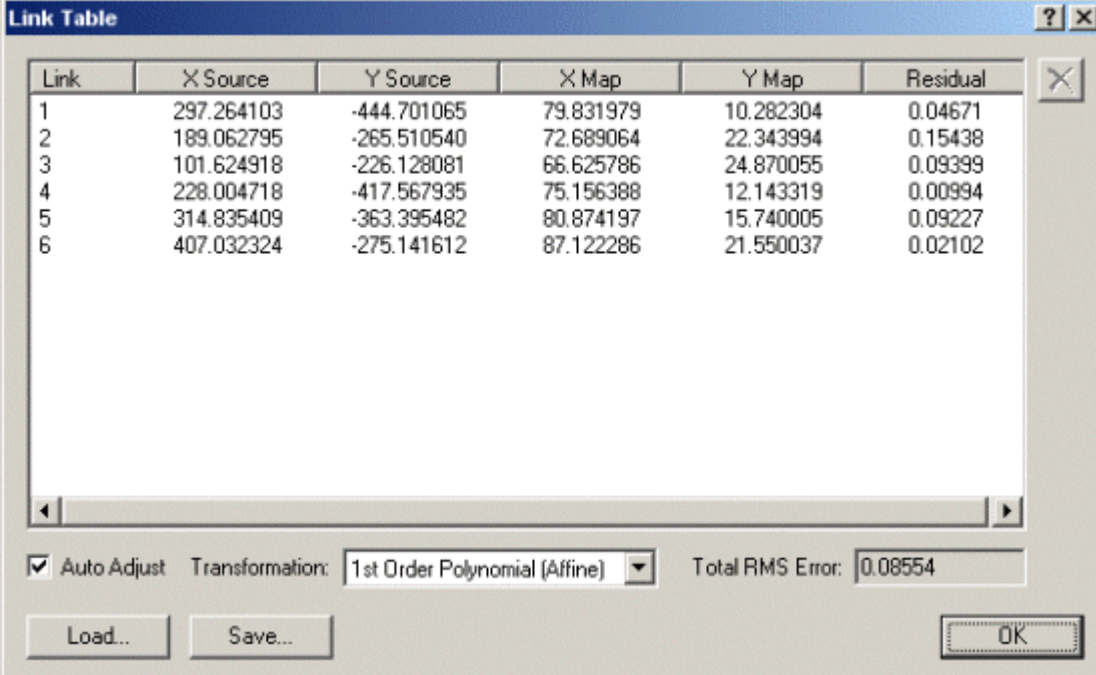


Auto Adjust is not selected then the transformation will only be applied when you choose *georeferencing>transformation*.

- Add at least four more control points by identifying identical features in both layers and repeating the process. Try to spread the control points evenly across the map area. The best results are normally obtained by selecting 3 points at the corners of the map and a couple more in the centre.
- If you make a mistake in placing control points, the individual links can be selected and deleted as appropriate. Experiment by deliberately placing a link in the wrong position and notice what happens to the raster as it is warped.

Now delete this link by choosing the *view link table* button  from the georeferencing tool bar.

This table shows all the links you have created so far. Select the link you which to delete by highlighting it in the table and then pressing delete. When a link is selected in the table the corresponding link will be highlighted in yellow in the map window.



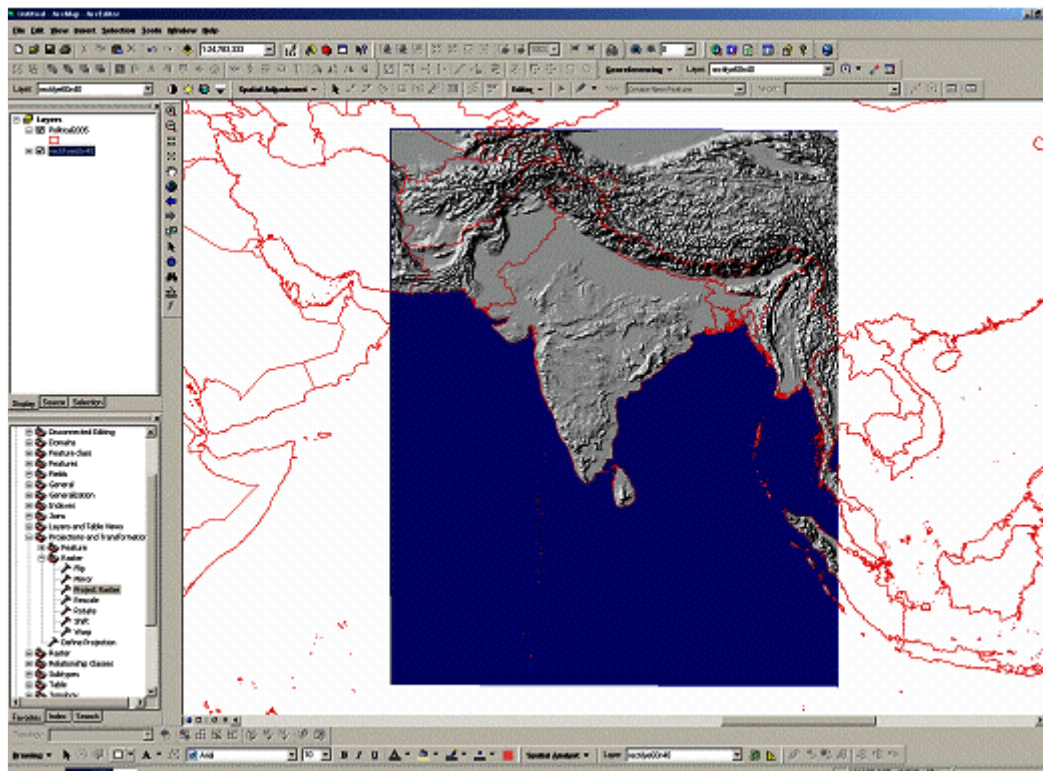
Link	X Source	Y Source	X Map	Y Map	Residual
1	297.264103	-444.701065	79.831979	10.282304	0.04671
2	189.062795	-265.510540	72.689064	22.343994	0.15438
3	101.624918	-226.128081	66.625786	24.870055	0.09399
4	228.004718	-417.567935	75.156388	12.143319	0.00994
5	314.835409	-363.395482	80.874197	15.740005	0.09227
6	407.032324	-275.141612	87.122286	21.550037	0.02102

### ***Step 5. Rectifying the image***

- When you're satisfied with the registration, save the georeferencing information with the raster. For most rasters, the georeferencing information is stored in a separate file with the same name as the raster but with an .aux file extension. You can permanently transform the raster by using the ***Rectify*** command on the georeferencing toolbar. The coordinate system assigned to the raster is the same as the coordinate system defined on the data frame the raster is part of. Choose *georeferencing>rectify*, give your file an appropriate name and accept the default settings then click save.

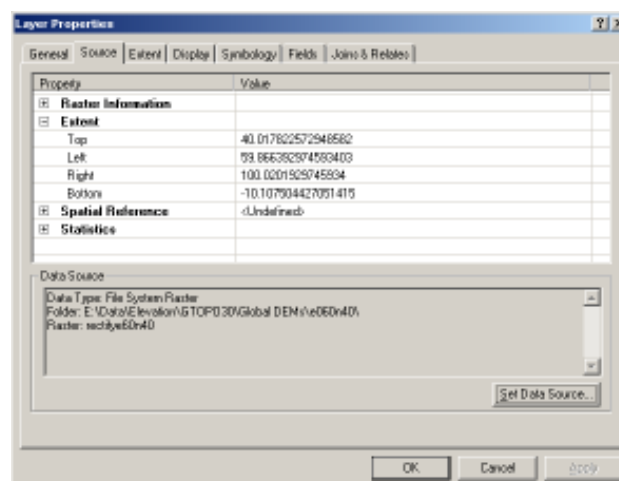
### Step6. Display the rectified image

- Click the Add data button and navigate to the directory where you saved the rectified image. Select the file and display it in the Data Frame. You should see the image now has a coordinate system, in this case geographic coordinates. Now add the Political layer, notice that the two layers are now coincidental.

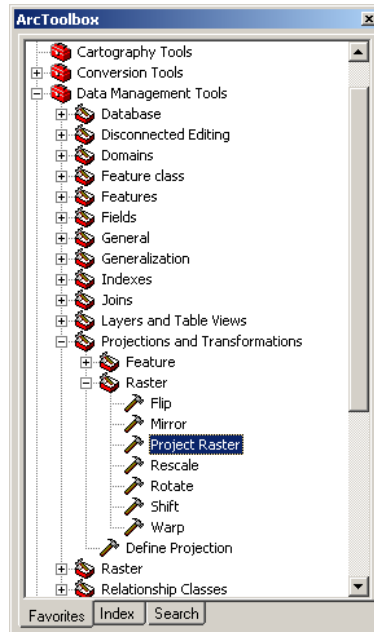


### Step7. Projecting the rectified image

- Right click on the rectified image and select properties. Click on the Source Tab. Notice there are coordinates for the Extent in Decimal Degrees



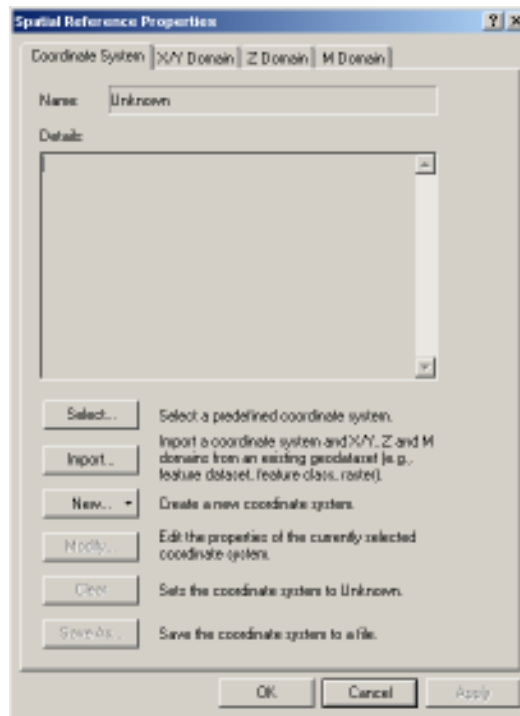
- Notice that the **Spatial Reference** is <undefined>. One more part of georeferencing is to “project” the data into a coordinate system. Close the Layer Properties dialog box. From ArcToolbox, select Data Management Tools and then expand the Projections and Transformations tools and expand the Raster tools and then double click on Project Raster.



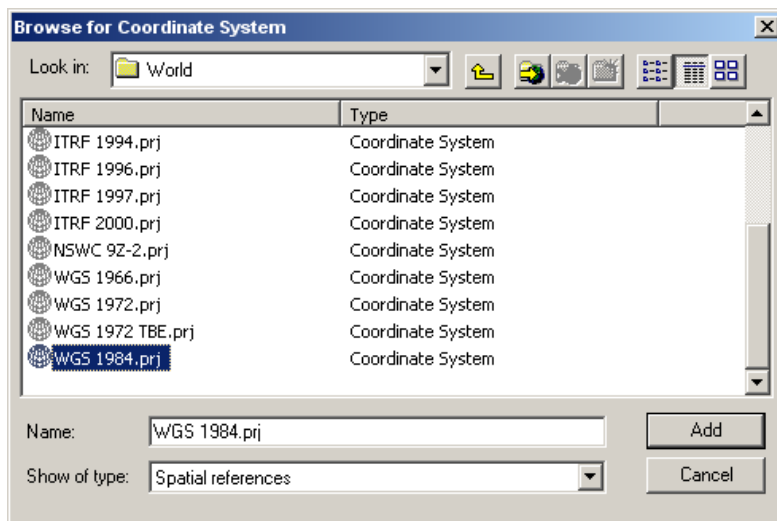
This will open the Project Raster dialog box



Select the newly rectified layer from the drop down list for **Input Raster**. Accept the default name for the **Output Raster** (or provide a name yourself). For the **Output Coordinate System** click on the icon to the right to open the **Spatial Reference Properties** dialog box

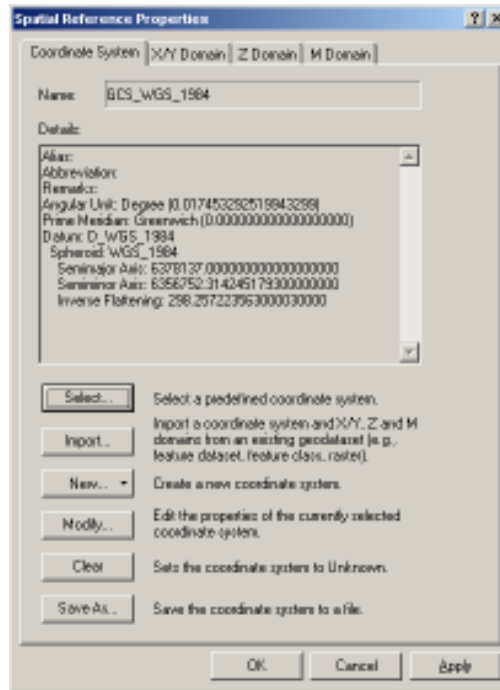


Click on **Select** to browse the predefined coordinate systems (Geographic or Projected). Double click on Geographic Coordinate Systems and then double click on World and select WGS 1984.prj and then click on Add.

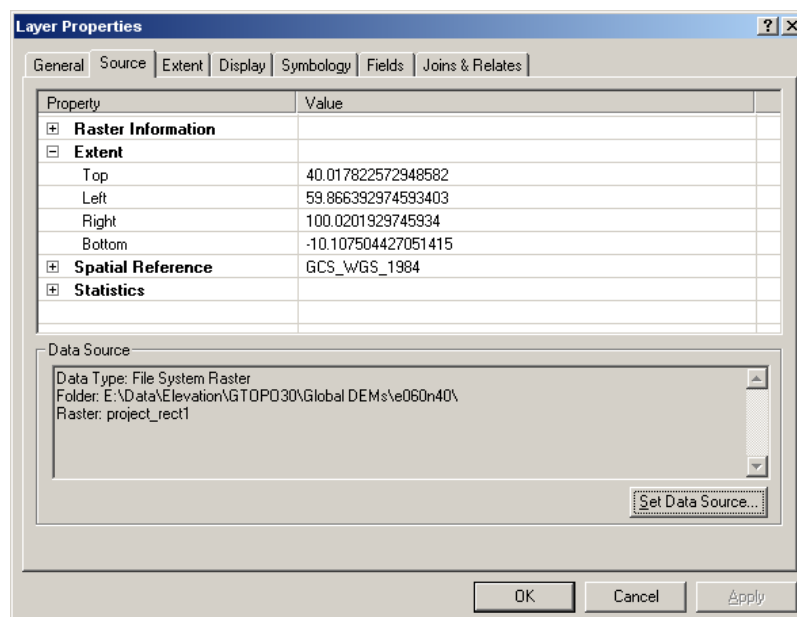


The projection details can now be seen in the Spatial Reference Properties dialog box.





Click on Apply. Then click on OK and then click on OK again. This will set the spatial reference for the image. Add the new layer to the Data Frame. Right click on the new layer and select Properties.



Notice that the Spatial Reference now has been set to geographic coordinate system WGS 1984.

ArcMap can perform what is commonly known as on-the-fly projection. This means ArcMap can display data stored in one projection as if it were in another projection. The new projection is used for display and query purposes only. The actual data is not altered.

## Tutorial 2

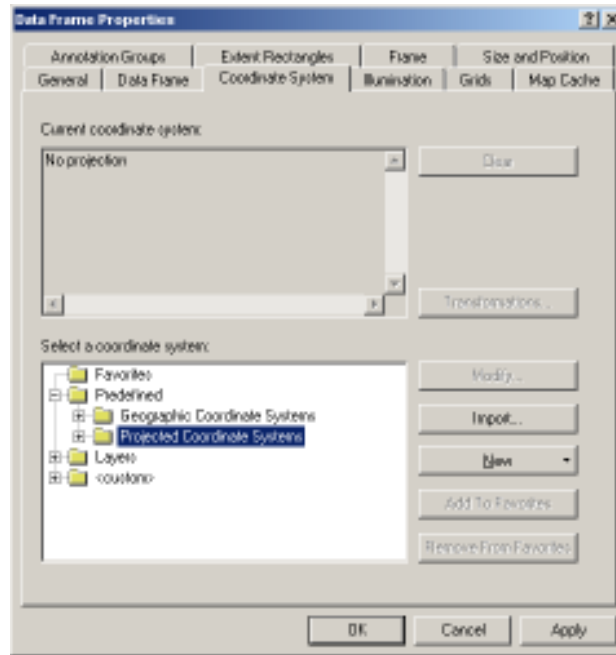
### Digitising a new Important Bird Area polygon

This tutorial will provide illustrations into successful digitising. Several datasets will be required and these are easily and freely obtained from the following websites;

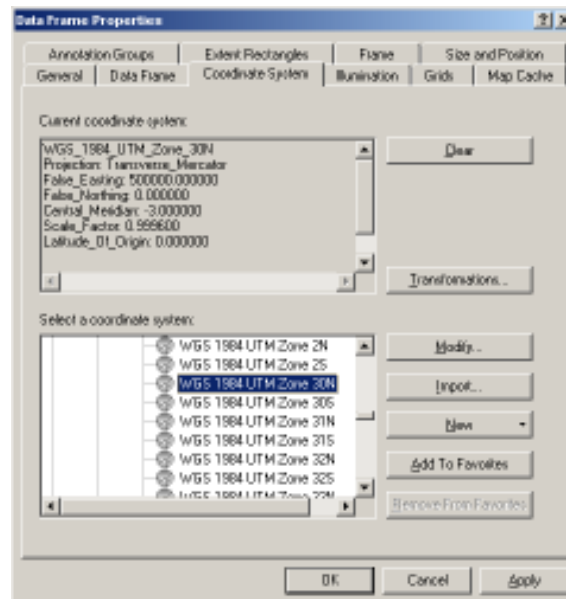
- Digital Chart of the World (for topographical data)  
<http://www.maproom.psu.edu/dcw/>
- Satellite imagery (Landsat Geocover)  
<https://zulu.ssc.nasa.gov/mrsid/>
- Important Bird Area template (a blank shapefile containing all the attributes BirdLife recommends, or you can create a new shapefile and add the attributes using the table described later in the tutorial).

#### *Step 1. Adding some data*

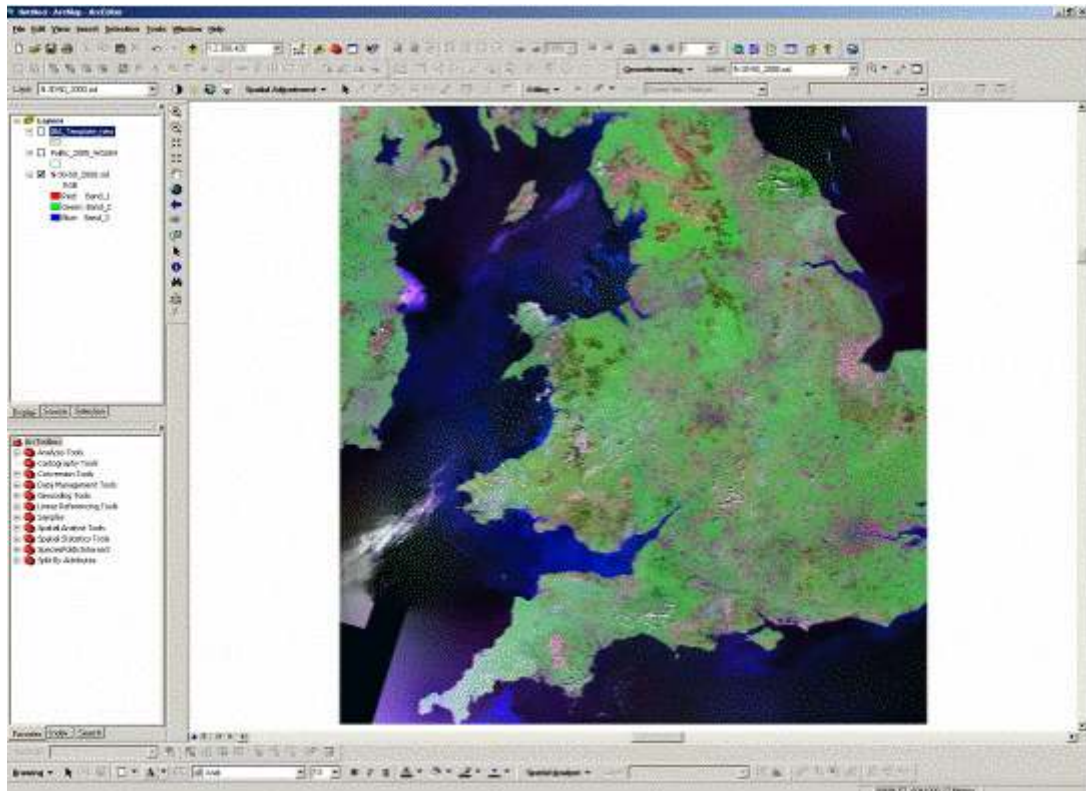
- Open ArcMap and add some data e.g. political boundaries, satellite image and the Important Bird Area template
- Examine the coordinate systems for each data layer. Notice that only two of these share a common projection (Political boundaries and the IBA template use the geographic projection WGS84; important note is that this is a non equal area projection). The satellite image uses the Universal Transverse Mercator projection (the UTM coordinate system is an equal area projection and is ideal for creating Important Bird Area boundaries). If you look at the filename for the satellite image e.g. N-30-50-2000.sid the N denotes north and the first number after the N is 30, this is the UTM zone. The second number denotes that the file extents are between 50 to 55 degrees of latitude.
- To start the process of digitising a feature, you first need to set the Data Frame coordinate system. Right click on the data frame and select Properties, and then expand the Predefined coordinate system folder as illustrated



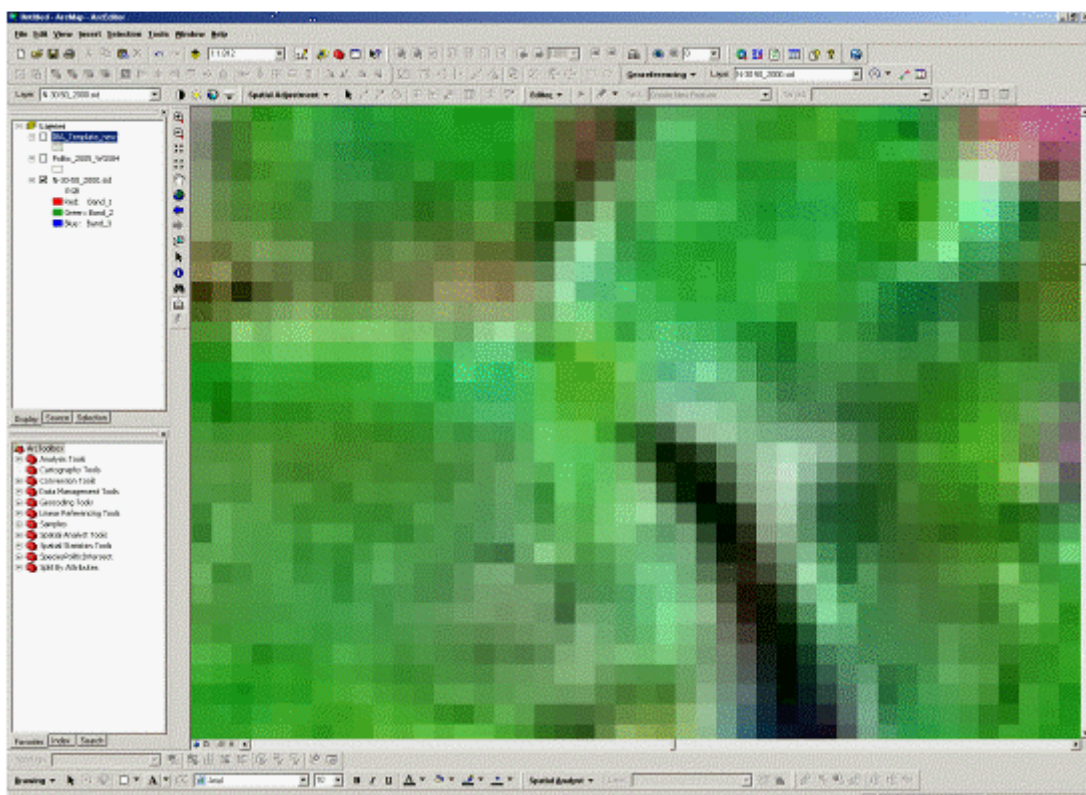
- Expand the Projected Coordinate System folder and open the UTM folder. Notice the various datums available, for this exercise, select WGS84. Scroll through the list and then select the UTM Zone for your satellite image, for this example WGS 1984 UTM Zone 30N is selected.




- Explore the satellite image using the zoom tools and try to familiarise yourself with the dataset.



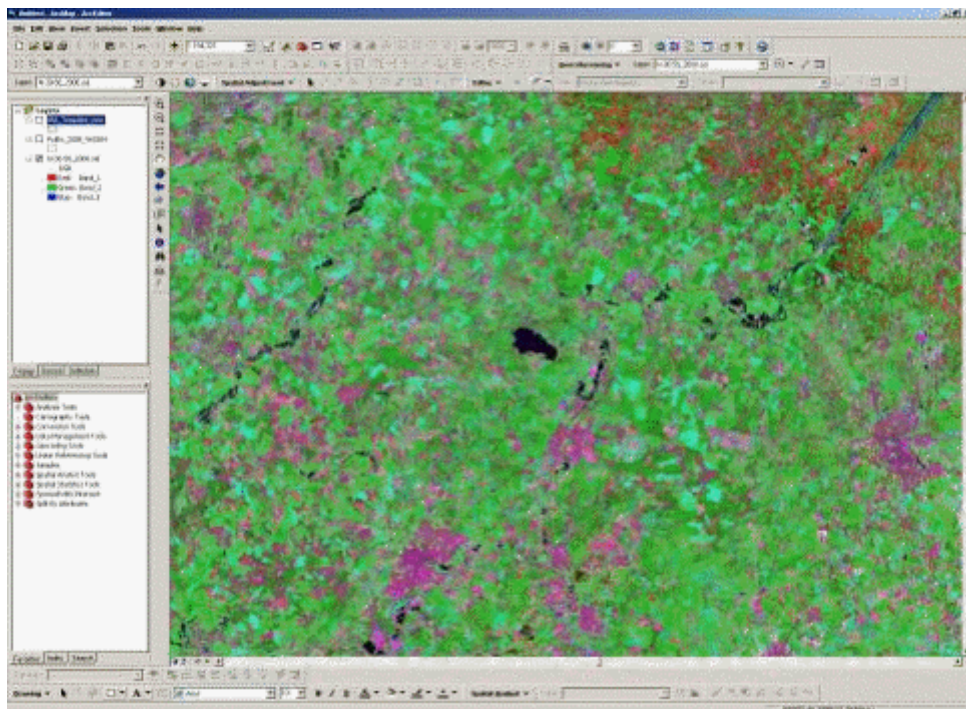
- Zoom in so that you can identify individual pixels



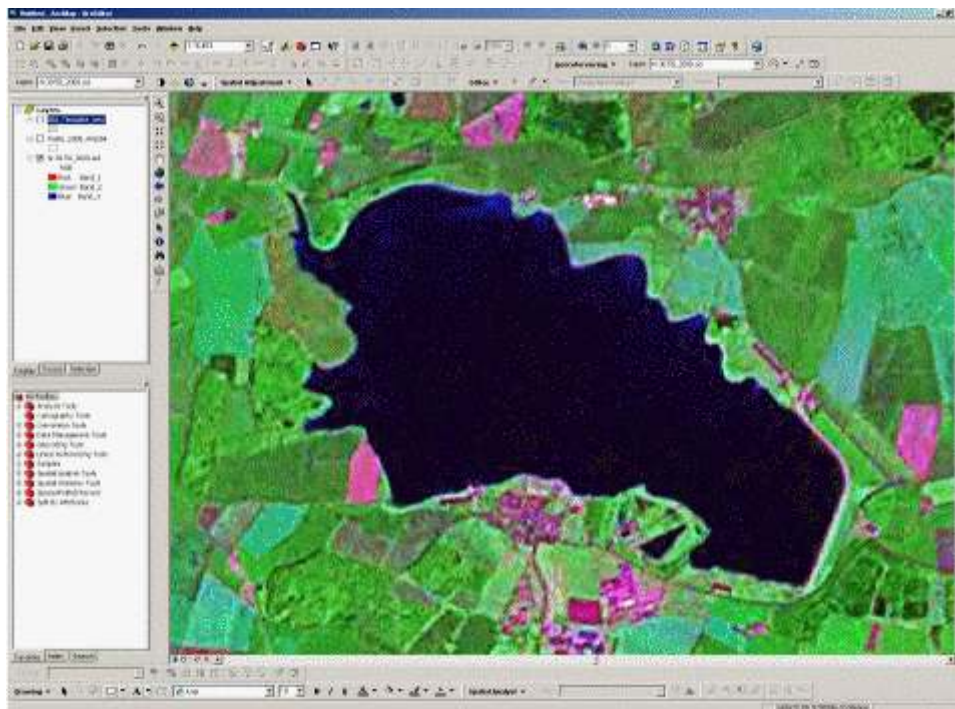
- Now select the Measure tool  from the Tools toolbar and measure one of the pixels, you should note that each pixel represents 14.25 metres on the



ground. Zoom out again and locate an area of interest that you want to digitise. In this example, the lake in the middle of the data frame is going to be digitised.

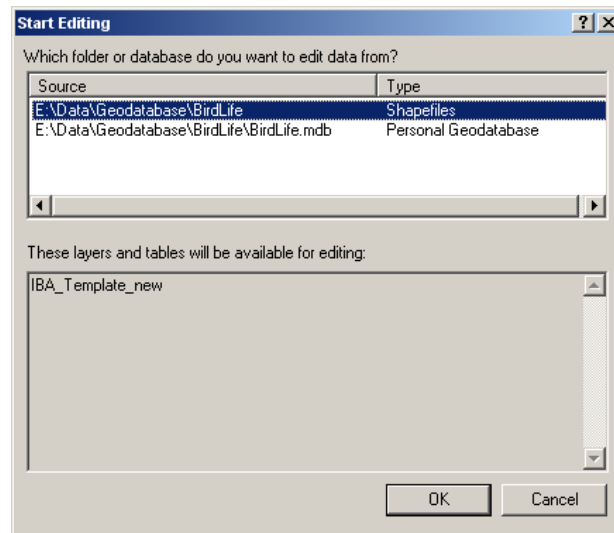


- Zoom in to the feature - remember that scale is important here, the more information you can see the more accurate your digitised boundary will be.





## Step 2. Making the data editable

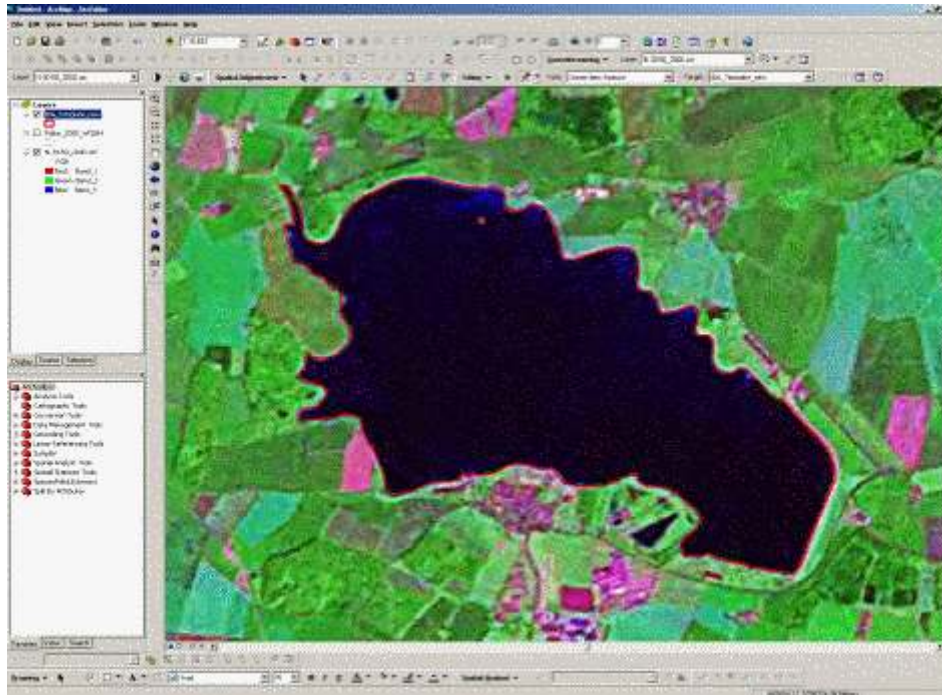
- Click on the IBA\_Template and make it active. Then select Editor and then Start Editing. Then select the IBA\_Template from the Start Editing dialog box;



- From the Editor toolbar, make sure that the Task is Create New Feature and that the Target is the IBA\_Template;



- Now select the Sketch Tool  icon and you can now start digitising your boundary. Notice the mouse cursor changes to  . Choose where you wish to start digitising and click the left mouse button to create the first vertex, then follow the boundary clicking as many vertices as your feature needs, remember that the more vertices, the more accurate the boundary. Press F2 to finish digitising the feature.



- Now that you have created a vector boundary, the next step is to open the attribute table and add the attribute values.

### ***Step 3. Adding attribute values***


- Right click on the IBA\_Template layer and select Open Attribute Table

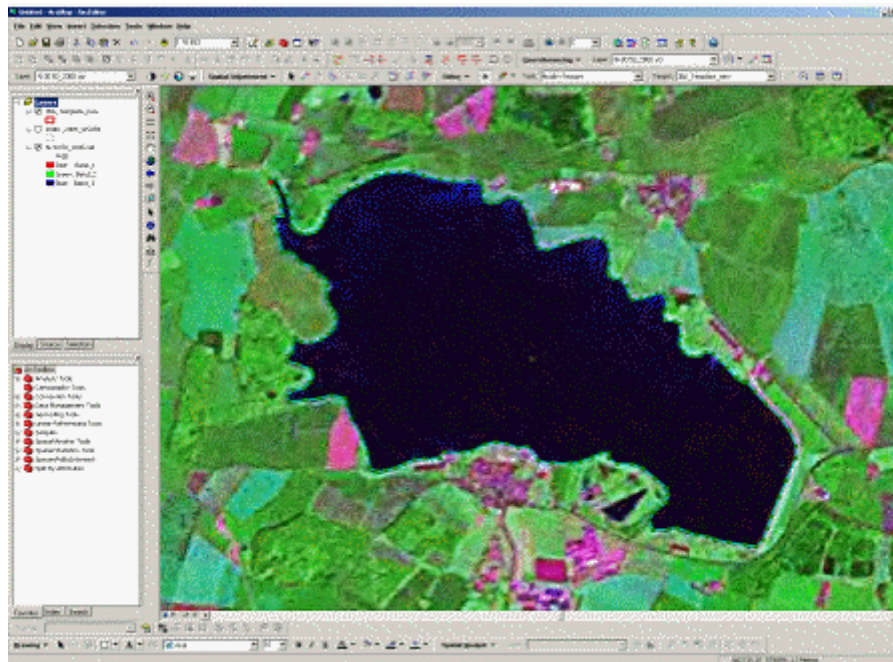
ID	Shape*	OBJECTID	SHAPEAREA	SHAPELENG	AREA	PERIM	PERIM2	PERIM3	PERIM4	PERIM5	PERIM6	PERIM7	PERIM8	PERIM9	PERIM10	PERIM11	PERIM12	PERIM13	PERIM14	PERIM15	PERIM16	PERIM17	PERIM18	PERIM19	PERIM20	PERIM21	PERIM22	PERIM23	PERIM24	PERIM25	PERIM26	PERIM27	PERIM28	PERIM29	PERIM30	PERIM31	PERIM32	PERIM33	PERIM34	PERIM35	PERIM36	PERIM37	PERIM38	PERIM39	PERIM40	PERIM41	PERIM42	PERIM43	PERIM44	PERIM45	PERIM46	PERIM47	PERIM48	PERIM49	PERIM50
1	Polygons																																																						


- The following table lists the attributes and the data types (Note \* denotes required field)



Attribute	Data Type	Notes
FID	ObjectID	Unique ID
Shape	Polygon	Geometry
OBJECTID	Long Integer	Unique ID
SitMapRecID	Long Integer	Unique ID
SitRecID*	Long Integer	Link to WBDB.Site.SitRecID (only if IBA confirmed and in WBDB, otherwise leave as 0)
StaRecID	Long Integer	Link to WBDB.LutSitStatus.StaRecID
QuaRecID	Long Integer	Link to WBDB.LutQuality.QuaRecID
RegRecID	Long Integer	Link to WBDB.LutRegion.RegRecID
CtyRecID	Long Integer	Link to WBDB.LutCountry.CtyRecID
National*	Char (120)	IBA National Name (in your language e.g French, Italian etc)
International*	Char (120)	IBA International Name (the IBA English name)
Area	Long Integer	IBA Area (In WBDB)
Lon	Double	Centroid coordinate (Decimal degrees)
Lat	Double	Centroid coordinate (Decimal degrees)
AltMin	Long Integer	Minimum altitude
AltMax	Long Integer	Maximum altitude
Management	Short Integer	Management plan (Y/N)
Boundary	Short Integer	Defined boundary (Y/N)
Digitised	Short Integer	IBA Digitised (Y)
NumPolys	Short Integer	How many polygons make up the IBA
Source*	Char (254)	Source of data used e.g. Landsat
NotesMap	Char (254)	Notes on digitising features
Notes	Char (254)	Notes about IBA
Active	Long Integer	Is the IBA active or not
Added	Date	Date IBA digitised
AddedBy	Long Integer	Who digitised
Changed	Date	Changed (edited)
ChangedBy	Long Integer	Who edited

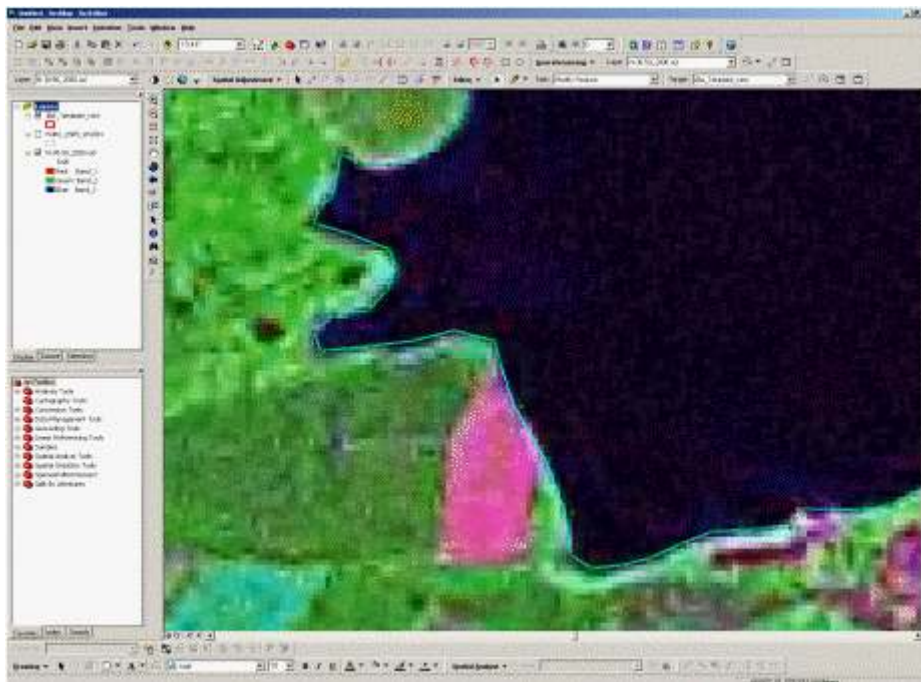
- When you have finished entering the attribute values for your new boundary and you are satisfied with the boundary definition you can click on Save Edits from the Editor Toolbar. If you need to re-adjust the boundary, select the Edit Tool  and double click on the digitised feature, notice that each vertex is now visible



- If you need to readjust the boundary, place the cursor over a vertex . Click on the vertex and drag it to another position, when you are satisfied with the



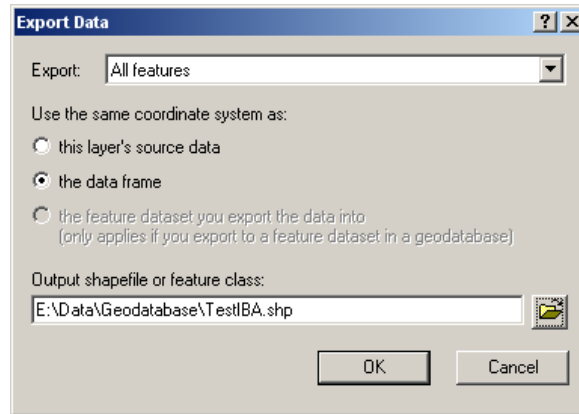
new position, click another vertex and do the same until the boundary is acceptable. You should see the original boundary highlighted in blue and the newly positioned vertices are coloured green;



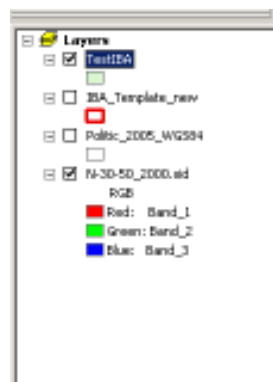
- When you have finished adjusting the boundary, right click the last vertex moved and select Finish Sketch, the boundary will now change. Click on Stop Editing from the Editor Toolbar and click Yes to Save Edits. You now have completed your first IBA boundary.

#### ***Step 4. Calculating area attributes***

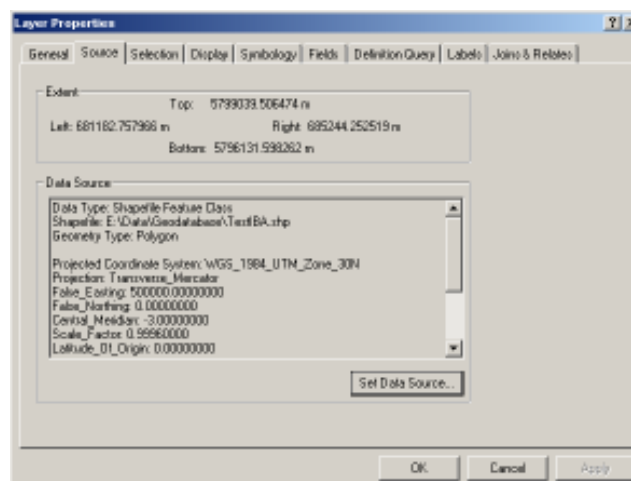
- The next step in the digitising process is to calculate the area for the polygon. There are several issues you need to be aware of. Firstly, the IBA\_Template has a geographic coordinate system so any area calculations will be erroneous. To calculate area metrics you need to have the data in an equal area projection. To do this easily, right click on the IBA\_Template and select Data and then Export Data. In the Export Dialog box, make sure that you click the Data Frame for the coordinate system and that you name the file to be exported.



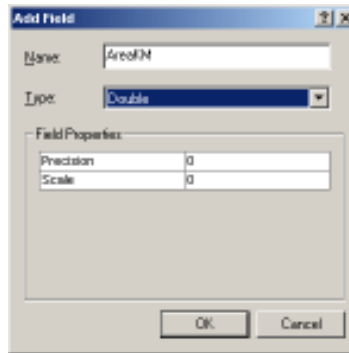
- Click OK and then click Yes to add the new data as layer. You should see the new layer added to the Table of Content Layers;



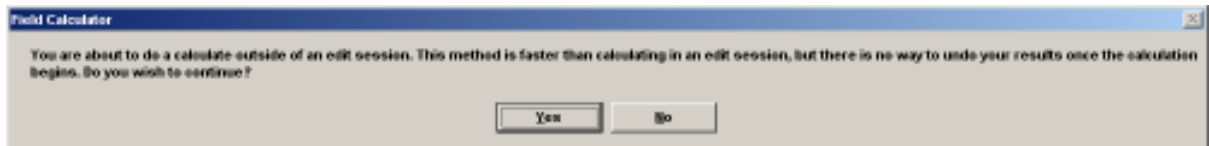
- Click the right mouse button on the new layer and select Properties and then click the Source Tab;



- Notice the Coordinate system is in the UTM projection, click on Cancel to close the dialog box. The next step is to calculate the area attribute.
- Open the attribute table for the new layer and from the Options button select Add Field



- Provide a name for the attribute (e.g. AreaKM) and define the data type (Double) and then click OK. The new attribute is created at the end of the existing attributes. Scroll across to the new attribute – AreaKM and on the attribute heading, right click and select Calculate Values. Click Yes to continue;

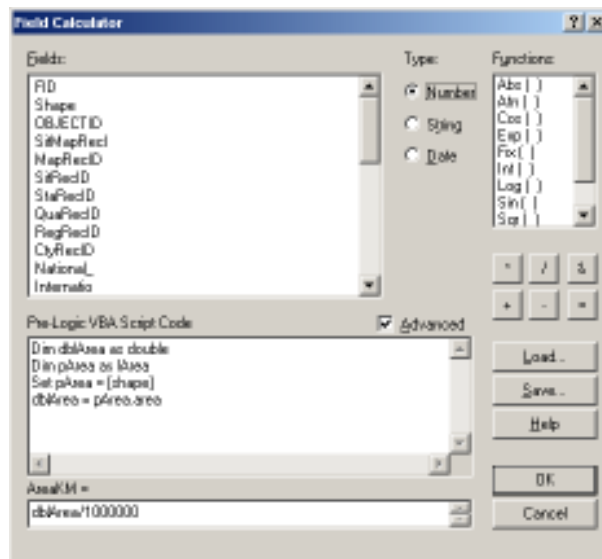


- You will now be presented with the Field Calculator dialog box, this allows you to calculate many different values for your attributes. Check the Advanced box and type the following VBA code into the Pre-logic VBA Script Code:

```
Dim dblArea as double
Dim pArea as IArea
Set pArea = [shape]
dblArea = pArea.area
```

- In the AreaKM box type:

```
dblArea/1000000
```



- Notice that the AreaKM attribute field is divided by 1000000. This is to return a value in square kilometres otherwise the result will be in square metres. Click OK to run the Field Calculator.

NotesMap	Notes	Active	Added	AddedBy	Changed	ChangedBy	AreaKM
		0	00:00:00		0	00:00:00	6224.314000

Records: 0 out of 1 selected

- You have now completed digitising an Important Bird Area boundary; now try adding another Important Bird Area boundary to your existing one.