Chapter 2.
Aerial Photographic Re-projection

METHODOLOGY

As part of the landscape survey multiple years of aerial photographs where scanned with the help of Staffordshire SMR from 1963, 1971, 1981, 1992, 2000 (with intensity images forming a layer for 2002, see above). All images where scanned at a minimum of 300dpi in Adobe PhotoShop 6 as tiff images with an average size of about 10MB. For the data to be fully integrated into the Where Rivers Meet (WRM) GIS (see below) and allow research groups to interpret and combine the dataset the photographs would have to be georeferenced. This procedure was undertaken in ERDAS Imagine 8.6 as the industry standard for image interpretation and processing.

The process of georeferencing, or reprojecting, entails imposing a real world co-ordinate framework onto the individual images, which start off without any form of anchor within the framework. In the case of the WRM project this would mean reprojecting the images from each year to the Ordnance Survey GB36 '02 co-ordinate system. Traditionally there are two ways of achieving this. If information pertaining to the camera lens, focal length, and flying height are known, and have the fiducial marks (the cross-hairs in each corner of the photograph plate) then the images can be orthographically processed within Imagine as a block and reprojected automatically. Unfortunately this information was not fully understood when this project was started and therefore a second method had to be employed.

Each image was paired up against its approximate location in modern Ordnance Survey Landline data. OS Landline data is a series of vector tiles of variable scale map data in the OSGB36 '02 co-ordinate system. By selecting locations common in both the aerial photograph and the OS Landline data a transformation framework can be established for the image.

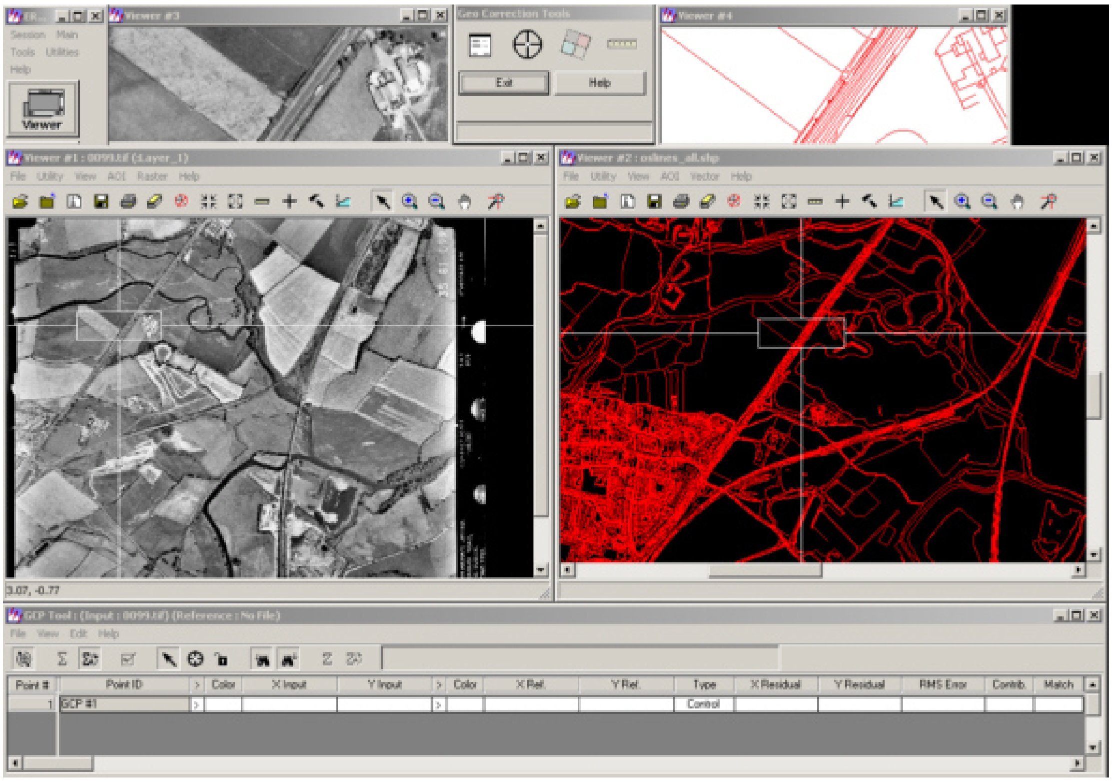

Figure 31: Geometric correction tool in ERDAS Imagine. Allows the selection of Ground Control Points for image transformation

The selection of these common locations, or Ground Control Points (GCP's) is fairly simple for the more modern imagery. Since 1980, the area in question has undergone rapid change, mostly due to quarrying. As the OS landline data has been updated from this point this makes GCP selection in some areas of the earlier imagery increasingly difficult. Each image rectified has a minimum of 25 separate GCPs spread evenly across its area. The large number of GCPs is even more important in the older imagery as lens distortion and image quality is worse.

Figure 32: Raw TIFF image with white GCP markers

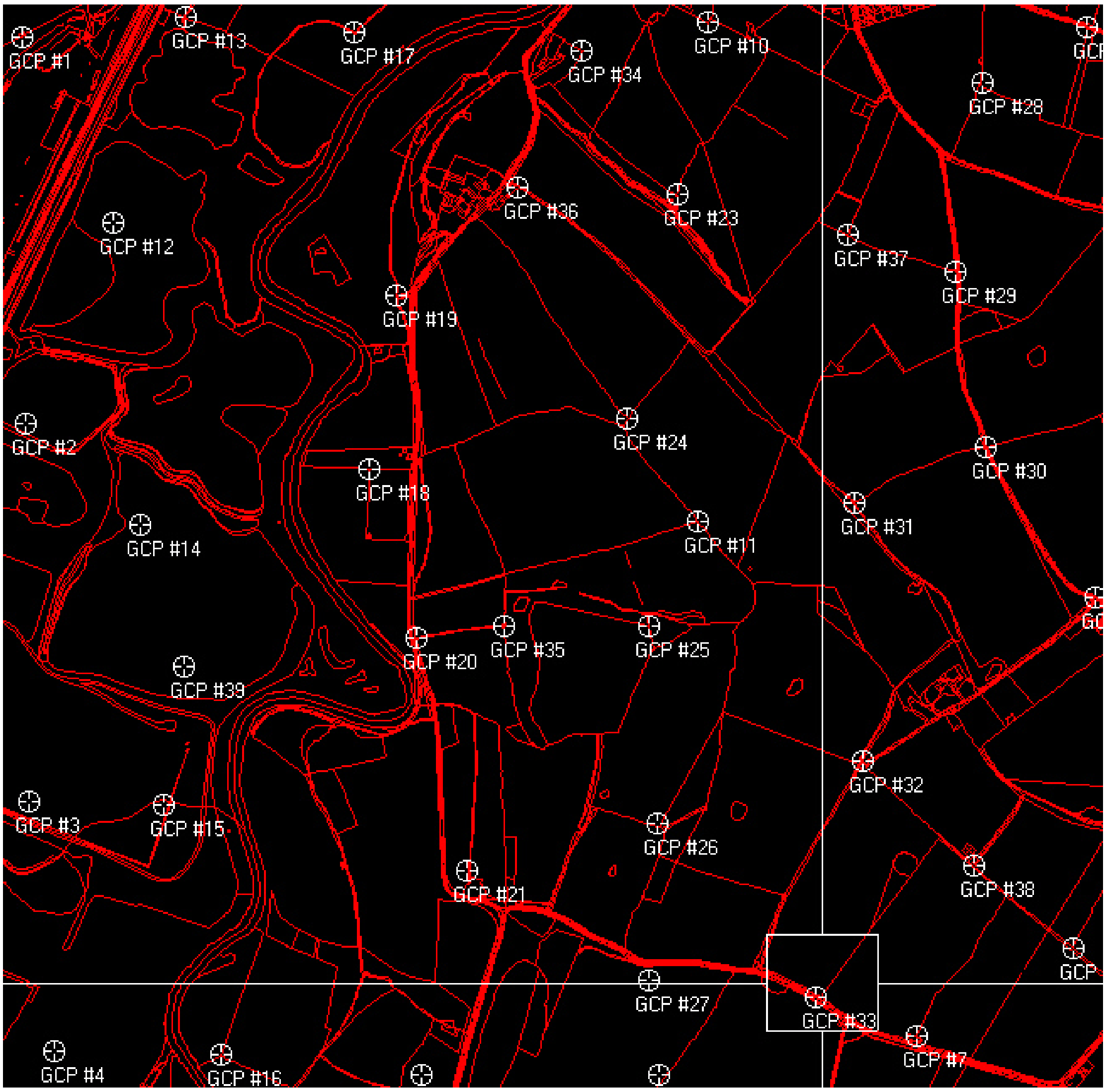

Figure 33: OS Landline data with matching GCP's for the above aerial photograph. Floating points on the above image related to locations on georeferenced images

Results and Discussion

Once an image had been rectified it could be used as a reference for overlapping photographs – enabling control points to be matched up in more complicated – or quarried out areas. For each GCP a measure of accuracy is calculated. The Route Mean Squared error (RMS) is a mathematical prediction of the difference in location from one co-ordinate framework to another, after transformation. This therefore acts as a gauge of accuracy for the GCP location. In the case of all the WRM images that were reprojected a RMS of no greater than 0.1 was achieved for the total image, roughly equating to a geographical difference of approximately 10cm between the image and the OS Landline.

The images were reprojected using a 3rd order Polynomial equation transformation. Depending on the type and state of the image to be reprojected a number of orders of polynomial transformation can be selected. The degree of complexity of the polynomial is expressed as the order of the polynomial. The order is the highest exponent used (ERDAS Field Guide, 6th Edition). A third order transformation is non-linear, meaning it can correct for distortions from an irregular plane and so is well suited for compensating errors from lens distortion and photograph warping.

Once the transformation is complete the image needs to be tagged with the correct co-ordinate statistics to enable them to be displayed as a mosaic. The map model and projection information have to be specified in Imagine and will then be applicable in other software packages as either a geoTiff or Imagines native .img format. The reprojected WRM aerial photos were then made into a mosaic together with a manual join. Imagine can 'mosaic' overlapping images but with aerial photographs the joins between images can often be apparent. It is therefore necessary to manually digitise a join on the overlapping area of the two images.

Figure 34: Dashed mosaic line tracing natural boundaries

The vector line was always digitised along natural boundaries disguising the join. Then as part of the mosaic a 'feather' zone was specified for five meters either side of the digitised line. The Feathering process mixes the pixel values from both images there by further disguising the seam. ERDAS Imagine then automatically colour balances the resulting image with the weight on the larger of the two images.

Although the above process is time consuming it does mean that a valuable resource can be integrated with other georeferenced datasets for specialists to analyse. The procedure can be completed quite quickly in Imagine or similar software packages with less control points, however, the accuracy achieved would be no where near the level required in the WRM project by geophysical and hydrological specialists. The above methodology produces high quality reprojections, a level that can be verified by the independent data collection and analysis in the Geophysics at Catholme report (WRM volume 4). Geophysics data collected in grids positioned with differential GPS identified anomalies in the soil that match up very precisely with the reprojected aerial photography.