Illumination Correction

Following image acquisition, we inspect the imagery for any processing errors and evaluate its actual coverage and quality. After this review, **GRS** initiates processing of the imagery to prepare it for use in the development of unsupervised and supervised classification training data sets. This preparation involves the correction of the image bands for differential illumination due to the topographic influences of slope and aspect.

Differential slope angles and orientation combine with the solar angle and azimuth to cause variation in the reflectance values represented in the satellite imagery. This differential illumination caused by slope and aspect can be a significant source of classification error in areas of high or moderate relief and of differing aspect. It can lead to confusion of substantially different land cover types that occupy different topography and aspect, but appear spectrally similar in the raw imagery. Conversely, differential illumination can also lead to the unnecessary collection of data at many field training sites in order to represent the spectral diversity of the same land cover type that will appear spectrally different due to the effects of differential illumination. The collection of a large number of ground samples in previous projects has provided **GRS** with information showing the influence of aspect and slope on various cover type characteristics and the confusion that may occur. Image correction reduces confusion, as well as the overall number of training classes needed to perform an accurate and thorough classification, thereby dramatically reducing project data collection needs and costs - significant factors in projects that concern large, rugged, and remote areas with limited accessibility.

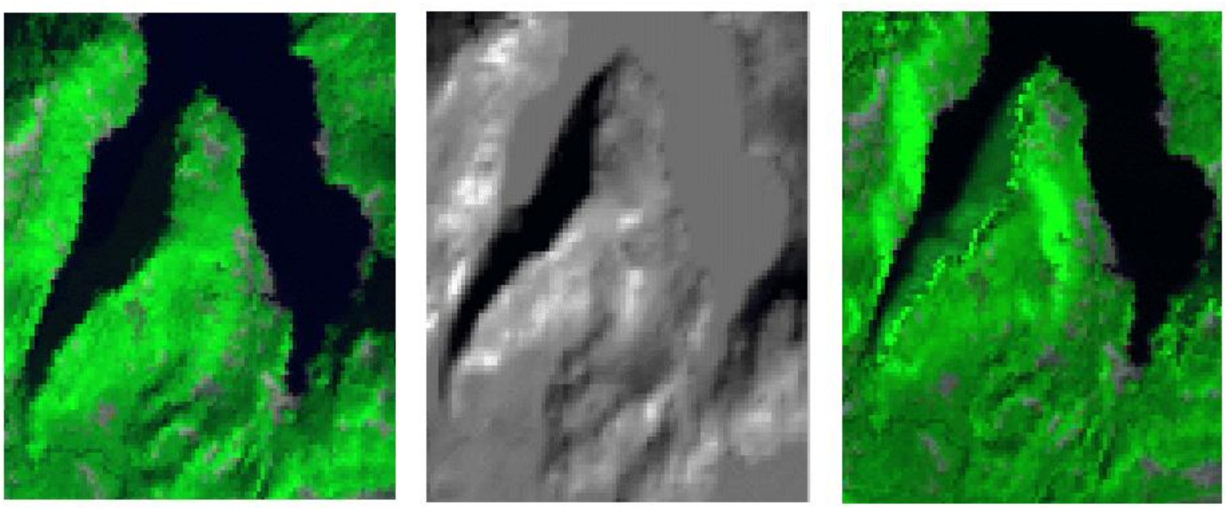

Figure 1: Illumination Correction Example - Katmai National Park

GRS has evaluated several methods of image correction and uses the Backwards Radiance Transformation Correction (BRTC) based on a non-Lambertian assumption and a Minnaert constant (Colby, 1991) to correct the imagery. This technique uses estimates of slope and aspect from a co-registered DEM along with the image acquisition sun angle and azimuth parameters to correct the images for differential illumination. This correction procedure minimizes the effect of aspect and slope, but maintains the distinct signatures of the different land cover types.

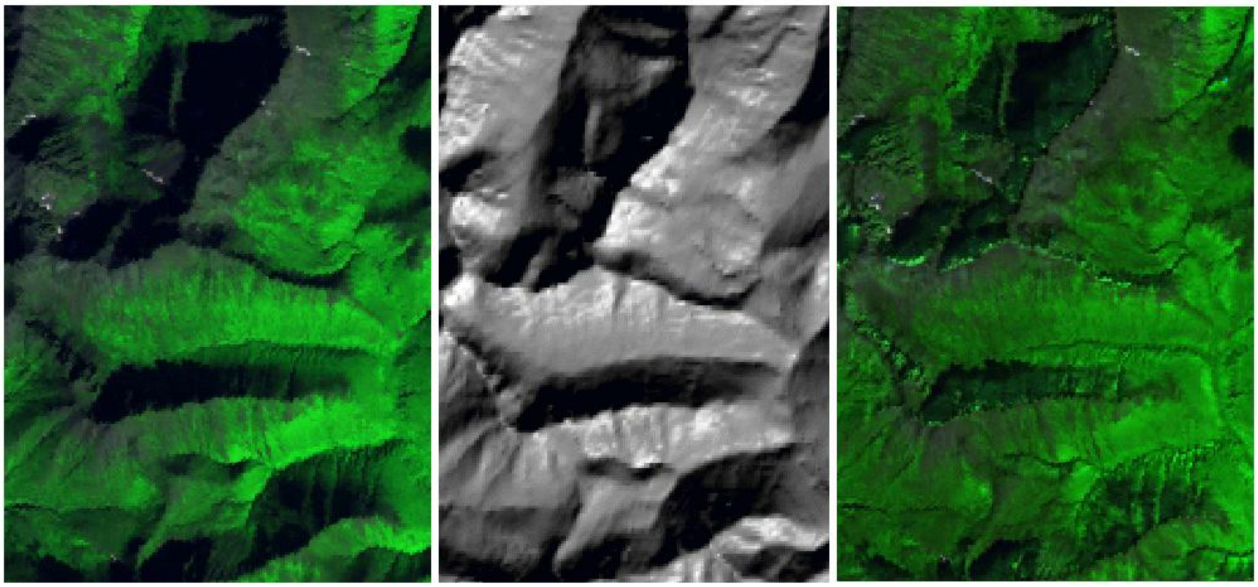

Figure 2: Illumination Correction Example - Katmai National Park

DEMs used during the image geocorrection process should be acquired at the same time as image acquisition, if possible. These data should be used to generate slope, aspect, and incidence angle data sets that correspond with the raw imagery. **GRS** then uses a proprietary process called ***GRS_illumcor*** to correct each band of the raw imagery. Corrected imagery is checked relative to the raw imagery to determine the proper application of the process. Cross-tabulation matrices (raw versus corrected) are generated and checked to verify that the process has worked properly and that 'hot spots' and 'cold spots' have not been generated. These conditions would indicate that the DEMs are misaligned relative to the imagery, as they indicate areas where lighter pixels on illuminated relief were lightened more, rather than darkened, and darker pixels on shaded relief were darkened more, rather than lightened. These conditions are readily identifiable in the cross-tabulation matrices by the presence of data shadows outside the normal range of the data distribution (misalignment results in these indicators in all bands, rather than isolated bands). Imagery and DEMs are processed and reviewed until the appropriate normalization results are obtained. If misalignment is indicated, efforts are undertaken to improve the alignment of these two data sets. Correction is completed when all imagery has been reviewed and accepted. Examples of image correction are shown in Figures 1 and 2. These figures represent two subsets of raw and normalized imagery, along with the associated DEMs used when classifying Katmai National Park.

Both figures demonstrate how the correction process removes the effects of differential illumination from the imagery. In Figure 2 this can be seen in the left portion of the image along the eastern shore of the lake. A significant area that appears to be a part of the lake is actually a shadow that has been normalized to show that it has spectral data. In Figure 3, the effects of correction can be seen along the opposite aspects along both the east/west and north/south oriented ridges. The corrected image shows data of similar spectral content on both sides of the opposite slopes. The overall impact of this process is that there is less confusion amongst different land cover types and that fewer training sites are needed to describe the image training sets. Both of these results improve projects results, by improving mapping accuracy as well as cost and efficiency.

Literature Cited

Colby, J., 1991. Topographic Normalization in Rugged Terrain. Photogramm. Eng. Remote Sens. 57(5): 531-537