
Using QuickBird Imagery in ESRI Software Products

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Using QuickBird Imagery in ESRI Software Products

Introduction

Purpose

This document provides instructions for using QuickBird Imagery products in software applications developed by Environmental Systems Research Institute (ESRI). These applications include both ArcView 3.x and ArcMap 9.x, a part of the ArcGIS suite.

Scope

QuickBird Imagery products are delivered in either 8-bit or 16-bit format. However, QuickBird collects data using an 11-bit dynamic range. Bit depth refers to the amount of energy that is stored in an image. To understand bit depth, you have to relate what you see in an image to the way that computers store data. Computers work with binary data, meaning that every number has a value of 0 or 1. To get more complex numbers, you have to string binary numbers together. For example, a string of two binary numbers (referred to as 2-bit data) would result in 4 possible values: 00, 01, 10, and 11. Take that concept a step further and think about 8-bit data. That would result in 2^8 or 256 possible values. Applying this back to imagery, 8-bit data allows you to store 256 possible values in each pixel. If you are viewing an image in gray tones, 0 corresponds to black, 255 corresponds to white, and all the levels in between correspond to different shades of gray.

Again, QuickBird collects data using an 11-bit dynamic range. This allows 2^{11} or 2048 possible intensity values for each pixel. Because computers cannot read 11-bit data, DigitalGlobe delivers data in either 8-bit or 16-bit format. The 8-bit data requires that QuickBird's 11-bit data be compressed. Therefore, data spanning 2048 values is rescaled to 256 values. If data are ordered in 16-bit format, the original 11 bits of data are simply stored in a 16-bit file. Placeholders are added to account for the 5 bit data difference, but no stretching is performed and no information is lost or gained. The question of whether to order 8-bit or 16-bit depth is often defined by what your imagery software can support and your intended use. For many users, the advantages of the 16-bit format outweigh the larger disk space necessary to store these files.

Most newer ESRI products can read and display both 8-bit and 16-bit files. However, because DigitalGlobe's 16-bit product is derived from an 11-bit dynamic range, these software products might need help from the user in determining the true maximum value of the imagery. ArcGIS is able to read and display both 8-bit and 16-bit files. ArcView 3.x can only display 8-bit files. 16-bit files can be read and displayed by ArcView 3.x using the Image Analysis extension.

Stretching an Image

Contrast stretching involves altering the distribution and range of Digital Number (DN) values. The range of DN values in an image is rarely as large as that of the display. Applying a contrast stretch compensates for this by expanding the histogram to the full range of possible DN values. This stretching typically enhances the image allowing the user more interpretive ability in shadows and other areas in the image. Stretching generally adds contrast and brightness making object differentiation less difficult and linear features more noticeable.

Several methods of contrast stretching are available to users of ESRI products including Standard Deviation, Histogram Equalize, Minimum/Maximum, Gaussian etc. For more information on these and other available stretching options, see the On-line Help for the application you are using.

Color Guns

Multispectral imagery gives users the ability to detect important differences between surface materials by combining different spectral bands. Within one band, different landcover types for example, may appear virtually identical. By choosing different band combinations surface materials can be contrasted from their surroundings using color.

One familiar band combination is the *near-infrared composite* where vegetation is portrayed in red. In this band combination, the blue band is not used and the remaining bands are shifted (visible green to the blue color gun, red to the green gun, and the NIR band to the red gun). The NIR composite is used primarily to show different growing stages of vegetation and to determine the vigor and health of different vegetation types.

The *true color composite* is also a popular choice in that it represents the most realistic view of surface materials, closely resembling what is seen by the human eye. The true color composite tends to be flat and have low contrast partly because the blue band is used and much of this band is reflected and scattered in the atmosphere. However, this shortcoming is overshadowed by the fact that many users find this composite creates the most useful background for the display of other GIS files. In a true color composite, the visible bands are each fired through their corresponding guns to create an image that approximates “true” color (red band through the red gun, blue through the blue gun, green through the green gun).

The important thing to remember here is that when viewing QuickBird imagery in ESRI software products, the user must always verify which bands are being used and to which gun each band is assigned. Bands can be selected and assigned to color guns in the properties dialog of the image in the Table of Contents (TOC). For additional information on assigning bands please refer to ESRI on-line help.

Imagery Usage Instructions

What follows is a step-by-step description of the situations an average user will encounter when using ESRI software products with QuickBird imagery, and how best to display the imagery to meet most user needs.

ArcView 3.x

When adding QuickBird imagery using ArcView 3.x, navigate to the directory where the imagery is stored and make sure you have chosen 'Image Data Source' in the *Add Theme Dialog*. This allows you to “see” and add image data types.

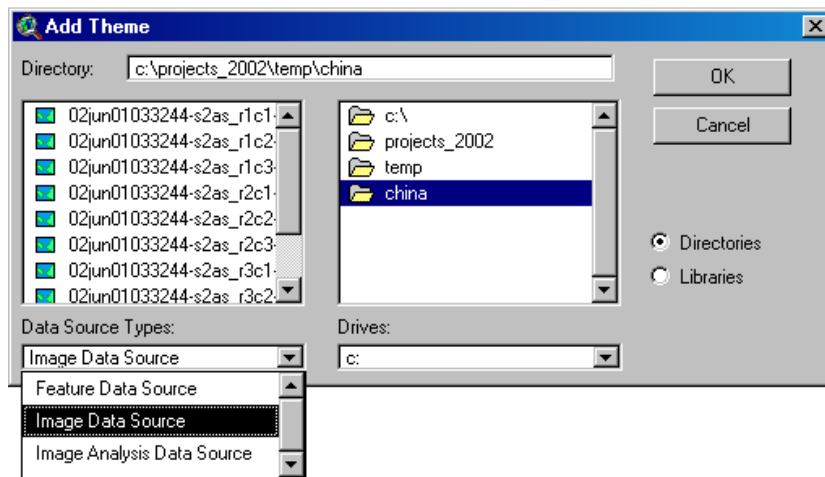


Figure 1. ArcView 3.x *Add Theme Dialog*. Choose 'Image Data Source' when adding any imagery.

8-bit imagery often displays with a green or blue tint and will seem “dark.” Although it is possible to adjust the way in which the bands are fired through the red, green, or blue guns, other image manipulation is not possible.

Stand-alone ArcView 3.x without the Image Analysis extension will not correctly display 16-bit imagery. When added, this imagery will typically display as a black square.

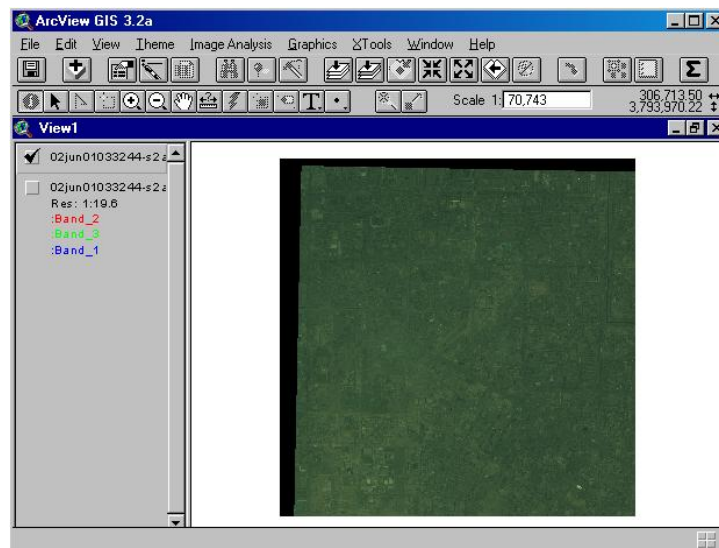


Figure 2. 8-bit image chip of China in AV 3.x. Notice the green, hazy appearance.

With the Image Analysis extension, ArcView 3.x becomes a more rigorous, image-based GIS application. If you have this extension:

- Always remember to set the *Data Source Type* to 'Image Analysis Data Source'
- Once you select the image in the *Add Theme Dialog* and add it, you will be asked to create Pyramids. Choose Yes or No depending on your user preference. Pyramids help to reduce the time it takes to display data by creating reduced resolution raster layers that record the original raster data in decreasing levels of resolution. For more information on pyramids, refer to the ESRI online help.
- Following this, the image will be added to the TOC in the View window.
- In Figure 3 below, notice the same image was added twice, the first as an 'Image Data Source,' the second as an 'Image Analysis Data Source.'

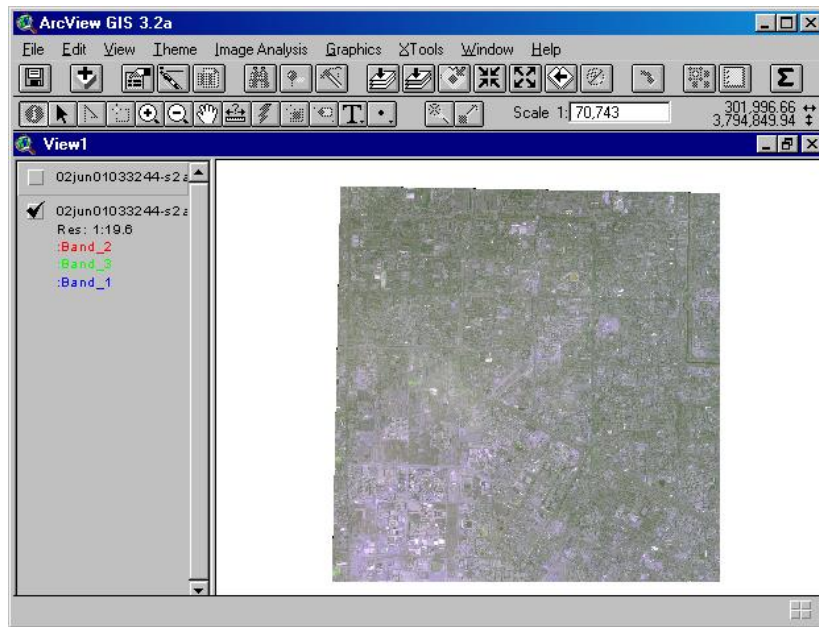


Figure 3. 8-bit image chip of China in AV 3.x using the Image Analysis Extension.

When you add imagery using Image Analysis, ArcView automatically performs a default Standard Deviations stretch to the image.

- In the figure above this is evident in the improved true-color appearance and the absence of the green haze
- Also, Image Analysis automatically attempts to make null values transparent, removing the black border found on most images

With the Image Analysis extension it is also possible to add and correctly display 16-bit imagery

- Again, ArcView performs a default stretch on the imagery and removes the null values from the display.

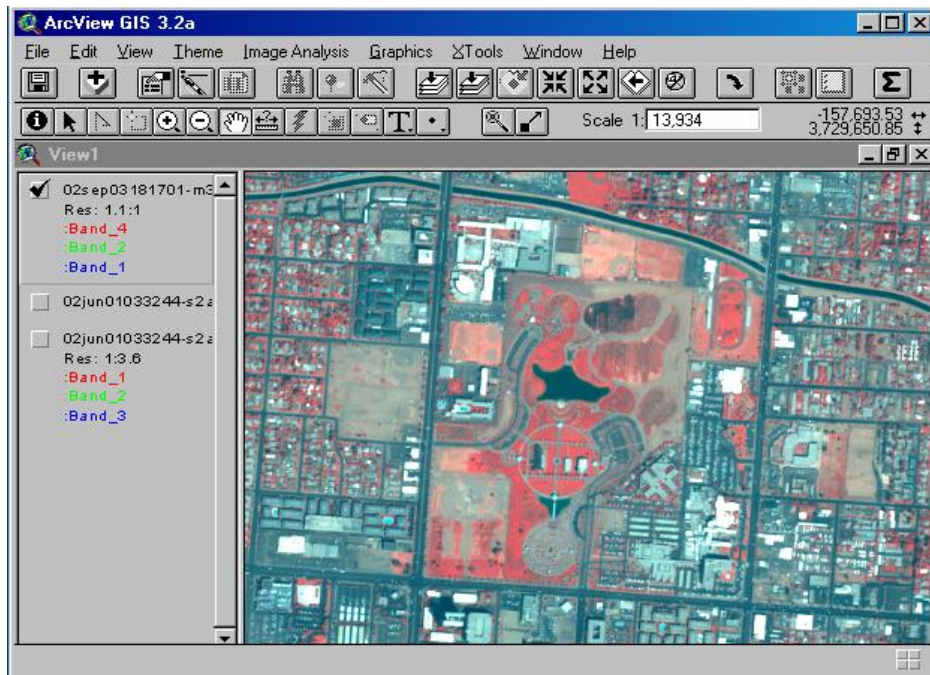


Figure 4. 16-bit image of Phoenix using the Image Analysis Extension. Shown using the NIR composite band combination. Vegetation is displayed in red.

When using ArcView 3.x and the Image Analysis extension to display QuickBird imagery:

- No additional steps are necessary to view an image once it has been added to your view
- Optional steps include brightness, smoothing, edge detecting, etc
- ArcView's online help discusses these in detail. The purpose of this paper is only to bring the image to a "viewable" state

ArcMap 9.x

ArcMap is able to load and display both 8-bit and 16-bit imagery without the use of extensions. The steps for making each image viewable are the same. As with ArcView 3.x, 8-bit imagery, by default, displays as a hazy, dark image. 16-bit imagery displays as a black square. The following steps correct both situations.

- Add the image
- Whether or not you create Pyramids is determined by user preference
- Once the image is in the TOC, right-click the image and select *Properties* from the pop-up list

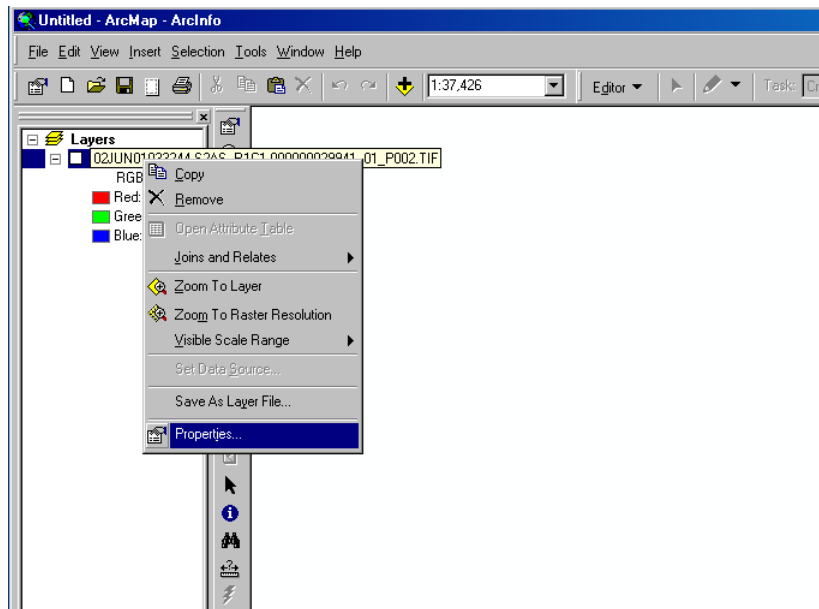


Figure 5. Right-click the image in the TOC and select 'Properties.'

In the *Layer Properties Dialog*, choose the *Symbology* tab.

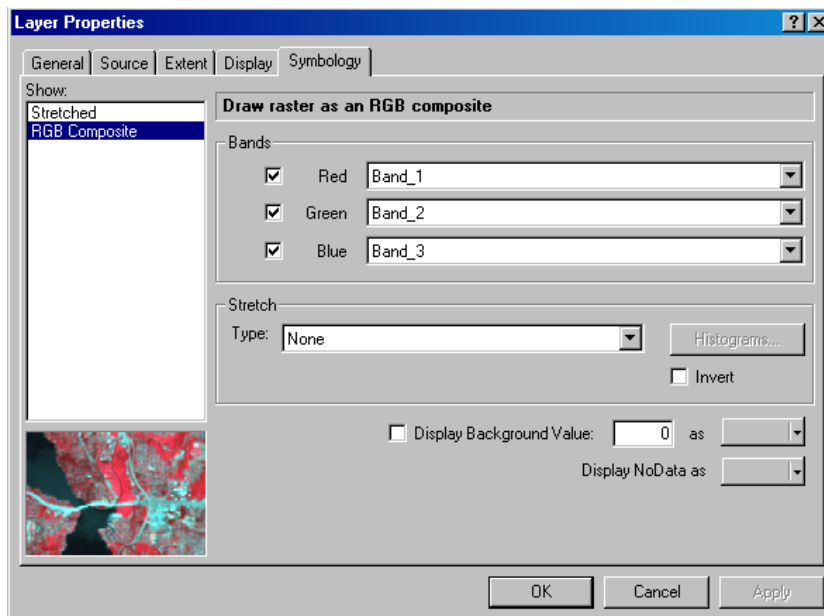


Figure 6. Choose the *Symbology* tab in the *Layer Properties Dialog*.

For multi-band images:

- Make sure the default selection 'RGB Composite' is selected under the 'Show:' box
- When using Panchromatic imagery this should default to 'Stretched'
- Change the 'Stretch' setting to any option other than 'None'
 - o See page two for a brief definition of the stretching procedure and read ESRI's online help for a description of each stretching option
 - o At this point, if you have not viewed the image before, you will need to generate statistics for each band of the image. This is done by pressing *Histograms...* to the right of the Stretch Type pull down menu.

You can track this progress in the lower left portion of the ArcMap window. When using Panchromatic 16-bit imagery, this can take 2-3 minutes.

- Once statistics have been generated, press *Apply* or *Ok* and your image will then display properly.

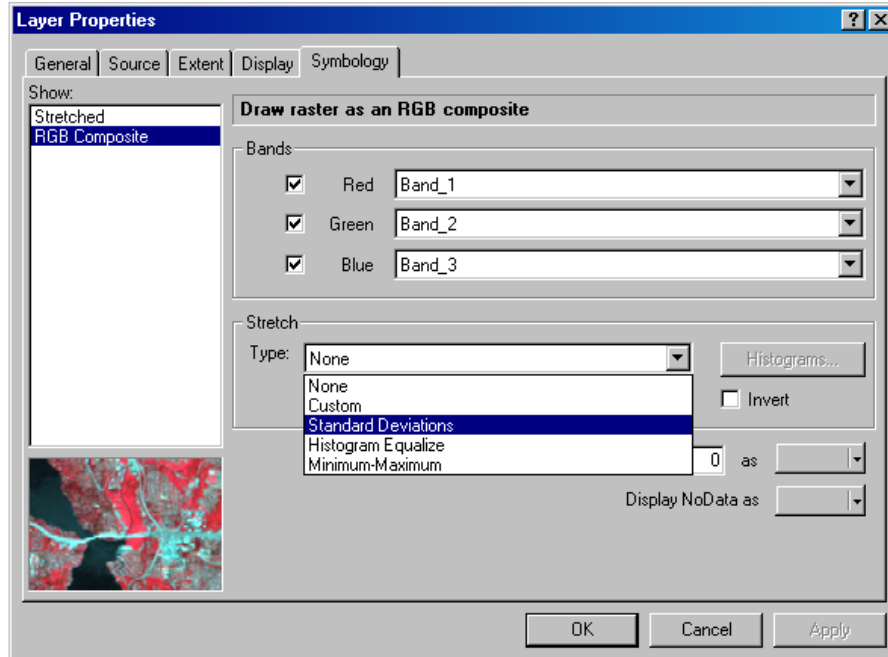


Figure 7. Press either *Apply* or *OK*. Your imagery will then display properly.