EarthSat NaturalVue™

A Global Landsat Image Dataset

Produced by

MDA Federal Inc.

The World's Source For Global Imagery

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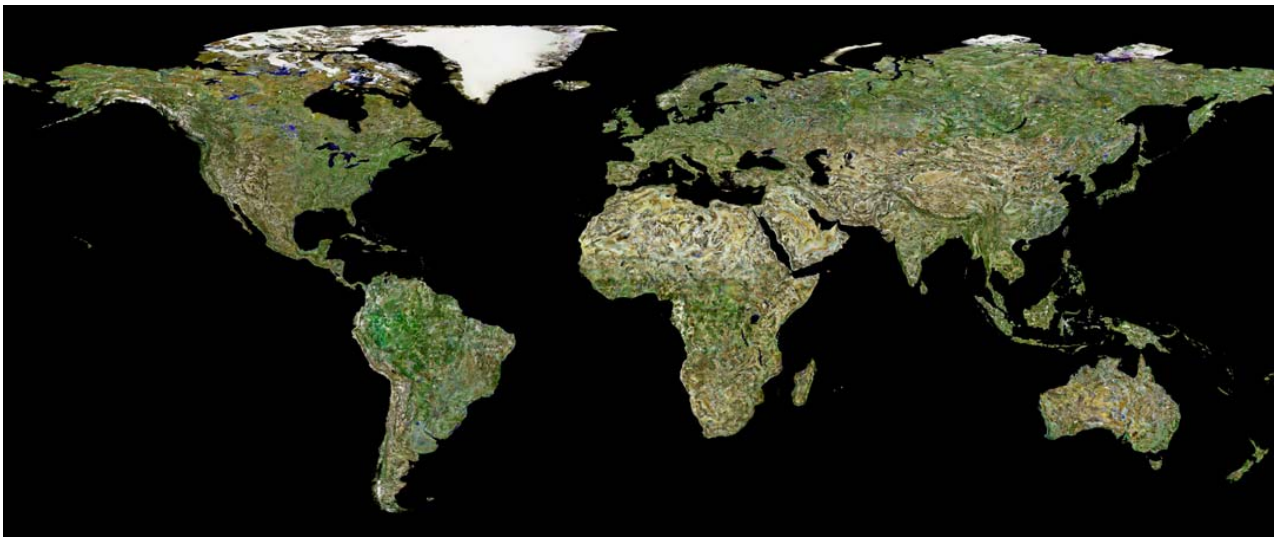
Executive Summary

MDA Federal's EarthSat NaturalVue is a natural color Landsat-7 derived circa year 2000, orthorectified, mosaicked and color balanced digital image dataset covering the entire land area of the Earth except for the high latitude polar regions. The EarthSat NaturalVue data set consists of 800 each 5x6 degree tiles with a resolution of .05 arc sec (approximately 15m) produced in a geographic projection. EarthSat NaturalVue is a trademarked product available only from MDA Federal Inc. and its licensed distributors.

Background

The GeoCover-Ortho program began in 1998 with a contract between MDA Federal Inc. (formerly Earth Satellite Corporation) and NASA to generate precision orthorectified image products of circa 1990 Landsat TM data along with a spatially coregistered set of orthorectified circa mid-1970s Landsat MSS data. This program was completed in December of 2002. In February of 2002, MDA was awarded a follow-on NASA contract to create a circa 2000 coverage of orthorectified Landsat-7 ETM+ data which is systematically coregistered with the earlier circa 1990 Landsat TM GeoCover-Ortho product.

The circa 1990 TM and circa mid-70's MSS coverage consisted of approximately 7,600 and 8,000 Landsat scenes, respectively. The circa 2000 Landsat ETM+ GeoCover-Ortho product was expanded to 8,500 scenes to include the vast majority of the ocean islands coverage. Figure #1 shows the coverage of the GeoCover-Ortho product as the color green. As these were the inputs data to the NaturalVue product, the green color also shows the coverage of the NaturalVue product.



Global Coverage

Figure 1. Coverage of MDA's EarthSat NaturalVue product (derived from the Year 2000 GeoCover-Ortho dataset)

The NASA accuracy specification was 50m RMS anywhere in the world. The best available U.S. Government control and elevation data were provided by NGA for the GeoCover-Ortho production.

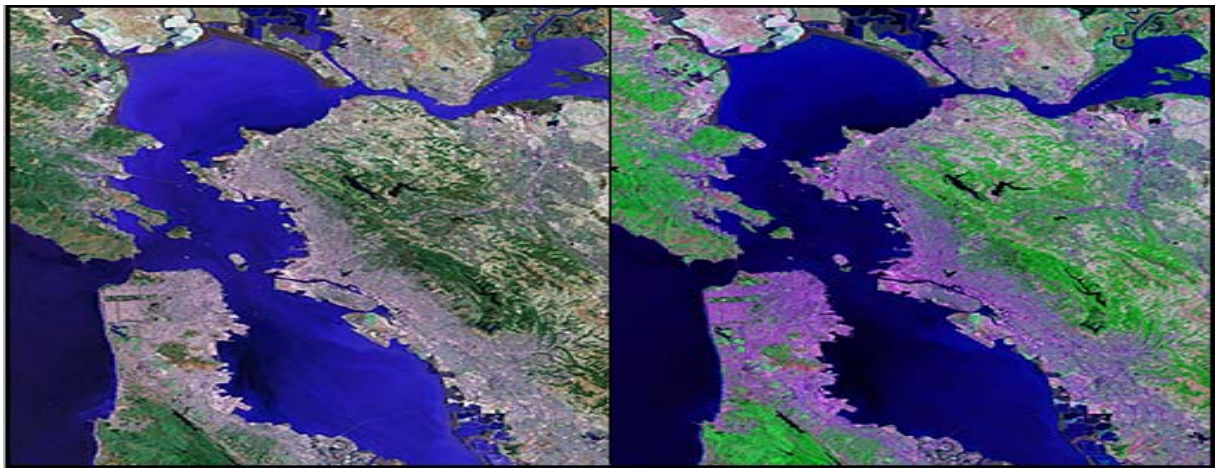
The GeoCover-Ortho products, using a patented orthorectification technique developed by MDA Federal, have achieved independently validated horizontal errors under 25 meters RMSE or 53.7 meters at 90% CE. Table 1 illustrates NASA's validation of the geometric accuracy of the GeoCover-Ortho data.

Area	RMSE (m)	90% CE (m)
Northeastern Africa	25	53.7
Middle East	22	47.2
United States	19	40.8

Table 1. Horizontal Accuracy of GeoCover-Ortho

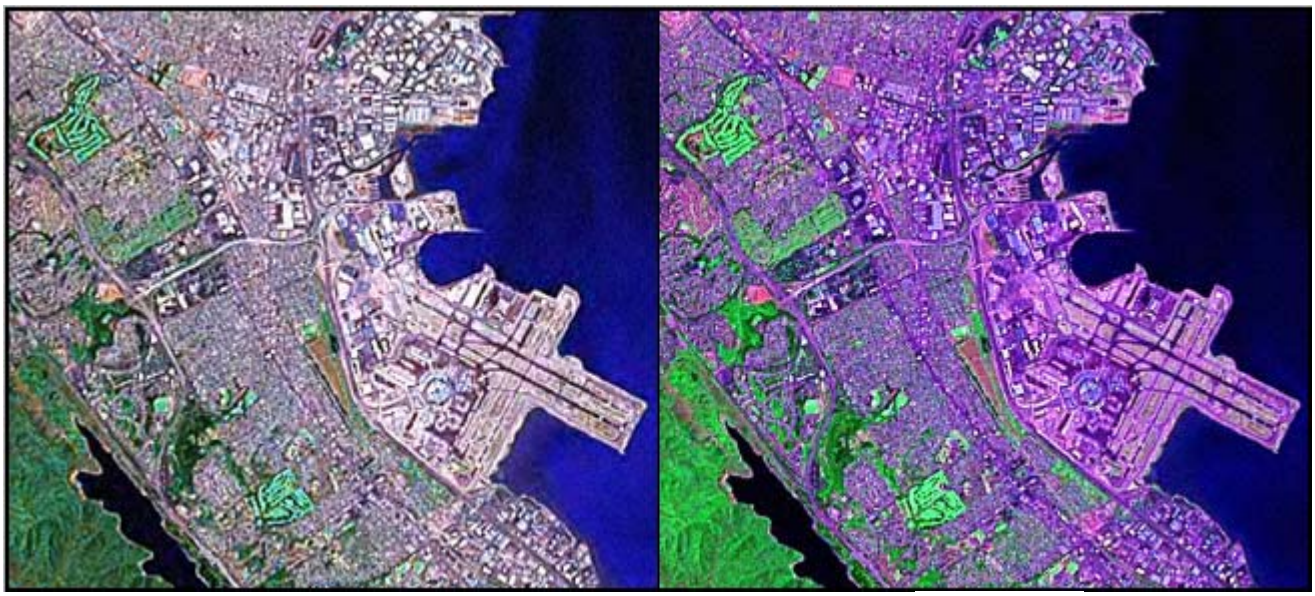
MDA's EarthSat NaturalVue Landsat Mosaic Product

By virtue of the visible red, green, and blue spectral bands of the ETM sensor, it is possible to create a straight forward "true color" image by simply color compositing ETM bands 3, 2, and 1 as R,G, and B, respectively. However, the generation of true natural color Landsat imagery by such a simple compositing approach is consistently plagued by the strong attenuation affect of haze in the higher frequency bands (ETM 1 and 2). To counteract this effect, several image processing techniques have been developed over the course of the past 20 years. Each has advantages and disadvantages. Over the past few years, MDA Federal has been actively engaged in research aimed at establishing a systematic processing technique that will consistently produce a high quality natural color image which renders a pleasing green/brown/blue dominated color pallet, while at the same time preserving the inherent textural and spectral information of the 14.25-meter Landsat data. The resulting MDA Federal proprietary process, (MDA Simulated Natural Color – SNAC) combines an image segmentation, linear band combination of the five lower frequency spectral bands, and a database controlled, adaptive, dynamic range adjustment to produce the final simulated natural color image. NaturalVue 2000 uses the SNAC algorithm. For production of their mosaic products, NASA requested that the band combination be a false color combination of ETM 7,4,2 as R,G,B. This combination avoids the haze issues associated with ETM 1, but has the undesirable side effect of turning cultural features purple and vegetation a florescent green. Figures 2, 3 and 4 show side-by-side comparisons of the San Francisco area in the NASA False Color (7,4,2), and MDA SNAC rendition both at 150-meter and 15-meter resolution, respectively.



EarthSat NaturalVue NASA 742

Figure 2. San Francisco Metropolitan Area, SNAC vs 742



EarthSat NaturalVue NASA 742

Figure 3. San Francisco Airport at 15-meters, SNAC vs 742

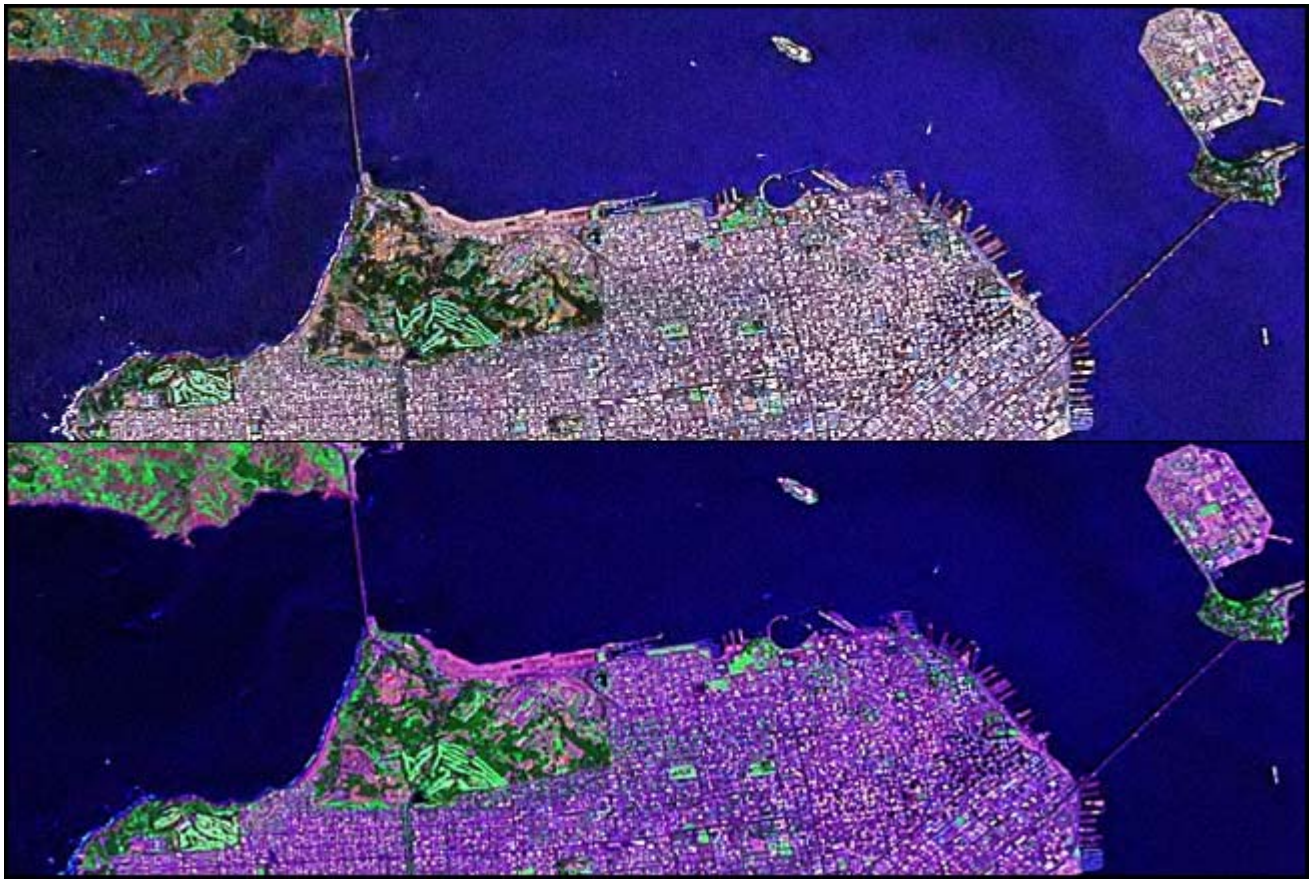


Figure 4. Downtown San Francisco (Showing Golden Gate & Bay Bridges) at 15-meters, EarthSat NaturalVue (Top) vs NASA 742 (Bottom)

Projection and Pixel Size

The NaturalVue product is produced in Geographic (Lat/Long) on the WGS84 datum/spheroid with pixel sizes of 0.5 arc seconds (approximately 15-meter at the equator). Resampling to 10-meter pixels is typically done to match multi-resolution files size and paging formats.

Contrast Adjustments

Landsat multispectral data, although systematically constrained to 8-bits dynamic range, displays a wide range of reflectance intensities within a single one-degree area. Much of the useful spatial and spectral information is often contained in the lesser-populated regions at the extremes of the spectral bands dynamic ranges. With most conventional approaches to contrast adjustment, a single contrast mapping is calculated from a systematic sampling of the image pixel values. This single mapping, often referred to as a "lookup table," is used to associate (or map) each of the raw pixel values to a new enhanced display value.

In spectrally homogeneous areas, this approach works well. However, in scenes where there are significant areas of high and/or low reflectance, the single lookup table approach will often severely compromise the display of spatial and spectral information within these areas. If the distribution of the brightness values is bimodal, the single lookup table approach forces the decision of using an all-inclusive table, which would give a flat feature poor image across the entire scene, or to choose one of the brightness regimes (either high or low) to enhance, thus destroying all spatial and spectral information in the other regime.

Value Added Solutions

There are two major market segments within the Defense and Intelligence industry where NaturalVue products play a significant role, visual simulation (VisSim) and mission planning and rehearsal. NaturalVue provides a global archive of medium resolution imagery that can be used as a foundation data layer for all visual based systems. These visual systems are fundamental in creating weapons training systems or improving battle space awareness. NaturalVue is even more valuable when used in conjunction with high-resolution data that is corrected to terrain data and color balanced to create an accurate out of the window experience for the user.

When NaturalVue imagery is combined with open source land cover classifications or other geospatial data, it becomes a powerful decision support tool in addition to enhancing the visual experience. There are many applications that are in development for use in Federal/Civil, State and Local Government as well as the intelligence community. Listed below is a partial list of a few likely defense and intelligence applications:

- C4ISR Battle Space Visualization
- Feature Extraction & Classification
- Mapping, Charting, Bathymetry & Geodesy
- Military Decision Making Process (MDMP)
- Intelligence Preparation of the Battlefield (IPB)

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