White Paper

Orthorectifying GeoEye Imagery from DigitalGlobe Using NEXTMap® World 30™ Digital Surface Models

INTERMAP

Intermap Technologies, Inc.®

8310 South Valley Highway, Suite 400

Englewood, CO 80112

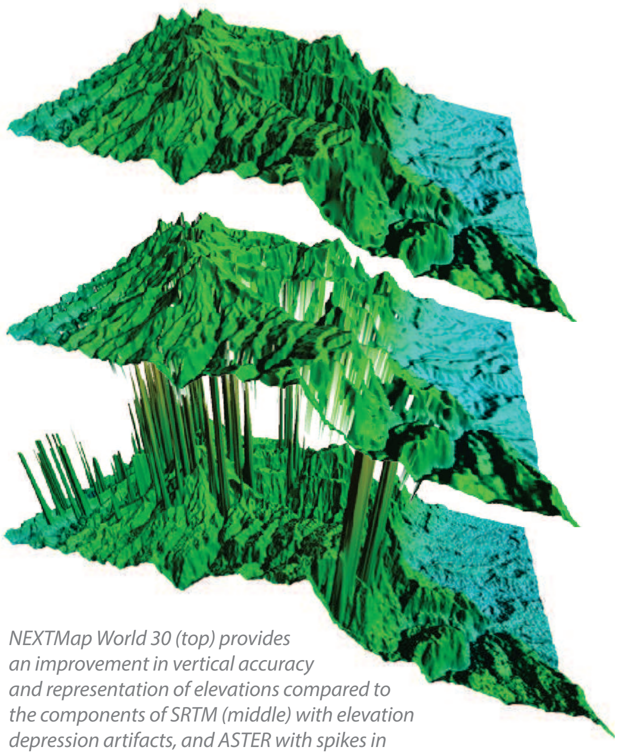
MAPMART

GLOBAL MAPPING SOLUTIONS

MapMart

10465 Park Meadows Drive, Suite 201

Lone Tree, CO 80124



NEXTMap World 30 (top) provides an improvement in vertical accuracy and representation of elevations compared to the components of SRTM (middle) with elevation depression artifacts, and ASTER with spikes in elevation artifacts (bottom).

Introduction

The NEXTMap® World 30™ digital surface model (DSM) by Intermap Technologies® provides seamless, surface elevation data with a 30-meter grid spacing so you can perform efficient geospatial analyses anywhere on earth. NEXTMap World 30 DSM data provides global coverage of all land masses on earth and is available today through Intermap or its distribution channels.

The World 30 DSM was created using Intermap's world-class enterprise digital elevation model (DEM) production workflow which allows for the integration of multiple elevation datasets such as from IFSAR, LiDAR, optical, air- and space-borne sources. NEXTMap World 30 DSM is a combination of 30- and 90-meter Shuttle Radar Topography Mission (SRTM) v2.1 data, 30-meter ASTER Global DEM v2.0, and 1-kilometer GTOPO30. Additionally, it has been ground controlled using LiDAR data from NASA's Ice, Cloud and Land Elevation Satellite (ICESat) data. The resulting product is the most accurate, off-the-shelf, global 30-meter ground sampling distance (GSD) DSM available.

The accurate topographic data of the NEXTMap World 30 DSM is used for orthorectification, telecommunication, forest management, aviation, engineering, energy exploration, natural resource conservation, public works design, firefighting, recreation, geology, and city planning, to name a few applications.

This paper discusses the application of using NEXTMap World 30 to orthorectify high-resolution satellite imagery. DEM data is used to correct the geometric distortions introduced by terrain variations. Using DEM data in the orthorectification process enables the final ortho-image to have uniform map scale across the image scene. Intermap and its partners, such as MapMart[1], tie high-resolution satellite imagery to NEXTMap World 30 to make the imagery more accurate which is required for mapping, spatial analysis, and many other applications. In this paper, Intermap and MapMart have collaborated on an assessment using NEXTMap World 30 DSM data to orthorectify GeoEye-1 high-resolution satellite imagery.

Objective

The objective of this assessment was to compare the horizontal accuracies of high-resolution DigitalGlobe[2] imagery that has been orthorectified using SRTM DSM v2.1 data and NEXTMap World 30 DSM data.

Test Site

The test site is to the south of San Antonio de los Cobres, a small town of the Salta Province in northwestern Argentina (Figure 1). The town is known for its high elevation of approximately 3,775 meters (12,385 feet) above sea level, making it one of the highest elevations of any city or town in Argentina. This site was selected because of the availability of suitable ground truth information and for the highly-variable terrain in the area, where a good quality DEM would be highly desirable to ortho-correct an image.

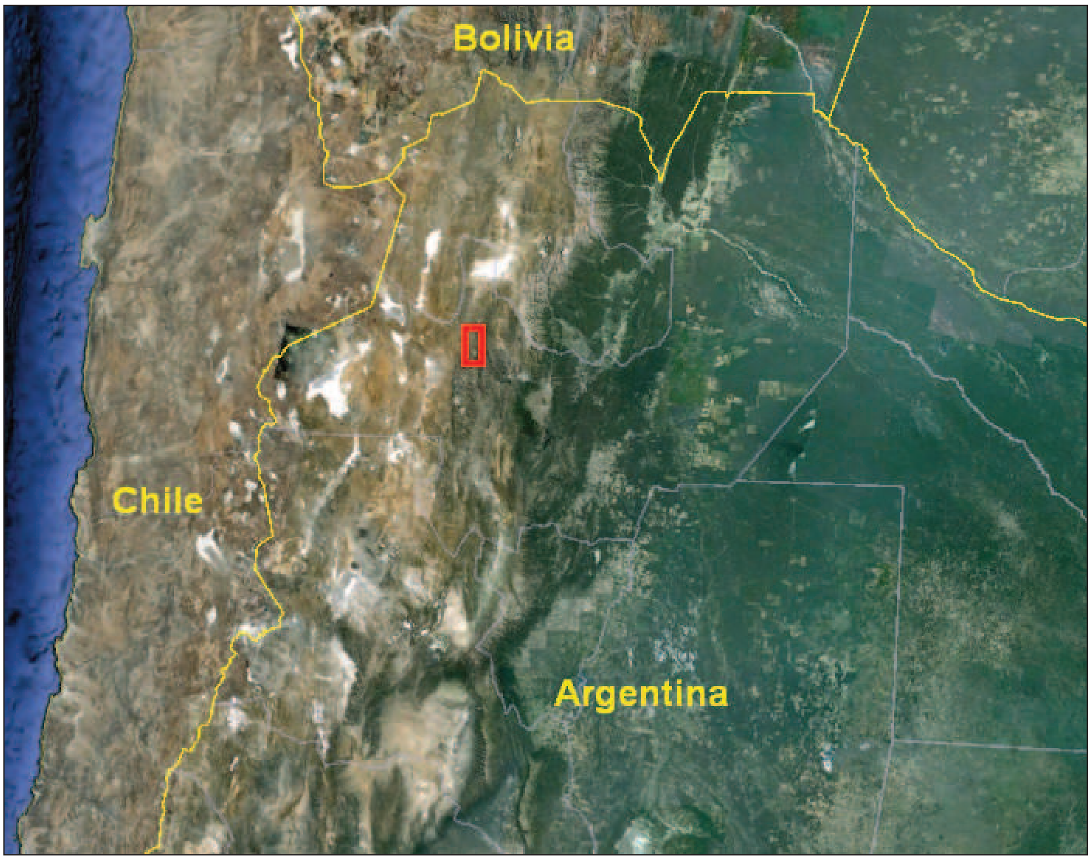


Figure 1. Location of the test site on Google Earth

1 *http://www.mapmart.com*
2 *http://www.digitalglobe.com*

Datasets

Six GeoEye-1 panchromatic images with 50-centimeter GSD were provided by DigitalGlobe through a partnership with MapMart as three stereo pairs. They covered a corridor approximately 40 kilometers in length on the northern part of National Route 40.

The images were acquired in May 2012. Twenty-four image-identifiable ground control points (GCP) were collected at the time of image acquisition. The distribution of the GCPs on orthorectified GeoEye-1 imagery is shown in Figure 2. Both SRTM v2.1 data (Figure 2, middle) and NEXTMap World 30 DSM data (Figure 2, right) were used as input in the orthorectification process. Additionally, a 5-meter digital terrain model (DTM) derived from the three GeoEye-1 stereo image pairs is available for comparative analysis.

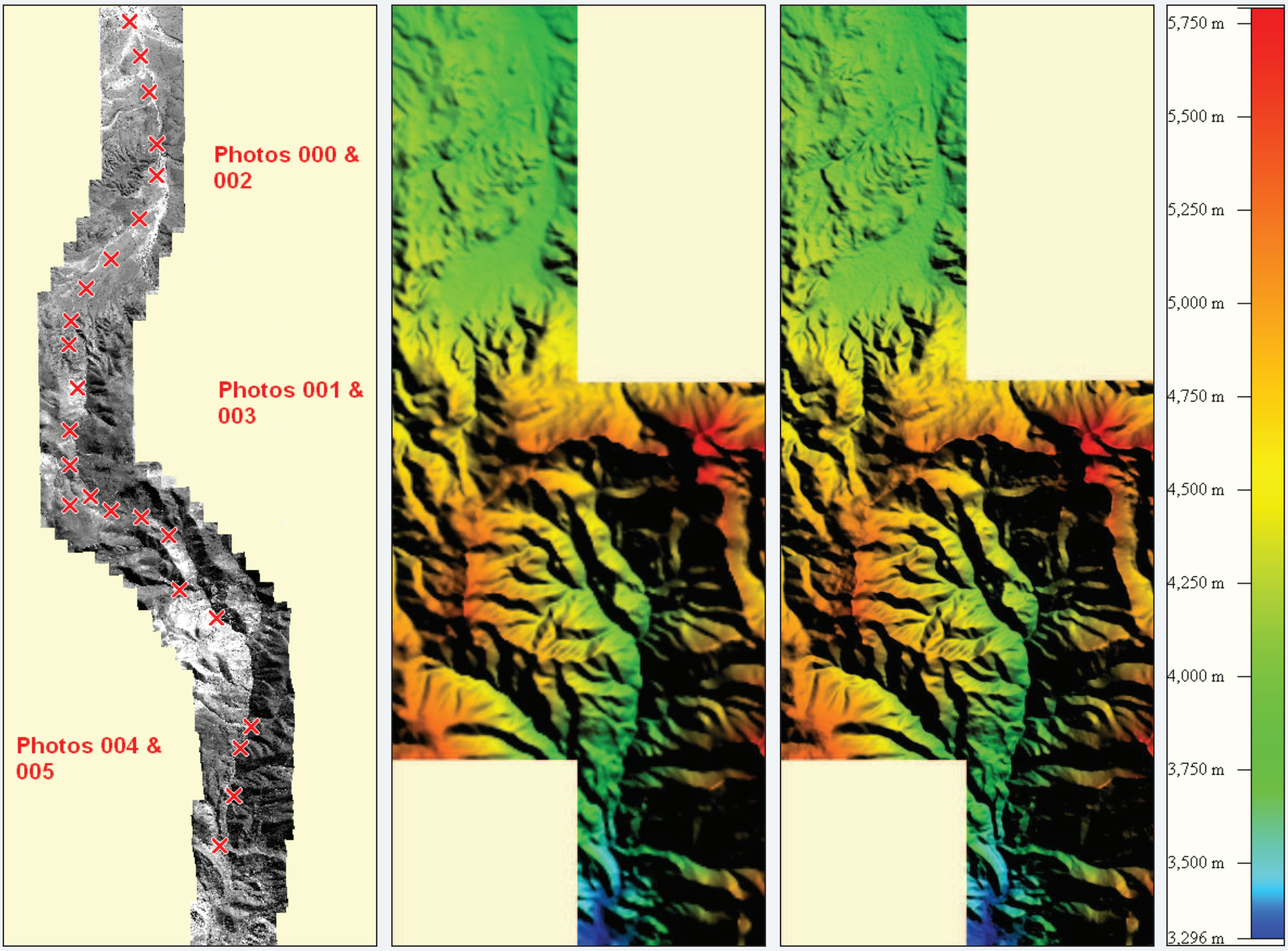


Figure 2. Distribution of GCPs on the GeoEye-1 images (left), an overview of SRTM (middle), and NEXTMap World 30 DSM (right)

Data Processing

The OrthoEngine module in PCI Geomatica V10.0[3] was used for this assessment. The mathematical model used was defined by the Rational Polynomial Coefficients (RPC) extracted from the imagery. These RPC models were directly used to generate ortho-imagery based on the SRTM and NEXTMap World 30 DSM data. For the purpose of comparison, we also used one to three GCPs to refine the RPC model with a zero order correction applied (i.e., bias removal). The refined RPC models were then used to generate ortho-imagery based on the GeoEye stereo-derived 5-meter DTM. The data was in the WGS84 ellipsoidal height reference before orthorectification. This is the same vertical datum used by the GCPs.

3 *http://www.pcigeomatics.com*

Horizontal Accuracy Assessment Results

The resulting orthorectified images were assessed for horizontal accuracy by comparing the observed GCP locations on the images to the ground truth target locations. The results are presented in Table 1. The horizontal or planimetric accuracy of the orthorectified GeoEye-1 images using NEXTMap World 30 DSM ranges from 1 meter to 5 meters RMSE, with an average of 3.4 meters RMSE, which is about a 15% improvement over the results obtained using SRTM. The best results are from the GeoEye stereo derived 5-meter DTM with an overall 22% improvement over the results obtained using SRTM.

Photo	#GCPs	Orthorectified Imagery Using SRTM + RPC (m, RMSE)	Orthorectified Imagery Using World 30 + RPC (m, RMSE)	Orthorectified Imagery Using 5m DTM + Refined RPC (m, RMSE)	NEXTMap World 30 Improvement over SRTM (%)	5m DTM Improvement over SRTM (%)
0	3	3.646	2.617	1.255	28.22	65.58
1	3	4.867	4.198	4.226	13.75	13.17
2	3	1.799	1.732	0.983	3.72	45.36
3	3	3.127	3.294	3.695	-5.34	-18.16
4	1	6.093	4.151	6.02	31.87	1.20
5	1	5.230	4.406	3.912	15.76	25.20
Overall Horizontal Accuracy		4.127	3.400	3.349	14.66	22.06

Table 1. Ortho-image accuracy assessment

Conclusion

This white paper has assessed the horizontal accuracy of GeoEye-1 imagery that was orthorectified using both SRTM and NEXTMap World 30 DEM data. The results indicate a 15% improvement in the horizontal accuracy of the orthorectified GeoEye-1 imagery when using the NEXTMap World 30 DSM in the orthorectification process in comparison to using the SRTM DEMdata.