
Satellite Remote Sensing for the 2002 Winter Olympic Games

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Introduction

The fanfare is over, the athletes have gone home, and life has returned to normal in Utah. By all indications, the 2002 Winter Olympic Games proved to be a success with the only real controversy centering around the judging of some events. Before and during the games though, there was a great deal of concern about security. Following the tragic events of September 11, 2001, the world's eyes were on the United States as we were slated to host a major international event. Could we achieve the level of security necessary for our visitors and residents? Many similar questions were foremost on the minds of Olympic organizers, public officials, and a very concerned public.

The U.S. Department of Agriculture (USDA) Forest Service had a premiere role in Olympic security for the Snowbasin, UT, venue. Snowbasin was the site of the men and women's Alpine ski events, including the downhill, giant slalom, and super-G. Because the Snowbasin Ski Area was located almost entirely on National Forest System (NFS) lands, primary responsibility for the venue's security fell on the USDA Forest Service and the Weber County Sheriff's Office.

Engineering Assistance

The USDA Forest Service Remote Sensing Applications Center (RSAC) became involved with Olympic security after being contacted by Kim Christensen, Region 4 Law Enforcement and Investigations (LEI) and lead USDA Forest Service representative for Olympic security at Snowbasin, and Russ Arthur, R-8 LEI. Russ was involved in security arrangements for the 1996 Summer Olympic Games in Atlanta. RSAC has had an active program supporting USDA Forest Service law enforcement for many years and has been involved with airborne and satellite imagery applications for marijuana detection, timber theft, arson, and other special projects. Operating under the direction of the United States Secret Service, USDA Forest Service LEI was designated as the lead Federal Agency for the 2002 Olympic security at the Snowbasin venue.

Specifically, LEI needed imagery and image-derived products for security planning, officer orientation, and operational use during the games. RSAC had previously collected airborne imagery for road construction related to the access for Snowbasin, but now needed an entirely different product. Because the imagery would be used for different purposes, it was desirable for it to be digital and geo-corrected. That way, many different products could be generated without a great deal of image processing.

The Solution

A relatively new satellite to acquire high-resolution imagery was selected as the most flexible tool. Space Imaging, Inc., had successfully launched the world's first commercial high-resolution satellite in September 1999. Known as IKONOS, this satellite has the capability to image roughly township-size areas, approximately 11 by 11 kilometers, at 1-meter spatial resolution in

black-and-white, and 4-meter resolution in color. RSAC had prior experience with IKONOS imagery and had used the products for various natural resource applications. One 11-by-11-kilometer digital scene costs about \$3,500.

One advantage of a stable space-based platform is its ability to produce a geo-corrected image product. Space Imaging claims a 12-meter geolocation accuracy for horizontal distances and a 10-meter accuracy for vertical distances, both without ground control. These are specified as 90 percent circular error for horizontal distances (CE90) and 90 percent linear error for vertical distances (LE90). This means that 90 percent of all measured horizontal points should be within 12 meters of their true location on the Earth. This level of accuracy was important to our intent of using digital elevation models (DEMs) to create a 3-D rendition of the ski area. Unless correlation of the imagery to the elevation data was good, features would not appear as correct.

Traveling at a velocity of 4 miles per second, and at an altitude of 423 miles above the Earth, the IKONOS satellite captured our image of Snowbasin on the morning of August 28, 2001 (figure 1). The image showed the new construction around the base facilities at Snowbasin and did a good job of accentuating the new asphalt concrete (AC) pavement forming the bus turning loop. This was a newly constructed area directly related to the 2002 Olympics that would enable spectators to pass through security before boarding buses at a distant location. Spectators could disembark from these “secured” buses without the need to pass through security clearance again.

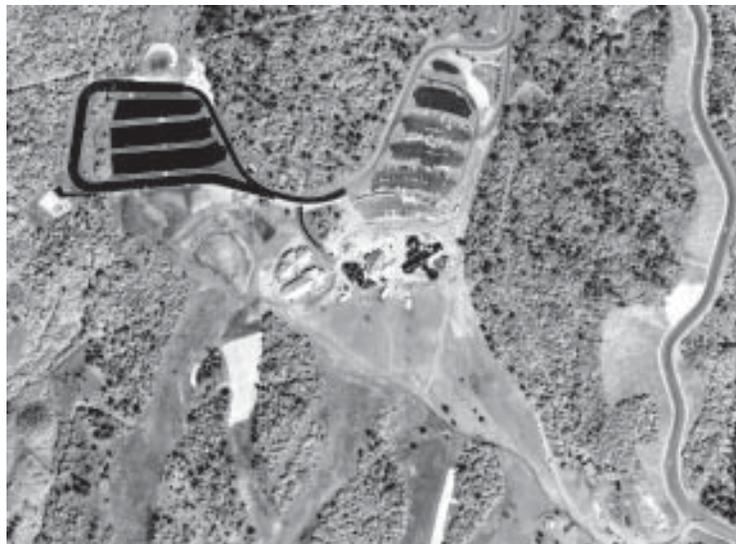


Figure 1. IKONOS satellite image of Snowbasin base facilities.

Product Development and Use

RSAC began working on image-derived products immediately after receiving the imagery, with Jan Johnson, an RSAC image analyst, performing the work. RSAC used GIS coverage, obtained from Region 4, to attribute the image with the locations of observation posts, helicopter landing zones, the downhill courses themselves, and other facility information. One of the more experimental products developed was a “fly-through” movie (figure 2). RSAC envisioned this overview product as an orientation tool for security

personnel who were unfamiliar with the Snowbasin site. RSAC hosted a meeting with representatives from USDA Forest Service LEI, the U.S. Secret Service, and the Weber County Sheriff's Office to discuss appropriate products and how they could be used. A high degree of enthusiasm was generated for the fly-through movie files and RSAC agreed to develop the agreed-upon products.

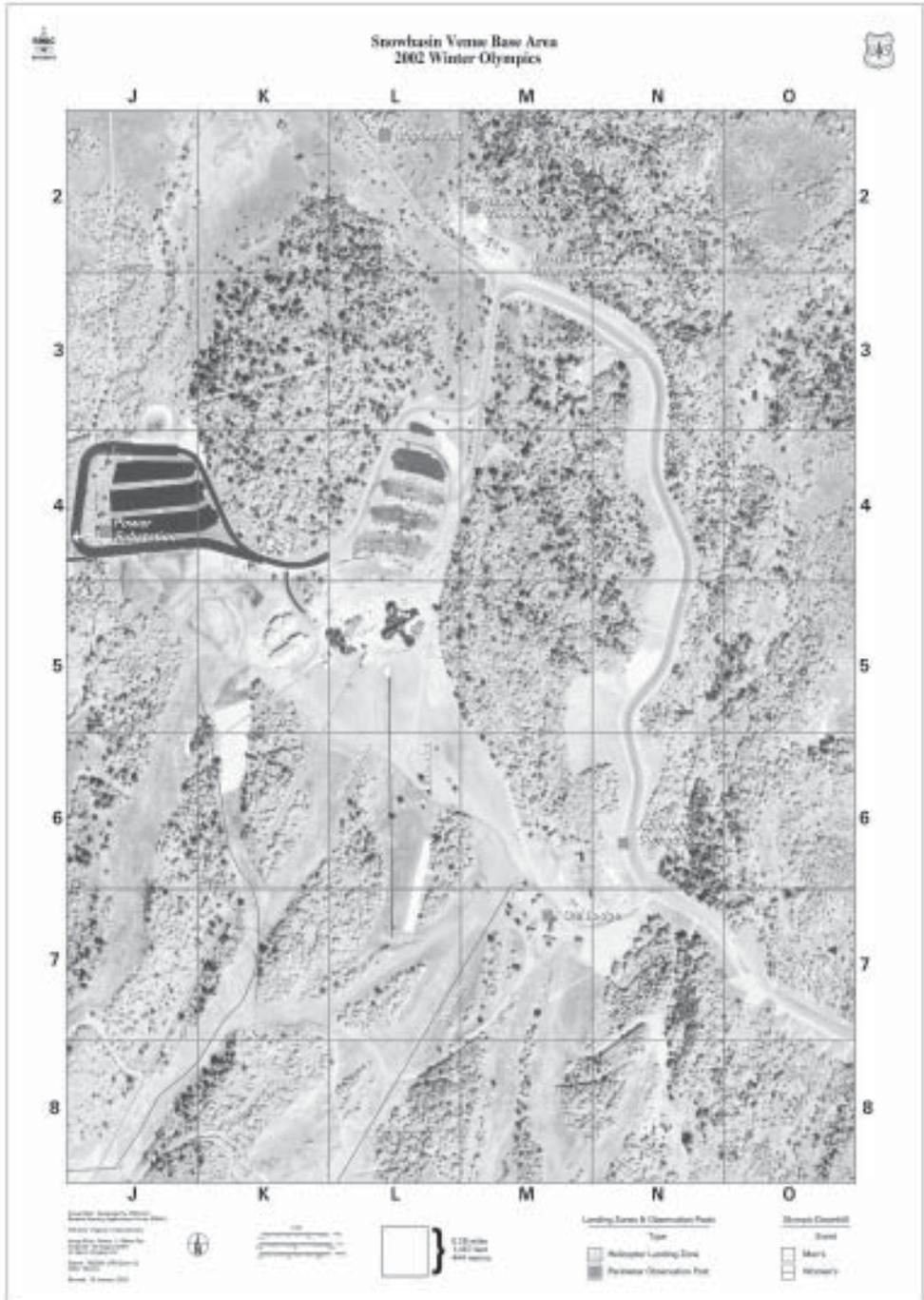


Figure 2. Screen capture of 3-D movie file used for orientation.

The movies for this project consisted of (.AVI) files that were produced with ERDAS IMAGINE software. ERDAS IMAGINE is the USDA Forest Service corporate image-processing software available under the IBM contract. Generating the fly-through movies requires the virtual GIS module, also available under the IBM contract. Preparation of the imagery consisted of draping it over a DEM in ERDAS IMAGINE and then positioning the virtual camera to various locations above the terrain with settings established for the view angle, field of view, and path. The advantage of an .AVI file is that it will run on almost any personal computer (PC) and can be paused on a scene to discuss individual features. The disadvantage of the .AVI file is that the person who generates the video movie sets its view. It is not possible to stop the view and rotate to some other area of interest. For that type of flexibility, one approach is to use ERDAS IMAGINE and Virtual GIS together running an Open Graphic Language application. Then the operator can move the virtual camera to any position and view a three-dimensional scene as desired.

For planning and operational use, the RSAC staff produced large 36-by-33-inch images depicting the Snowbasin venue overview (figure 3) and detail (figure 4) of the base facilities. In addition, the center staff also produced small 8-1/2-by-11-inch copies of the overview imagery for each officer to carry in the field and to be positioned in portable remote post stations. Further enhancements to the images included grid squares with letters and numbers along the edges so security personnel could relay position and traffic reports keyed to locations on the imagery.



Figure 3. Olympic venue overview map produced from satellite imagery.

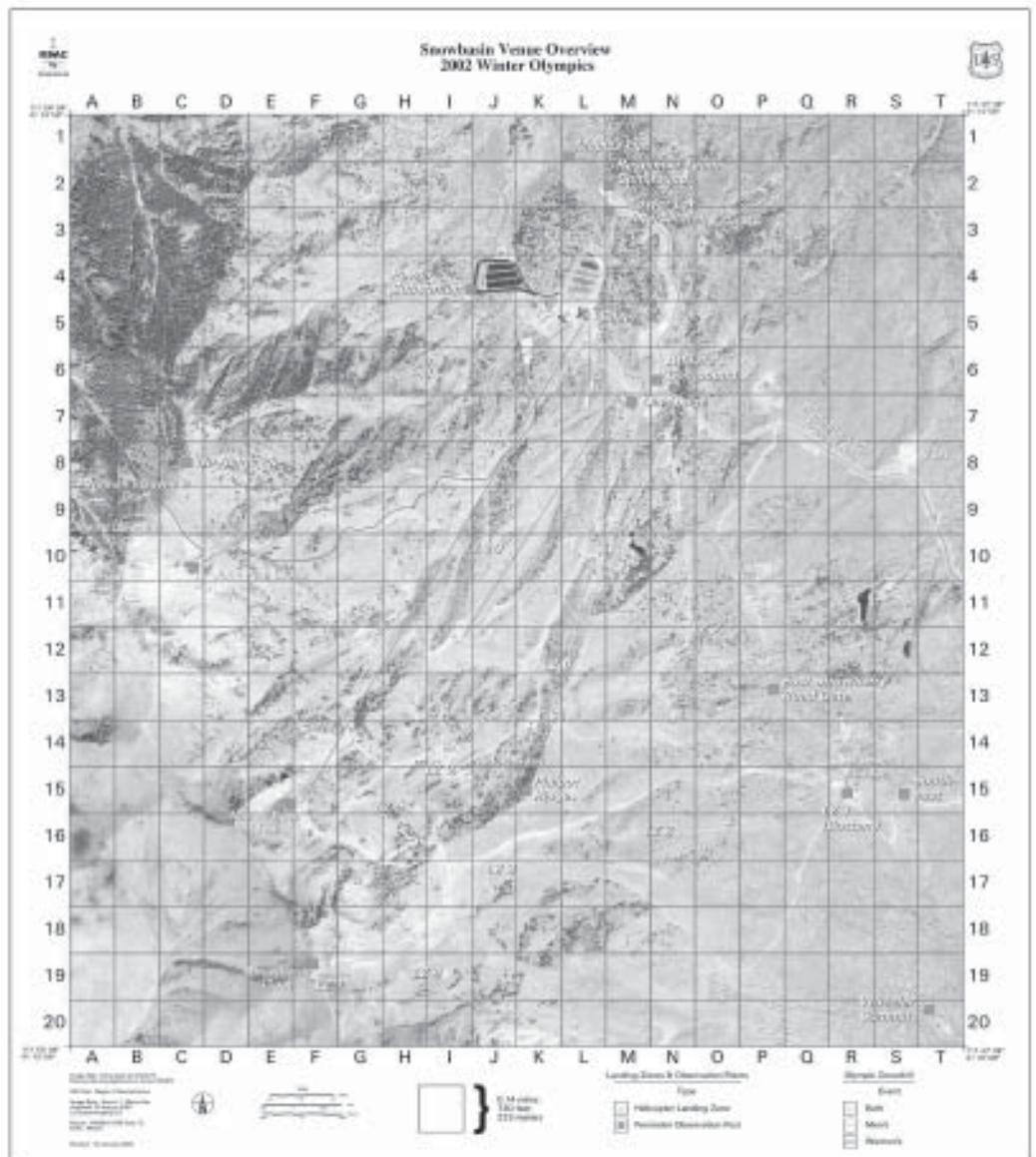


Figure 4. Olympic venue base facilities map produced from satellite imagery.

The imagery had a chance to shine at an event before the Olympics began. It was used to brief Attorney General John Ashcroft when he visited Salt Lake City to review security for the games. The large-image prints with attribute information were used to review security measures with the Attorney General (figure 5). Ashcroft had some very positive comments about the USDA Forest Service's use of these products and the preparation and precautionary measures the Agency's law enforcement personnel had taken.

Another story associated with these image products occurred when RSAC used a local shop to laminate the large prints and personal copies. RSAC personnel requested permission from the shop owner to "stand guard" during the lamination process to ensure that no copies were unaccounted for. Because the prints contained the mountaintop locations of security personnel and the radio call names for the facilities, there was keen interest in protecting this information.



Figure 5. Attorney General John Ashcroft (second from left) being briefed on security at the Snowbasin venue during his pre-Olympic visit.

Summary

The purchase of relatively inexpensive commercial satellite imagery resulted in multiple field uses. The final products were used in a variety of vital roles including the everyday planning of multiagency special operations, guidance for USDA Forest Service LEI and other Federal and State officers positioned in remote posts, dispatch controls, relief and response positions, and for briefing and planning with the Olympic event managers. They were effective tools for presenting overviews to visiting department and agency heads. The products were placed inside the Olympic command center in Salt Lake City, as well as at the onsite command station at the venue (figure 5).

As it turned out, only a few minor intrusions occurred at the venue, and onsite personnel handled them easily. Quantifying the benefits of these imagery products is difficult. However, if any major problems had occurred, these products would have been heavily used by field officers and command personnel. The command dispatchers used the imagery products daily for tracking officers and assigning locations. The products proved invaluable to the dispatchers because they allowed a view of the topography to those unfamiliar with the terrain.

More and more specialists and resource managers are expecting accurate information about the lands we manage. Remote sensing often can provide agency personnel with relevant geospatial information that serves us well in a variety of unexpected ways, such as for the 2002 Olympics. The old adage “a picture is worth a thousand words” still holds true today as advanced satellite imagery is used to collect data on complex terrain and vegetation features.



Figure 6. Onsite command station at the venue with image products in the background.