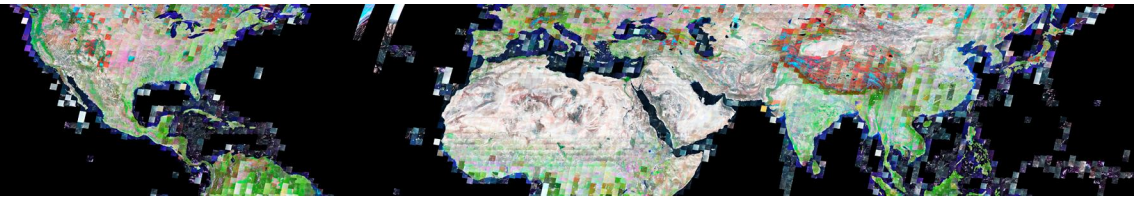
USGS
science for a changing world



LANDSAT Update - Volume 2, Issue 3, 2008

Secretary Kempthorne Showcases Free Public Availability of Landsat Satellite Image Archive at ESRI Conference

SAN DIEGO, CA -- Secretary of the Interior Dirk Kempthorne announced at the ESRI Conference that his direction to the U.S. Geological Survey (USGS) to make its 35-year Landsat satellite image archive available over the Internet for free marks the commitment of the department to breaking down information barriers.

“With the click of a mouse, scientists, government officials and land managers will be able to see the changes in the earth’s landscape at any point in the past three and a half decades,” he told the conference on Saturday. Some 14,500 participants are gathered this week in San Diego for the ESRI conference.

"This is a great contribution,” said ESRI President Jack Dangermond. “It will open up new avenues for geographic understanding around the globe. It represents the democratization of digital data and empowers people everywhere with rich information."

The USGS, an Interior agency, expects to have the full archive online by February 2009. The Department of the Interior has the responsibility for coordinating the geospatial activities of the entire federal government through the Federal Geographic Data Committee.

“As Secretary of the Interior, I have made breaking down barriers and building bridges a high priority of the department,” Kempthorne said. “We are fully committed to this task.”

The Landsat archive is an unequaled 35-year record of the Earth’s surface that is valuable for a broad range of uses from climate change science to forest management to emergency response. As an example of uses for the archive, Kempthorne showed a Landsat image of Las Vegas in 1973 compared with an image from 2000. The juxtaposition of the images provided a dramatic picture of the explosive population growth and the rapid spread of the city into the surrounding desert ecosystems.

"Data is the power in the engine of innovation," said geographer Roger Tomlinson, an emcee at the ESRI conference known as the “father of GIS.”

A technical announcement of the Landsat archive’s availability can be found at
http://landsat.usgs.gov/images/squares/USGS_Landsat_Imagery_Release.pdf

Landsat Science Team Spotlight

Feng Gao, Senior Scientist
Earth Resources Technology, Inc. & NASA Goddard Space Flight Center

Figure 1. Feng Gao, Senior Scientist

Feng Gao has 15 years of experience in remote sensing modeling and applications. He has been actively involved in Landsat data processing, new algorithm development, and multi-sensor data fusion using Landsat and MODIS data.

His focus on the Landsat Science Team is to develop a consistent Landsat dataset from MSS, TM/ETM+, and international Landsat-like data sources for land cover change detection. (View his presentation from the January 2008 Science Team Meeting.)

Gao received his PhD in Geography at Beijing Normal University, China, in 1998. He had a major role in the development of the MODIS Bidirectional Reflectance Distribution Function (BRDF)/Albedo product from 1998 to 2004.

Gao has published articles in *IEEE Geoscience and Remote Sensing* ("On the Blending of the Landsat and MODIS Surface Reflectance: Predicting Daily Landsat Surface Reflectance" Vol. 44, August 2006) and in the *Journal of Geophysical Research* (MODIS bidirectional reflectance distribution function and albedo Climate Modeling Grid products and the variability of albedo for major global vegetation types", Vol. 110, January 2005,)

The International Charter "Space and Major Disasters"

The International Charter “Space and Major Disasters” is an agreement designed to mitigate the effects of disasters on human life and property. Established in 2000, the Charter seeks to provide a unified system of space data acquisition and delivery through Authorized Users to help those affected by natural or man-made disasters. The Charter has been activated in response to over 200 hazards since its inception.

On May 4, 2008, the Nargis cyclone hit the country of Burma (Myanmar) causing devastation to Rangoon (Yangon), the capital of Burma, and the surrounding area. The Charter was activated in response to this emergency, and within hours of activation, Landsat images were delivered to agencies and first responders.

These Landsat 7 images show the Gulf of Martaban. The city of Rangoon is the grey area in the center and to the west of the Gulf where two rivers converge slightly inland. Rangoon is easily seen in the March 3 image. Although cloudy, the area of inundation is evident in the May 5, 2008, image.

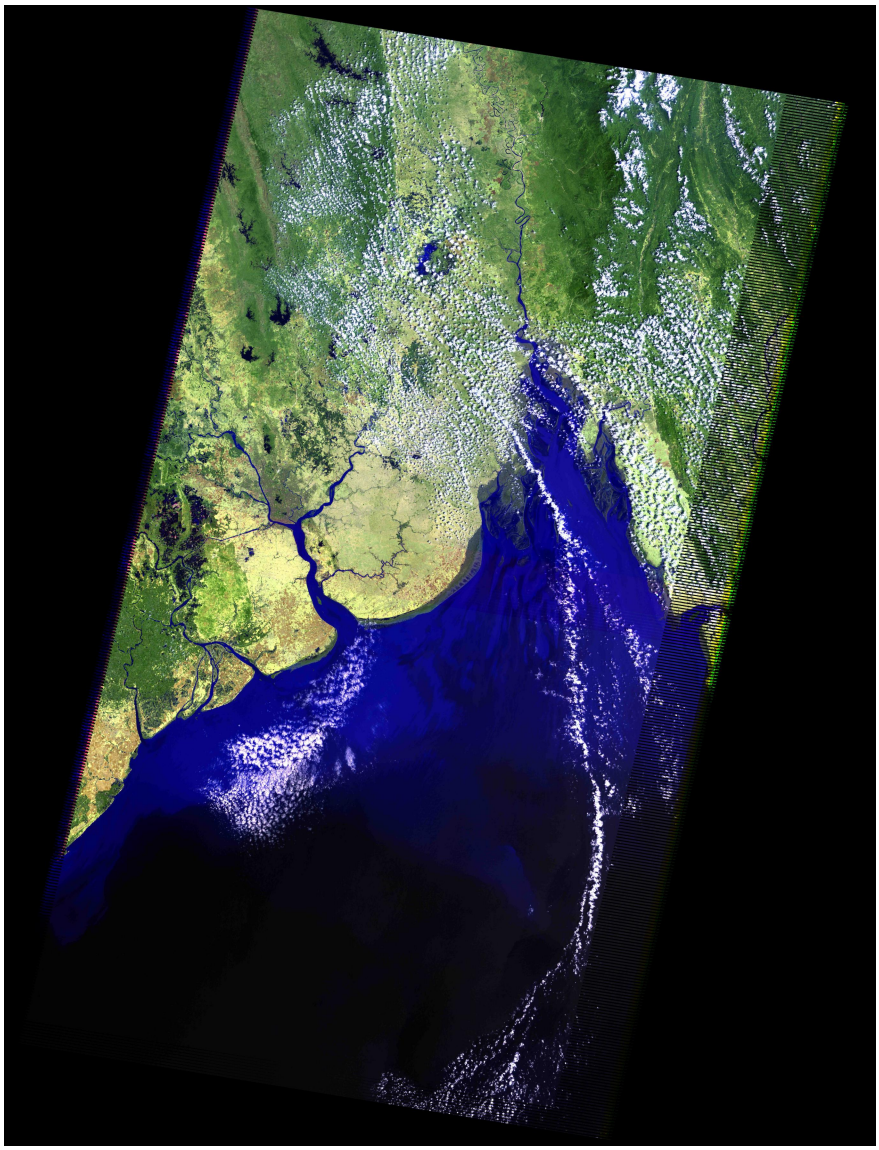


Figure 2. Gulf of Martaban image, March 3, 2008. Path 132, Row 48 & 49. Bands 7,5,3

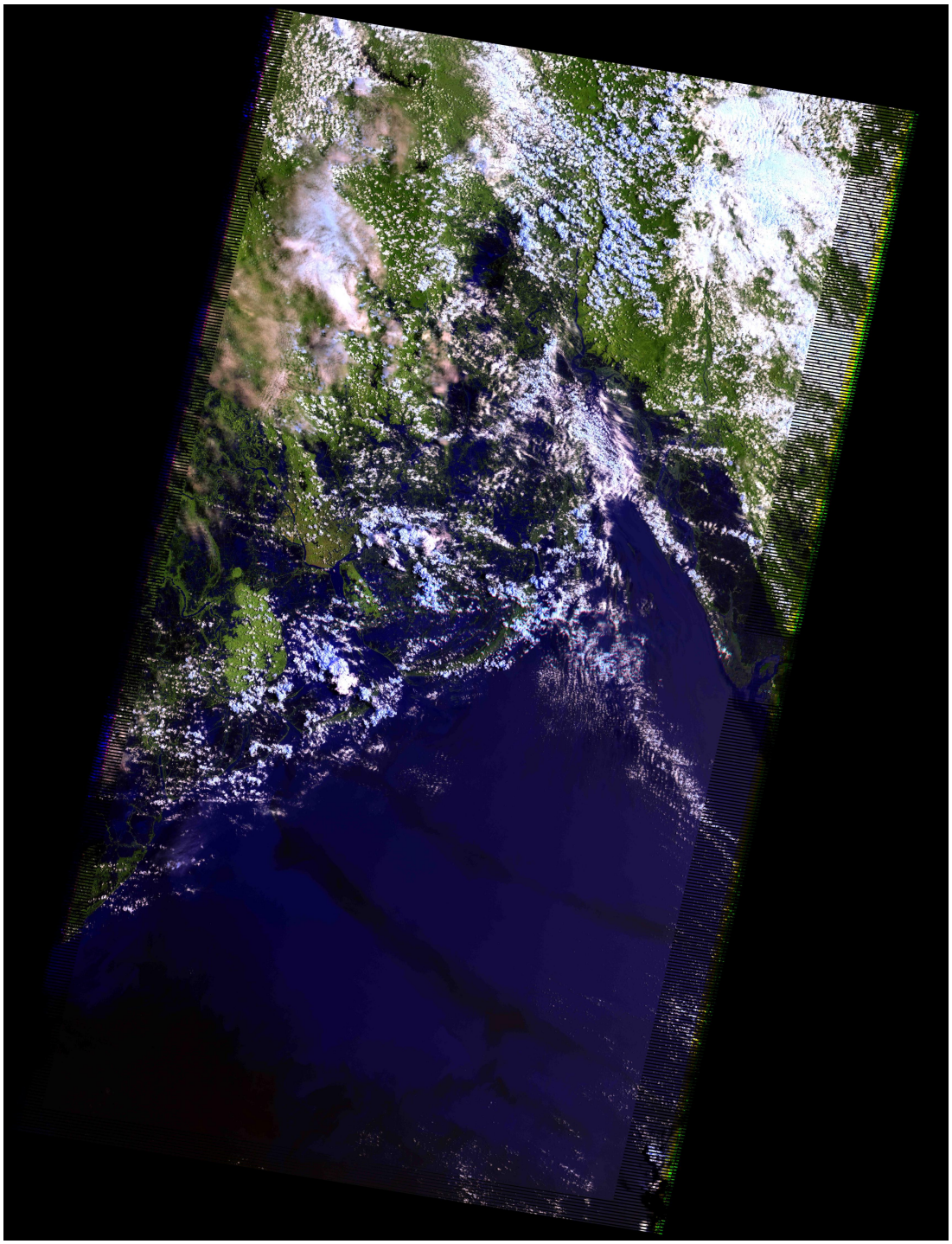


Figure 3. Gulf of Martaban image, May 5, 2008. Path 132, Row 48 & 49. Bands 7,5,3

EROS Authors in Recent Publications

Landsat data in peer-reviewed, published articles.

Radiative forcing over the conterminous United States due to contemporary land cover land use albedo change

GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L09706, doi:10.1029/2008GL033567, 2008

Christopher A. Barnes and David P. Roy

Received 6 February 2008; revised 28 March 2008; accepted 4 April 2008; published 9 May 2008.
http://www.agu.org/journals/gl/gl0809/2008GL033567/2008GL033567.pdf

Identifying Mangrove Species and Their Surrounding Land Use and Land Cover Classes Using an Object-Oriented Approach with a Lacunarity Spatial Measure

GIScience and Remote Sensing, v. 45, no. 2, p. 188-208.

Soe W. Myint
School of Geographical Sciences, Arizona State University, P.O. Box 870104, Tempe, Arizona 85287-0104
Chandra P. Giri
Science Applications International Corporation (SAIC)/U.S. Geological Survey, Center for Earth Resources Observation and Science (EROS), Sioux Falls, South Dakota 57198-0001
Le Wang
Department of Geography, University at Buffalo, State University of New York, 105 Wilkeson Quadrangle, Buffalo, New York 14261
Zhiliang Zhu
U.S. Geological Survey, Center for Earth Resources Observation and Science (EROS), Sioux Falls, South Dakota 57198-0001
Shana C. Gillette
Institute for Animal Population Health, and Department of Journalism and Technical Communication, Colorado State University, Ft. Collins, Colorado 80523
http://bellwether.metapress.com/content/j513751t653p6282/fulltext.pdf

Did You Know? From the Landsat Legacy Project

http://library01.gsfc.nasa.gov/landsat/

Landsat data revealed a fault across the proposed path of a new gas pipeline in Bolivia. Engineers chose a different route that avoided the fault zone. The new path was actually shorter than the original one, an unexpected but welcome benefit.

Landsat 5 25th Anniversary Images

To honor the 25th year of Landsat 5, the Landsat Project has added 33 images to the Landsat Image Gallery spanning the life of the satellite. Launched in 1984, Landsat 5 has collected over 192 terabytes of data (over 766,000 scenes) during its 3.2-billion-mile journey.

From Australia to Yellowstone, Alaska to the Volga River Delta in Russia, the imagery is remarkable. The images showcase the diversity of land and habitats that make Earth unique and spectacular. These scenes and other imagery in the Landsat Image Gallery are available for high-resolution download. Go to the Landsat website and click the Gallery tab.

Landsat Science Team Meeting

The fourth meeting of the Landsat Science Team was held July 15-17, 2008, in Reston, Virginia, USA.

A status review of Landsat 5 and 7 satellites and Landsat Data Continuity Mission (LDCM) development progress (with high focus on the Operational Land Imager) were the primary topics of discussion. Science and applications results from Landsat Science Team Principal Investigator research activities were also presented.

The outcomes from the meeting included:

- Acknowledgment of USGS efforts to open the Landsat archive to no-cost access, and reiteration of the importance of the earliest possible LDCM launch
- The urgent need to begin planning Landsat 9
- The authorization of a National Land Imaging Program that ensures the operational status of Landsat.

The meeting agenda and presentation materials can be found on the USGS Landsat Web site: http://landsat.usgs.gov/science_LST_Team_Meetings.php.

Tips and Tricks

Figure 4 shows general Landsat 5 seasonality and Worldwide Reference System (WRS) row cutoffs. The green band represents the area of the earth that could be collected year-round. The range of data collections possible for any given latitude corresponding to any given date can be ascertained by following the yellow lines. For example, from approximately April 22 through August 12, all of Greenland could be included in data collections. Because Landsat 5 requires a ground station for live downlink, only the stations in Figure 5 can actively receive images over their areas. For more information on domestic and international ground stations, please see http://landsat.usgs.gov/about_ground_stations.php.

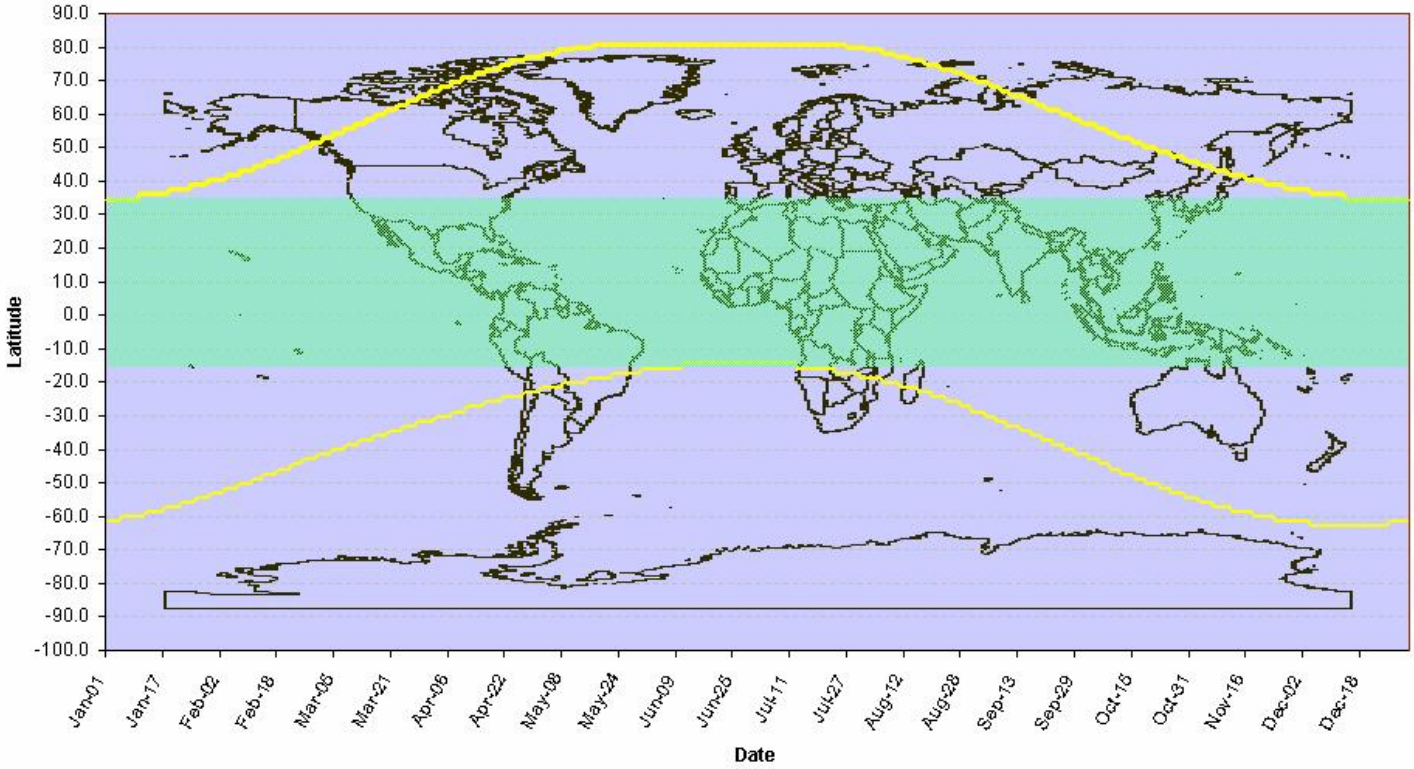


Figure 4. Latitude Cutoff vs Date

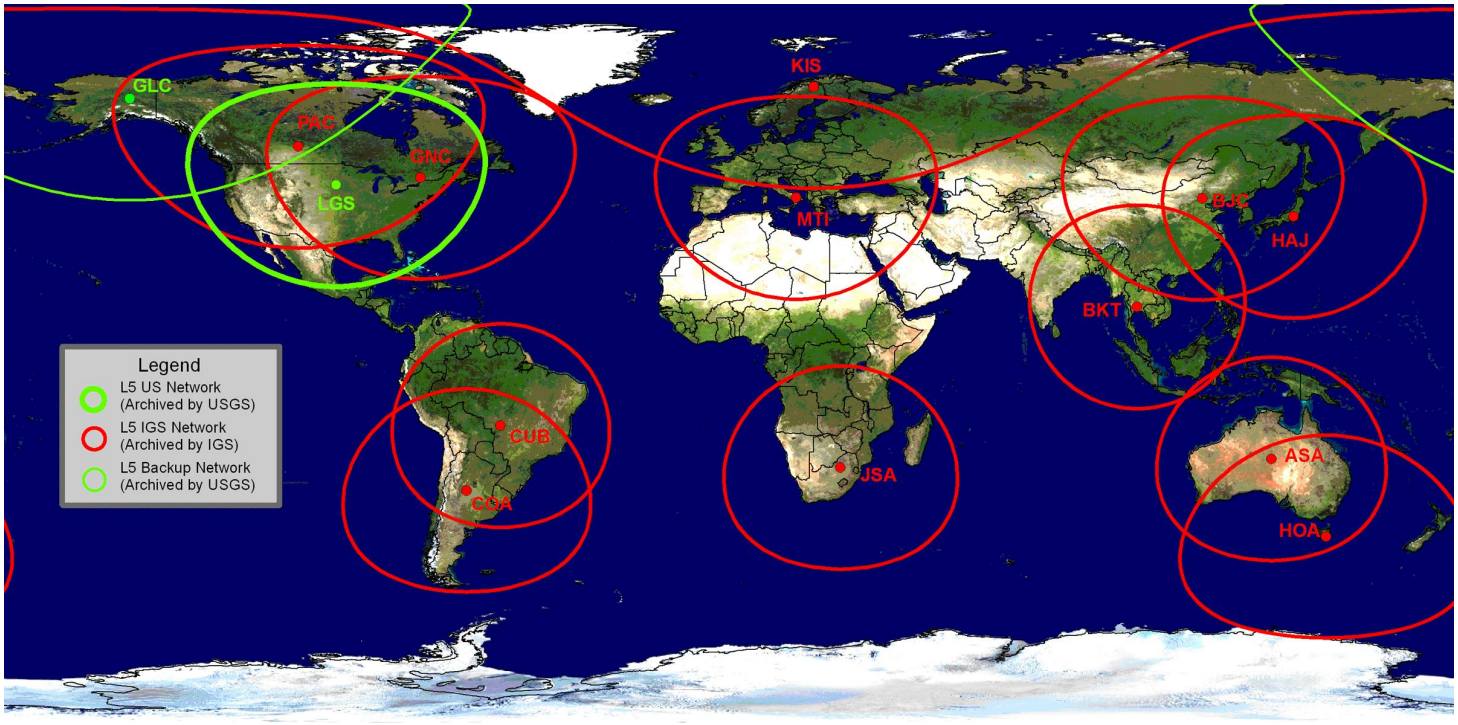
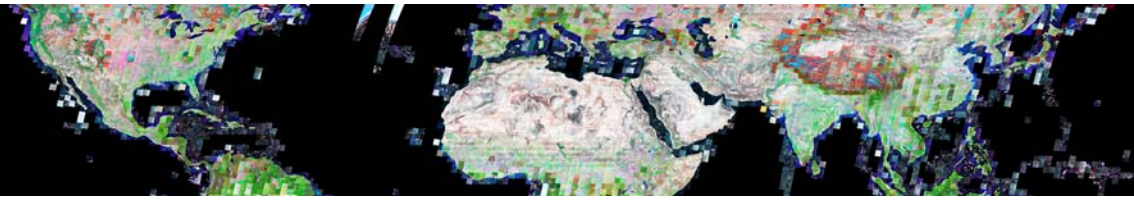


Figure 5. Landsat 5 International Ground Station Network



LANDSAT Update – Volume 2, Issue 2, 2008

Imagery for Everyone

By February 2009, any Landsat archive scene selected by a user will be processed, at no charge, automatically to a standard product recipe and staged for electronic retrieval. In addition, newly acquired scenes meeting a cloud cover threshold of 20% or below will be processed to the standard recipe and placed online for at least 3 months, after which they will remain available for selection from the archive. Details can be found in the USGS Technical Announcement below or the file can be downloaded from the Landsat Web page.
http://landsat.usgs.gov/products_data_at_no_charge.php

Technical Announcement

U.S. Department of the Interior
U.S. Geological Survey

Timeline Set to Release Entire USGS Landsat Archive at No Charge.

RESTON, VA – The USGS Landsat archive is an unequaled 35-year record of the Earth's surface that is valuable for a broad range of uses, ranging from climate change science to forest management to emergency response, plus countless other user applications. Under a transition toward a National Land Imaging Program sponsored by the Secretary of the Interior, the USGS is pursuing an aggressive schedule to provide users with electronic access to any Landsat scene held in the USGS-managed national archive of global scenes dating back to Landsat 1, launched in 1972. By February 2009, any archive scene selected by a user – with no restriction on cloud cover – will be processed automatically to a standard product recipe, using such parameters as the Universe Transverse Mercator projection, and staged for electronic retrieval. In addition, newly acquired scenes meeting a cloud cover threshold of 20% or below will be processed to the standard recipe and placed online for at least three months, after which they will remain available for selection from the archive.

Newly acquired, minimally cloudy Landsat 7 Enhanced Thematic Mapper Plus (ETM+) data covering North America and Africa are already being distributed by the USGS over the Internet at no charge, with expansion to full global coverage of incoming Landsat 7 data to be completed by July 2008 (see timeline below). The full archive of historical Landsat 7 ETM+ data acquired by the USGS since launch in 1999 will become available for selection and downloading by the end of September 2008. At that time, all Landsat 7 data purchasing options from the USGS, wherein users pay for on-demand processing to various parameters, will be discontinued.

By the end of December of 2008, both incoming Landsat 5 Thematic Mapper (TM) data and all Landsat 5 TM data acquired by the USGS since launch (1984) will become available, with all Landsat 4 TM (1982-1985) and Landsat 1-5 Multispectral Scanner (MSS) (1972-1994) data becoming available by the end of January 2009. All Landsat

data purchasing options from the USGS will be discontinued by February 2009, once the entire Landsat archive can be accessed at no charge.

Landsat scenes can be previewed and downloaded using the USGS Global Visualization Viewer at http://glovis.usgs.gov [under "Select Collection" choose Landsat archive: L7 SLC-off (2003-present)]. Scenes can also be selected using the USGS EarthExplorer tool at http://earthexplorer.usgs.gov [under "Select Your Dataset" choose Landsat Archive: L7 SLC-off (2003-present)]. For further information on Landsat satellites and products, see http://landsat.usgs.gov.

Landsat Imagery Archive Release Schedule	
Data	**Available over the Internet**
Landsat 7 – all new global acquisitions	July 2008
Landsat 7 – all data	September 2008
Landsat 5 – all TM data	December 2008
Landsat 4 – all TM data	January 2009
Landsat 1-5 – all MSS data	January 2009

Shallow-Water Features Identified with Landsat 7 Imagery

Landsat 7 acquired unique open-water scenes for a project that identified the location of shallow-water hazards in the Indian Ocean in 2006. A year prior, concerns were raised regarding the accuracy of aging maps used for navigation that documented sub-surface features and hazards.

Seventy-five Enhanced Thematic Mapper Plus (ETM+) scenes were identified which showed shallow-water features, such as seamounts, reefs, submerged atolls, or shallow banks. Some of these features had been incorrectly mapped, and others were previously unknown.

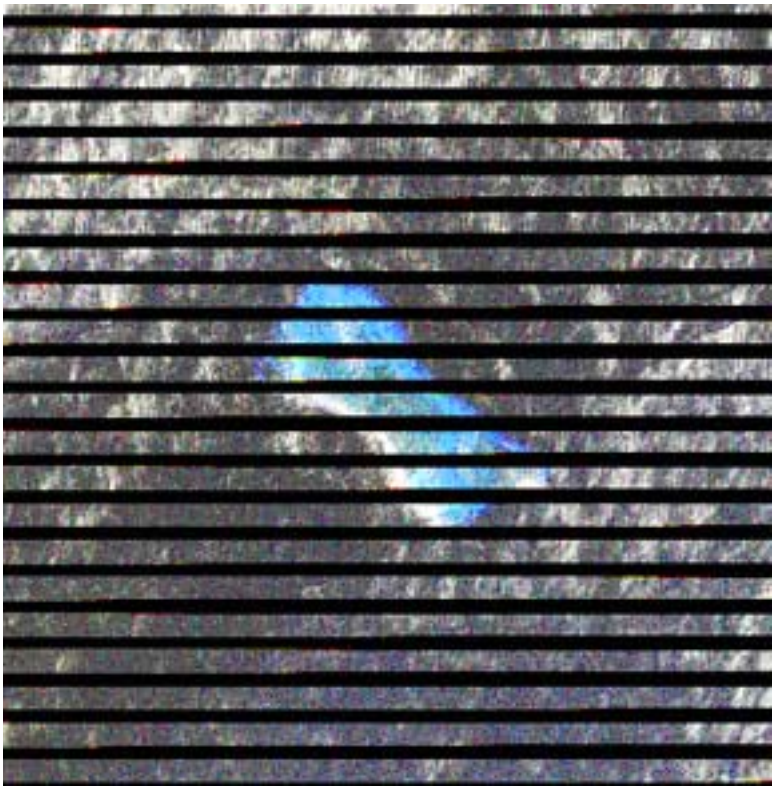


Figure 1. Shallow-water feature near the Seychelles

Fig. 1 shows a shallow-water feature near the Seychelles, northeast of Madagascar in the Indian Ocean (path 152, row 66). The visible bands (3, 2, and 1) demonstrate the ability to identify sub-surface features with the Landsat 7 ETM+ instrument.

Landsat Science Team Spotlight

Dr. Robert Bindschadler – Chief Scientist
Hydrospheric and Biospheric Sciences Laboratory
NASA's Goddard Space Flight Center, Greenbelt, Maryland

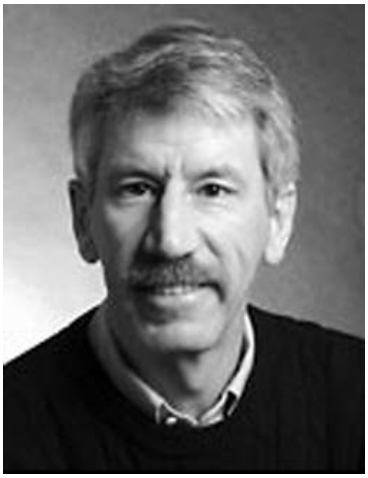


Figure 2. Dr. Robert Bindschadler

Dr. Robert Bindschadler has been an active Antarctic field researcher for the past 25 years and has led numerous field expeditions to Antarctica and has participated in expeditions to glaciers and ice caps around the world. He maintains an active interest in the dynamics of glaciers and ice sheets, investigating how remote sensing can be used to improve our understanding of the role of ice in the Earth's climate.

Applications developed by Dr. Bindschadler include measuring ice velocity and elevation using both visible and radar imagery, monitoring melt of, and snowfall on, ice sheets using microwave emissions, and detecting changes in ice sheet volume by repeat spaceborne radar altimetry.

He has advised the U.S. Congress and Vice President on the stability of ice sheets and ice shelves and served on many scientific commissions and study groups as an expert in glaciology and remote sensing of ice.

Dr. Bindschadler was awarded the Antarctic Service Medal in 1984 and the National Aeronautics and Space Administration (NASA) Exceptional Scientific Achievement Medal in 1994.

He has published over 130 scientific papers and numerous review articles and has provided expert opinion regarding glaciological impacts of the climate on the world's ice sheets and glaciers.

NASA's Earth Observatory has featured Dr. Bindschadler's work on numerous occasions, including David Herring's 2005 "Time on the Shelf" (http://earthobservatory.nasa.gov/Study/TimeShelf/), the 2008 article titled "Christmas Among Crevasses: How a Goddard Scientist Spent His Holiday Season" (http://eospso.gsfc.nasa.gov/eos_observ/pdf/mar_apr.pdf - pages 10-21), and more recently, his instrumental involvement with the **Landsat Image Mosaic of Antarctica (LIMA)**, (http://lima.nasa.gov) the first ever true-color high-resolution satellite view of Antarctica.
http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17599

For more details on Dr. Bindshadler, including a listing of his published works, go to the following NASA Web site: http://neptune.gsfc.nasa.gov/personnel/profile.php?id=4.

Did You Know…?

The Entity Identifiers have recently changed for all Landsat scenes. The new format allows the year to be completely displayed, as well as the code of the Ground Station that downlinked the data from the satellite. These changes were made to comply with the new Landsat Mission Data Dictionary (LMDD) effort, which made all fields of U.S. Geological Survey (USGS) search engines and databases consistent.

Example of new format:
LT40170361982320XXX08
L = Landsat
T = TM
4 = Satellite #
017 = Path (WRS-2)
036 = Row (WRS-2)
1982 = Year
320 = Julian day of year
XXX * = The Ground Station that received the data downlink from the satellite.
08 = version 00-99 (related to ingest processing)

*Ground Station codes can be found within this Landsat FAQ:
http://landsat.usgs.gov/tools_faq.php?id=1

Web Page Updated

The USGS Landsat and USGS Landsat Data Continuity Mission (LDCM) Web sites have been combined into one unified structure. Changes include an updated look, improved functionality, and a more intuitive menu system. The updated Web site is located at http://landsat.usgs.gov.

Landsat Data Continuity Mission USGS Acquisition Strategy for Ground System Segments

The National Aeronautics and Space Administration (NASA) and the Department of the Interior's U.S. Geological Survey (USGS) share responsibility for the Landsat Data Continuity Mission (LDCM). NASA will develop the flight systems including the spacecraft, instrument, mission operations element and mission launch, and perform on-orbit checkout. The USGS will develop, implement, and operate the ground data acquisition network and image processing and archive facilities and will disseminate products to the user community. In addition, the USGS will be responsible for satellite flight operations.

The USGS LDCM acquisition strategy is based upon competitive procurements for the engineering, development, integration and test, and operation of the ground system elements. The two largest USGS LDCM related contracts were awarded in March 2008—the LDCM Data Continuity Contract (LDCC) was awarded to Science Applications International Corporation (SAIC), and the USGS Earth Resources Observation and Science (EROS) Technical Support Services Contract (TSSC) was awarded to Stinger Ghaffarian Technologies, Inc. (SGT). The following list outlines the acquisition strategy for the LDCM ground system segments and their associated elements:

Flight Operations Segment:

The Ground Network Element (GNE) will be procured through a competitive solicitation for ground network equipment and services to ensure repetitive and timely global data acquisition. The exact GNE procurement approach is under study and will be finalized by mid-2008. Definition and integration of the GNE will be supported by the LDCC contractor.

The Collection Activity Planning Element will be modeled after the successful Long-Term Acquisition Plan employed for Landsat 7 to collect global data and will be developed by the LDCC contractor.

The Mission Operations Element (systems required for control and management of the spacecraft and instrument) will be competitively procured through NASA's acquisition process. The Mission Operations Center - a facility to house these operational systems and associated staff - will be configured within the USGS EROS Center through competitive procurement of design and facility modification contracts.

The Flight Operations Team will be procured competitively through a USGS solicitation.

Data Processing and Archive Segment:

The Storage and Archive Element and the User Portal Element will be developed by the USGS EROS Center TSSC contractor.

The Image Processing Element and the Ground System Infrastructure Element will be developed by the LDCC contractor.

Ground System Architecture Analysis and Integration:

The USGS will lead ground system integration activities and will acquire architecture analysis and integration support through a Federally Funded Research and Development Center (FFRDC) contract. The EROS Center TSSC contractor will also provide ground system and segment level engineering and integration support.

Global Land Survey 2005

In the past, the U.S. Geological Survey (USGS) and NASA collaborated on the creation of three global land datasets from Landsat data: one from the 1970s, and one each from circa 1990 and 2000. Each of these global datasets was created from the primary Landsat sensor in use at the time: the Multispectral Scanner in the 1970s, the Thematic Mapper (TM) in 1990, and Enhanced Thematic Mapper Plus (ETM+) in 2000.

To extend this multi-decadal Landsat data collection, NASA and the USGS have again partnered to develop the Global Land Survey 2005 (GLS 2005), a new global land dataset with core acquisition dates of 2005-2006. The data will consist of both Landsat TM and ETM+ imagery, making GLS 2005 the first-ever global dataset built with data from two sensors.

Direct downlink to a ground station is the only way to acquire Landsat 5 TM data. To obtain Landsat 5 TM imagery for areas outside the United States, the USGS negotiated agreements with ground stations around the globe to downlink and send data to the USGS Landsat Ground Station. These agreements make thousands of additional Landsat 5 TM scenes available for GLS 2005 consideration.

The USGS Landsat Ground Station archives nearly 100,000 new Landsat 7 ETM+ images every year. These images are a record of nearly all the land area on Earth. ETM+ scenes have a 22% data loss due to the Scan Line Corrector failure in 2003. Correction of these sensors requires combining two ETM+ scenes for each path/row to have complete, or near-complete, coverage.

The Landsat 7 ETM+ and Landsat 5 TM data incorporated into the GLS 2005 dataset must meet quality and cloud cover standards. Data recorded in 2004 and 2007 will be used as needed to fill areas of low image quality or excessive cloud cover.

The GLS 2005 dataset will be only scene-based (other decadal datasets also included mosaics), and individual scenes will be made available as they are processed. Landsat 7 ETM+ scenes in GLS 2005 became available beginning in February 2008. Landsat 5 TM scenes will not be available until late 2008.

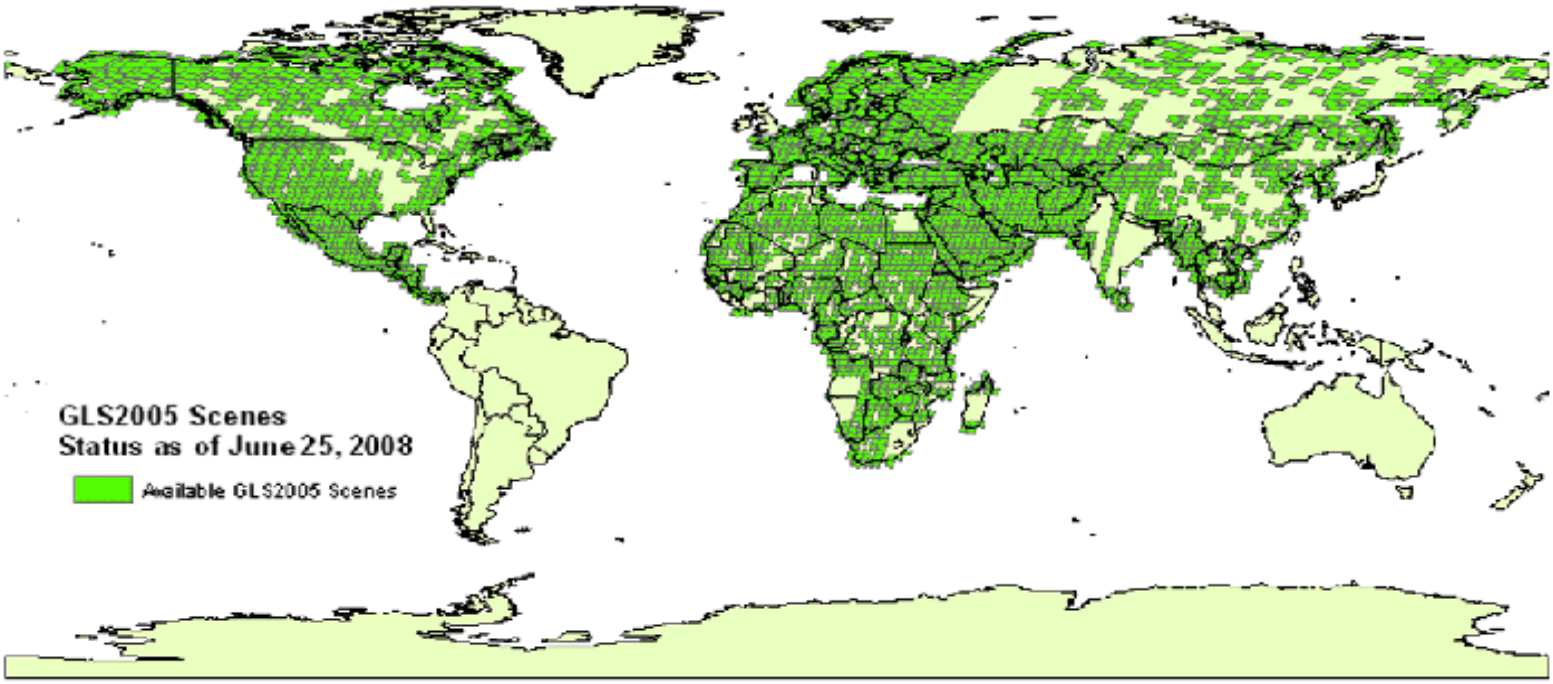


Figure 3. GLS 2005 scenes collected as of June 25, 2008

Largest Continent Released for Newly Acquired Landsat Data

The USGS Landsat Project has expanded its free data acquisitions to Eurasia. As nearly cloud-free scenes are acquired by Landsat 7, they are automatically processed and posted online for users to download at no charge. Because only a portion of the globe is collected daily, and some of the images are cloud-covered, not all areas of Eurasia are equally available at all times. To view and download this data, please visit the Standard L1T dataset in the Landsat Science Collection in GloVis or EarthExplorer.

Ob River Flooding

Beginning its thaw in early May, the Ob River and its tributary the Irtysh flow from the Altay Mountains of northern China to the Arctic Ocean. The northern reaches of the Ob flow over a flat permafrost plain past the cities of Ozernyy and Nefteyvgansk in northern Russia.

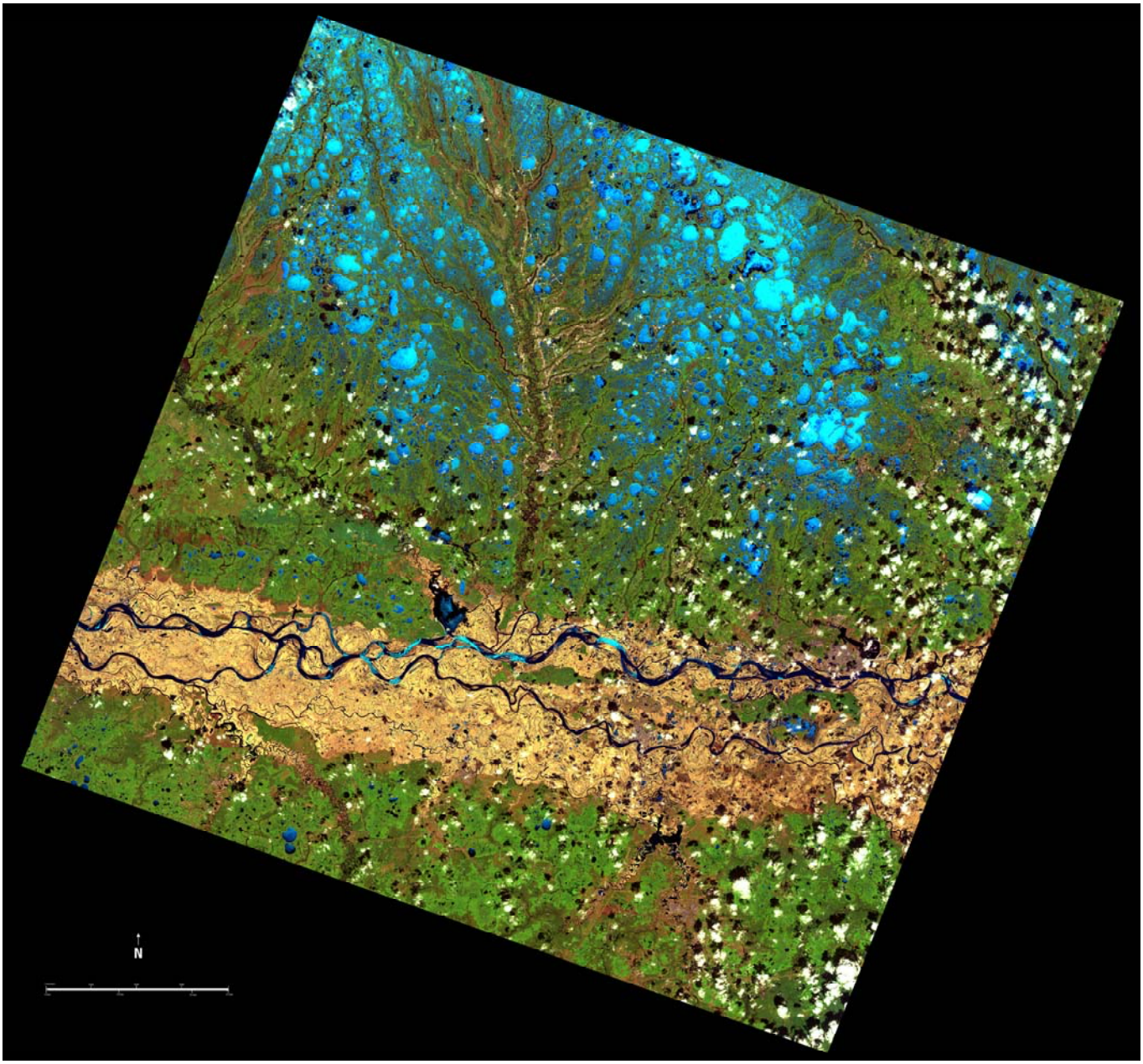


Figure 4. Ob River - May 1, 2007

Since the river cannot cut deep channels into the frozen land, it flows out over the surrounding plain during the spring melt, as shown in the mid-May image.

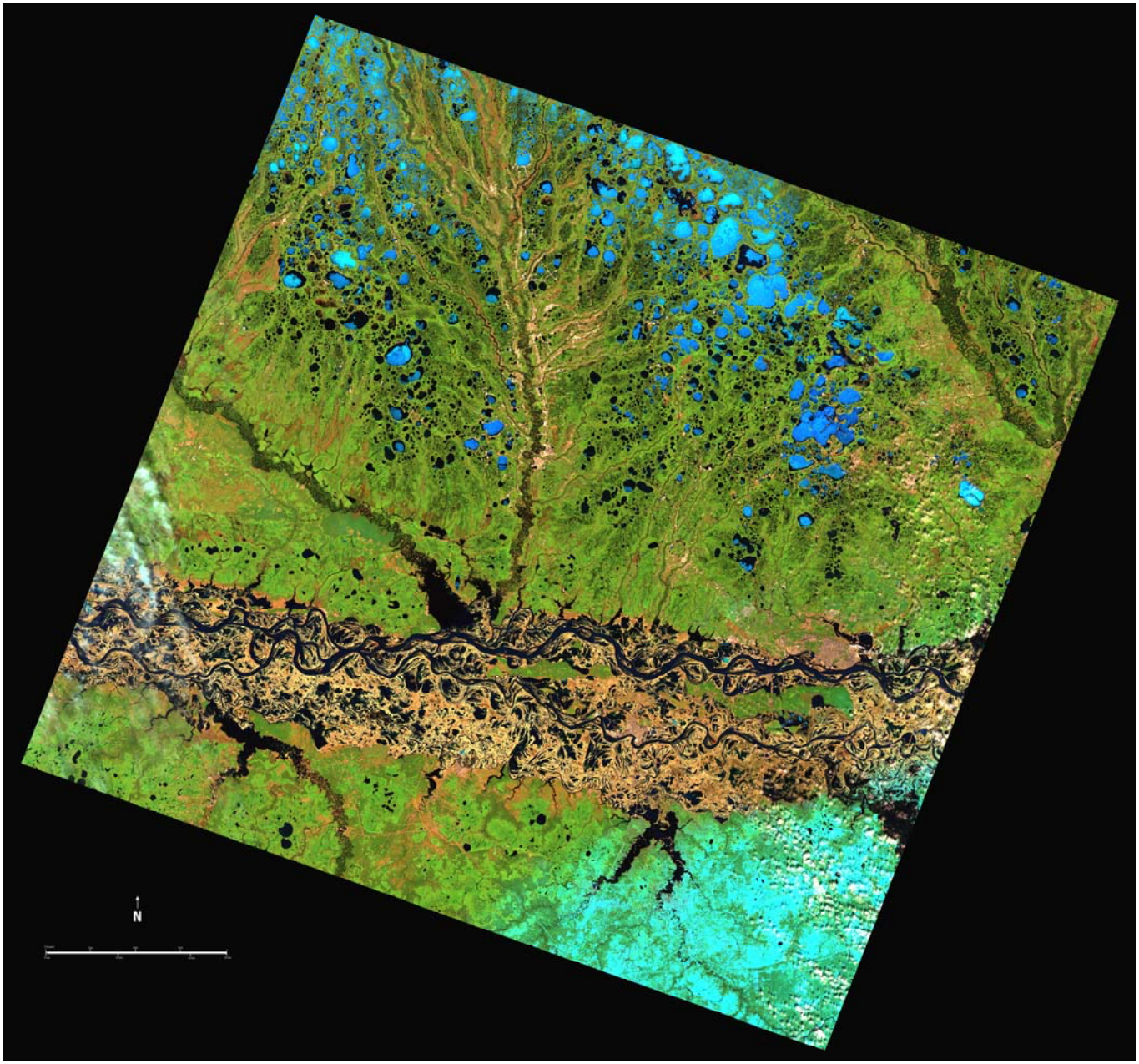


Figure 5. Ob River - May 17, 2007

LANDSAT Update - 25th Anniversary of Landsat 5

Exceeding expectations: Above and beyond the call of duty

Figure 1. Artist's rendition of Landsat 5 in orbit

When Landsat 5 was launched in the spring of 1984, no one imagined that we would be receiving images from the same equipment 24 years later. The endurance of the system and all of the components onboard have far exceeded expectations and have provided valuable earth data to scientists, educators, government decision makers, and technical users worldwide.

Changes in the Earth's surface are recorded the Thematic Mapper (TM) instrument onboard Landsat 5. Land surfaces flooded by water, expansion of urban areas, and forested areas cleared by fire or humans are just a few examples of what Landsat 5 can tell us about the earth.

U.S. Department of the Interior
U.S. Geological Survey

Bolivia Deforestation

These images show the progression of deforestation in Bolivia from 1986 to 2000. This area lies northeast of Santa Cruz de la Sierra, Bolivia, in an area of tropical dry forest. Since the mid-1980s, the resettlement of people from the Altiplano (the Andean high plains) and a large agricultural development effort (the Tierras Baja project) has lead to this area's deforestation.

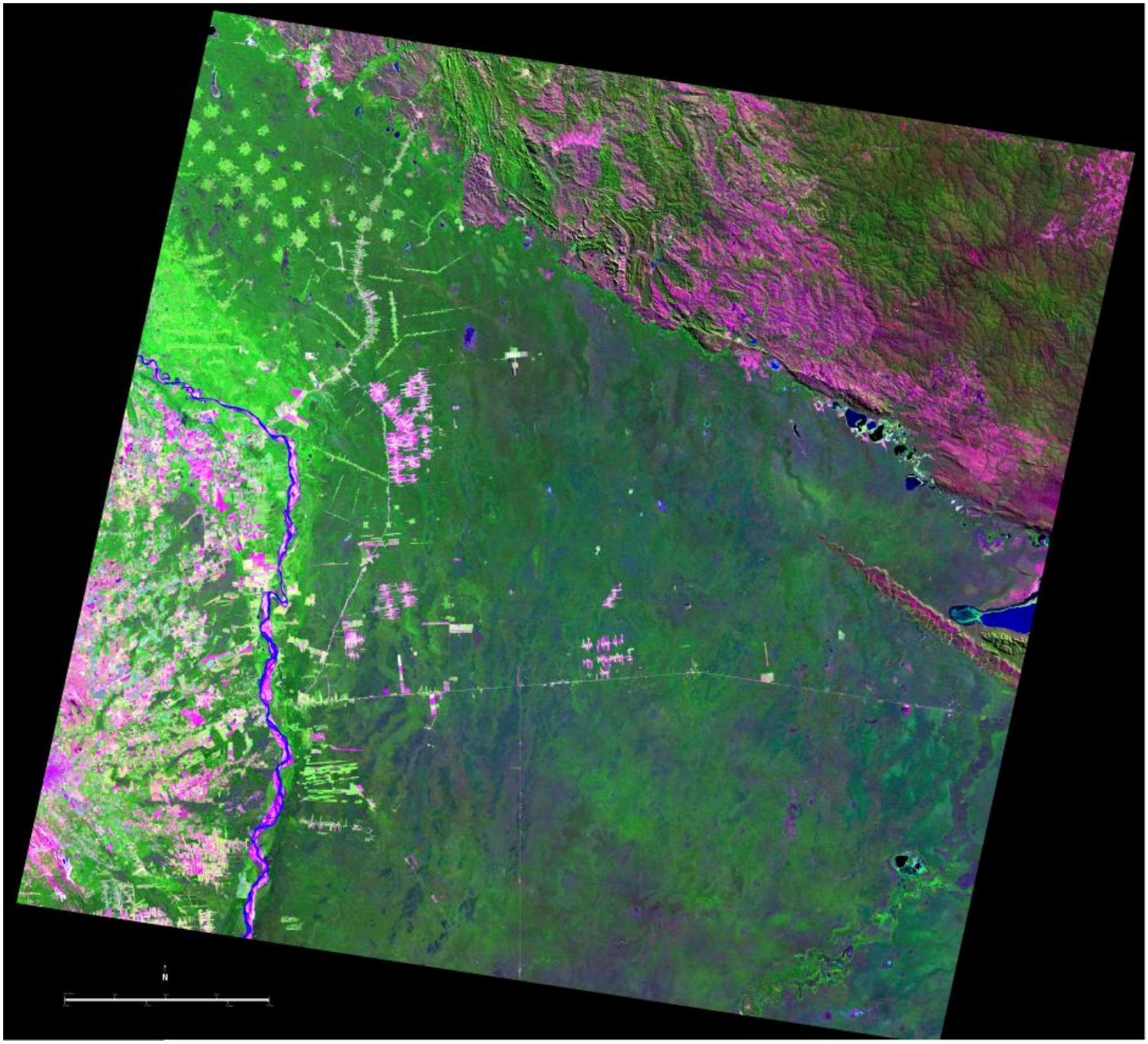


Figure 2. Bolivia, July 2, 1986

The pie or radial patterned fields (upper left) are part of the San Javier resettlement scheme. At the center of each unit is a small community.

The rectangular, light purple areas are fields of soybeans cultivated for export. The dark green strips running through the fields are windbreaks, which help prevent wind erosion of the area's fine soils.

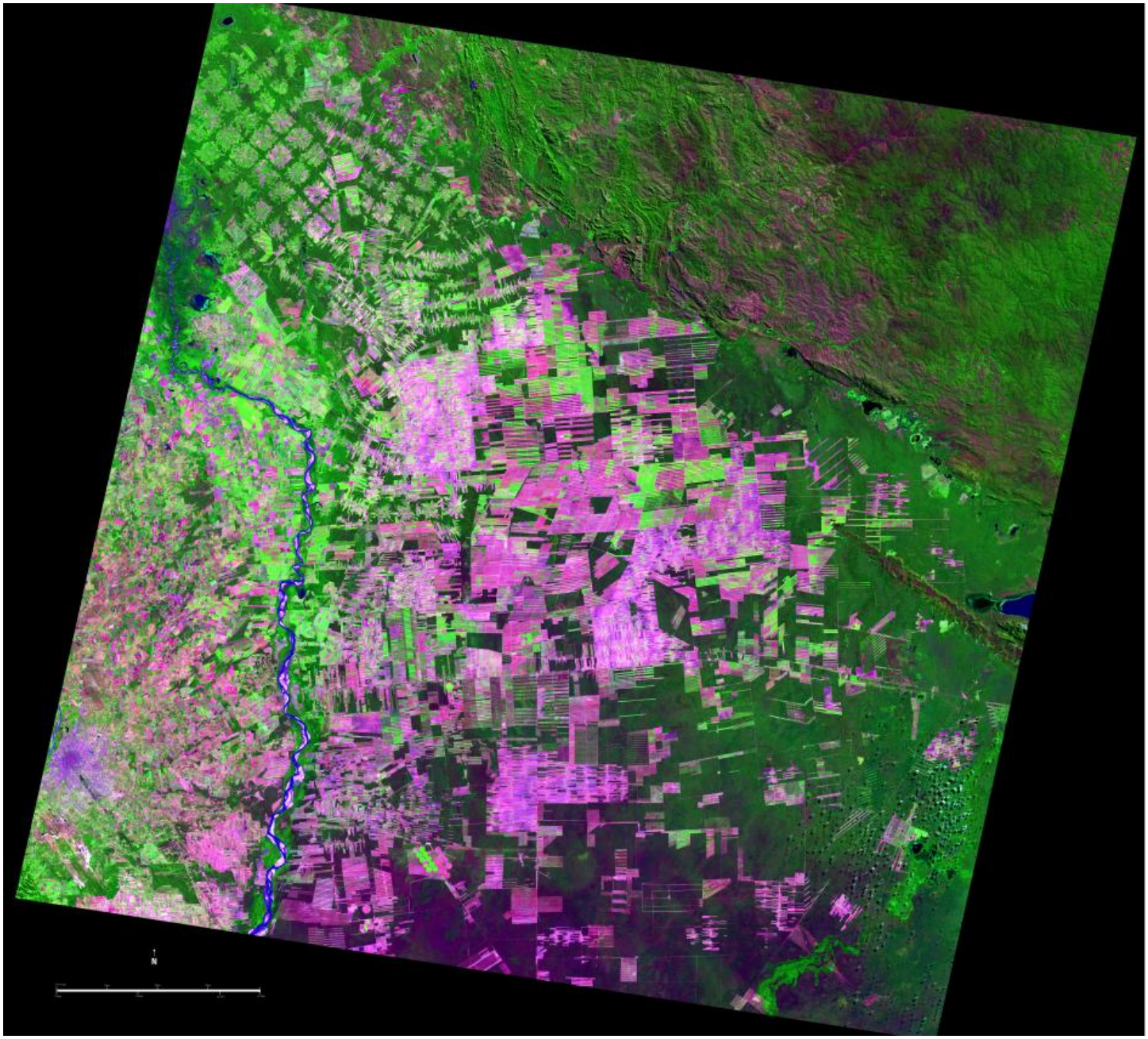


Figure 3. Bolivia June 22, 2000

Growth in the Desert – Las Vegas

These images from 1984 and 2007 show the increasing urban sprawl of Las Vegas, Nevada, and the shrinking of Lake Mead on the border of Nevada and Arizona. Rapid growth in Las Vegas has led to increased demand for water resources, while below-average rainfall has decreased the water levels in Lake Mead, as the source of 90% of southern Nevada's water.

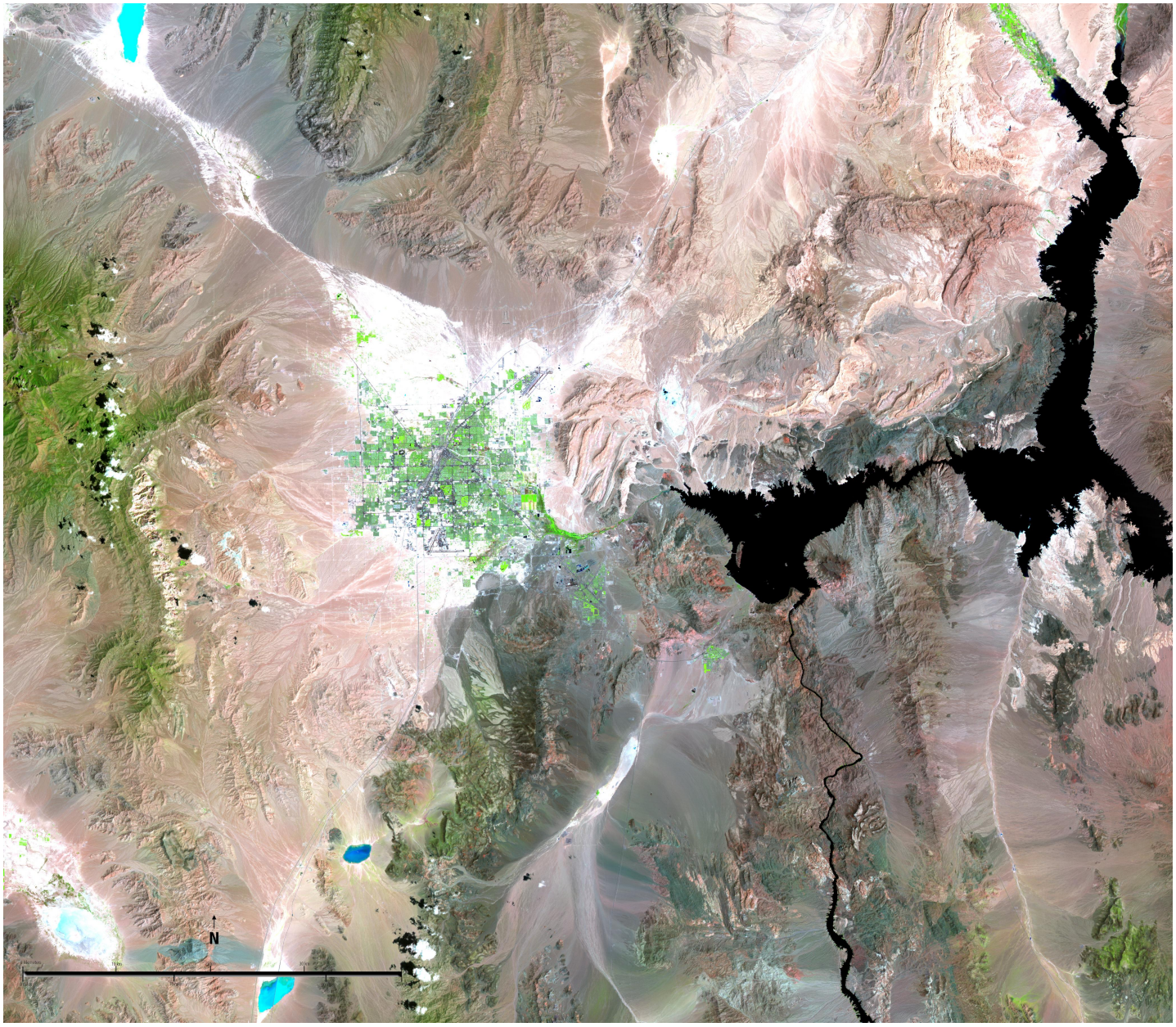


Figure 4. Urban Growth 1984 - Las Vegas, Nevada

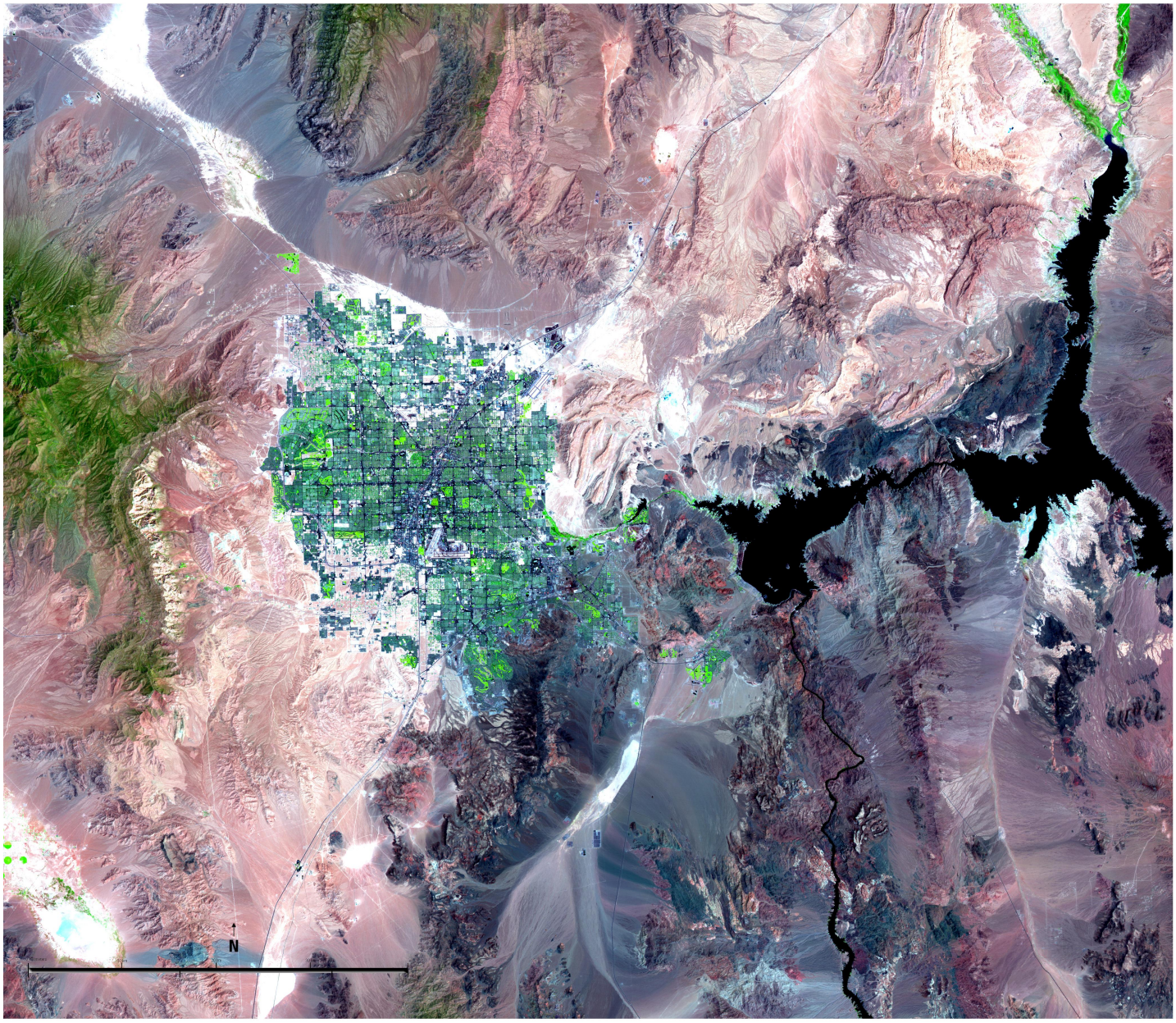


Figure 5. Urban Growth 2007 - Las Vegas, Nevada

Keeping a Satellite Functioning for 25 Years…What Could Possibly Go Wrong?

Since its launch in 1984, a number of component failures and other malfunctions have beset Landsat 5, and challenged the knowledge of the staff working to fix the 1980's-technology. Each time the system has come back to life to continue as a necessary and important asset to the USGS Landsat program.

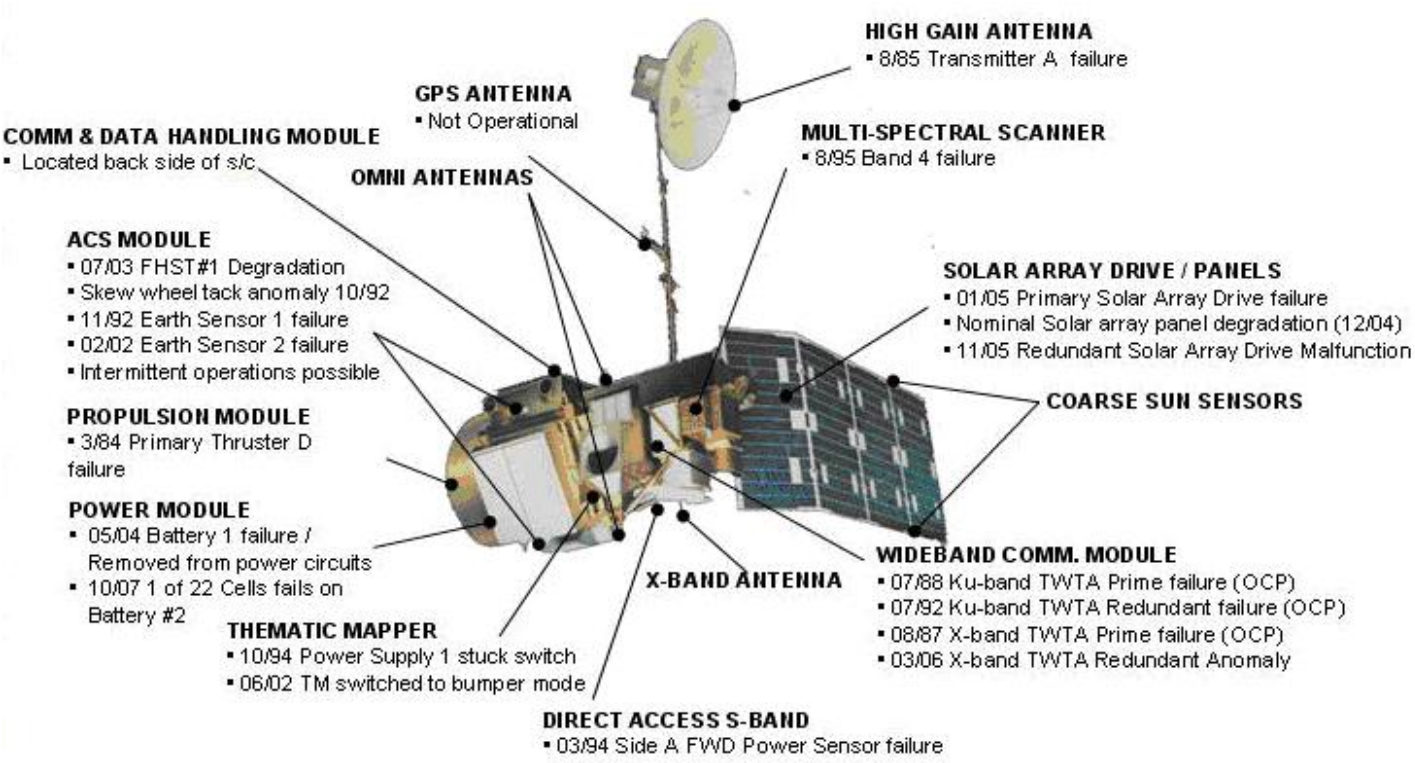


Figure 6. Component problems or failures during Landsat 5's mission, specified by month/year.

Belize, Central America

This image provides a view of the Belize Barrier Reef, the longest coral reef in the Western and Northern Hemispheres and second largest worldwide only to the Great Barrier Reef of Australia. Running the entire coastline of Belize in Central America, the Belize Barrier Reef supports a large number of patch reefs, shoals, and over 1,000 islands called "cayes." Most of these cayes, and the entire coastline of the country outside of settlements, are protected by huge forests of mangrove.

The Turneffe Atoll is shown on the right side of the image. As one of three large coral atolls outside of the reef, it stretches over 30 miles long and 10 miles wide and is surrounded by one of the most fertile marine ecosystems in the world - a natural nursery for fish, sharks, and crocodiles. A network of flats, creeks, and lagoons dotted by many mangrove islands runs throughout the shallow interior of the atoll.

Belize City is situated on the outlet of land near the center of the image. It is the largest city in Belize and is the nation's principal port and its financial and industrial hub.

Figure 7. Barrier Reef off the coast of Belize, March 1994

The Rocky Mountain Trench

The high reflectance of clouds compared to the surrounding land, coupled with the low sun elevation when this image was acquired, causes low clouds to appear red as they fill a portion of the Rocky Mountain Trench. Running parallel with the peaks of the Canadian Rockies and ranging from 2 to 10 miles wide and about 900 miles long, the Trench aligns with the Fraser River and makes its way past Mount Robson, the highest peak in the Canadian Rockies at 3,954 meters. Mount Robson is near the center of this image.

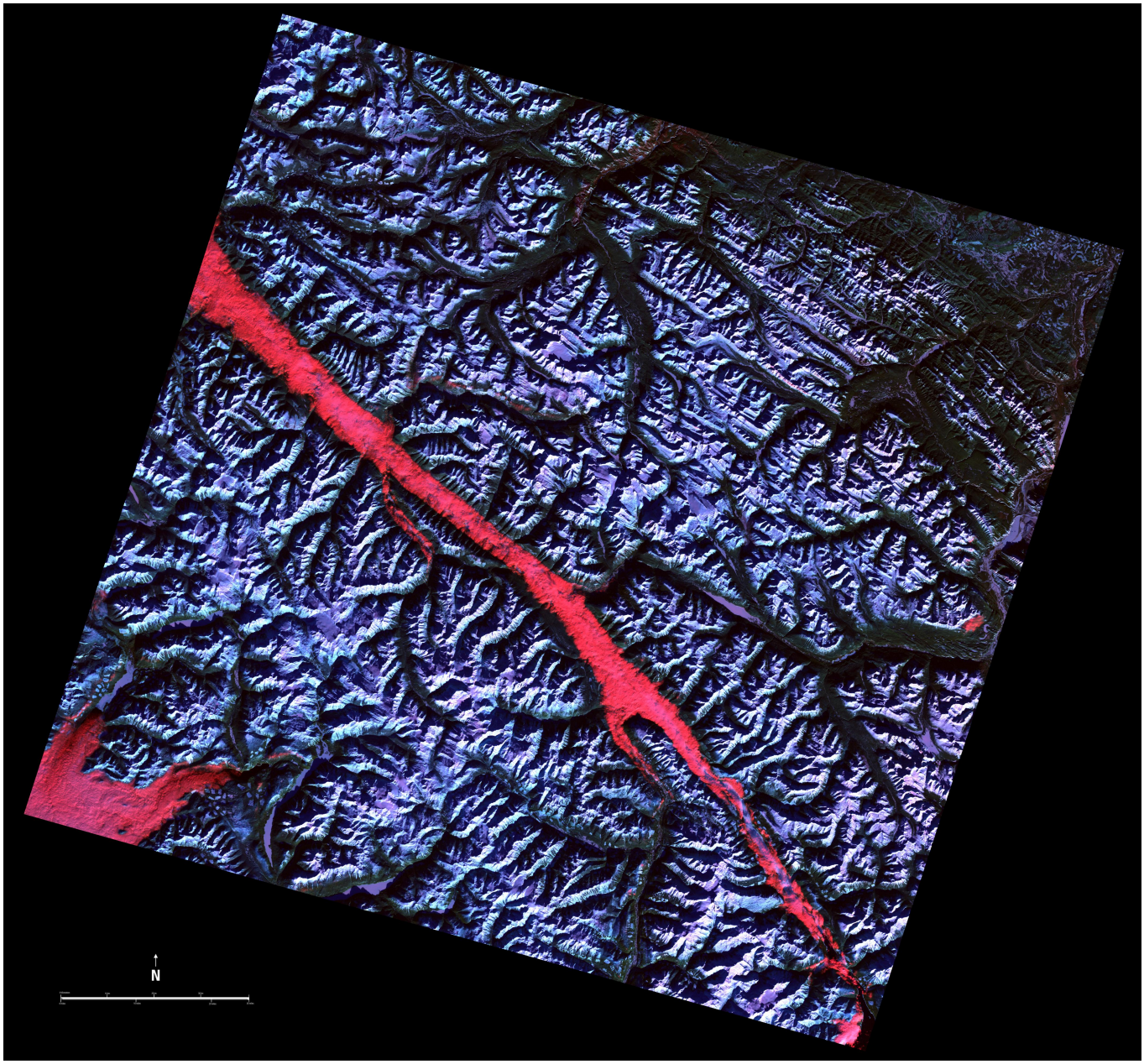


Figure 8. Rocky Mountain Trench, February 2004

Lake Eyre, Australia

Lake Eyre is part of Lake Eyre National Park within the Lake Eyre Basin. The basin is one of the world's largest drainage systems, totaling more than 1 million square kilometers. The Georgina, Diamantina, and Cooper Rivers all drain into the lake. Other rivers in the Simpson Desert would flow into the Eyre, but they are ephemeral and are dry much of the year. Lake Eyre is usually a large salt pan; however, when the seasonal rains occur, water gathers in the lake bed. In the last 150 years, the lake has filled completely only three times. When it does, many species of birds migrate to the area.

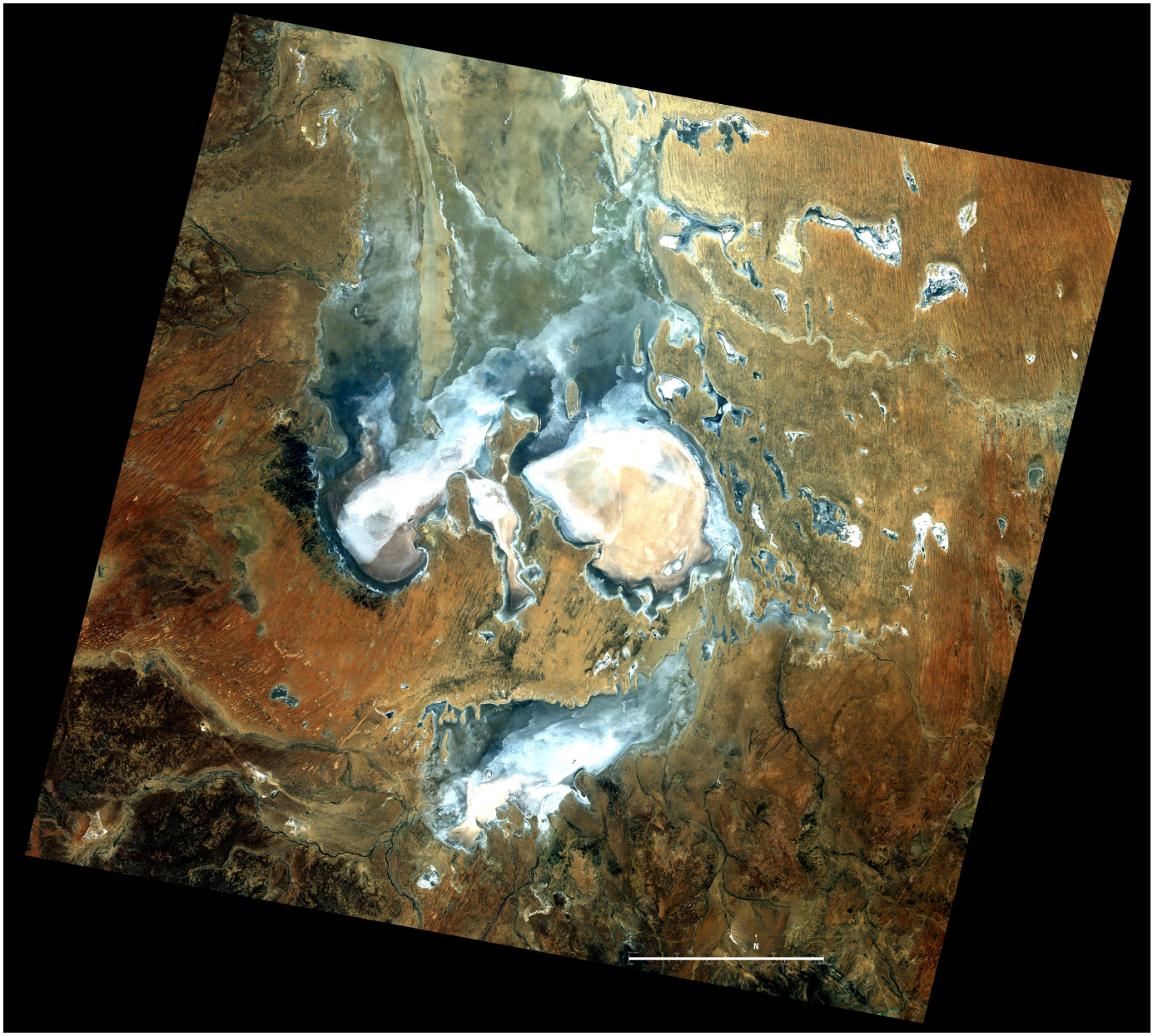


Figure 9. Lake Eyre in Australia, August 2006

Jayakwadi and Ujani Dams, India

These images show the areas of the Jayakwadi and Ujani Dams in western India.

Built across the River Godavari in the 1990s, the Jayakwadi Dam is located at the eastern side of the Nath Sagar Reservoir. The dam is famous for its vantage points for bird watching, because a wide variety of resident and migratory birds are found in the vicinity of the dam. In August 2006, the floodgates of the dam were opened because of heavy rainfall in the region, and the small town of Paithan experienced its worst flood in known history.

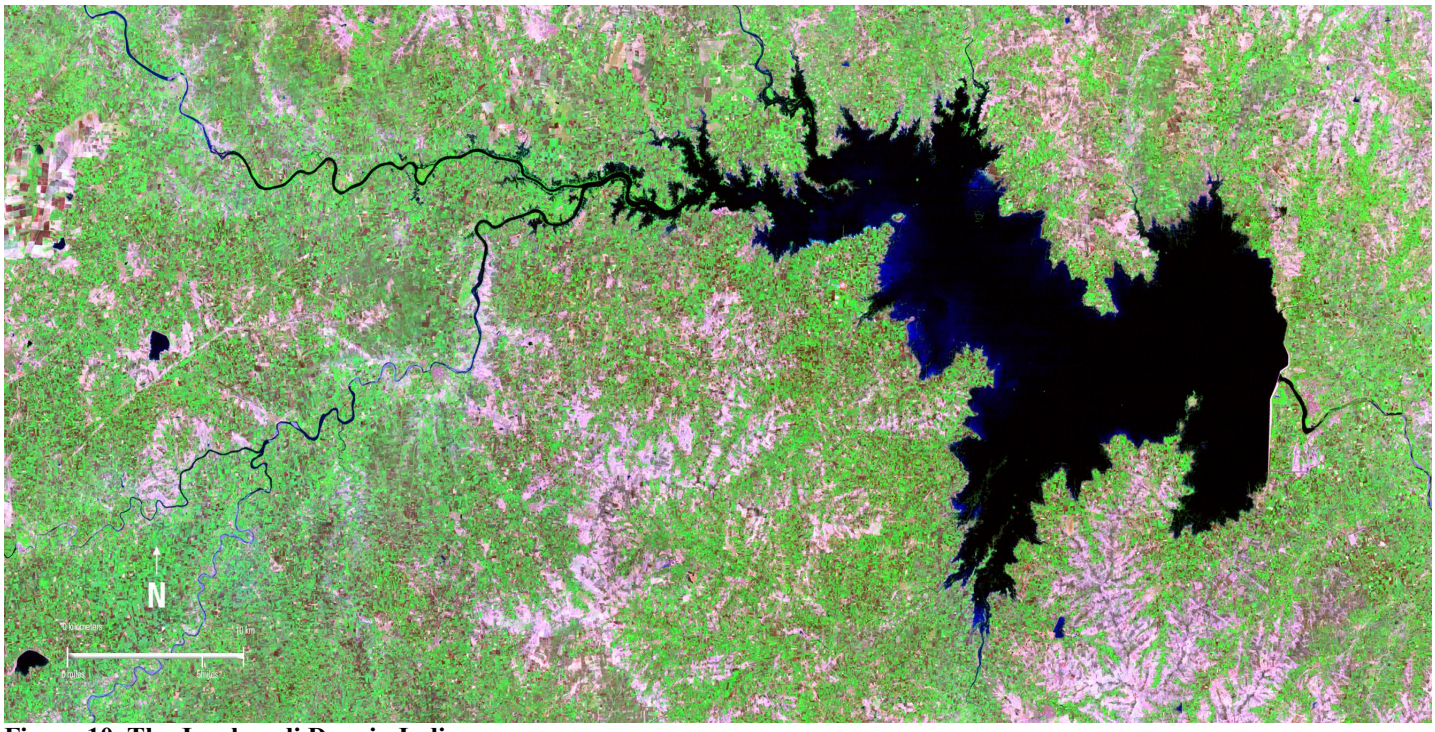


Figure 10. The Jayakwadi Dam in India

The Ujani Dam is built on the Bhima River and helps contain one of the largest reservoirs in the region supplying water for drinking, irrigation, and hydroelectricity. The dam has also lessened threats of floods to downstream settlements. The Bhima River runs in a well-entrenched valley, and its banks are heavily populated. Local irrigation helps support sugarcane, an important irrigated cash crop, as well as rice and sorghum.

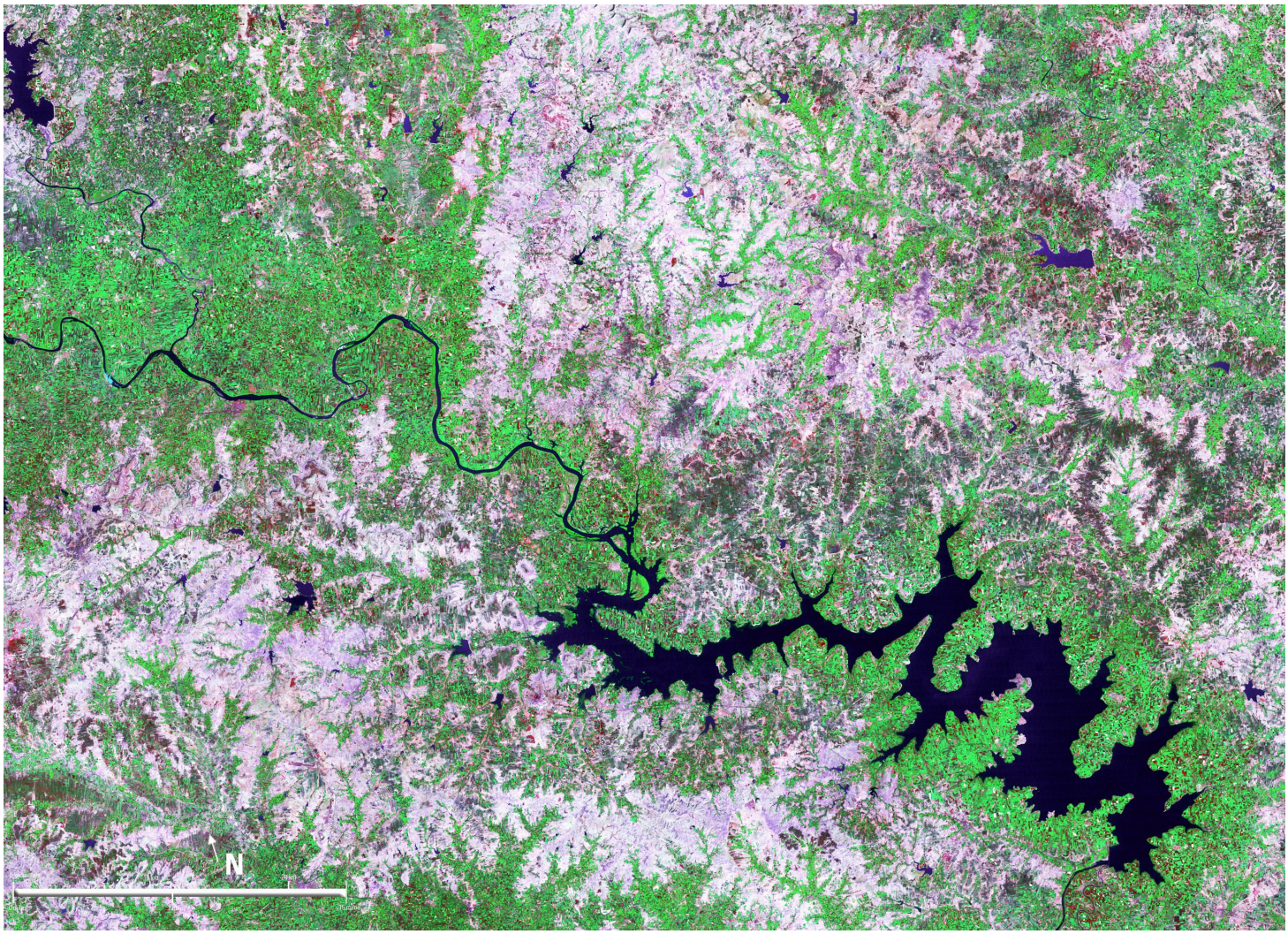


Figure 11. The Ujani Dam in India

The Fjords of Sogn og Fjordane – Norway

The fjords of Sogn og Fjordane dominate this image of the western coastline of Norway. Carved out of mountains by glaciers, the flooded u-shaped valleys are surrounded by steep cliffs, verdant slopes, and snow-capped mountain tops.

Nordfjord is home to the Jostedalsbreen National Park, which covers an area of more than 1,300 sq km and is located near the center of this image. Within the Park is the largest glacier in continental Europe, Jostedalsbreen Glacier. Also located in Nordfjord, Hornindalsvatnet is considered the deepest and clearest lake in Europe at over 500 meters deep. This is the darkest water body in the north-central part of this image.

The fjord in the southern portion of this image is Sognefjord. As the largest fjord in Norway, it stretches over 200 kilometers inland. Cliffs surrounding the fjord rise quickly to heights of 1,000 meters and more.

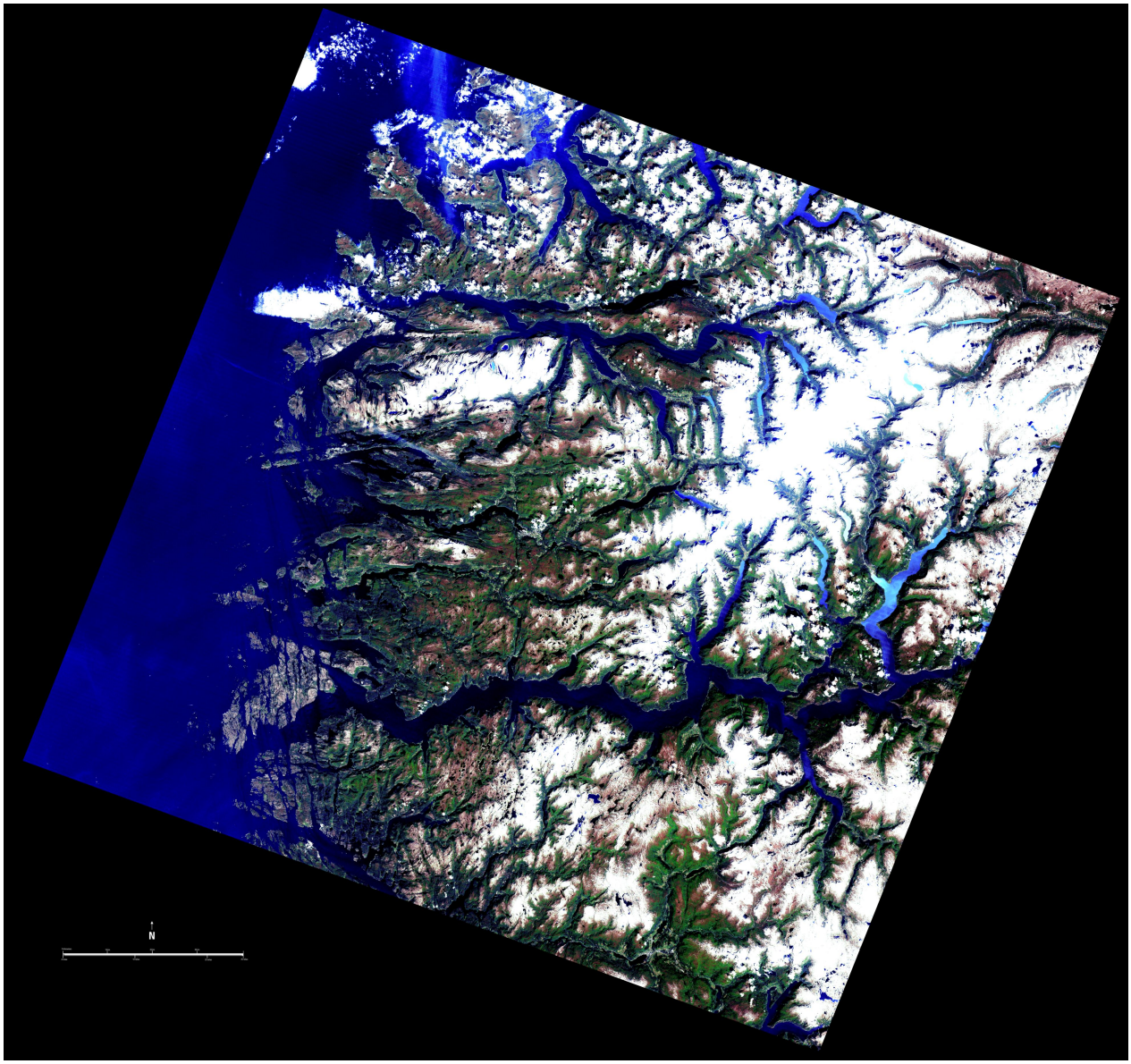


Figure 12. The Fjords of Sogn og Fjordane in Norway, July 2003

Yellowstone National Park – 1988 Fires

Lightning strikes in late June 1988 sparked a series of major wildfires that burned the already dry Yellowstone National Park. Fires continued until the snow began to fall in September, and when all of the fires were finally extinguished in November, 36 percent of Yellowstone National Park was burned to varying degrees of intensity.

Recovery started as soon as spring returned, as nutrients from the ash helped the vegetation to flouish. Wildflowers were abundant by midyear, and the grasses and shrubs were a rich green.

These images show the area during the time of active fires, and as recovery continued through the years. The fires appear as dark red and smoke billows in the August 1988 image. Deep red scars can be seen in the October 1988 image. As vegetation recovery continues, dark red fades to a mixture of red and green in the 1993 and 2007 images.

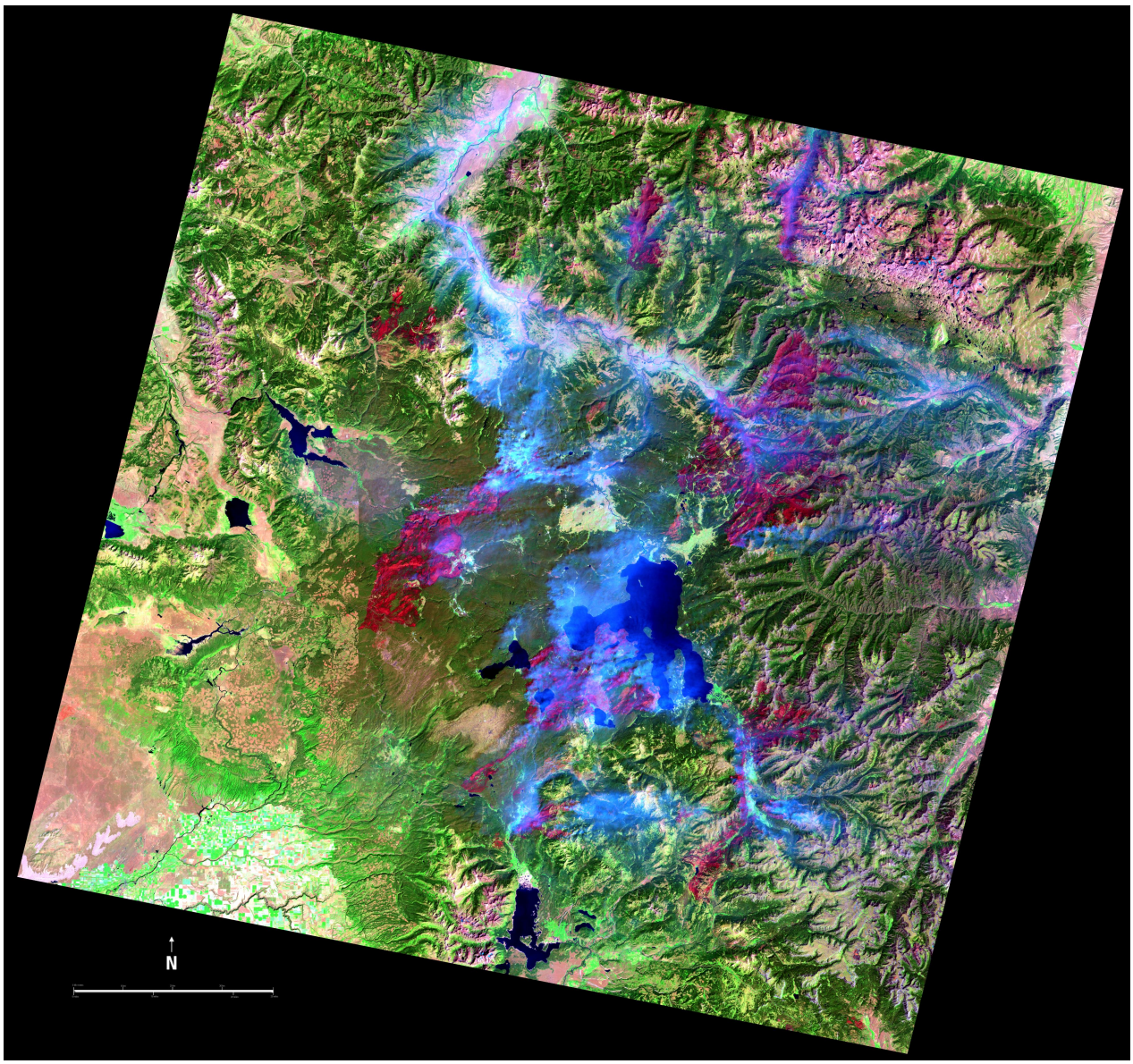


Figure 13. Yellowstone National Park, August 1988

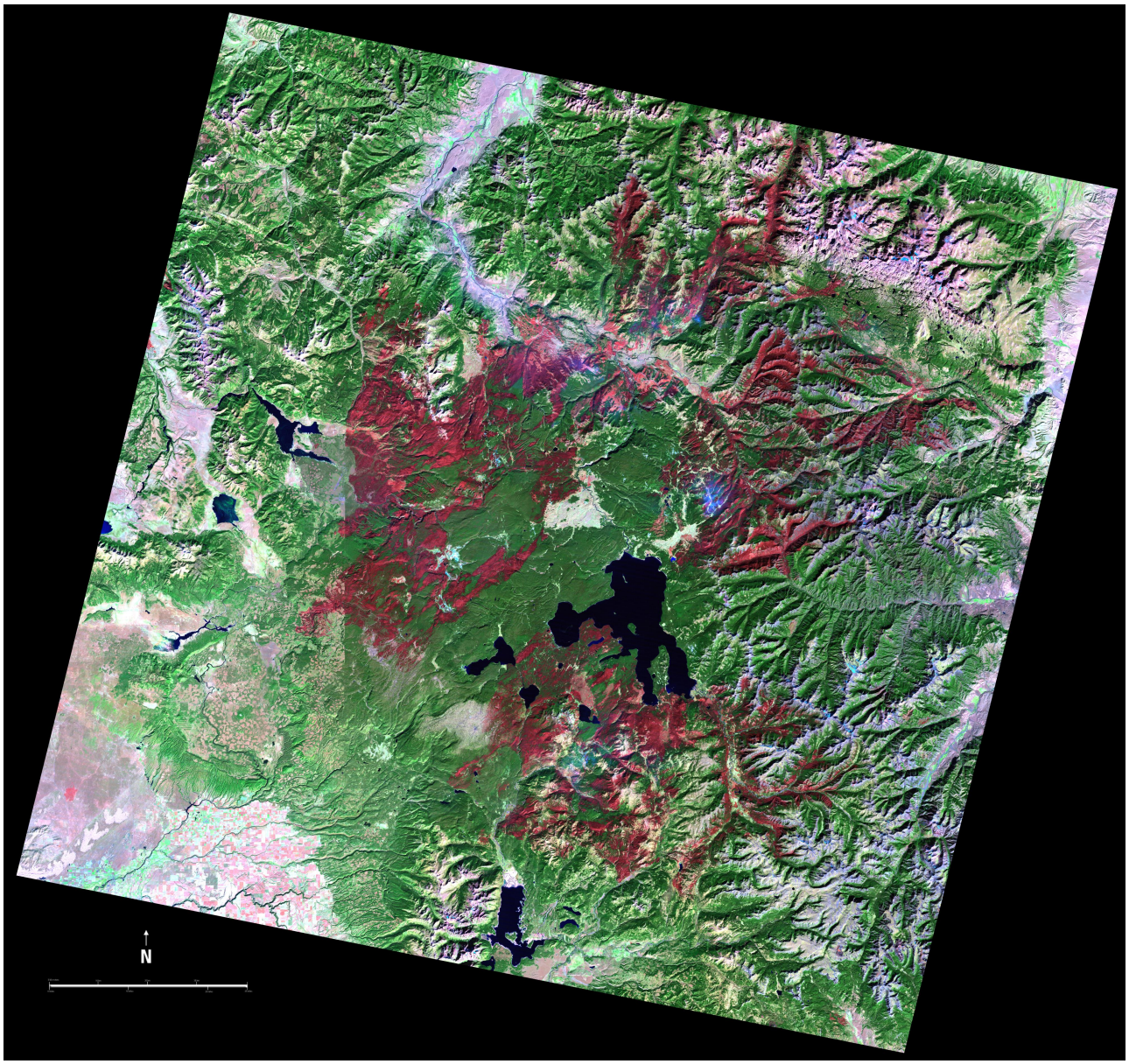


Figure 14. Yellowstone National Park, October 1988

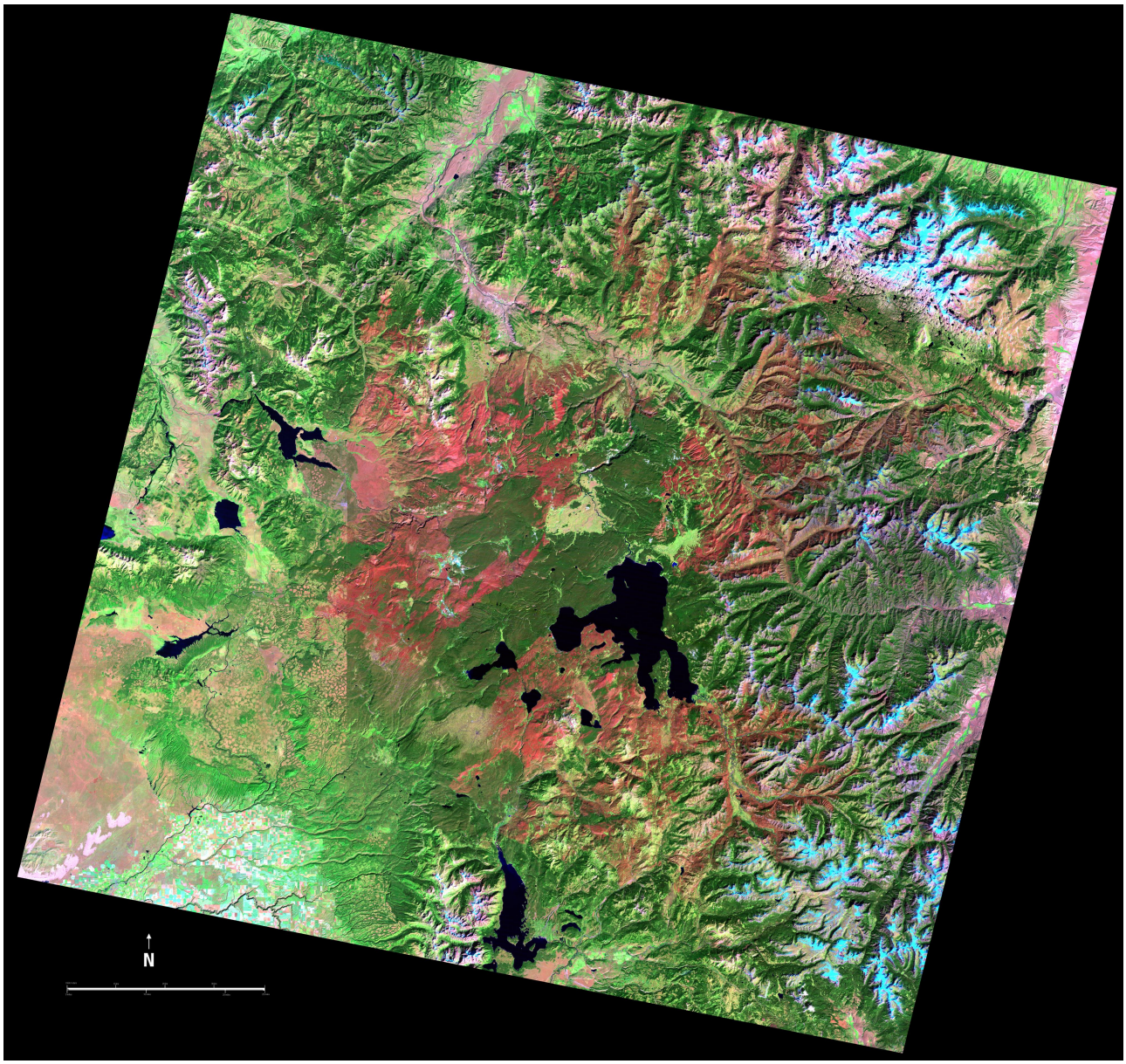


Figure 15. Yellowstone National Park, September 1993

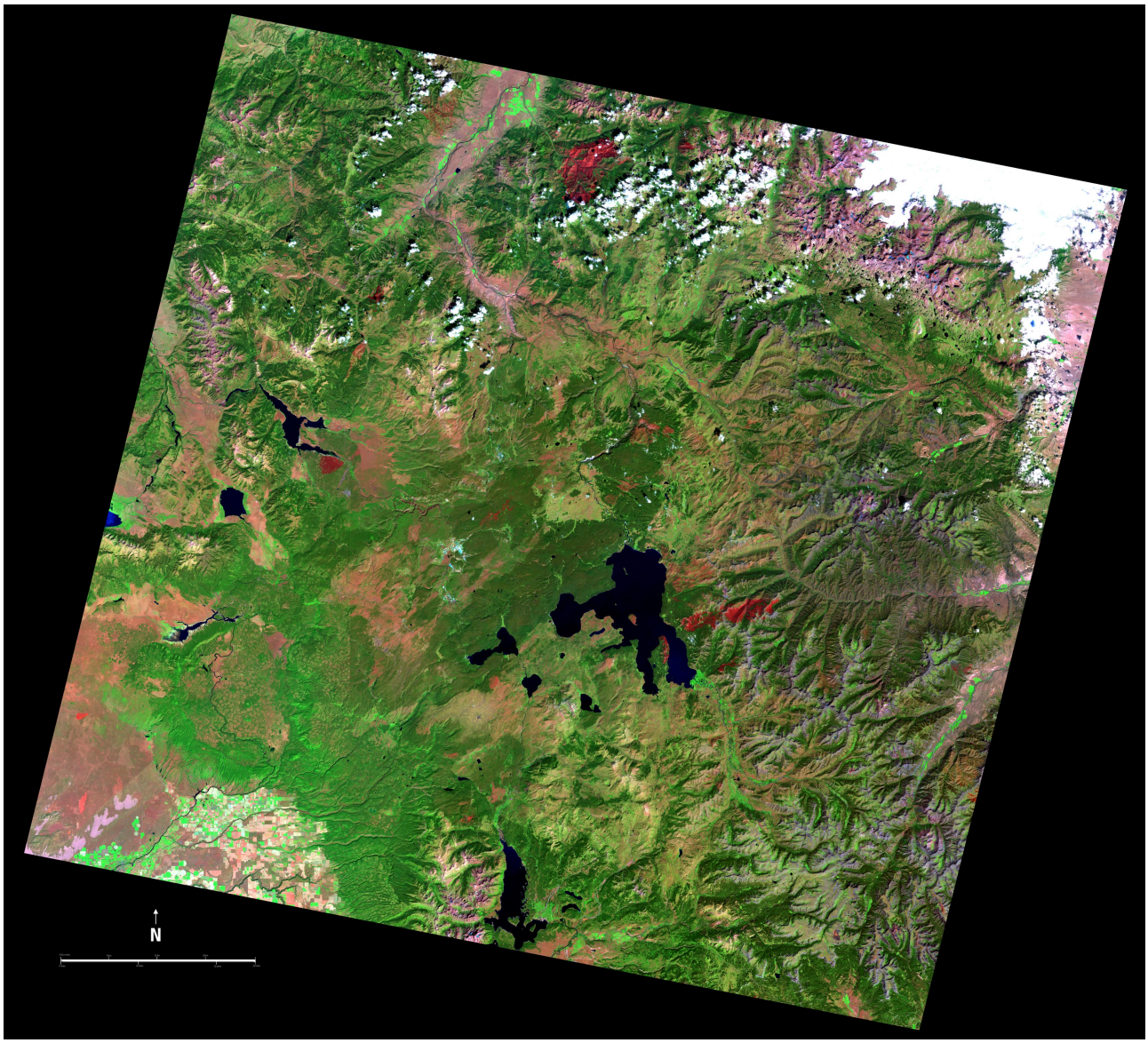
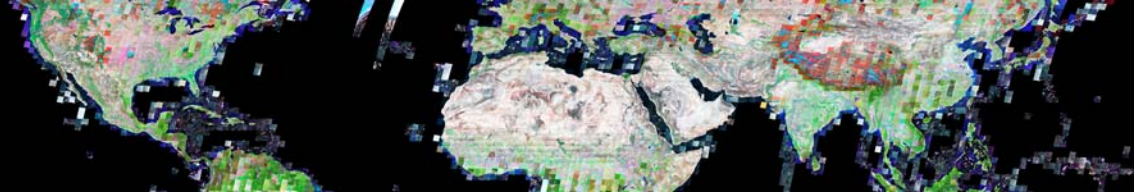


Figure 16. Yellowstone National Park, August 2007



LANDSAT Update - Volume 2, Issue 1, 2008

USGS Data Search and Discovery Survey Reveals New Insights

In the last issue, we talked about the Landsat customer satisfaction survey and the satisfaction those respondents reported for the two primary data search tools that USGS EROS offers: Earth Explorer and GloVis. To delve further in to the “why’s” of the customer satisfaction ratings, the USGS performed another, more focused survey of Earth Explorer and GloVis users.

Of the 231 people sampled in this data discovery survey, 119 of them provided useful responses, for a response rate of 53%. Eighty of the respondents (69%) reported preferring Earth Explorer and 28 (24%) reported preferring GloVis, but again, satisfaction ratings for GloVis overall were higher than those for Earth Explorer. In this survey, we asked a few more critical questions to help us discover why.

Why don’t they use GloVis?
We asked the users who stated that they do not use GloVis to explain, in their own words, why they don’t use it. We then categorized the written responses. There was an overwhelming similarity in many of the responses—it appears many users don’t know GloVis exists. This could be a plausible explanation for the comparatively large usage rate of Earth Explorer.

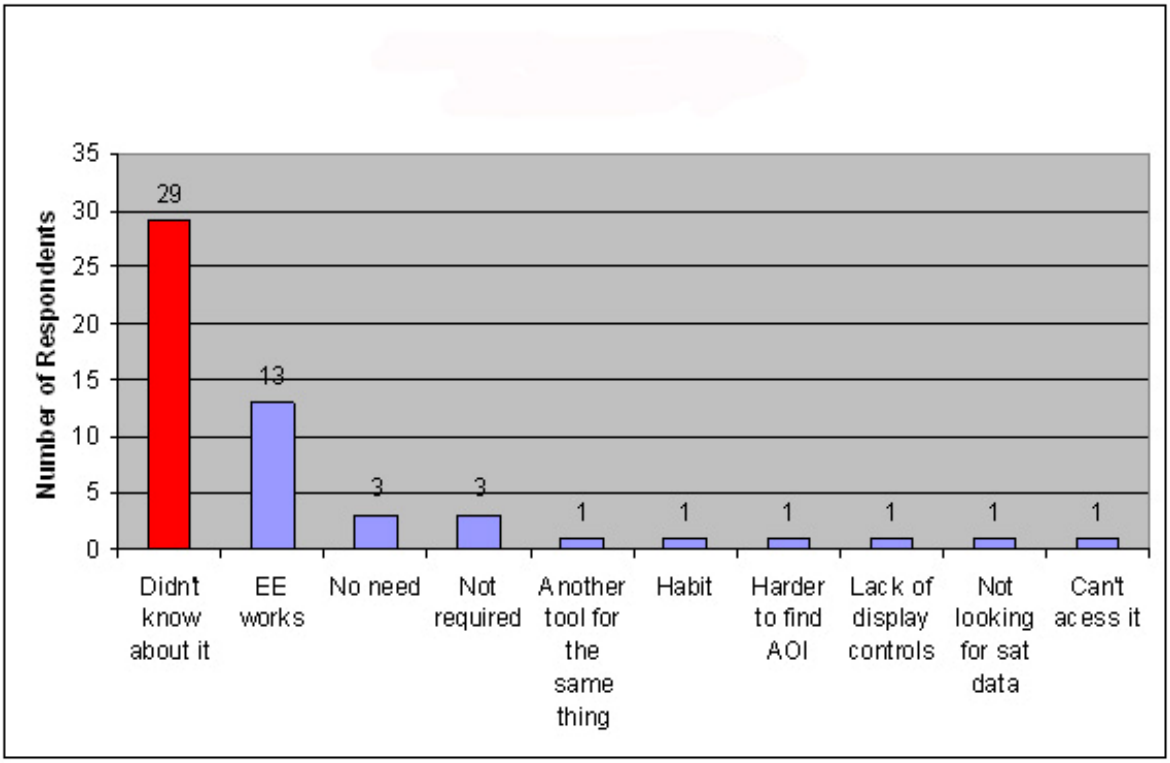


Figure 1. Why don't you use Glo Vis? (written responses)

Of course, GloVis is not helpful for seeking data that is only available in Earth Explorer, but it's definitely good for Landsat image searches (which was the original intent of the GloVis tool). The survey results show that of all the datasets available, over half (56) of Earth Explorer users use Earth Explorer to search for Landsat imagery.

What does this mean for users?
Landsat data users who have been using Earth Explorer may also want to give GloVis a try for their data searches and orders. It's a very visual way of finding Landsat data.

Results shown are as reported in the survey. Because of survey biases, they may not accurately reflect the opinion of Landsat users.

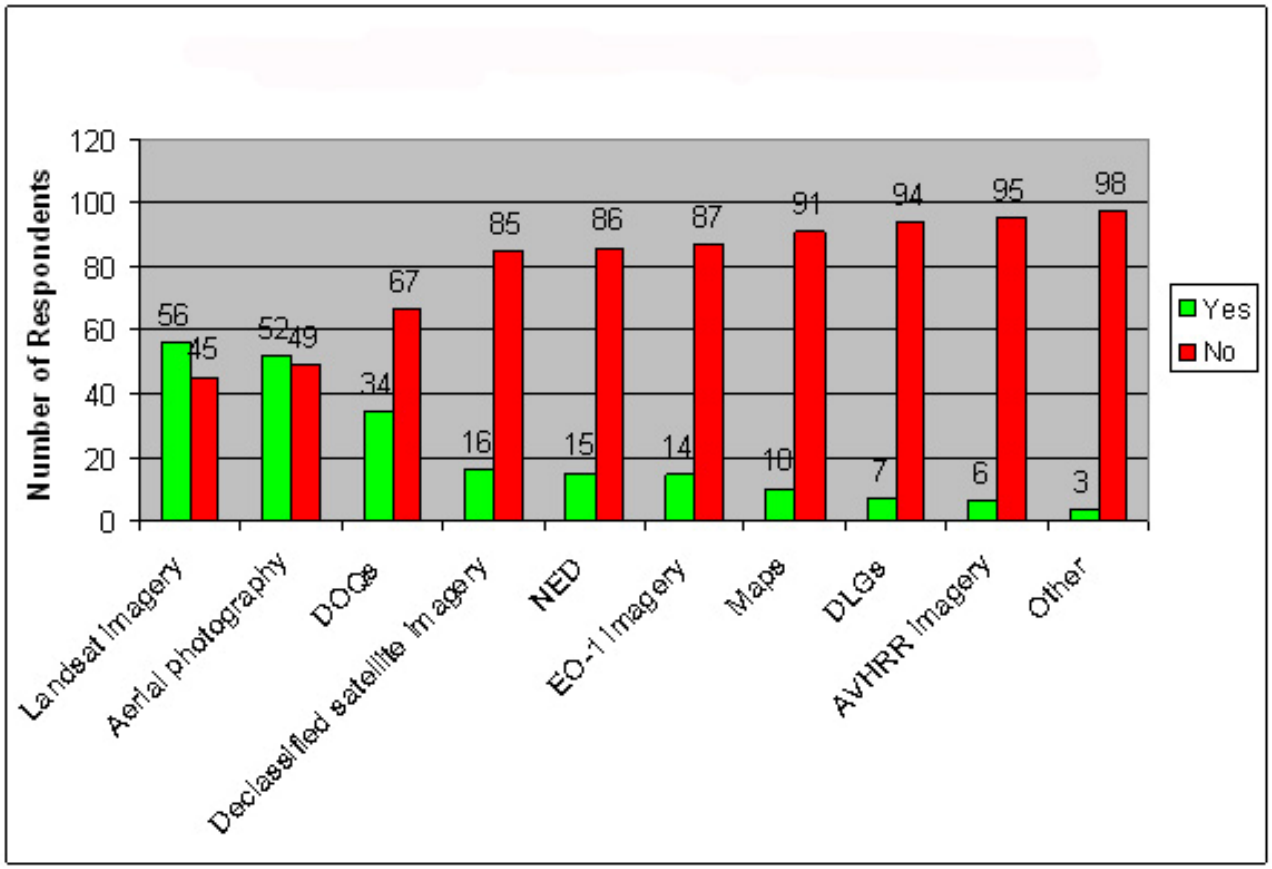


Figure 2. What types of data do you use EE to search for?

Sioux Falls...We Have a Problem

A satellite that has survived 8 times longer than its design life is bound to have a long history of miraculous recoveries. When Landsat 5 launched on March 1, 1984, expectations were high based on the success of the previous four missions. Since then, at least 22 different problems have surfaced (called anomalies), all of which have been overcome by redundant systems or ingenuity of the Flight Operations Teams. (For current information on the status of Landsat 5 please go to the Landsat homepage: http://landsat.usgs.gov/index.php)

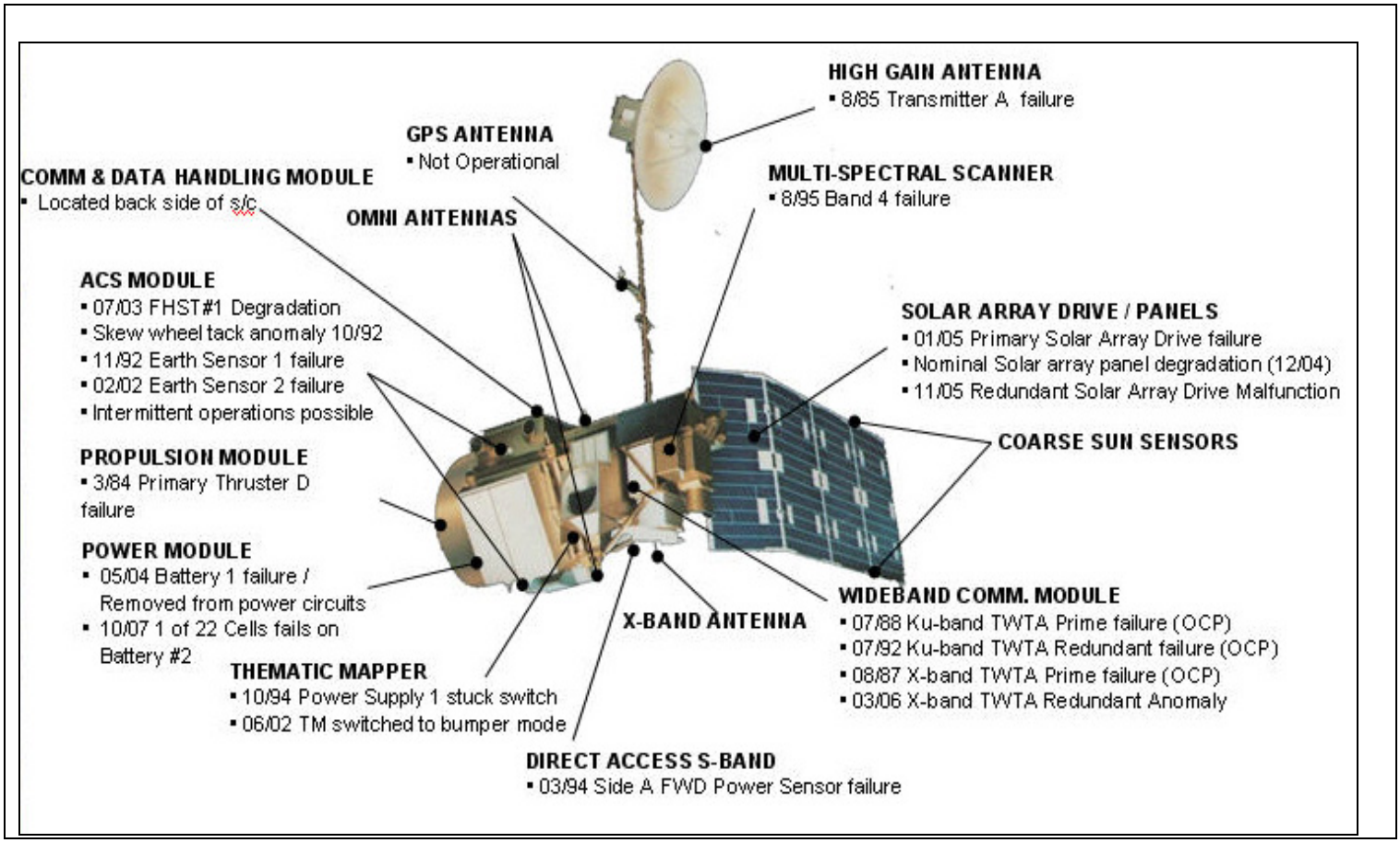


Figure 3. Landsat 5 Flight Segment anomalies

Landsat Spotlight

Martha Anderson

Figure 4. Martha Anderson, Ph.D.

Anderson is a **Research Physical Scientist** at the U.S. Department of Agriculture - Agricultural Research Service (USDA-ARS) Hydrology and Remote Sensing Laboratory in Beltsville, Maryland, USA.

Anderson's research focus includes water, energy and carbon flux mapping at field to continental scales using thermal remote sensing, drought monitoring and early detection based on land-surface temperature signals, remote sensing of soil moisture for assimilation into hydrologic and meteorological models, and studies on the effects of landscape heterogeneity on land-atmosphere interactions.

Anderson has been awarded a number of research grants, many associated with water fluxes and land surface energy, and surface soil moisture studies employing a number of satellite sensors and the data they produce. Her primary focus as a member of the Landsat Science Team is mapping drought and evapotranspiration, using Landsat and GOES thermal imagery.

The Global Land Survey (GLS) Dataset

The USGS Landsat Project is currently focused on a major effort to process and disseminate four global datasets, circa 1975, 1990, 2000, and 2005. The three oldest data collections are a reprocessing of the tri-decadal global Landsat orthorectified datasets that have been a standard in the community for many years. Improvements to geometric and topographic inputs, incorporate by MDA Federal, Inc., will result in a higher precision dataset, called the Global Land Survey (GLS), and will be identified by acquisition dates (GLS 1975, GLS 1990, and GLS 2000). As the reprocessing effort moves forward, a new dataset, the Global Land Survey (GLS 2005), will be completed. All new collections will be registered to the GLS 2000 dataset.

The North America portion of the GLS 2000 dataset will be released in the first quarter of 2008, and continental groups will follow (Africa, Eurasia, etc.). The GLS 2005 data will be released following the availability of the GLS 2000 data. The GLS 2005 is a mixed dataset that incorporated the best scenes from either the Landsat 5 Thematic Mapper (TM) or the Landsat 7 Enhanced Thematic Mapper Plus (ETM+). This new data collection will be completed by the end of 2008.

The partners for the Global Land Survey include NASA and the University of Maryland. For more information on the GLS 2005 dataset, please see http://mdgls.umd.edu/ or http://landsat.usgs.gov/project_facts/mid_decadal.php.

Did you know…?

Do-It-Yourself Gap-filling with SLC-off data – ERDAS Imagine
NOTE: References to non-USGS products do not constitute endorsement by the U.S. Government.

For many, Landsat 7 ETM+ SLC-off data has been difficult to use due to a hardware failure that results in 22 percent of the data missing from each scene. The Landsat Project has developed several products that can minimize the gaps. The most popular is the "off-to-off" product that takes two (or more) ETM+ scenes, radiometrically matches them, and then combines them for more complete coverage. Now that the Landsat Project is distributing orthorectified data at no charge, users can combine their own scenes with Commercial-off-the-Shelf software. Below, the directions for combining scenes in the Leica Systems ERDAS Image program are described. No-charge SLC-off data can be found at Earth Explorer (Landsat Standard L1T dataset) and GloVis (found under Landsat Science > SLC-off Std L1T).

Use model-maker to add each band in Image 1 to the corresponding band in Image 2. The following statement says:
Where Image 1 > 0, use Image 1 data, Otherwise, use Image 2. Image 2 data will fill the gaps in Image 1.

Use the following syntax (this example is for Band 5) in the model:
EITHER $n1_l71015033_03320070515_b50 IF ($n1_l71015033_03320070515_b50 > 0) OR $n2_l71015033_03320070531_b50 OTHERWISE

Then you can layer stack, or leave the files as individual bands. Note: these directions do not include radiometric matching.

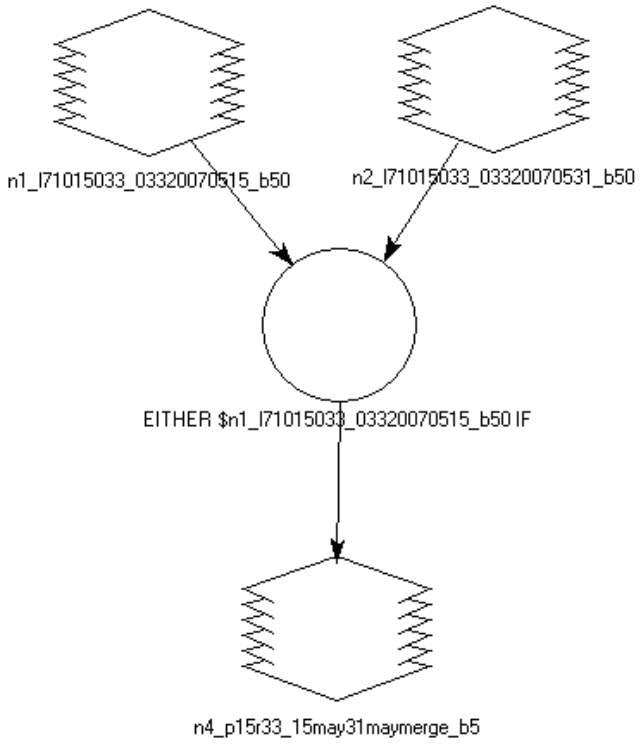


Figure 5. Combining scenes in Leica Systems ERDAS Imagine

While still having a small residual gap, the image below is two scenes combined (without histogram correction applied).

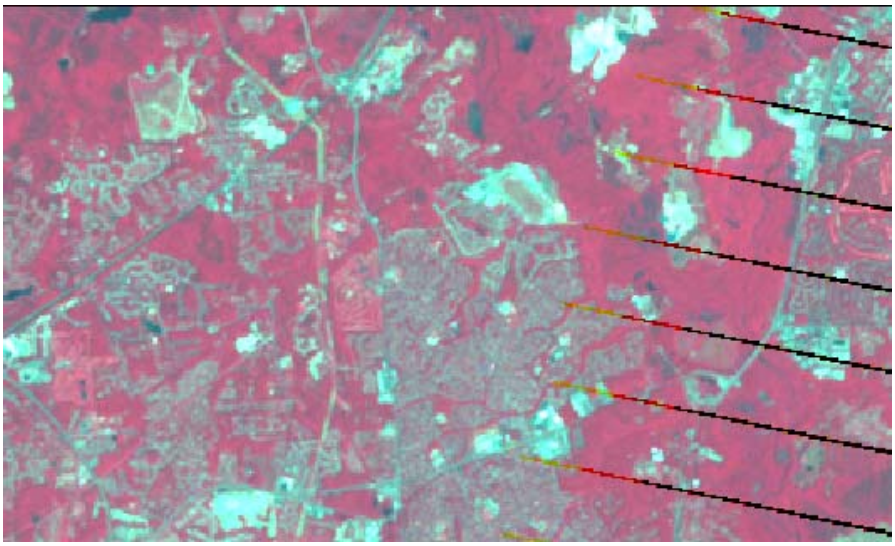


Figure 6. Combined scenes without histogram correction

Landsat Images for your Homepage

If you are not familiar with gadgets, they are mini-web applications that run on any web page or on your iGoogle homepage. Our gadget features beautiful images of our earth from the **USGS EROS Earth as Art** gallery and allows you to download the full-resolution, full-color jpeg (JPG) image right from the gadget. You can also rotate through the image gallery using the arrows. A new image will load every time you visit the page.

All you need to do is click on either (or both) of these links to get started:

- **Add it to your web page or blog:**

http://gmodules.com/ig/creator?synd=open&url=http://landsat.usgs.gov/gadget/earthasart.xml

- **Add it to your iGoogle page:**

http://www.google.com/ig/adde?source=ignsrc1&moduleurl=http%3A//landsat.usgs.gov/gadget/earthasart.xml

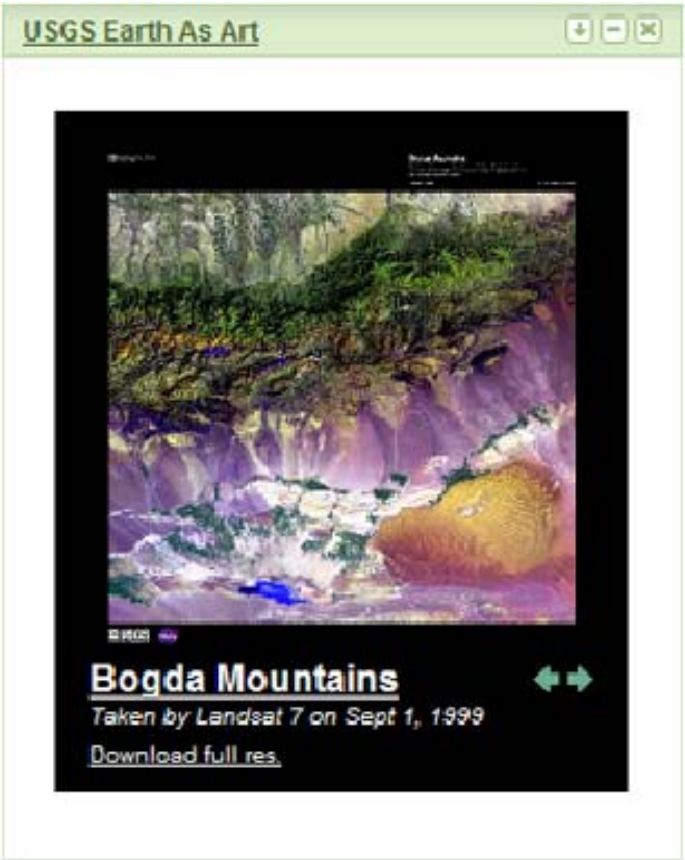


Figure 7. Earth as Art Google Gadget

High Elevation

Salar de Uyuni is the world's largest salt flat, located in Bolivia. It comprises over 12,000 sq km in the Potosi region and is at an elevation of 3,653 meters.

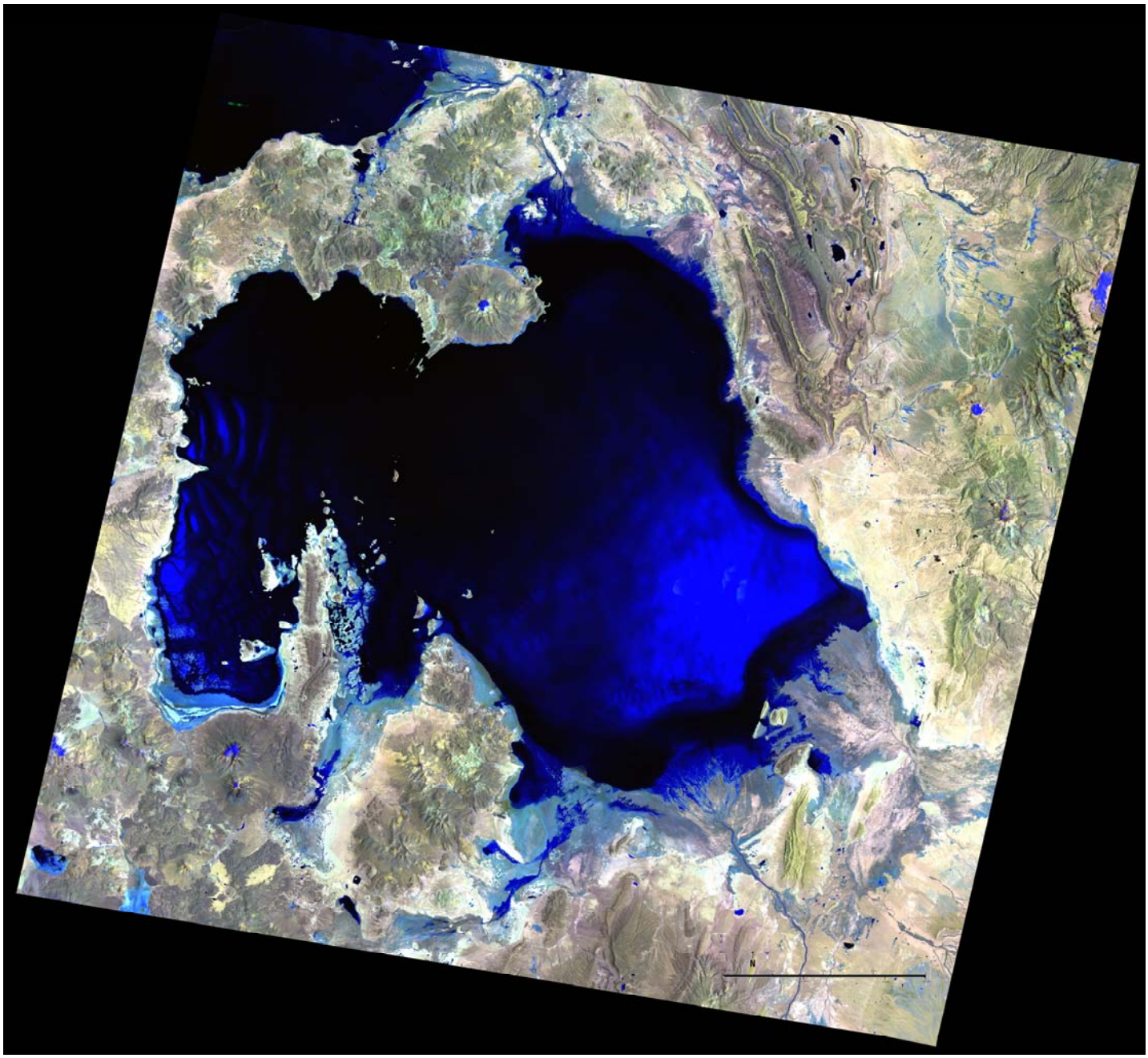


Figure 8. Bands 7,5,4. Landsat 5, January 31, 1987. Path 233/Row 74.

When the huge prehistoric salt lake Lago Minchín, which used to cover all of southern Bolivia, began to dry up, it left several small lakes behind – along with several huge salt pans. Perhaps the most incredible of these is the Salar de Uyuni.

The Salar de Uyuni has salt over 10 meters thick in the center, and supports surface water in portions through much of the year. Islands rise out of it, rocky and covered in cactus, surrounded by salt as far as the eye can see. It has ’ojos’, which are deep holes in the salt pan where water circulates to the surface of the salt.

These two Landsat 5 images demonstrate the ways in which minerals appear differently with different spectral band combinations.

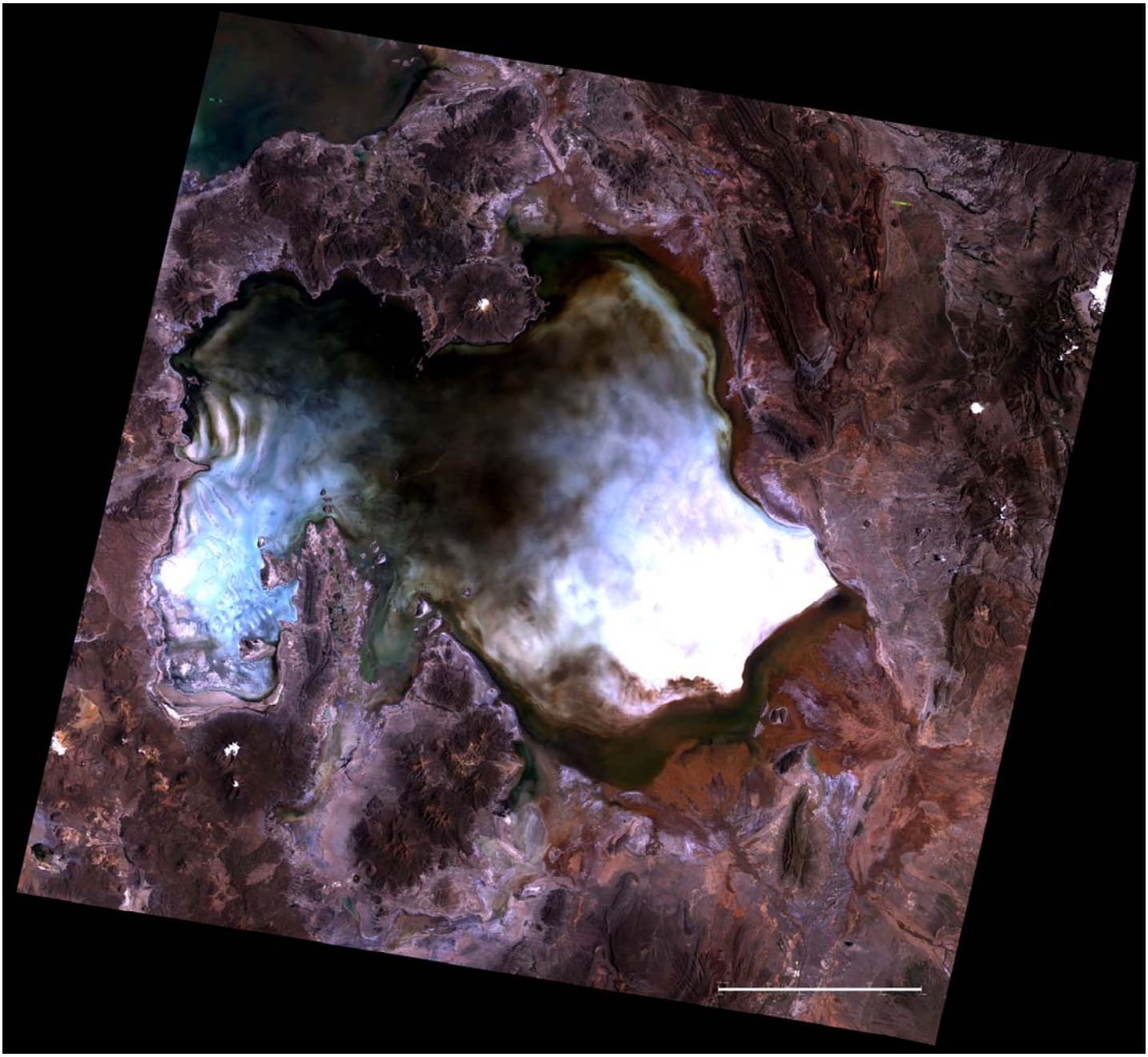


Figure 9. Bands 3,2,1. Landsat 5, January 31, 1987. Path 233/Row 74.

USGS at the Association of American Geographers Conference

Booth # 321

April 15 – 19, 2008

4443 Advancing the Landsat Mission I

Scheduled on Friday, 4/18/08, from 2:30 PM - 4:10 PM

Sponsorship(s):
Remote Sensing Specialty Group

2:30 PM **Author(s):** Curtis E Woodcock - Department of Geography and Environment, Boston University
Title: *Using Landsat to write the history of the surface of Earth: A research agenda*

2:50 PM **Author(s):** Rachel Headley - United States Geological Survey
Kristi Kline - USGS
Title: *The Landsat Project: New Products, Activities, and No-Charge Data*

3:10 PM **Author(s):** Michael Headley - USGS
Title: *The Landsat Data Continuity Mission: Development Status and Product Plans*

3:30 PM **Author(s):** Jeffrey G Masek - NASA GSFC
Rachel Headley - USGS EROS
Steven J Covington - USGS / The Aerospace Corporation
Title: *The Global Land Survey 2005 Project*

3:50 PM **Author(s):** Bruce Quirk - United States Geological Survey
Title: *The National Land Imaging Program*

4543 Advancing the Landsat Mission II

Scheduled on Friday, 4/18/08, from 4:40 PM - 6:20 PM

Sponsorship(s):
Remote Sensing Specialty Group

4:40 PM **Author(s):** Shannon Franks - University of Maryland - College Park
Jeffrey Masek - NASA GSFC
Steve Covington - USGS
Title: *Large Area Scene Selection Interface (LASSI). The methodology used to select scenes for the Global Land Survey 2005*

5:00 PM **Author(s):** Robert Bindschadler - NASA
Douglas Binnie - USGS
Adrian Fox - British Antarctic Survey
Andrew Fleming - British Antarctic Survey
Patricia Vornberger - SAIC
Jerry Mullins - USGS
Title: *The new Landsat Image Mosaic of Antarctica; A part of your world you've never seen before*

5:20 PM **Author(s):** Jim Vogelmann - SAIC
Zhi-liang Zhu - US Forest Service
Susan K Maxwell - SAIC
Title: *Monitoring Long Term Trends in Forest Condition in the Southwestern United States using Multitemporal Landsat Data*

5:40 PM **Author(s):** Chengquan Huang - University of Maryland
Zhiliang Zhu - USDA Forest Service
Hua Shi - SAIC
Samuel N Goward - University of Maryland
John R.G. Townshend - University of Maryland
Title: *An assessment of forest disturbance and regrowth in Mississippi and Alabama using time series stacks of Landsat observations acquired since 1984*

6:00 PM **Author(s):** Samuel N. Goward - University of Maryland
Darrel L. Williams - NASA Goddard Space Flight Center
Andrew Macatee - University of Maryland
Title: *Cloud Contamination in Landsat Imagery: Current and Future Possible Solutions*