

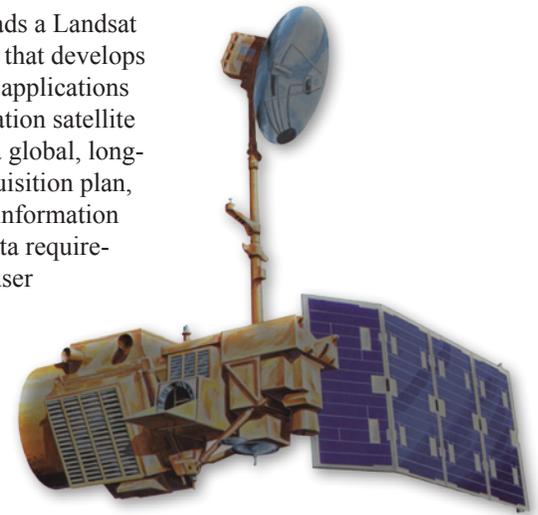
LANDSAT: A GLOBAL LAND IMAGING PROGRAM

Landsat satellites have continuously acquired space-based images of the Earth's land surface, coastal shallows, and coral reefs across four decades. The Landsat Program, a joint effort of the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA), was established to routinely gather land imagery from space. In practice, NASA develops remote-sensing instruments and spacecraft, launches satellites, and validates their performance. The USGS then assumes ownership and operation of the satellites, in addition to managing all ground-data reception, archiving, product generation, and distribution. The result of this program is a visible, long-term record of natural and human-induced changes on the global landscape.

In the mid-1960s, the U.S. Department of the Interior, NASA, and the U.S. Department of Agriculture embarked on an ambitious effort to develop and launch the first civilian Earth-observation satellite. This goal was achieved on July 23, 1972, with the launch of Landsat 1. Landsat satellites have since provided the worldwide science and resource management communities with an archive of space-based land remote-sensing data—a valuable resource for people who work in agriculture, geology, forestry, education, regional planning, mapping, and global change research. Landsat 7 (launched in 1999) continues to capture hundreds of images of the Earth's surface each day. Landsat 5 (launched in 1984) encountered technical problems

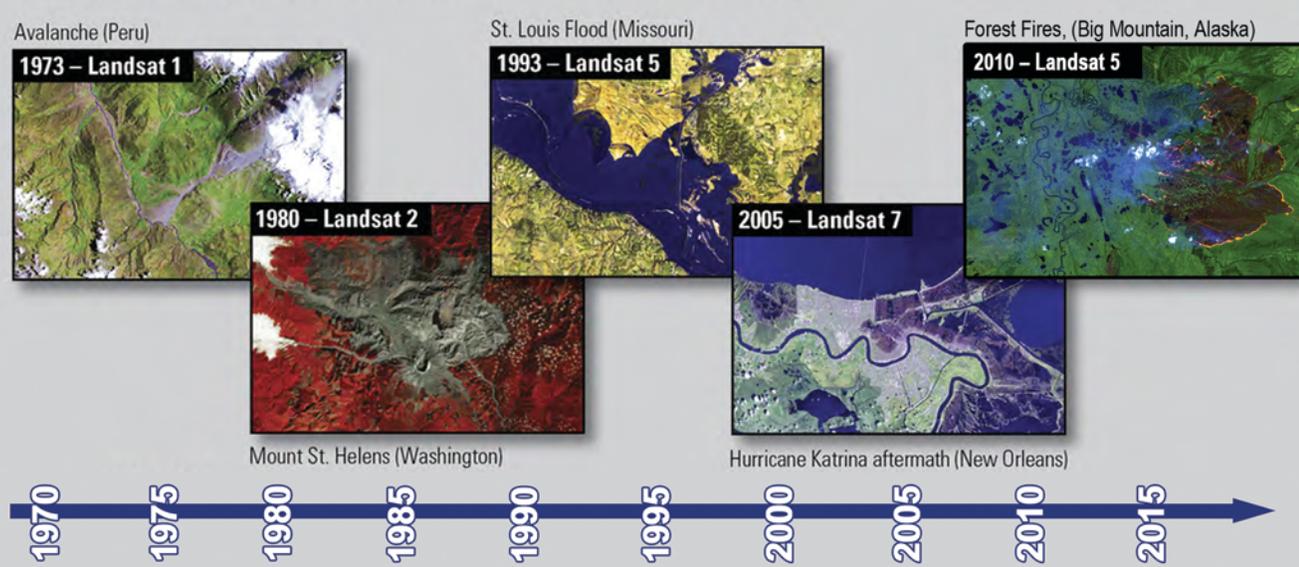
in November 2011, and imaging remains suspended, as of this printing, while engineers explore alternatives for restoring normal operations. Landsat 6, the only satellite in the series not developed by NASA, failed to achieve orbit in 1993. The next generation land-observation system, the Landsat Data Continuity Mission (LDCM—to become Landsat 8 after launch in January 2013), is intended to ensure continuity of Landsat data well beyond the duration of the Landsat 7 mission.

The USGS leads a Landsat Science Team that develops and evaluates applications of next-generation satellite data, defines a global, long-term data acquisition plan, and provides information on Landsat data requirements of the user community.



Landsat 5 Satellite.

Approaching Four Decades of Earth Imaging



LANDSAT
MISSION OVERVIEW

Approaching four decades of Earth imaging.

Characteristics of the Landsat System

Each Landsat satellite images the Earth's surface along the satellite's ground track in a 185-kilometer wide (115-mile wide) swath as the satellite moves in a descending orbit (moving from north to south) over the sunlit side of the Earth. Each satellite crosses every point on the Earth at nearly the same time once every 16 days. Landsats 5 and 7 were placed in orbit at 705 kilometers (438 miles) altitude, circling the Earth every 99 minutes.

The primary sensor onboard Landsats 1, 2, and 3 was the Multispectral Scanner (MSS), with an image resolution of approximately 80 meters in four spectral bands ranging from the visible green to the near-infrared (IR) wavelengths (table 1). The MSS sensor on Landsat 3 included a fifth band in the thermal-infrared wavelength.

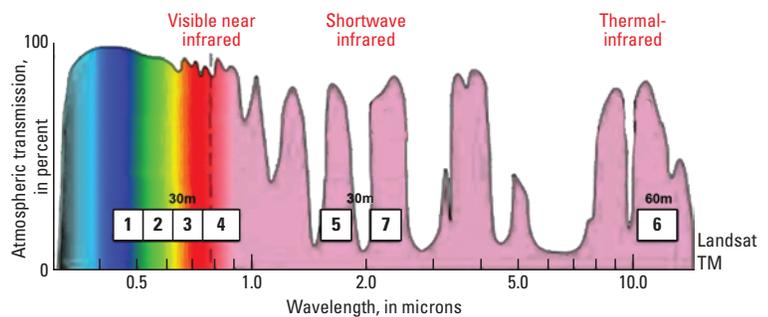
The improved Thematic Mapper (TM) sensors onboard Landsats 4 and 5 were designed with several additional bands in the shortwave infrared (SWIR) part of the spectrum, plus an improved spatial resolution of 120 meters for the thermal-IR band and 30 meters for the other six bands (table 1).

Landsats 5 and 7 orbits are offset to allow 8-day repeat coverage of any area on the globe. Landsat 7 carries the Enhanced Thematic Mapper Plus (ETM+), with 30-meter visible and IR bands, a 60-meter spatial-resolution thermal band, and a 15-meter panchromatic band (table 2).

Table 1. Multispectral Scanner (MSS) band designations changed from Landsats 1, 2, and 3 to Landsats 4 and 5.

[IR, infrared]

| Landsats 1, 2, and 3 spectral bands | Landsats 4 and 5 spectral bands | Use |
|-------------------------------------|---------------------------------|---|
| Band 4 – green | Band 1 – green | Emphasizes sediment-laden water and delineates areas of shallow water. |
| Band 5 – red | Band 2 – red | Emphasizes cultural features. |
| Band 6 – near IR | Band 3 – near IR | Emphasizes vegetation boundary between land and water, and landforms. |
| Band 7 – near IR | Band 4 – near IR | Penetrates atmosphere haze best; emphasizes vegetation, boundary between land and water, and landforms. |



Locations of Landsat bands in the electromagnetic spectrum.

Table 2. Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) sensor band designations.

[IR, infrared]

| Spectral bands | Use |
|----------------|--|
| 1 Blue-green | Bathymetric mapping; distinguishes soil from vegetation, deciduous from coniferous vegetation. |
| 2 Green | Emphasizes peak vegetation, which is useful for assessing plant vigor. |
| 3 Red | Emphasizes vegetation types. |
| 4 Near IR | Emphasizes biomass content and shorelines. |
| 5 Reflected IR | Discriminates moisture content of soil and vegetation; penetrates thin clouds. |
| 6 Thermal IR | Useful for thermal mapping and estimated soil moisture. |
| 7 Reflected IR | Useful for mapping hydrothermally altered rocks associated with mineral deposits. |
| 8 Panchromatic | Landsat 7 carries a panchromatic band (visible through near infrared) with 15-meter resolution for “sharpening” of multispectral images. |