Landsat Missions

Landsat—Earth Observation Satellites:

- Since 1972, Landsat satellites have continuously acquired space-based images of the Earth's land surface, providing data that serve as valuable resources for land use/land change research.
- Landsat is a joint effort of the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA). NASA develops remote sensing instruments and the spacecraft, then launches and validates the performance of the instruments and satellites. The USGS then assumes ownership and operation of the satellites, in addition to managing all ground reception, data archiving, product generation, and data distribution. The result of this program is an unprecedented continuing record of natural and human-induced changes on the global landscape.

Landsat Missions: Imaging the Earth Since 1972:

- In the mid-1960s, stimulated by U.S. successes in planetary exploration using unmanned remote sensing satellites, the Department of the Interior, NASA, and the Department of Agriculture embarked on an ambitious effort to develop and launch the first civilian Earth observation satellite.
- Their goal was achieved on July 23, 1972, with the launch of the Earth Resources Technology Satellite (ERTS-1), which was later renamed Landsat 1.
- The launches of Landsat 2, Landsat 3, and Landsat 4 followed in 1975, 1978, and 1982, respectively. When Landsat 5 launched in 1984, no one could have predicted that the satellite would continue to deliver high quality, global data of Earth's land surfaces for 28 years and 10 months, officially setting a new Guinness World Record for "longest-operating Earth observation satellite."
- Landsat 6 failed to achieve orbit in 1993; however, Landsat 7 successfully launched in 1999 and continues to provide global data.
- Landsat 8, launched in 2013, continues the mission, and Landsat 9 is tentatively planned to launch in 2020.

Satellite Acquisitions:

- The Landsat 7 and Landsat 8 satellites both orbit the Earth at an altitude of 705 kilometers (438 miles) in a 185-kilometer (115-mile) swath, moving from north to south over the sunlit side of the Earth in a sun synchronous orbit. Each satellite makes a complete orbit every 99 minutes, completes about 14 full orbits each day, and crosses every point on Earth once every 16 days. Although each satellite has a 16-day full-Earth-coverage cycle, their orbits are offset to allow 8-day repeat coverage of any Landsat scene area on the globe. Landsats 4 and 5 followed the same orbit as Landsats 7 and 8.
- Landsats 1, 2, and 3 orbited at an altitude of 920 kilometers (572 miles), circling the Earth every 103 minutes, yielding repeat coverage every 18 days.

Sensors and Band Designations:

Landsat band wavelength comparisons
All bands 30-meter resolution unless noted

Band designations	L8 OLI/TIRS		L7 ETM+		L4-5 TM		L4-5 MSS*		L1-3 MSS*	
Coastal/Aerosol	Band 1	0.43–0.45	--	--	--	--	--	--	--	--
Blue	Band 2	0.45–0.51	Band 1	0.45–0.52	Band 1	0.45–0.52	--	--	--	--
Green	Band 3	0.53–0.59	Band 2	0.52–0.60	Band 2	0.52–0.60	Band 1	0.5–0.6 *	Band 4	0.5–0.6 *
Panchromatic	Band 8**	0.50–0.68	Band 8 **	0.52–0.90	--	--	--	--	--	--
Red	Band 4	0.64–0.67	Band 3	0.63–0.69	Band 3	0.63–0.69	Band 2	0.6–0.7 *	Band 5	0.6–0.7 *
Near-Infrared	Band 5	0.85–0.88	Band 4	0.77–0.90	Band 4	0.76–0.90	Band 3	0.7–0.8 *	Band 6	0.7–0.8 *
Near-Infrared	--	--	--	--	--	--	Band 4	0.8–1.1 *	Band 7	0.8–1.1*
Cirrus	Band 9	1.36–1.38	--	--	--	--	* Acquired at 79 meters, resampled to 60 meters ** 15-meter (panchromatic) T1 = Thermal (acquired at 100 meters, resampled to 30 meters) T2 = Thermal (acquired at 120 meters, resampled to 30 meters)			
Shortwave Infrared-1	Band 6	1.57–1.65	Band 5	1.55–1.75	Band 5	1.55–1.75				
Shortwave Infrared-2	Band 7	2.11–2.29	Band 7	2.09–2.35	Band 7	2.08–2.35				
Thermal	Band 10 T1	10.60–11.19	Band 6 T2	10.40–12.50	Band 6 T2	10.40–12.50				
Thermal	Band 11 T1	11.50–12.51	--	--	--	--				

Uses of Landsat bands

Band name	L8 OLI/TIRS	L7 ETM+	L4-5 TM	L4-5 MSS	L1-3 MSS	Description of use
Coastal/Aerosol	Band 1	--	--	--	--	Coastal areas and shallow water observations; aerosol, dust, smoke detection studies.
Blue (B)	Band 2	Band 1	Band 1	--	--	Bathymetric mapping; soil/vegetation discrimination, forest type mapping, and identifying manmade features.
Green (G)	Band 3	Band 2	Band 2	Band 1	Band 4	Peak vegetation; plant vigor assessments.
Red (R)	Band 4	Band 3	Band 3	Band 2	Band 5	Vegetation type identification; soils and urban features.
Near-Infrared (NIR)	Band 5	Band 4	Band 4	Band 3	Band 6	Vegetation detection and analysis; shoreline mapping and biomass content.
	--	--	--	Band 4	Band 7	
Shortwave Infrared-1 (SWIR-1)	Band 6	Band 5	Band 5	--	--	Vegetation moisture content/drought analysis; burned and fire-affected areas; detection of active fires.
Shortwave Infrared-2 (SWIR-2)	Band 7	Band 7	Band 7	--	--	Additional detection of active fires (especially at night); plant moisture/drought analysis.
Panchromatic (PAN)	Band 8	Band 8	--	--	--	Sharpening multispectral imagery to higher resolution.
Cirrus	Band 9	--	--	--	--	Cirrus cloud detection.
Thermal (T)	Band 10	Band 6	Band 6	--	--	Ground temperature mapping and soil moisture estimations.
	Band 11			--	--	

Applications of Landsat Data:

- Landsat data support a vast range of applications in areas such as global change research, agriculture, forestry, geology, land cover mapping, resource management, water, and coastal studies. Specific environmental monitoring activities such as deforestation research, volcanic flow studies, and understanding the effects of natural disasters all benefit from the availability of Landsat data. In recent years, Landsat data have also been used to track oil spills and to monitor mine waste pollution. Table 2 lists Landsat bands and describes the use of each band to help users determine the best bands to use in data analysis.

- The consistency of Landsat data acquisitions through the years and the richness of the archive, combined with the no-cost data policy, allow users to exploit time series of data over extensive geographic areas to establish long-term trends and monitor the rates and characteristics of land surface change.