

# Web Resources: Remote Sensing Imagery of Environmental Change

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Remote sensing involves the detection and measurement of electromagnetic energy reflected from the earth's surface. While remote sensing includes images taken from airplanes, the emphasis in this review is upon satellite imagery scanning the visible and infrared spectrum. The "Global Focus" sites listed below, for example, display planetary-scale natural and human processes at work. "Regional Focus" sites feature continental-scale phenomena and include views of deforestation, ozone depletion, agricultural patterns, desertification, water management, urbanization, oil slicks, and more. "Sites Focusing on Natural Hazards" stress the impact of hurricanes, drought, fire, volcanoes, and floods. All sites have the potential to demonstrate the dynamic, interconnected nature of our planet.

The best sites like "Earthshots" and "Earth Observatory" provide accompanying narratives, references, locator maps, thumbnail previews, instructor lesson plans, or sequential imagery. The "NASA Earth Observatory: Data And Imagery" is one of the more interactive sites allowing for the simultaneous comparison of several global data layers as a function of time, for example, forest cover with extent of fires.

Many of the available image files are quite large with 1 MG downloads not being unusual. For best results these sites should be accessed through a cable modem. Sites that required special viewers or required images to be downloaded only through FTP were excluded.

The suggestions below are not a "best of the best" regarding remote sensing imagery; nonetheless, the suggested sites are practical, are well organized, have authentic content, and few, if any, grammatical errors. Many worthy resources do not appear because of space limitations. The sites listed here appeal to a middle school audience and above. Finally, as we draw knowledge from these images, let us for a moment remember the crew of the Shuttle Challenger, who gave their lives to advance our knowledge of the Earth through remote sensing.

The sites reviewed are archived at "Resources For Earth Science And Geography Instruction" (<http://personal.Cmich.edu/~franc1m/homepage.htm>) and were featured on the weekly "Earth Science Sites of the Week Listserv." To suggest useful sites for listing in future installments or to be added to the listserv please contact Mark.Francek@cmich.edu

## Sites with a Global Focus

Site Name	Author	URL	Description
Earthlight At Night	NASA	<a href="http://antwrp.gsfc.nasa.gov/apod/image/0011/earthlights_dmsp_big.jpg">http://antwrp.gsfc.nasa.gov/apod/image/0011/earthlights_dmsp_big.jpg</a>	Challenge students to decipher the planet's urban and transportation patterns as illuminated by human-made lights. Interesting features include the Trans-Siberian railroad, U.S. Township and Range, and the 38 <sup>th</sup> parallel marking the boundary between industrial South Korea and agrarian North Korea.
NASA Earth Observatory: Data And Imagery	NASA	<a href="http://www.earthobservatory.nasa.gov/Observatory/#">http://www.earthobservatory.nasa.gov/Observatory/#</a>	Build animations from a number of monthly datasets including aerosol concentration, chlorophyll (land and sea), cirrus reflectance, cloud forcing, cloud fraction, fires, emitted heat radiation, vegetation, net radiation, ozone, rainfall, sea surface temperature, reflected radiation, surface temperature, and ultraviolet exposure. Options exist allowing you to compare one dataset with another.
Blue Marble	NASA	<a href="http://earthobservatory.nasa.gov/Newsroom/BlueMarble/">http://earthobservatory.nasa.gov/Newsroom/BlueMarble/</a>	Find the most detailed earth image (1 km. resolution) yet to be taken. This beautiful image features a cloud-swathed North and Middle America and would make a great introductory slide for a presentation. More detailed imagery is available by Hemisphere.
Seawif Animations	Goddard Space Flight Center/NASA	<a href="http://seawifs.gsfc.nasa.gov/SEAWIFS/IMAGES/MOVIES.html">http://seawifs.gsfc.nasa.gov/SEAWIFS/IMAGES/MOVIES.html</a>	Download .mpg animations showing the entire planet for the following themes: biosphere, clouds, ozone, rain, visible, infrared, land cover, relief, snow/ice, temperature, temperature differences, and the ocean planet. These animations aren't particularly large, around half a megabyte, but need captions describing exactly what is depicted.

### *Sites with a Regional Focus*

Site Name	Author	URL	Description
Earthshots	EROS /USGS	<a href="http://edc.usgs.gov/earthshots/slow/tab/eofcontents">http://edc.usgs.gov/earthshots/slow/tab/eofcontents</a>	Find images of environmental change including farm abandonment from the Chernobyl disaster, tropical deforestation in Brazil, oil fires during the Gulf War, and urban sprawl associated with the phenomenal growth of Las Vegas. Each image has accompanying narratives, maps, and references.
NASA Visible Earth	NASA	<a href="http://visibleearth.nasa.gov/">http://visibleearth.nasa.gov/</a>	Access almost 5000 NASA satellite images with accompanying descriptions for agriculture, atmosphere, biosphere, cryosphere, human dimensions (environmental impacts), hydrosphere, land surface, oceans, radiance of imagery (examples of imagery using different sensors), and solid earth (rocks, tectonics, volcanoes). The site's search capability is noteworthy.
Terraserver	Microsoft Corp.	<a href="http://www.terraserver.microsoft.com/">http://www.terraserver.microsoft.com/</a>	Combine and analyze the features displayed on USGS topographic map and USGS aerial photograph for the U.S. Complete topographic map coverage exists for the U.S.; most of the coterminous U.S. has aerial photograph coverage. The search capability allows quick access to over 3 terabytes of spatial information.
Geomorphology From Space	NASA	<a href="http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GE_O_HOME_PAGE.html">http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GE_O_HOME_PAGE.html</a>	Use this site to emphasize how geomorphology and geology influence environmental change. Discover over 200 images of tectonic, volcanic, fluvial, deltaic, coastal, karst lakes, eolian, glacial landforms. The "Planetary" section shows landforms from other planets. Commentary, photographs, locator maps, and an occasional geologic map come with each image.
NASA Visible Earth	NASA	<a href="http://visibleearth.nasa.gov/Human_Dimensions/Environmental_Impacts/">http://visibleearth.nasa.gov/Human_Dimensions/Environmental_Impacts/</a>	Access environmental impact images for biomass burning (296 images) deforestation (2 images), eutrophication (7 images), industrial emissions (10 images), oil spills (3 images), and urbanization (23 images).
SAR Images Of Environment Change	JPL/NASA	<a href="http://www.jpl.nasa.gov/radar/sircxsar/">http://www.jpl.nasa.gov/radar/sircxsar/</a>	View Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar (SAR) imagery which uses microwaves that are not degraded by cloud cover and can thus access sites under a variety of weather conditions. The site highlights images relating to archaeology, cities, ecology and agriculture, geology, oceans, rivers, snow, ice, glaciers, volcanoes, and interferometry (a method to overcome image blurring)
Space Imaging	Space Imaging	<a href="http://www.spaceimaging.com/gallery">http://www.spaceimaging.com/gallery</a>	Many sites offer imagery only at resolutions of 30 m per pixel or greater; this site displays imagery at 1 m using the IKONOS satellite. Find sample images of the World Trade Center before and after September 11, 2001, the Grand Canyon, tornado damage, and a variety of cities.
Seawifs Project	Goddard Space Flight Center/NASA	<a href="http://seawifs.gsfc.nasa.gov/SEAWIFS.html">http://seawifs.gsfc.nasa.gov/SEAWIFS.html</a>	The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project provides remote sensing imagery focusing on the ocean. Find datasets and teacher resources on plankton, upwelling, and food webs.
Total Ozone Mapping Spectrometer	NASA/Goddard	<a href="http://jwocky.gsfc.nasa.gov/ozone/today.html">http://jwocky.gsfc.nasa.gov/ozone/today.html</a>	Find near real time ozone data for the North and South pole plus full day global images.
NASA Image Exchange (Nix)	NASA	<a href="http://nix.nasa.gov">http://nix.nasa.gov</a>	Of all the image databases listed, the NASA Image Exchange (NIX) is probably the most comprehensive. Access over 450,000 of NASA's online image and photo collections. Unfortunately, images vary greatly in quality and detail.
<b><i>Sites Focusing On Natural Hazards</i></b>			
Earth Observatory: Natural Hazards	NASA	<a href="http://earthobservatory.nasa.gov/NaturalHazards/">http://earthobservatory.nasa.gov/NaturalHazards/</a>	Draw from a variety of hazard based imagery in the news featuring droughts, earthquakes, floods, severe storms, volcanoes, oil slicks, dense fog, and glacier collapse.
Operation Significant Event Imager	NOAA	<a href="http://www.osei.noaa.gov/index.html">http://www.osei.noaa.gov/index.html</a>	Locate imagery with a hazards theme featuring high-resolution, detailed imagery of dust storms, fires, floods, icebergs, ocean turbidity, thunderstorms, snow cover, tropical cyclones, unique imagery (eclipse and fog), and volcanoes. Images can be previewed through thumbnails and then viewed at full resolution.