WATCHING OVER TEXAS FROM SPACE

An Earth Observations education resource for grades 4 -12 in support of TEKS covering Earth Science and Environmental Science Standards

Developed by TexasView with support from Grant Number G14AP00002 from the Department of the Interior, United States Geological Survey to AmericaView

3.4 HOW IS TEXAS CHANGING? Imagery key

The lessons and the activities in "How is Texas Changing?" are designed to introduce students to changes in landforms, land cover, and human infrastructure as it appears on satellite imagery. I have used a scaffolded approach in this book, and Which is Which does not address scale or geographic grids. Later lessons will address these issues. I have used state-managed lands as the anchors for the lessons and activities labeled as TPWD images, including Texas' State Parks, Historic Areas, and Natural Areas. For the lessons and activities labeled EO or ES, I have used imagery of sites in Texas from the NASA Earth Observatory web site or the USGS Earthshots website. This document provides links to the source of the images for all of the How is Texas Changing lessons and activities.

All TPWD imagery was captured from the Texas Watershed Viewer:

- https://tpwd.maps.arcgis.com/apps/Viewer/index.html?appid=2b3604bf9ced441a98c500763b8b1048

All EO imagery was captured from the Earth Observatory web site

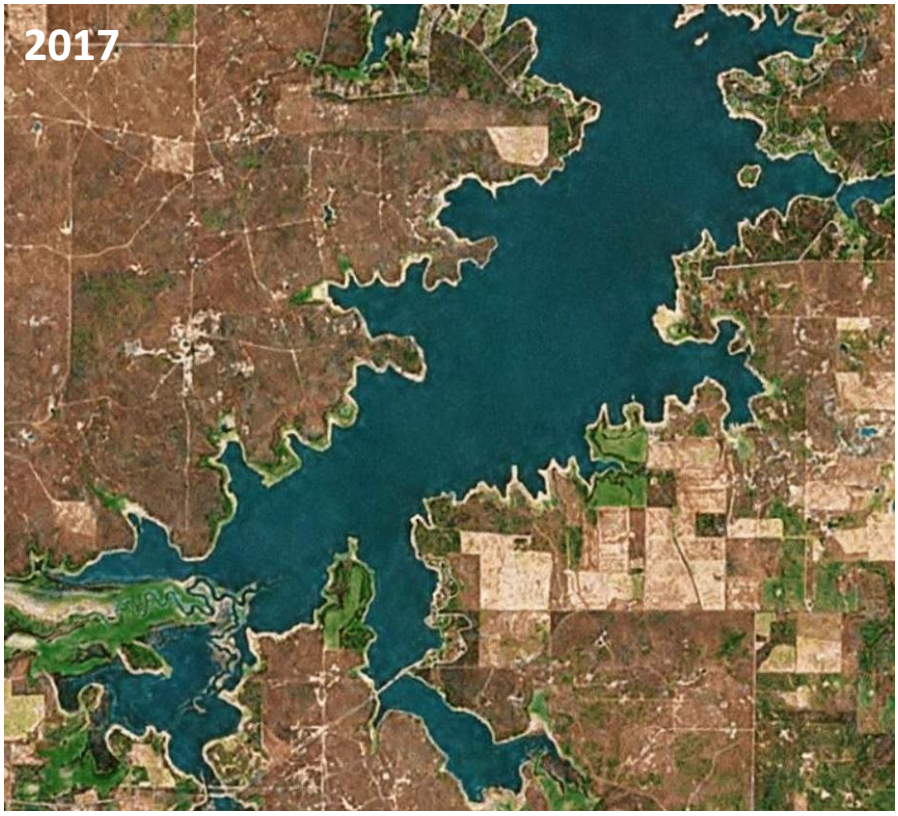
- NASA Earth Observatory - Home

All USGS Earthshots imagery was captured from

- Earthshots | Earth Resources Observation and Science (EROS) Center (usgs.gov)

HOW IS TEXAS CHANGING?

Imagery Key for Texas Parks and Wildlife (TPWD) Lessons and Activities



Texas Watershed viewer data from 2017
Texas Watershed Viewer (arcgis.com)

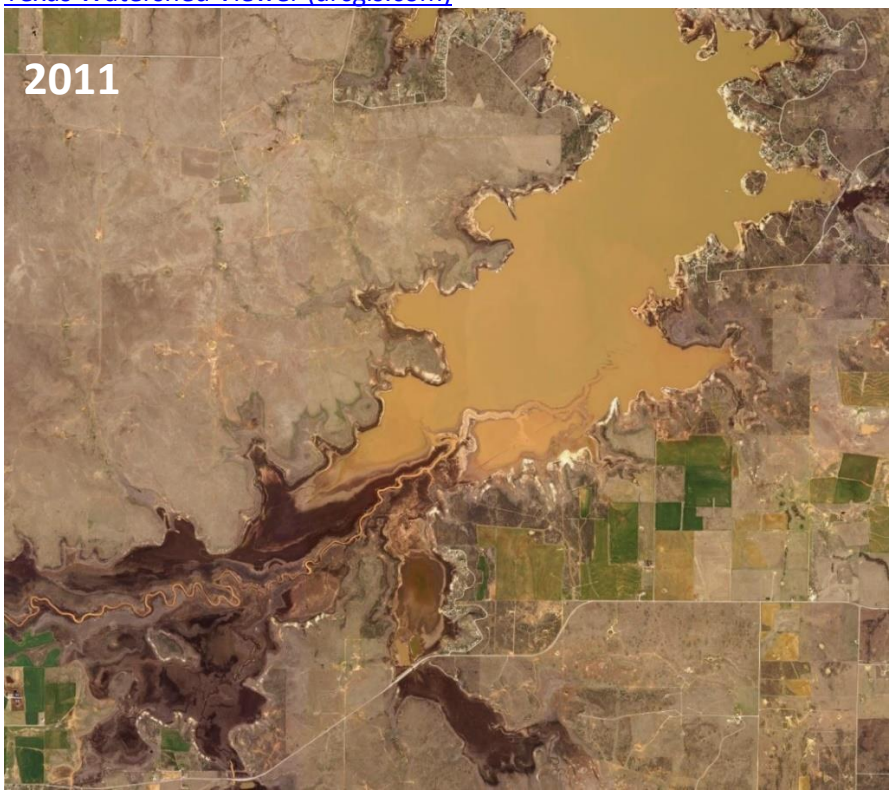


Image processed by author

A clear blue lake shrinks, and lake bottom sediments are exposed

2010 – 2011 was the single driest year in Texas' recorded history. Lakes receded dramatically across the state. The drought continued for several years, and lake levels did not return to normal until 2015, when record-breaking rains restored Lake Arrowhead to above 90% capacity.

Key Phrase correlations: **Identify changes to Earth's surface features; Recognize landforms/ land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's subsystems.**

Key word correlations: **Deposition; lakes; satellite imagery; drought; agriculture.**

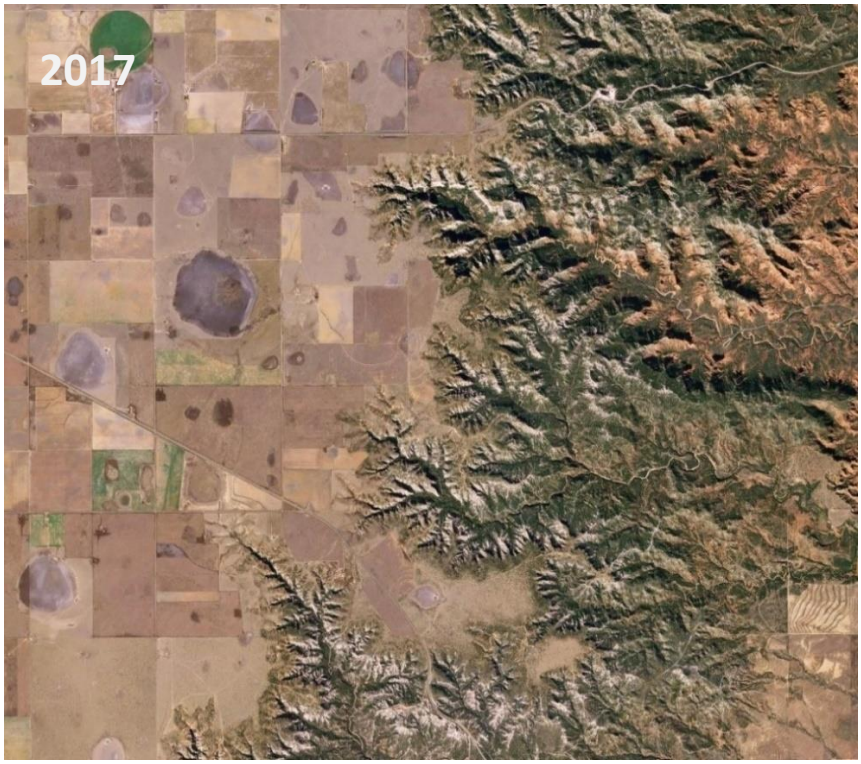
Historical Imagery Viewer (arcgis.com)

Two streams enter a bay behind a barrier island; their deltas expand and merge

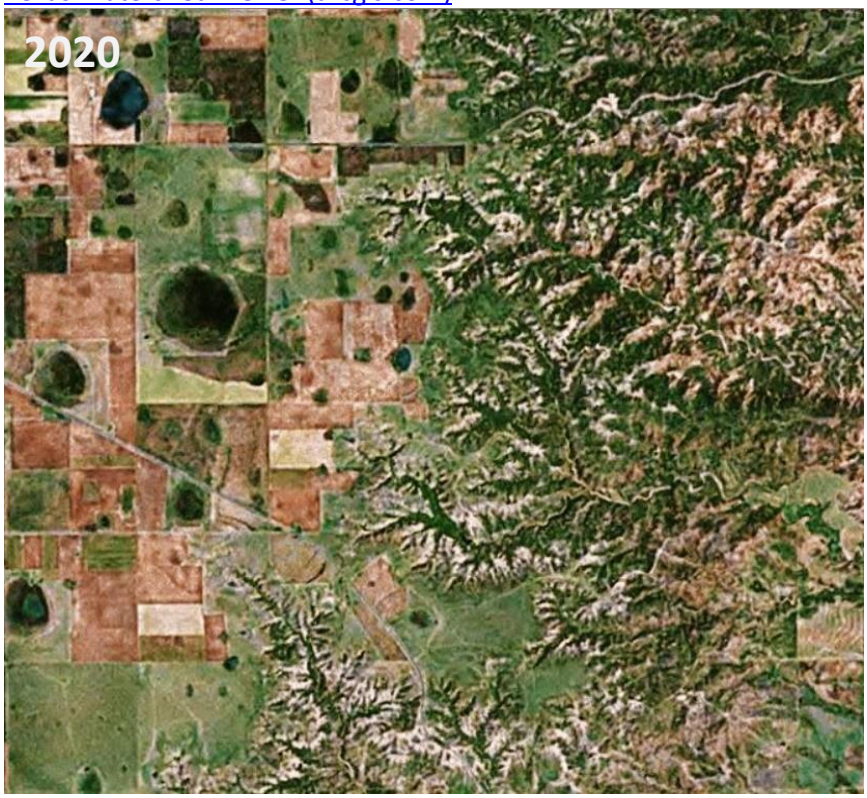
Between the mainland and Matagorda barrier island on the Gulf of Mexico, runoff drains into the bay through several artificial canals. The easternmost canal carries water and sediment into the Gulf, while the two western canals deliver water and sediment into the bay. Sediment from these two canals has been building deltas for decades, and they have merged since the late 1970s.

Key Phrase correlations: **Identify changes to Earth's surface features; Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.**

Key word correlations: **Deposition; deltas; bays; barrier islands; satellite imagery; development; rate of change; runoff.**



Texas Watershed viewer data from 2017
Texas Watershed Viewer (arcgis.com)



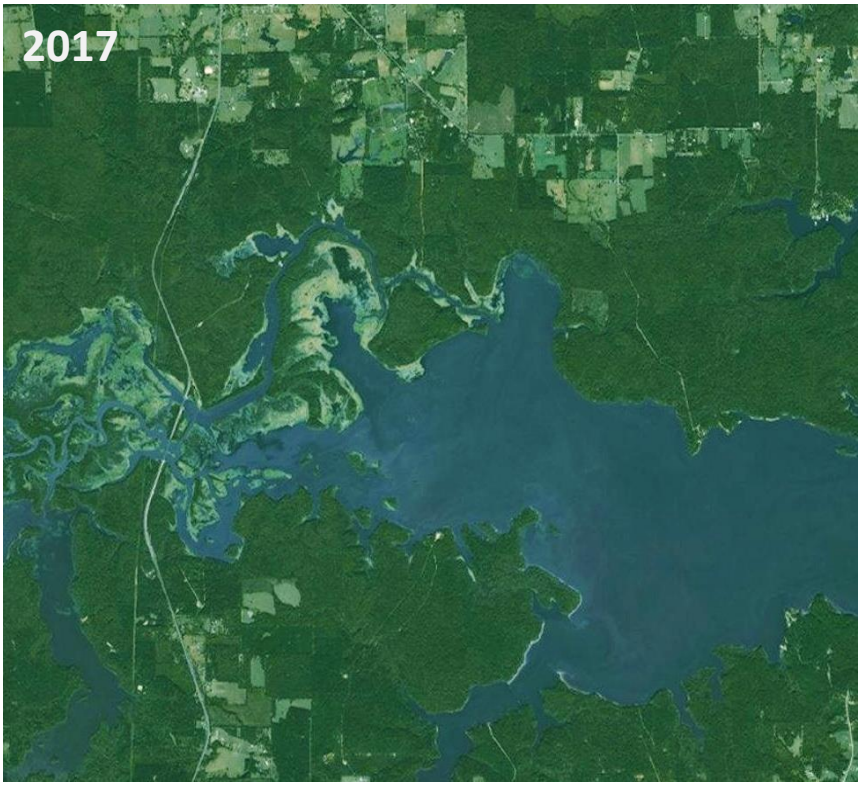
Texas Watershed viewer data from 2020
Texas Watershed Viewer (arcgis.com)

Where erosion etches a deep canyon in a flat plateau, seasonal rains fill small lakes in farmland.

Palo Duro Canyon is the second largest canyon in the United States. It is eroded into the "caprock" – a hard layer that underlies a flat-lying region in the Panhandle area of Texas. Nearly 1000 small, wind-scoured depressions fill with playa lakes after rainfall events. Groundwater recharges through these lakes to fill the Ogallala aquifer, which supports irrigated agriculture on the plateau.

Key Phrase correlations: Identify changes to Earth's surface features; Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.

Key Word correlations: **Erosion; plateaus; canyons; lakes; satellite and aerial imagery; topographic maps; agriculture; rate of change.**



Texas Watershed viewer data from 2017
Texas Watershed Viewer (arcgis.com)

Texas Watershed viewer data from 2020
Texas Watershed Viewer (arcgis.com)

Heavy rains raise lake levels to flood numerous islands and fill lake with sediment

Wright Patman Lake is a man-made flood-control reservoir on the Sulphur River. It also serves as a drinking-water reservoir for the local cities.

Key Phrase correlations:
Identify changes to Earth's surface features; Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.

Key word correlations:
Deposition; rivers; lakes; satellite imagery; topographic maps; flooding; development; use of fresh water; dams; agriculture; water movement.

Texas Watershed viewer data from 2020
[Texas Watershed Viewer (arcgis.com)]

A wildfire burns through forested hills and towns

In early September of 2011, during a period of extended drought in Texas, a wildfire ignited and quickly grew to cover 32,000 acres. Over 95 percent of Bastrop State Park, which conserves the westernmost stand of loblolly pine in the United States, was impacted by the fire. The forest is still recovering.

Key Phrase correlations: **Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.**

Key word correlations: **Lakes; satellite imagery; wildfire; development; rate of change.**

A wildfire burns through coastal marsh grasslands; a road acts as a firebreak

Where the salt marsh meets the sea, marsh grasses are adapted to periodic wildfires that help prevent invasion of woody species.

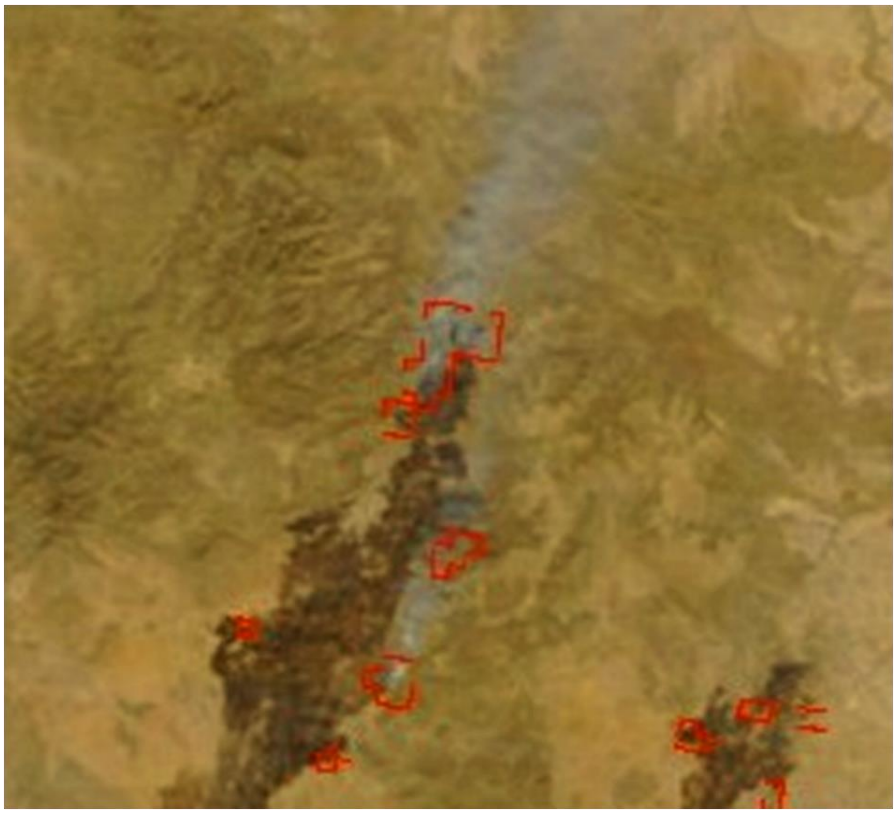
Key Phrase correlations: **Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.**

Key word correlations: **Lakes; beaches; satellite imagery; wildfire; development; rate of change.**

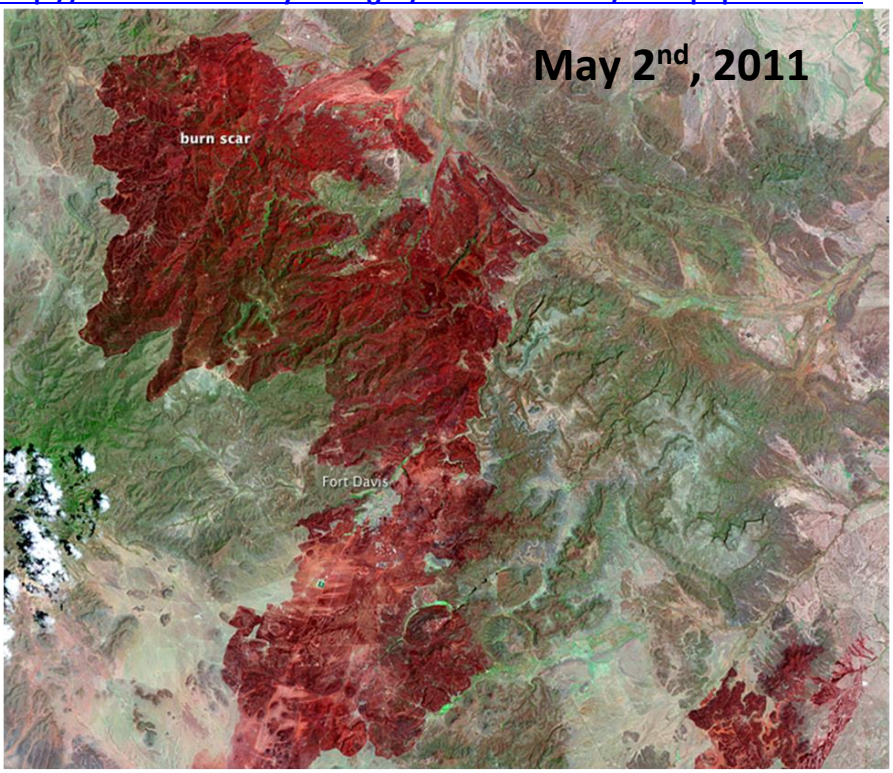
Texas Watershed viewer data from 2020
Texas Watershed Viewer (arcgis.com)

HOW IS TEXAS CHANGING?

Imagery Key for NASA Earth Observatory and USGS Earthshots Lessons and Activities



http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=50075



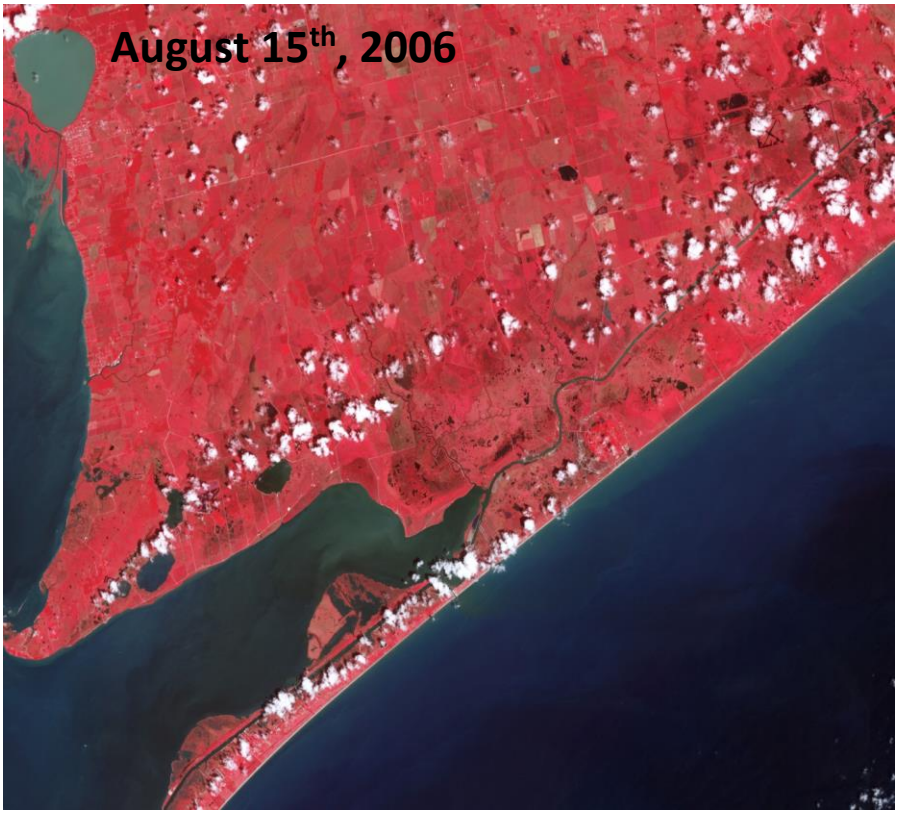
http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=50480

A wildfire burns through wooded hills and towns.

The Davis Mountains were burning in April of 2011. Actively-burning fires are visible in the first image to the top left, taken by the MODIS instrument on NASA's Terra satellite on April 10th, 2011. The Rock House Fire began on April 9th and by May 10th had burned over 300,000 acres of grassland and forest. On the bottom left unburned, vegetated areas are green; the dramatic expansion of the burn area towards the NW, shown in dark red, nearly surrounds the small historic town of Fort Davis .

Key Phrase correlations: **Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.**

Key word correlations: **Lakes; beaches; satellite imagery; wildfire; development; rate of change.**



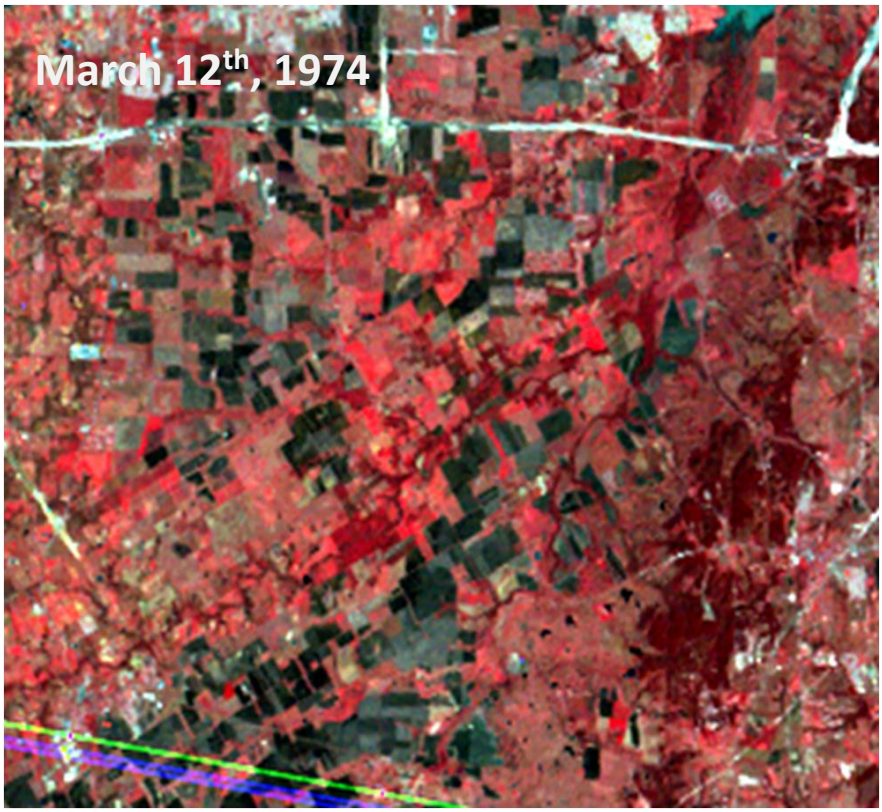
http://earthobservatory.nasa.gov/IOTD/view.php?id=35514&eocn=image&eoci=related_image

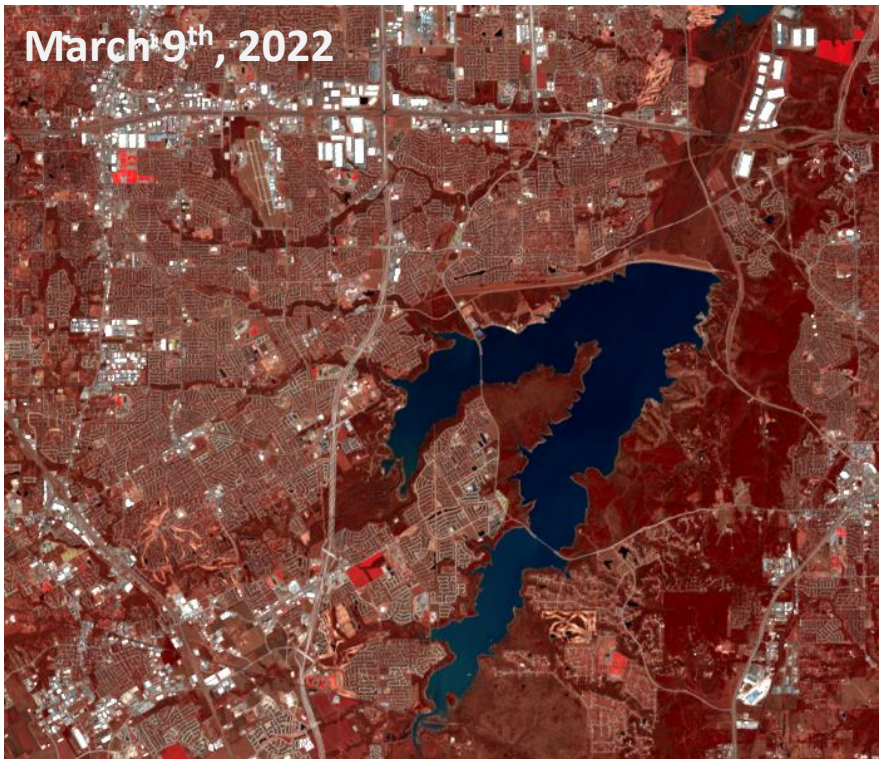
Turbulence and salty storm surge from Hurricane Ike destroy vegetation along the Gulf of Mexico coastline

When Hurricane Ike came ashore on September 13th, 2008, storm surge inundated the coastline; east of Galveston the height reached 15 feet above sea level. In this false-color ASTER image from NASA's Terra satellite, healthy vegetation appears red and extends to the coastline prior to the hurricane. After Ike, the inundated areas appear brown and several inland areas remain flooded weeks after the storm.

Key Phrase correlations: **Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.**

Key word correlations: **Lakes; beaches; bays; satellite imagery; hurricane; development; rate of change.**





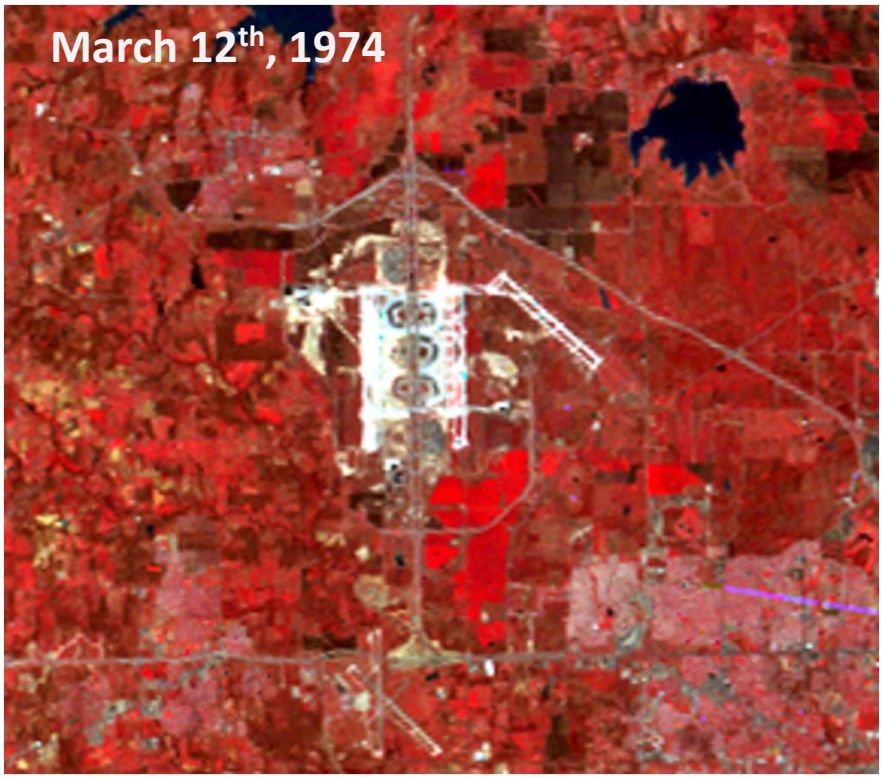
Farmland is flooded to develop a water reservoir; residential and industrial development follow

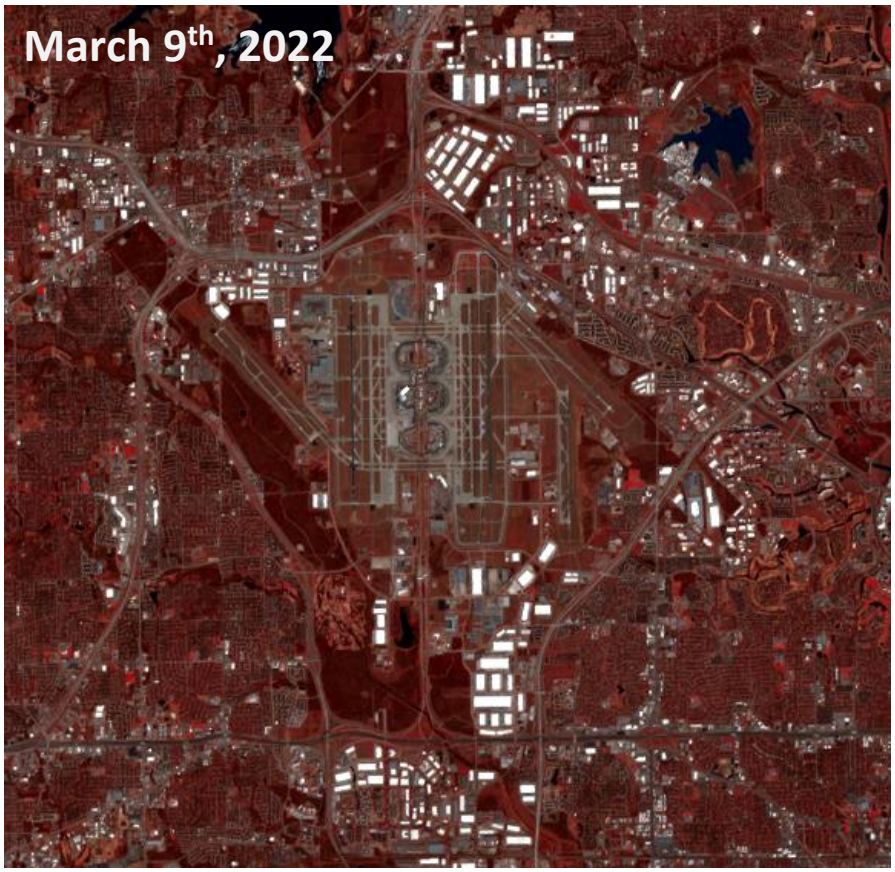
Landsat imagery shows an agricultural area southeast of Dallas slated to serve as a site for a new drinking water /flood control/ recreational reservoir, Joe Pool Lake. The lake began filling in 1986 and by 1989 was filled. Farmland was flooded, and the adjacent farmland was rapidly replaced with residential, commercial, and industrial development. The area directly adjacent to the lake remains relatively undeveloped and is home to Cedar Hill State Park and several Grand Prairie city parks.

Key Phrase correlations: **Recognize landforms/land features; Impact of humans on Earth's systems; Interpret Earth's surface features using a variety of methods; Use of resources: impacts on Earth's systems**

Key word correlations: **Lakes; rivers; satellite imagery; population growth; development; use of fresh water; agriculture; environmental impacts.**

[Joe Pool Lake | Earth Resources Observation and Science (EROS) Center (usgs.gov)]





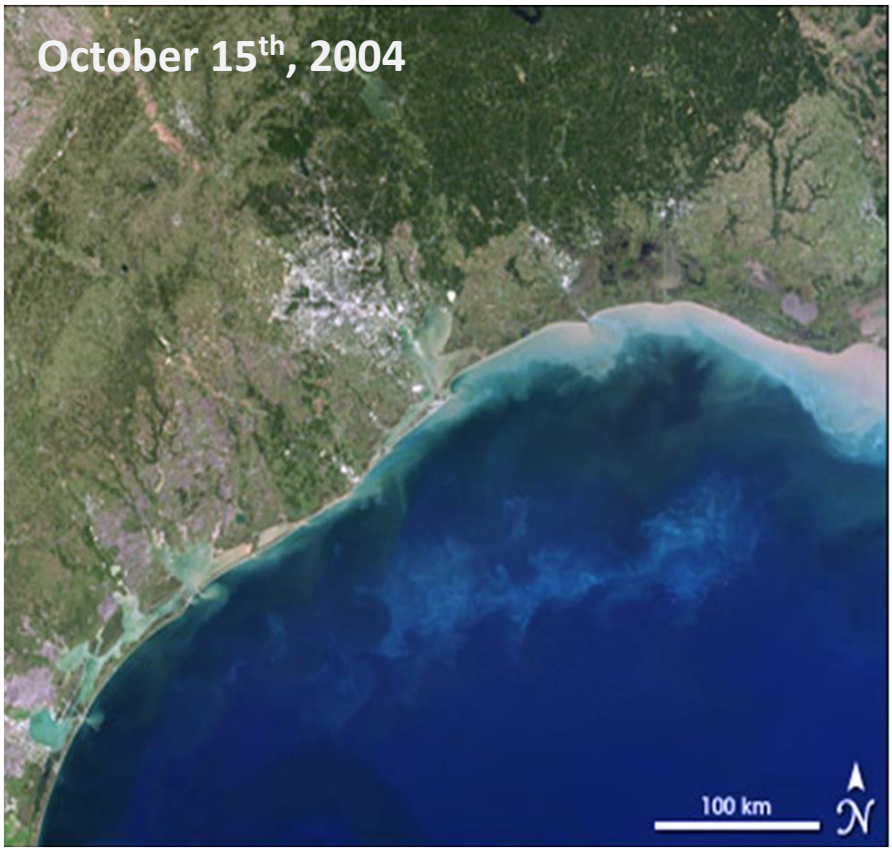
Airport expands over cropland; residential and industrial development swells around the edges

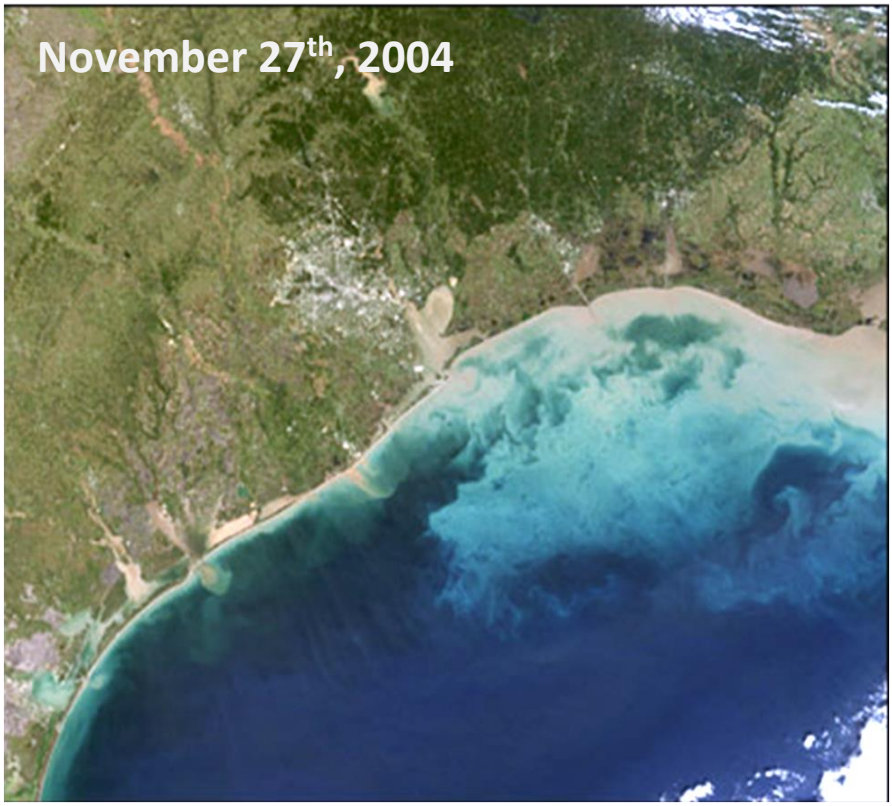
Dallas-Fort Worth International Airport lay to the north and outside the main DFW metroplex is 1974, when first it opened. Surrounded by open cropland, the airport has continuously added runways and other infrastructure. The area adjacent to the airport has filled in rapidly. Industrial development (which shows up as large white rectangles on this Landsat image on the bottom left) dominated towards the east, while residential development encroached from the west.

Key Phrase correlations: **Recognize landforms/land features; Impact of humans on Earth's systems; Interpret Earth's surface features using a variety of methods; Use of resources: impacts on Earth's systems**

Key word correlations: **Lakes; rivers; satellite imagery; population growth; development; agriculture; environmental impacts.**

[Dallas-Fort Worth International Airport | Earth Resources Observation and Science (EROS) Center (usgs.gov)]





http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=14283

Heavy rains/flooding carry sediment into coastal bays and the Gulf of Mexico

A month of heavy rainfall in the fall of 2004 led to extensive flooding. Houston Texas, which appears on this MODIS imagery as a slightly off-center spoke-shaped gray feature, experienced flood heights of over 6 feet above normal along Buffalo Bayou. These floods and also carried large amounts of sediment into Texas rivers and streams, which made its way into the coastal bays and out into the Gulf of Mexico.

Key Phrase correlations: **Identify changes to Earth's surface features; Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of changes in Earth's subsystems and natural hazards; Impact of humans on Earth's systems; Earth's systems continuously change over a range of time scales.**

Key word correlations: **Deposition; rivers; bays; barrier islands; satellite imagery; flooding; development; water movement.**

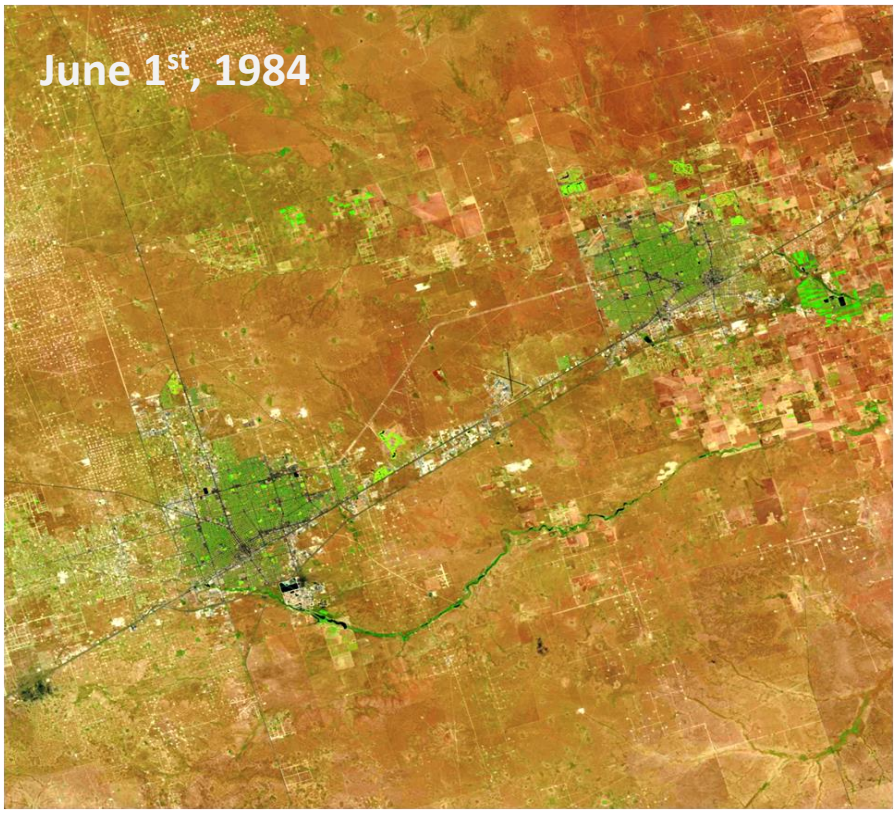
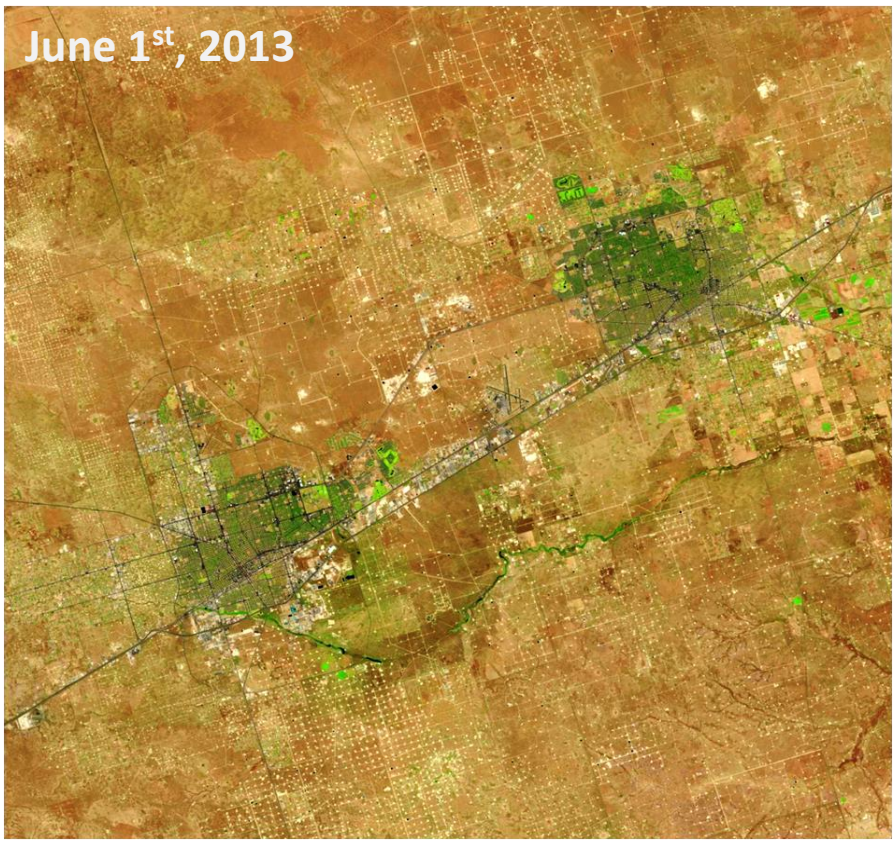


Image source link (USGS Image of the Week) no longer active for this pair)



Texas Oil Field Expansion, 1984 – 2013.

Oil and gas production in the Permian Basin of west Texas is carried out primarily from two cities, Midland (upper right) and Odessa (lower left). In this Landsat image both of the arid-region cities appear bright green (irrigated lawns and trees). Oil fields appear as densely spaced bright dots where well sites have been cleared for access.

Key Phrase correlations: **Recognize landforms/land features; Interpret Earth's surface features using a variety of methods; Impact of humans on Earth's systems; Use of resources: impacts on Earth's systems**

Key Word correlations: **Rivers; satellite imagery; development; fossil fuel burning; energy production; environmental impacts.**