#SPACEJOURNALISM

Derek Watkins
The New York Times
@dwtkns

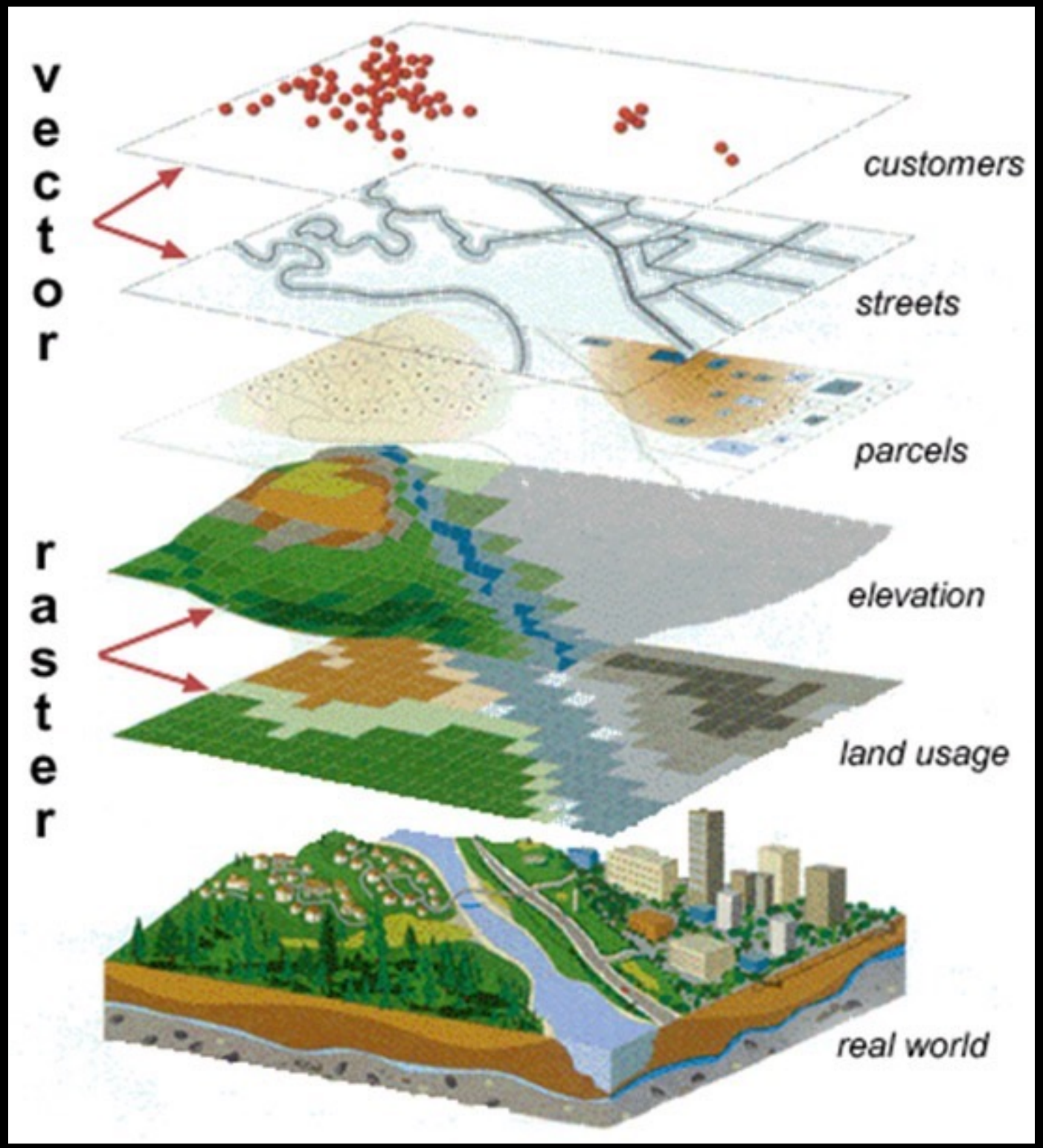
Al Shaw
ProPublica
@A_L

Brian Jacobs
National Geographic
@btjakes

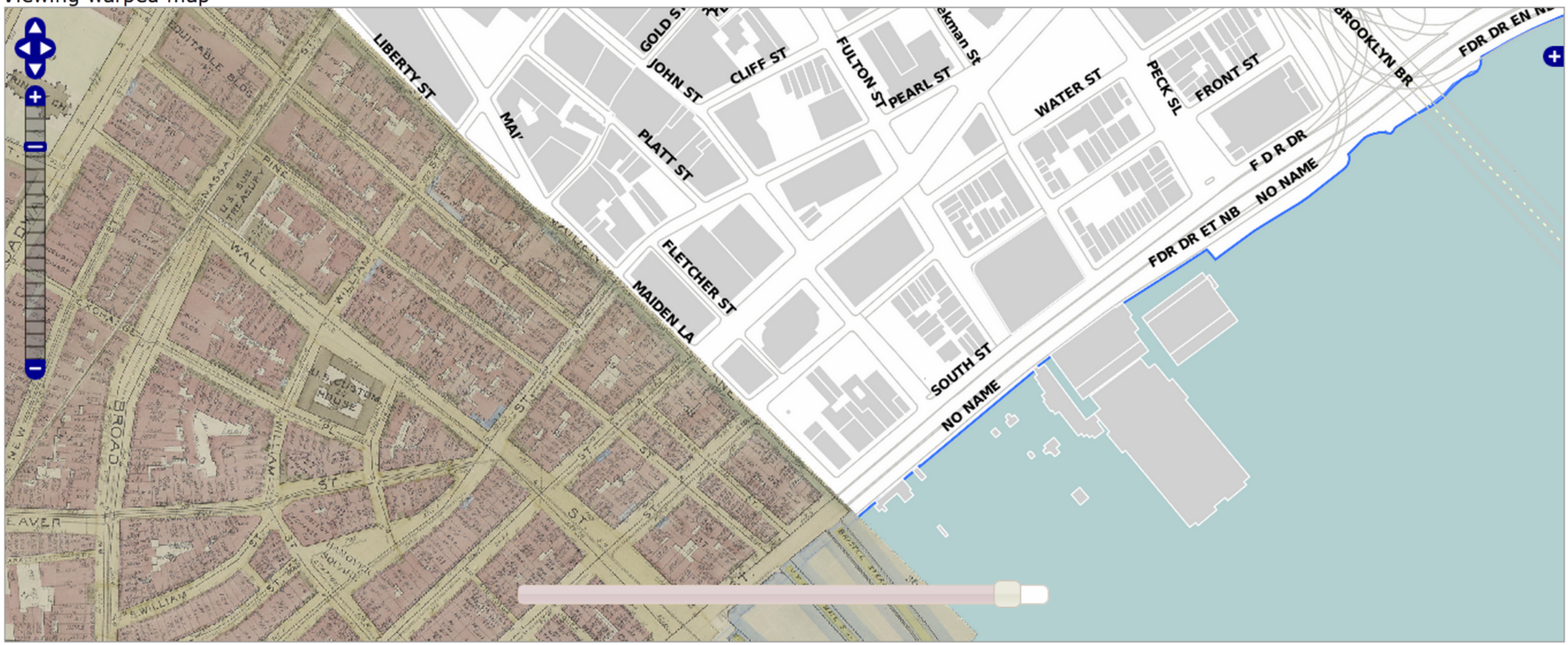
Lela Prashad
NiJeL
ASTER
@lelap

RESOURCES
http://bit.ly/nicar-space

Parana
Central
Salta
Chaco
Iberá Wetlands
Corrientes
Rio Grande do Sul
Catamarca
Santiago del Estero
Santa Fe
Mar Chiquita
La Rioja
Uruguay
Entre Rios
Chile
San Juan
Cordoba
Montevideo
Buenos Aires
Rio de La Plata
San Luis
Santiago
Mendoza
Argentina
Buenos Aires
La Pampa
Neuquen
Rio Negro
Golfo San Matías
US Dept of State Geographe
© 2014 Inav/Geosistemas S
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA,
Chubut
Argentine Sea
Tour Guide

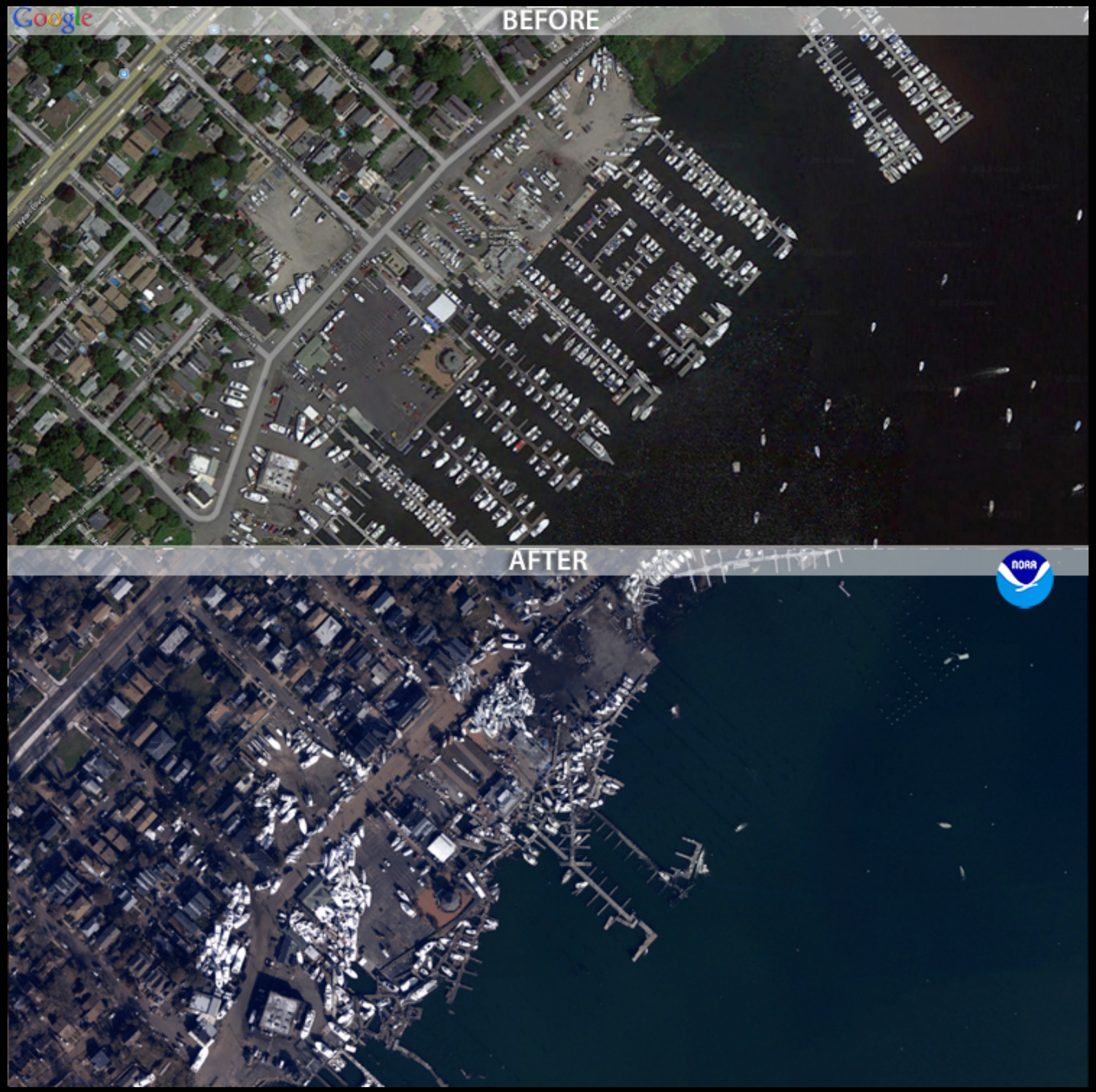

vector
raster
customers
streets
parcels
elevation
land usage
real world

Viewing warped map

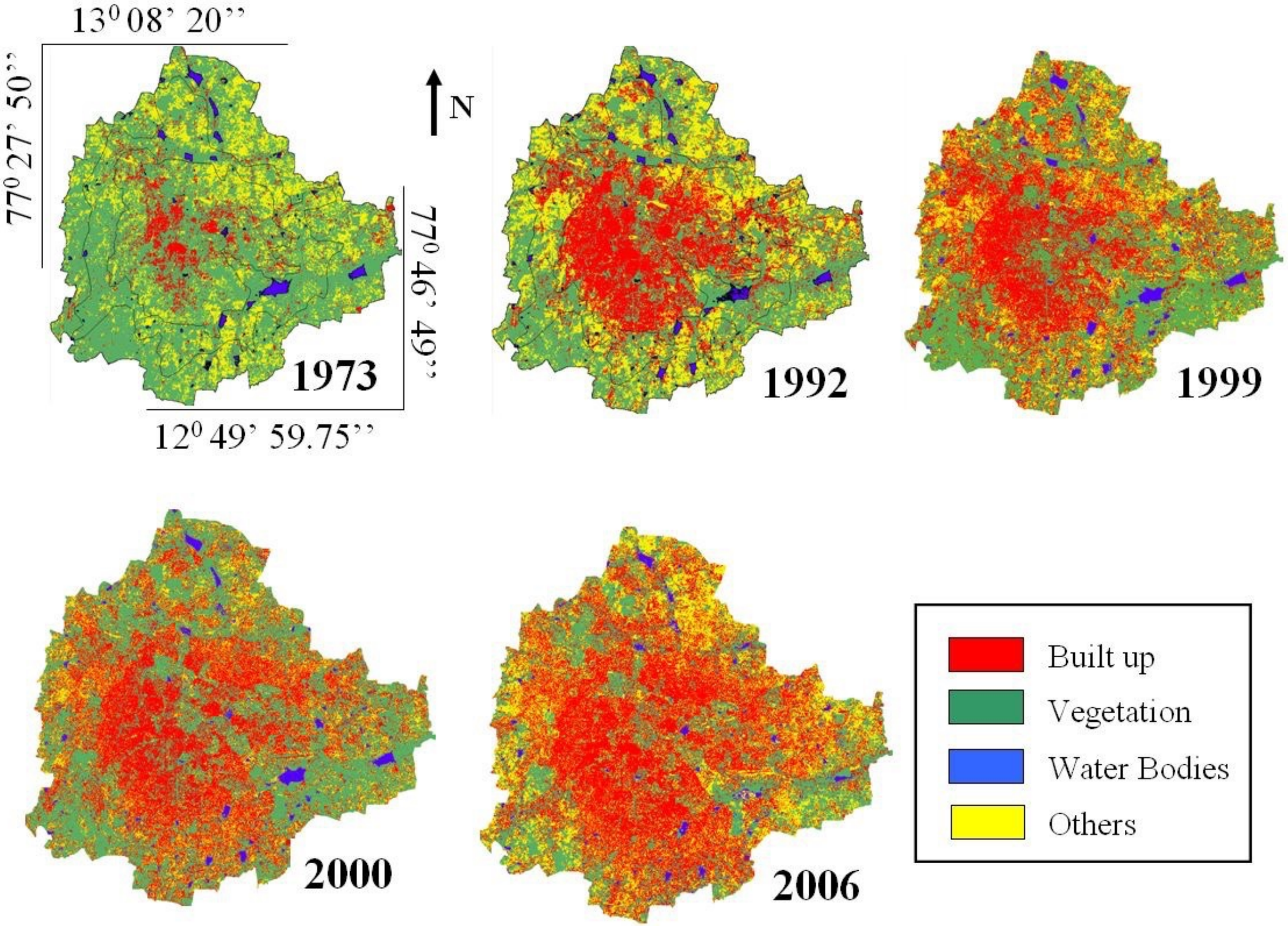


Transparency: 92

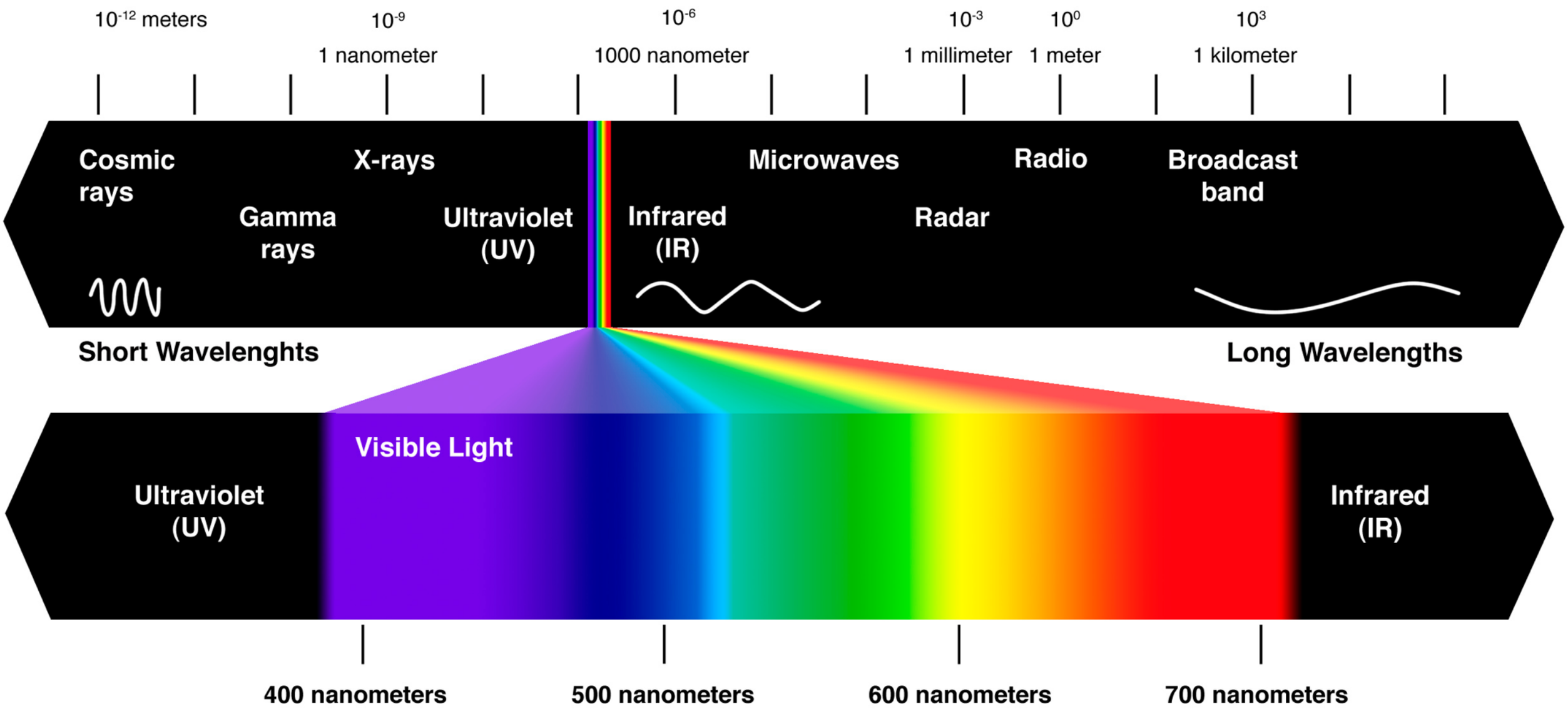
http://maps.nypl.org/warper/maps/17757#Preview_Rectified_Map_tab



http://oceanservice.noaa.gov/news/weeklynews/nov12/ngs-sandy-imagery.html


13⁰ 08’ 20’’
77⁰ 27’ 50’’
77⁰ 46’ 49’’
12⁰ 49’ 59.75’’
N
1973
1992
1999
2000
2006
Built up
Vegetation
Water Bodies
Others

REMOTE SENSING
CRASH COURSE


10^{-12} meters
10^{-9}
1 nanometer
10^{-6}
1000 nanometer
10^{-3}
1 millimeter
10^{0}
1 meter
10^{3}
1 kilometer
Cosmic rays
Gamma rays
X-rays
Ultraviolet (UV)
Infrared (IR)
Microwaves
Radar
Radio
Broadcast band
Short Wavelenghts
Long Wavelengths
Visible Light
Ultraviolet (UV)
Infrared (IR)
400 nanometers
500 nanometers
600 nanometers
700 nanometers

Swift
Fermi
Chandra
Kepler
Hubble
Herschel
Spektr-R
NuSTAR
GALEX
Spitzer
Planck

gamma ray X-ray ultraviolet visible infrared microwave radio

SOFIA
Keck
HESS
SALT
Gemini
CARMA
Greenbank
VLA

PASSIVE VS. ACTIVE

Radar (Radio Detection and Ranging)

Scatterometer (microwave radar)

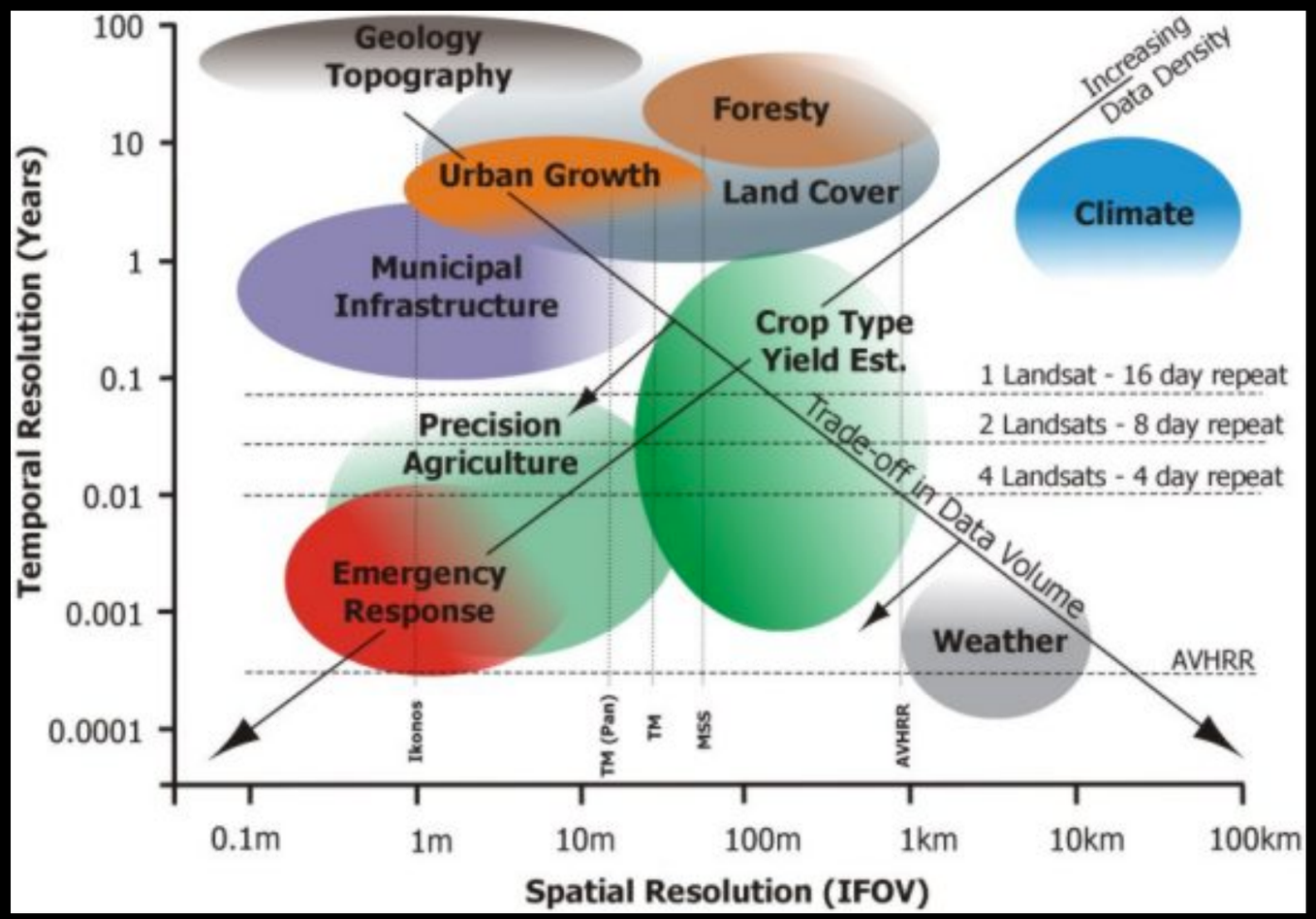
Lidar (Light Detection and Ranging)

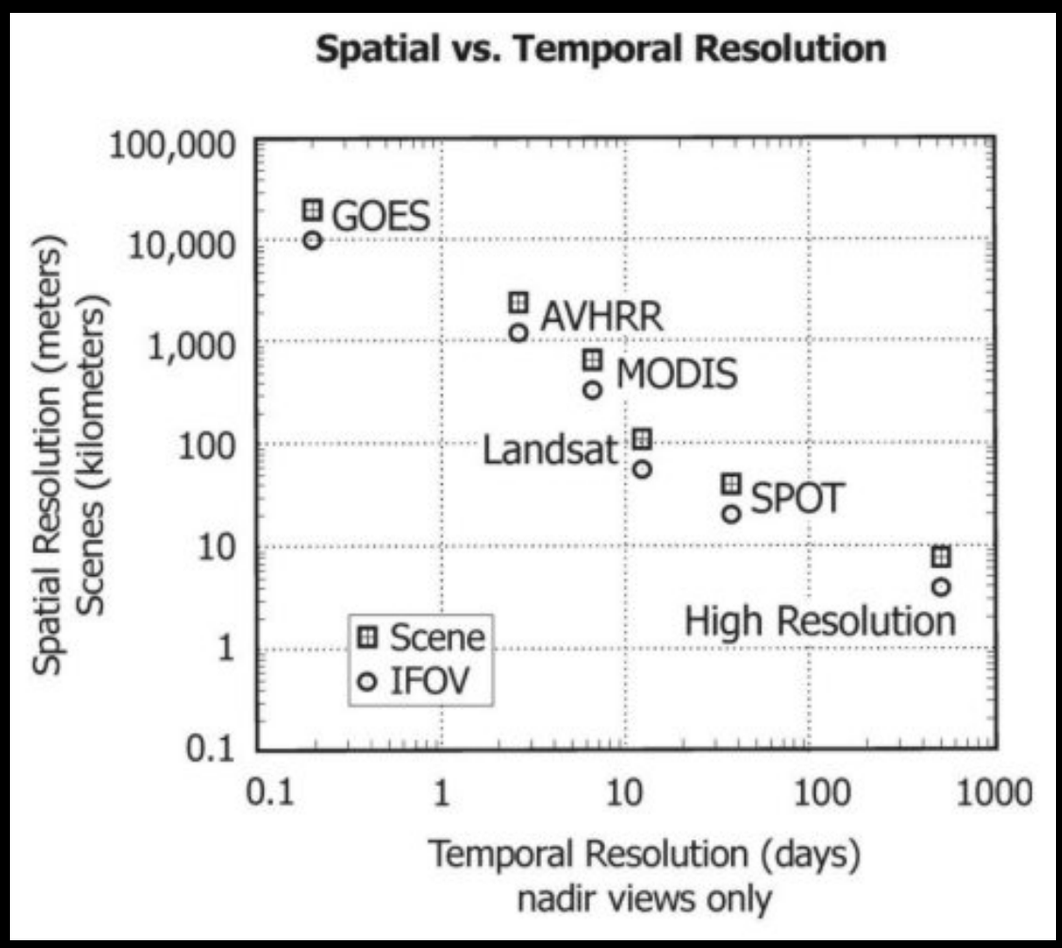
Laser Altimeter

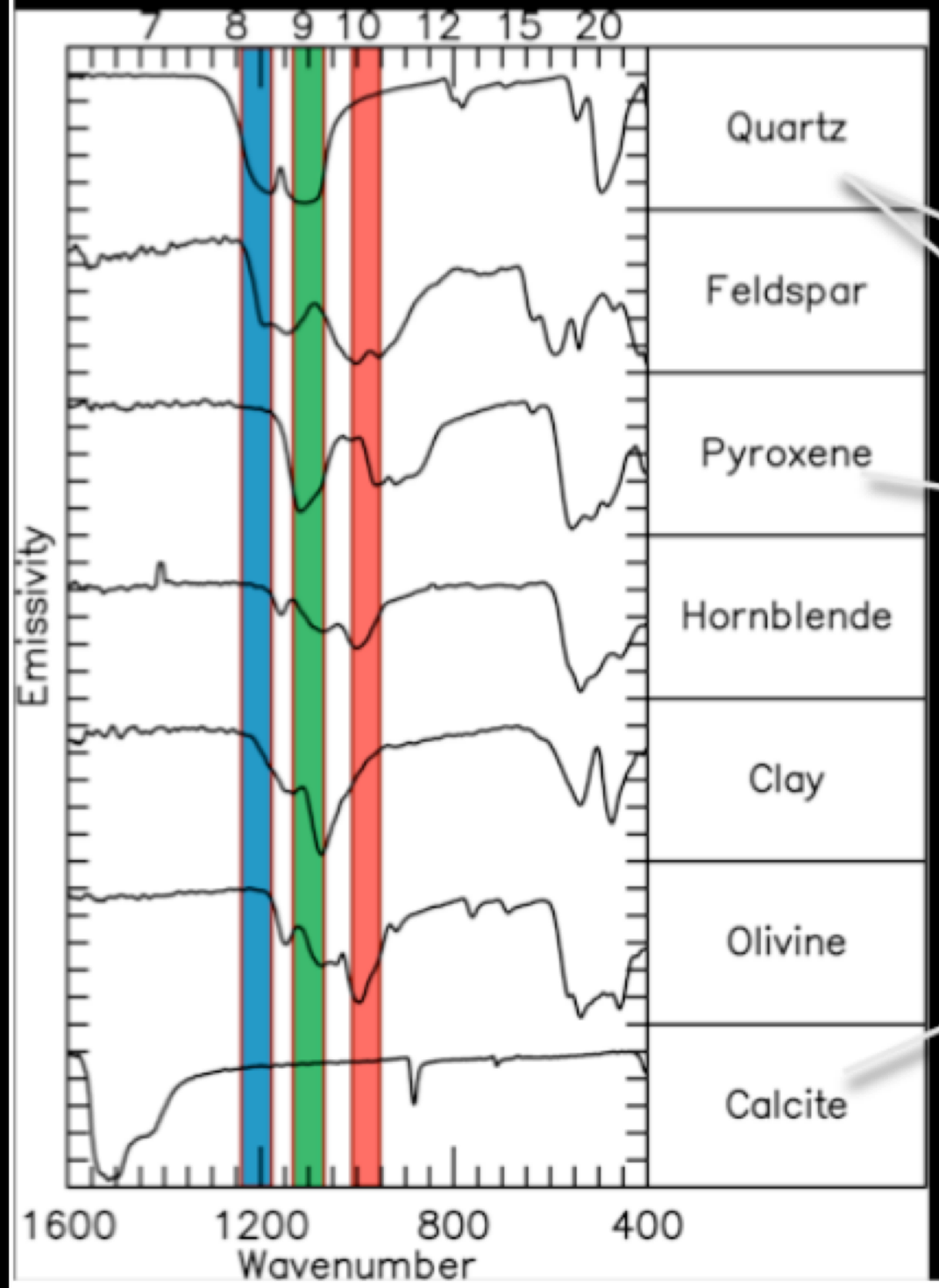
GRACE

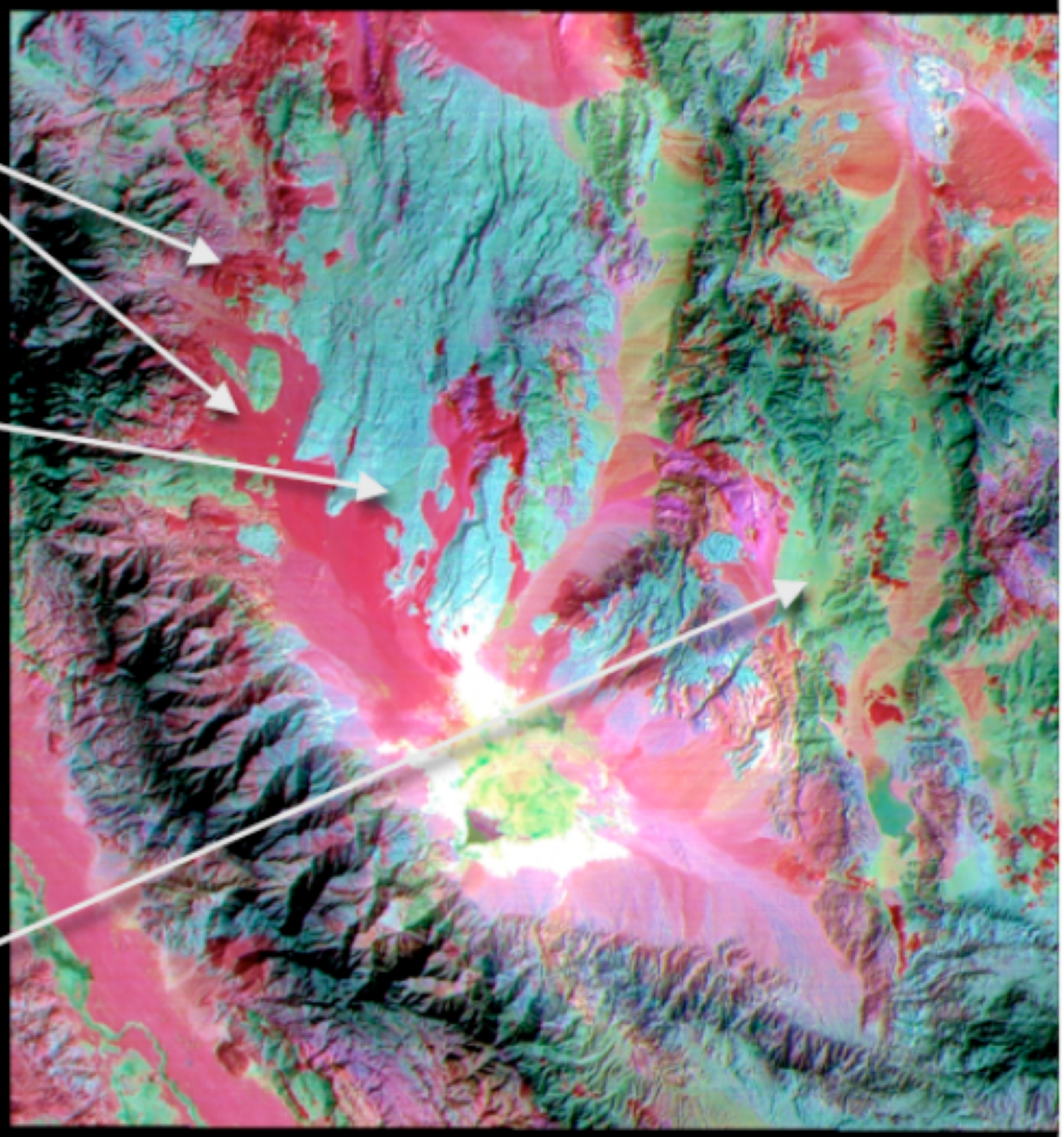
RESOLUTION

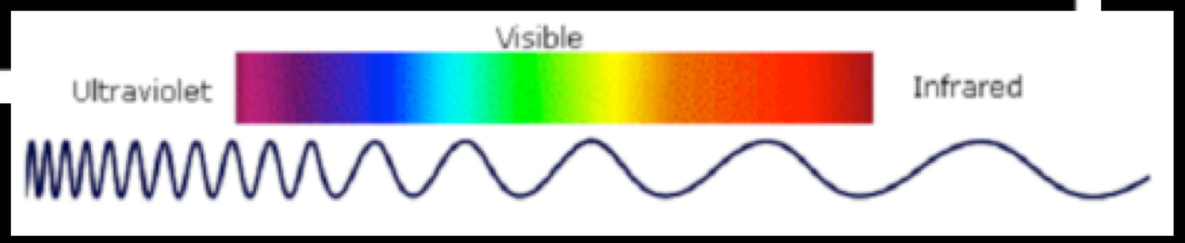
SPATIAL / SPECTRAL / TEMPORAL

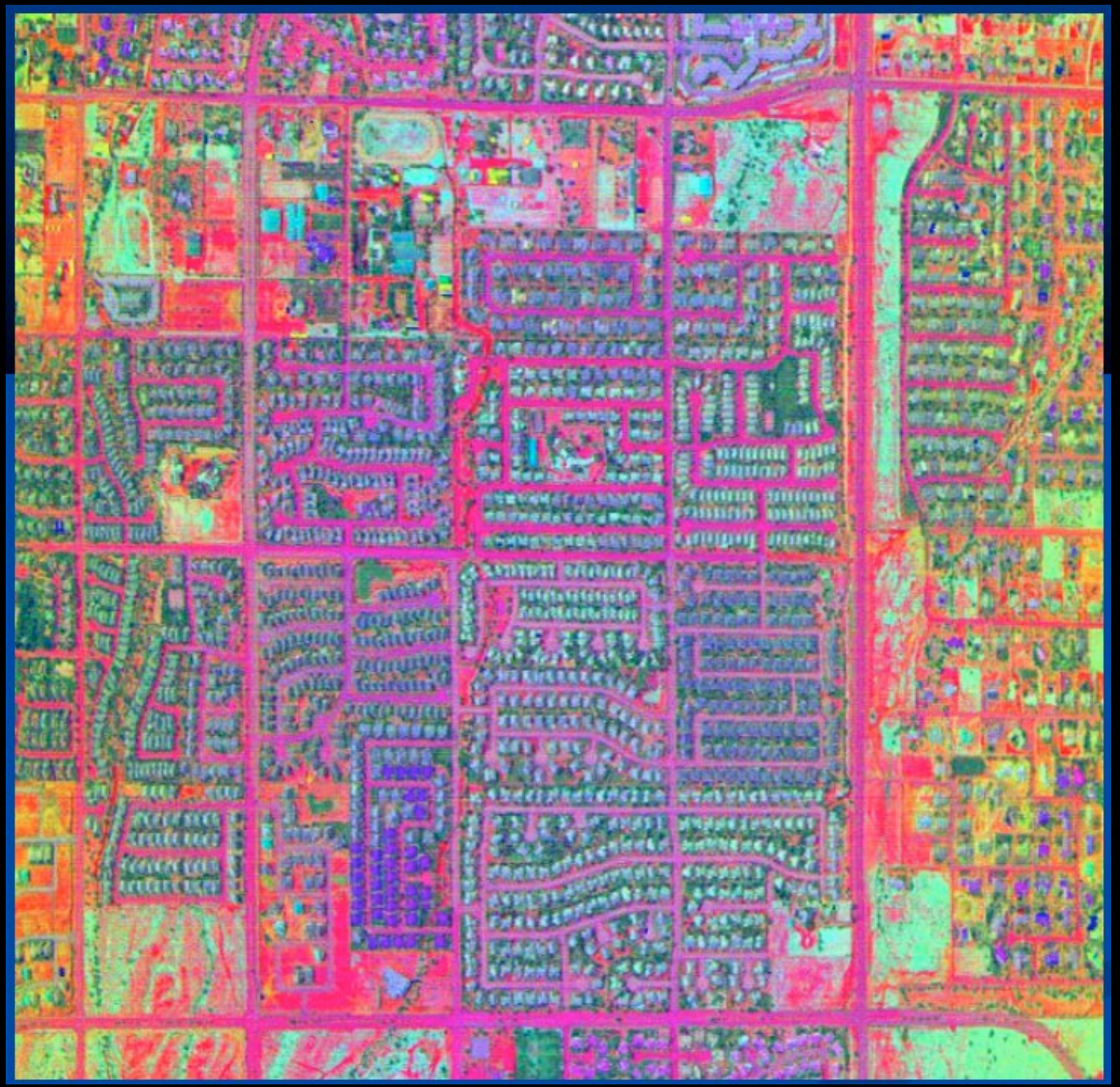





7
8
9
10
12
15
20
Emissivity
Quartz
Feldspar
Pyroxene
Hornblende
Clay
Olivine
Calcite
1600
1200
800
400
Wavenumber




Visible
Ultraviolet
Infrared



Red: concrete

Green: grass

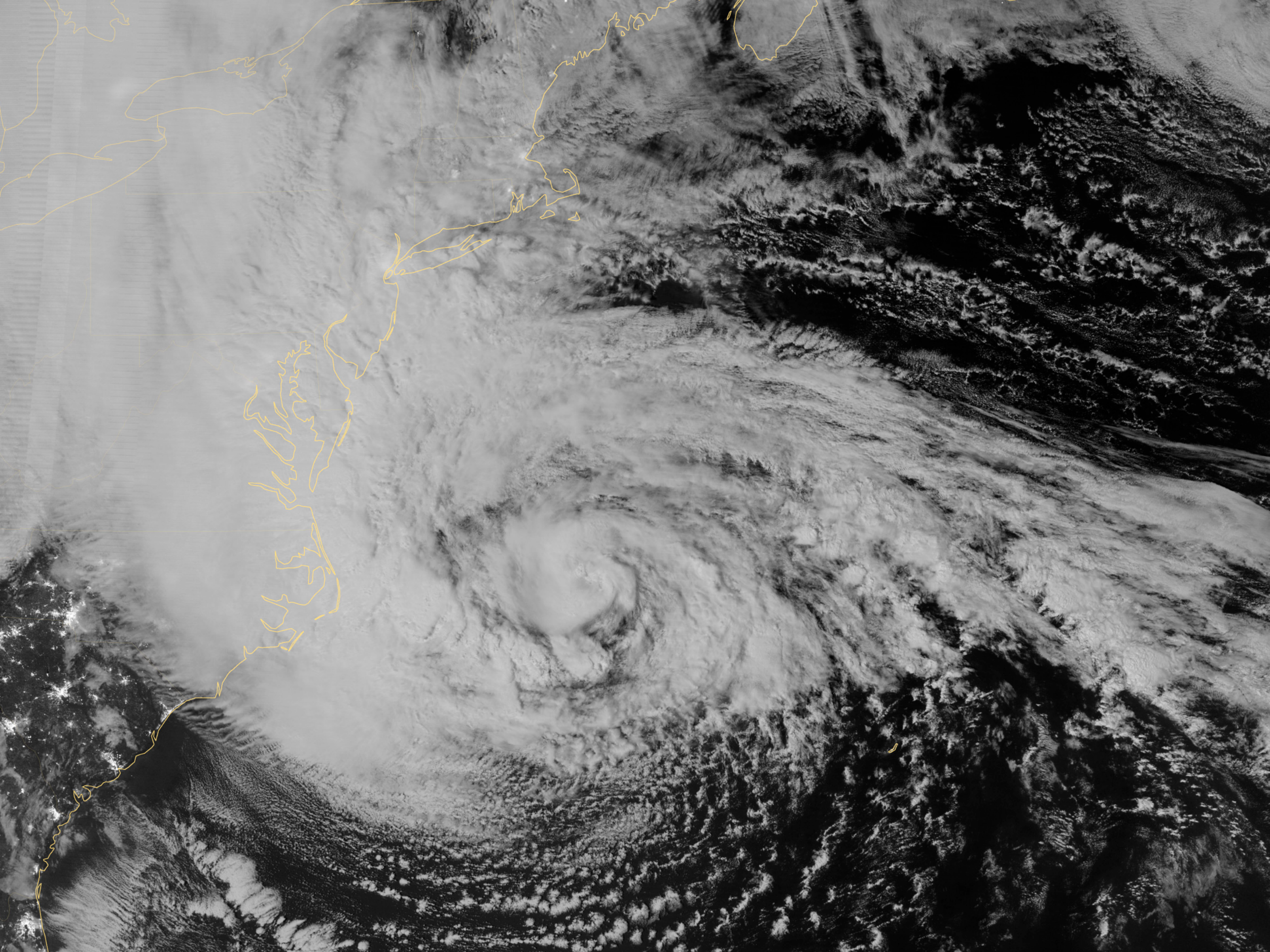
Blue: water

Pink: asphalt

Brown & tan: bare soil and gravel

Dark green: trees

Cyan: roofing materials



Piqiang Fault

2 km

Pine Island Glacier

Iceberg B-31

5 km

1 km

Camarillo

burn scar

Newbury Park

2 km

San Pablo Bay

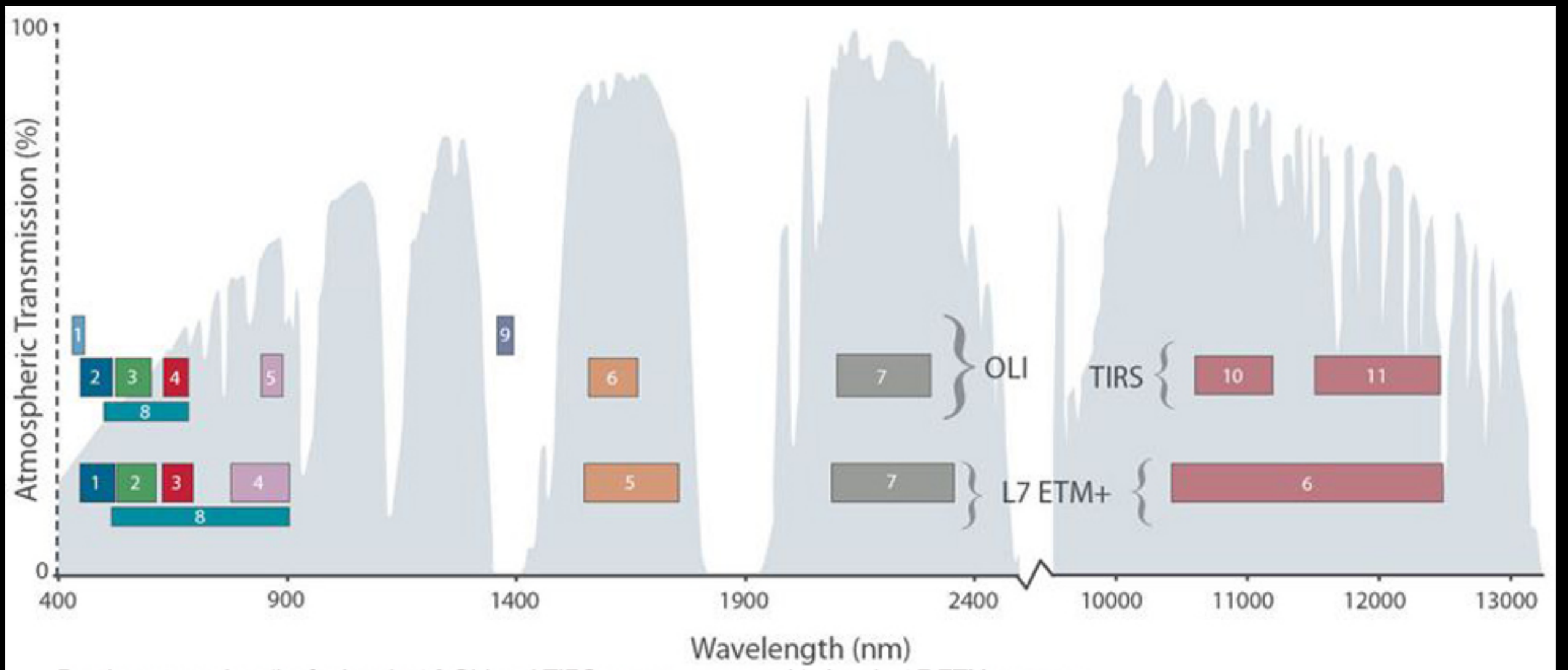
Carquinez Strait

Golden Gate

Oakland

San Francisco

5 km



Bandpass wavelengths for Landsat 8 OLI and TIRS sensor, compared to Landsat 7 ETM+ sensor

Note: atmospheric transmission values for this graphic were calculated using MODTRAN for a summertime mid-latitude hazy atmosphere (circa 5 km visibility).

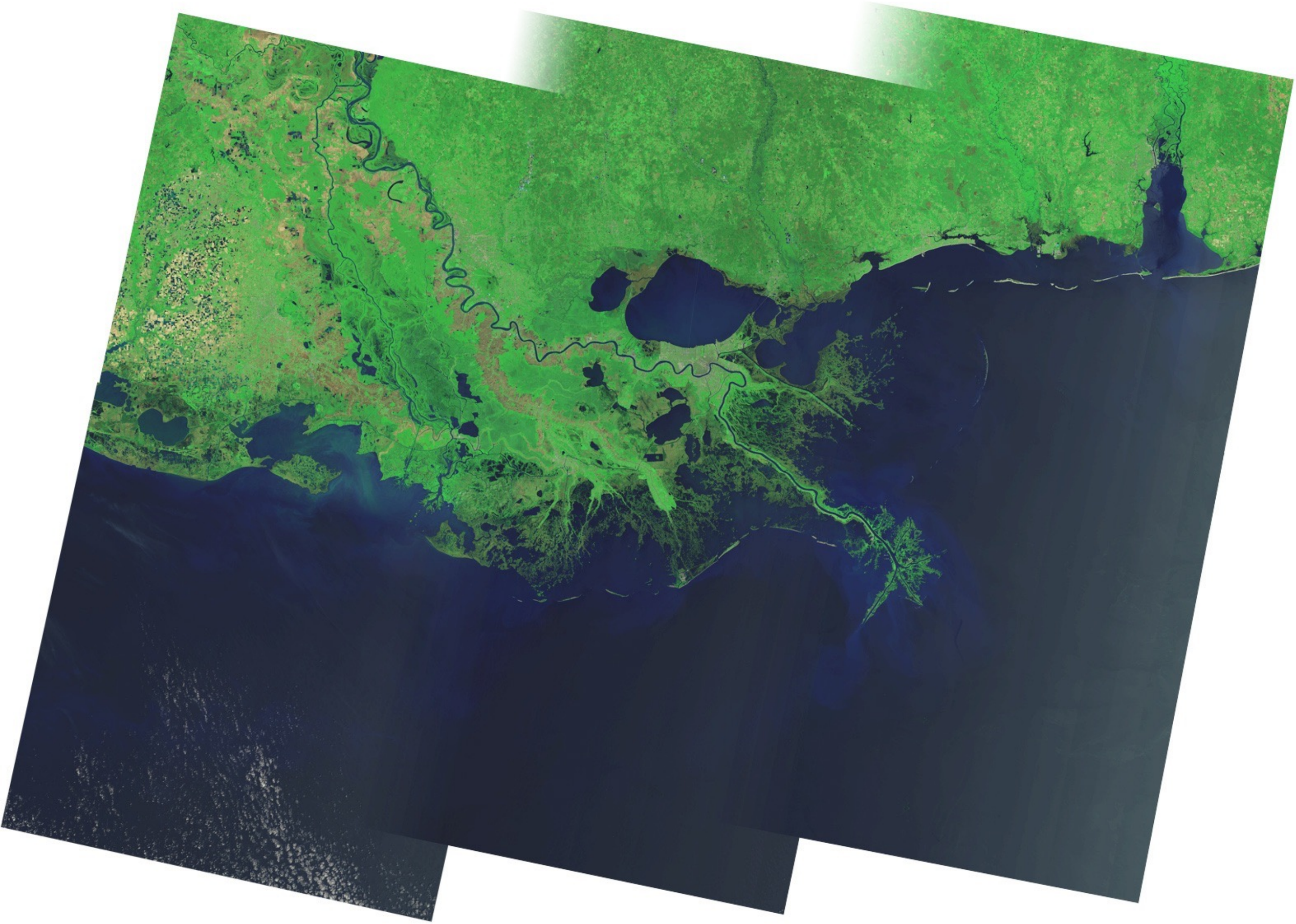
Landsat 8 scene / bands

File	Band Name	Bandwidth (μm)	Resolution (m)
LC80140322014139LGN00_B1.TIF	Coastal	.43 – 0.45	30
LC80140322014139LGN00_B2.TIF	Blue	0.45 – 0.51	30
LC80140322014139LGN00_B3.TIF	Green	0.53 – 0.59	30
LC80140322014139LGN00_B4.TIF	Red	0.64 – 0.67	30
LC80140322014139LGN00_B5.TIF	NIR	0.85 – 0.88	30
LC80140322014139LGN00_B6.TIF	SWIR 1	1.57 – 1.65	30
LC80140322014139LGN00_B7.TIF	SWIR 2	2.11 – 2.29	30
LC80140322014139LGN00_B8.TIF	Pan	0.50 – 0.68	15
LC80140322014139LGN00_B9.TIF	Cirrus	1.36 – 1.38	30
LC80140322014139LGN00_B10.TIF	TIRS 1	10.6 – 11.19	100
LC80140322014139LGN00_B11.TIF	TIRS 2	11.5 – 12.51	100
LC80140322014139LGN00_BQA.TIF			
LC80140322014139LGN00_MTL.txt	metadata		

Landsat 8 Band Combinations

Natural Color	4 3 2
False Color (urban)	7 6 4
Color Infrared (vegetation)	5 4 3
Agriculture	6 5 2
Atmospheric Penetration	7 6 5
Healthy Vegetation	5 6 2
Land/Water	5 6 4
Natural With Atmospheric Removal	7 5 3
Shortwave Infrared	7 5 4
Vegetation Analysis	6 5 4

http://blogs.esri.com/esri/arcgis/2013/07/24/band-combinations-for-landsat-8/



Case Study: “Losing Ground”

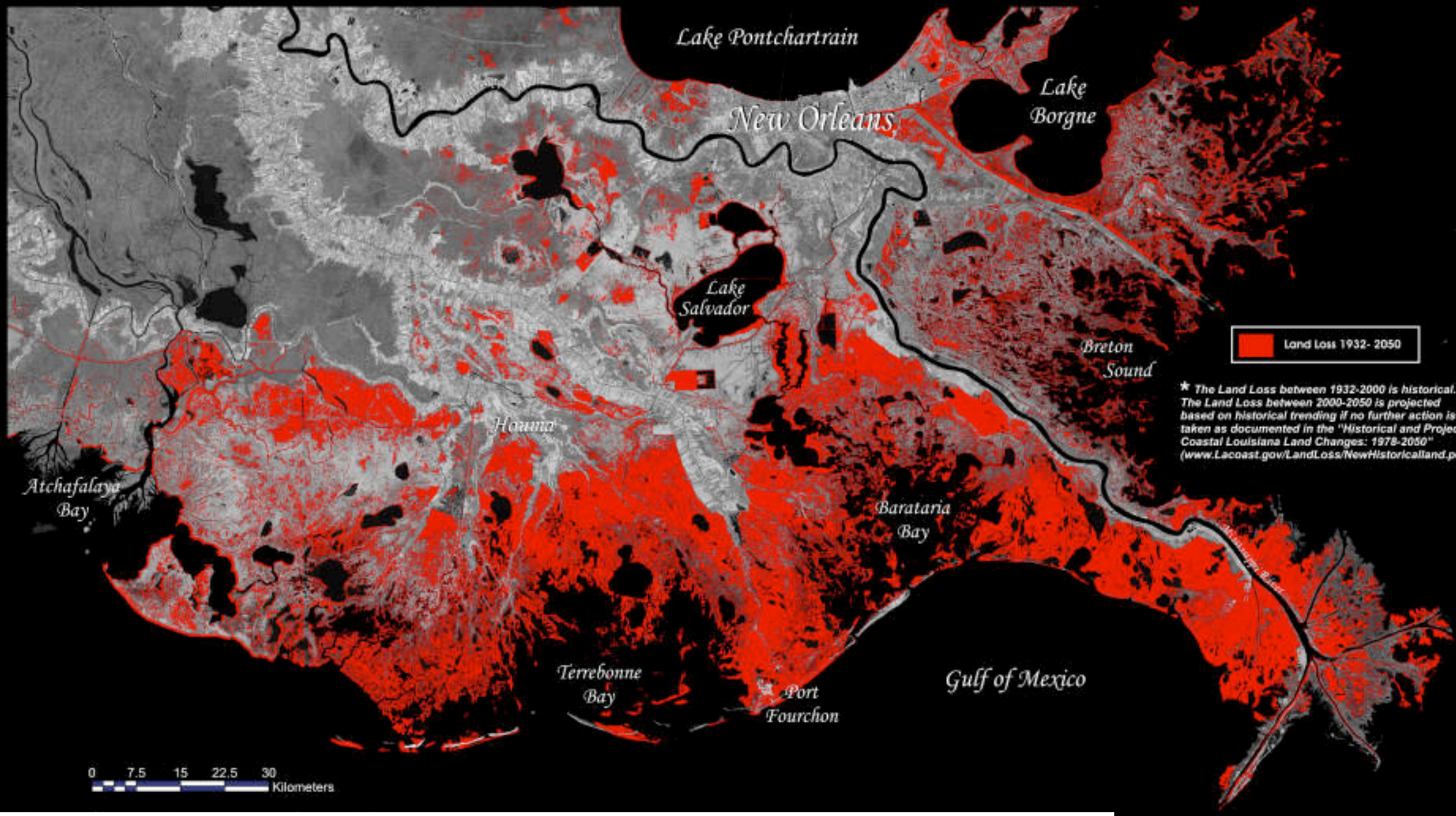
@A_L

http://j.mp/nicar-louisiana

NASA Landsat, processed by ProPublica

Southeast Louisiana Land Loss

*Historical and Projected Land Loss in the Deltaic Plain

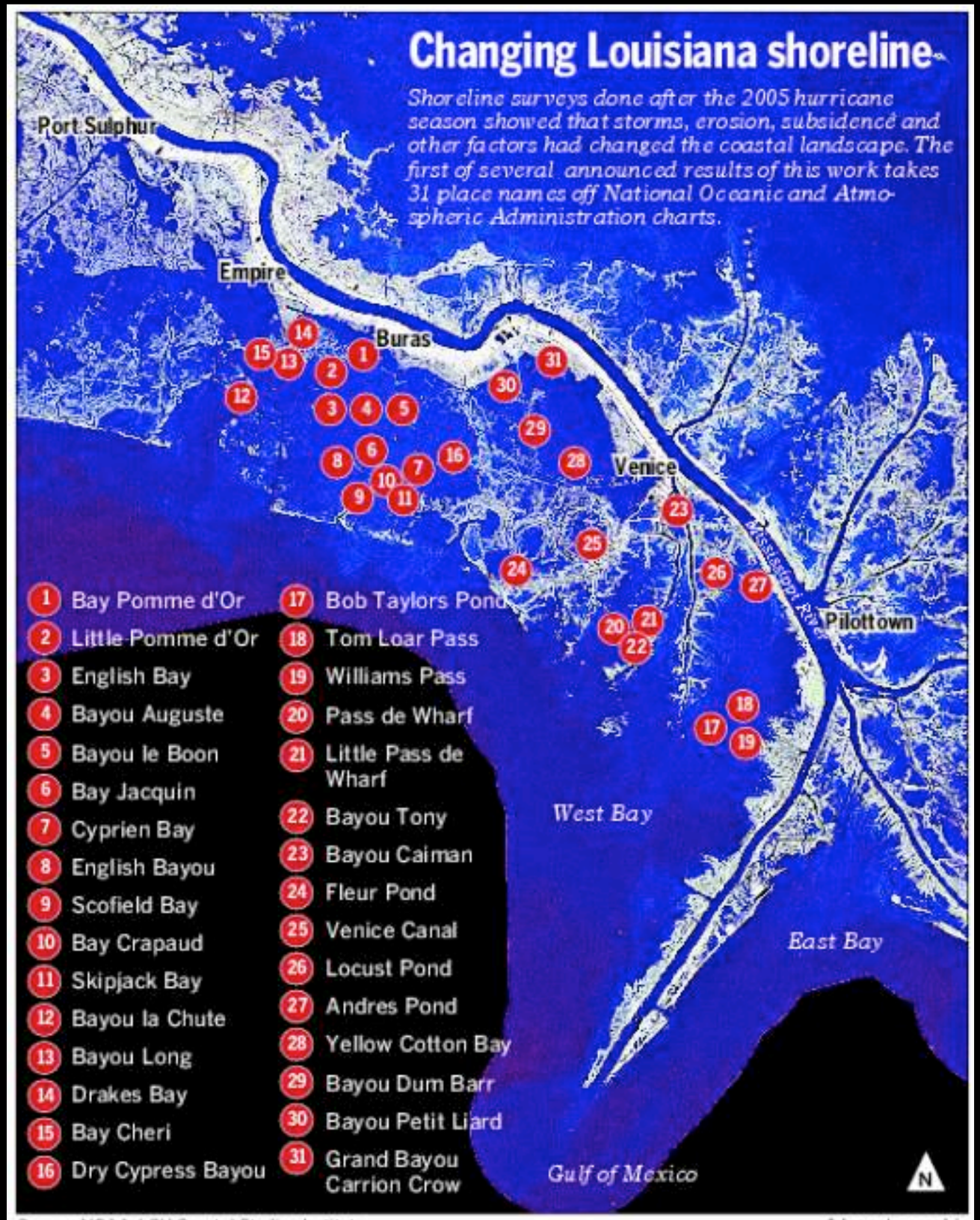


http://www.nwrc.usgs.gov/factshts/2005-3101/2005-3101.htm

primarily
Louisiana

Changing Louisiana shoreline

Shoreline surveys done after the 2005 hurricane season showed that storms, erosion, subsidence and other factors had changed the coastal landscape. The first of several announced results of this work takes 31 place names off National Oceanic and Atmospheric Administration charts.



Source: NOAA, LSU Coastal Studies Institute

Advocate graphic

http://theadvocate.com/news/neworleans/5827922-148/areas-gone-on-noaa-charts

1956

1972

2013

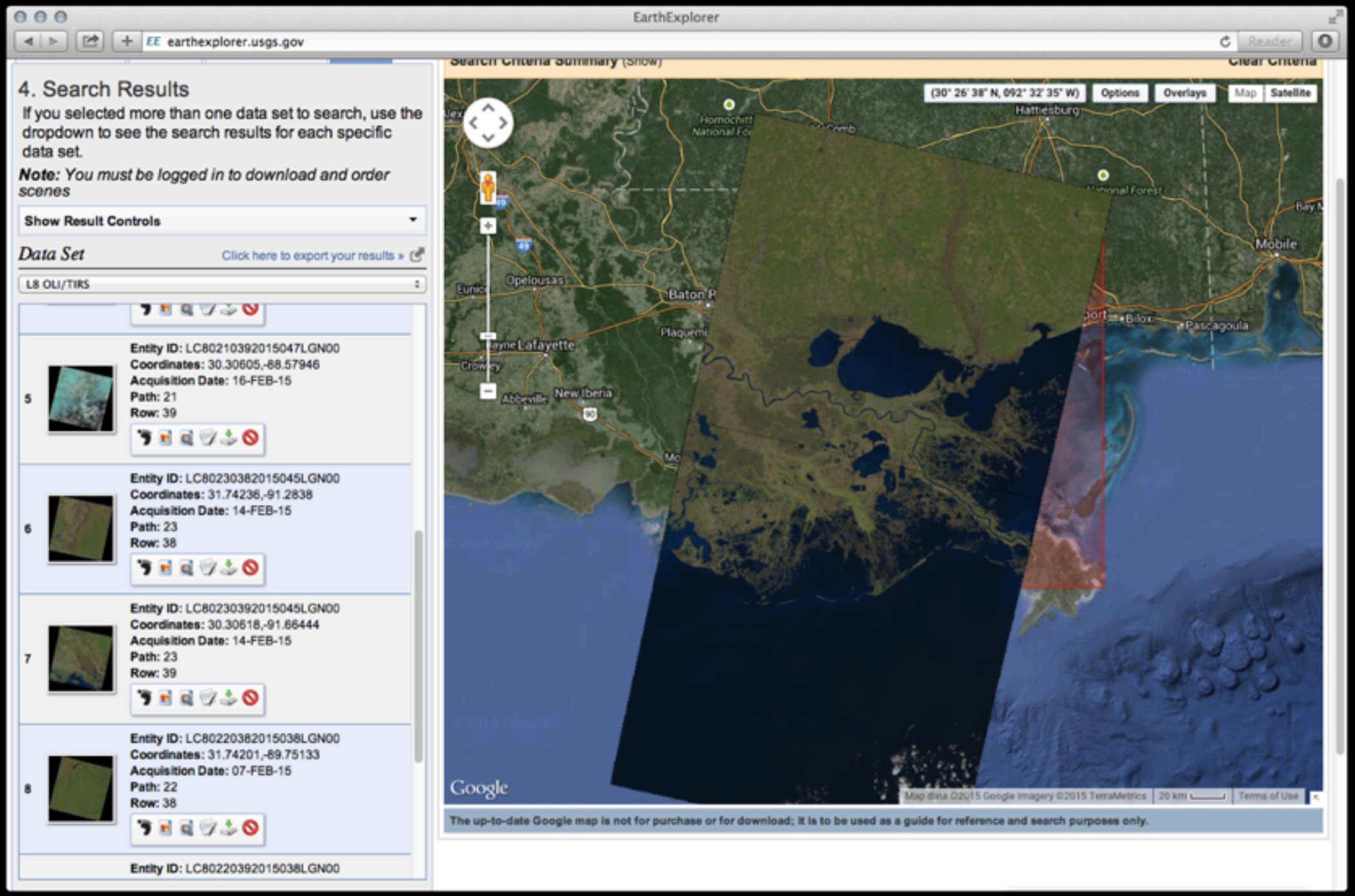
“Wagon wheel,” Venice, La.

USGS Aerials

Investigative Space Journalism!

NASA

Acquiring Imagery



http://earthexplorer.usgs.gov

landsat-util

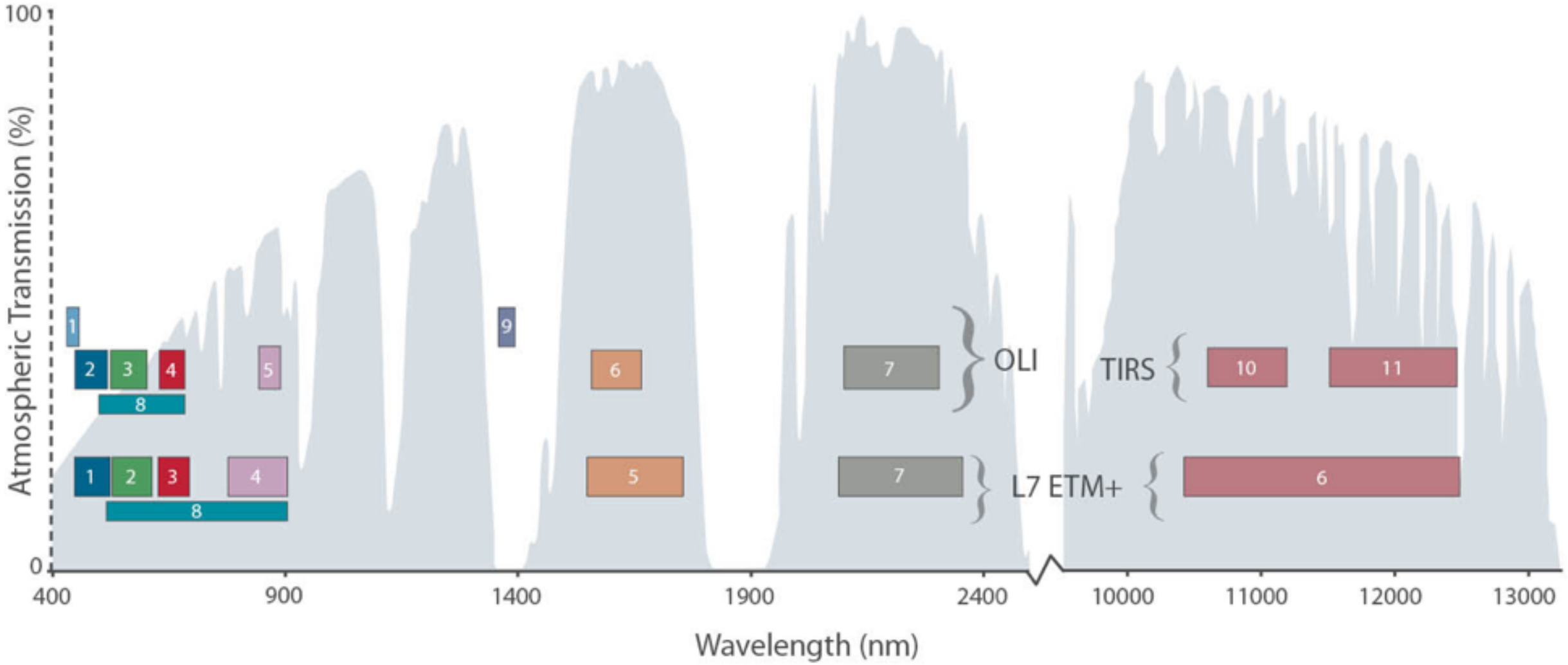
https://github.com/developmentseed/landsat-util

```
landsat search --download --cloud 4 --start "january 01 2014"
--end "january 10 2014" pr 009 045

landsat process path/to/LC80090452014008LGN00.tar.bz
```

TBA command line processing hotness: Jeff Larson's lightning talk tomorrow

Landsat 8



NASA

Landsat 8

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) Launched February 11, 2013	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Coastal aerosol	0.43 - 0.45	30
	Band 2 - Blue	0.45 - 0.51	30
	Band 3 - Green	0.53 - 0.59	30
	Band 4 - Red	0.64 - 0.67	30
	Band 5 - Near Infrared (NIR)	0.85 - 0.88	30
	Band 6 - SWIR 1	1.57 - 1.65	30
	Band 7 - SWIR 2	2.11 - 2.29	30
	Band 8 - Panchromatic	0.50 - 0.68	15
	Band 9 - Cirrus	1.36 - 1.38	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100 * (30)
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100 * (30)

NASA

LC80450292013225LGN00_B1.TIF
LC80450292013225LGN00_B2.TIF
LC80450292013225LGN00_B3.TIF
LC80450292013225LGN00_B4.TIF
LC80450292013225LGN00_B5.TIF
LC80450292013225LGN00_B6.TIF
LC80450292013225LGN00_B7.TIF
LC80450292013225LGN00_B8.TIF
LC80450292013225LGN00_B9.TIF
LC80450292013225LGN00_B10.TIF
LC80450292013225LGN00_B11.TIF
LC80450292013225LGN00_BQA.TIF
LC80450292013225LGN00_MTL.txt

http://earthobservatory.nasa.gov/blogs/elegantfigures/2013/10/22/how-to-make-a-true-color-landsat-8-image/

https://www.mapbox.com/blog/putting-landsat-8-bands-to-work/

Mapbox

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BLOG

Putting Landsat 8's Bands to Work

By Charlie Loyd on June 14 2013

Here's a picture of LA, just like an ordinary digital camera would take (if it had ten times as many megapixels and were in space). The image is only two weeks old, taken from Landsat 8, launched by NASA late this winter. Landsat 8 is already one of our favorite data sources – and not just ours: at State of the Map last weekend, it kept coming up in conversation with people from all kinds of backgrounds. More than just adding fresh true-color imagery from Landsat 8 to MapBox Satellite, we're investing in data services using the multispectral information that the satellite provides. Its non-visual bands let us analyze everything from terrain types to crop growth to natural disasters – all around the world, sometimes within hours. This post introduces some of Landsat 8's features, to give you a feel for what the world looks like through its lens.

http://earthobservatory.nasa.gov/blogs/elegantfigures/2013/10/22/how-to-make-a-true-color-landsat-8-image/

NASA EARTH OBSERVATORY
Where every day is Earth Day

Home Images Global Maps Features News & Notes

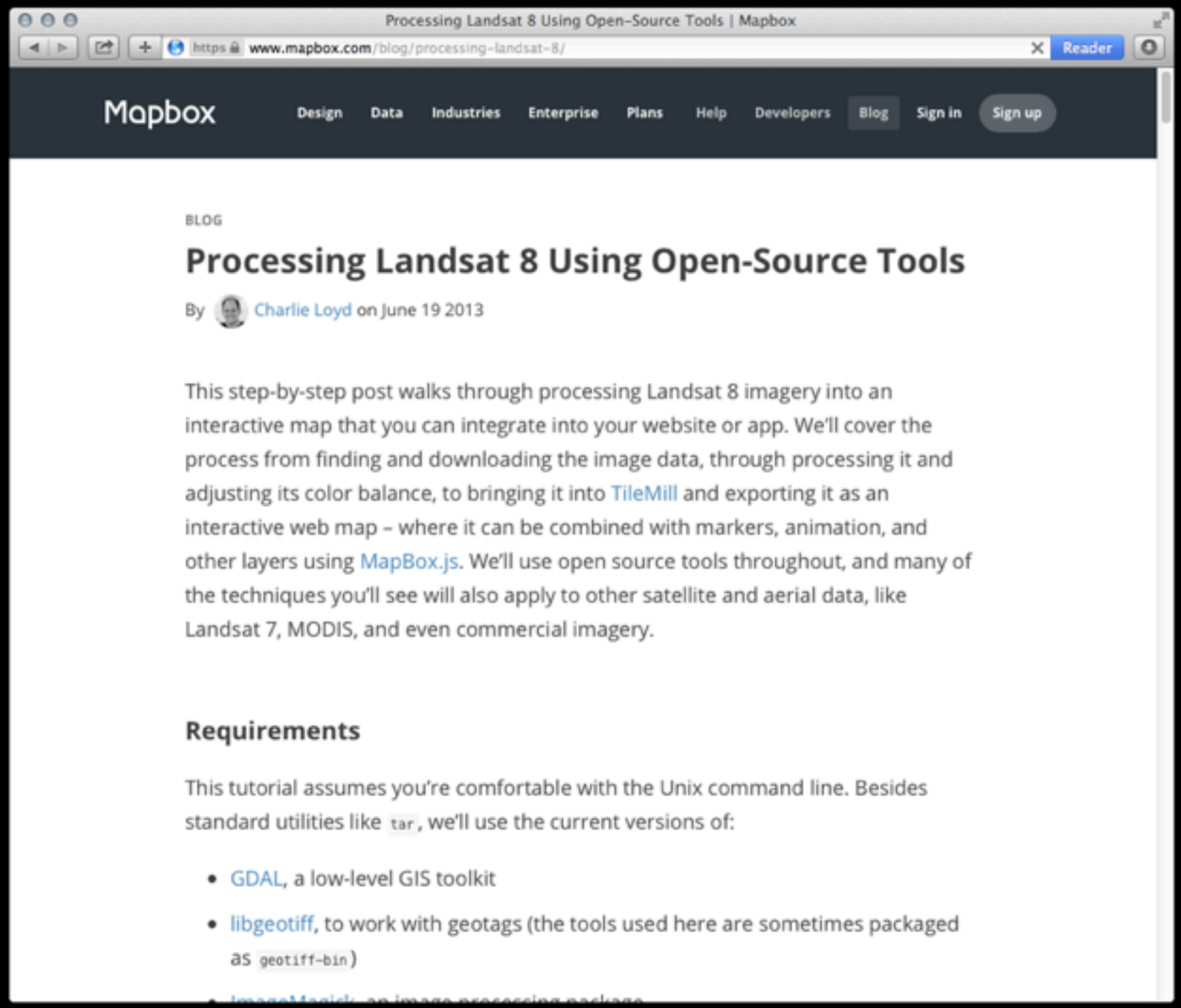
Home / Blogs / Elegant Figures / How To Make a True-Color Landsat 8 Image

How To Make a True-Color Landsat 8 Image

October 22nd, 2013 by Robert Simmon Share

Since its launch in February 2013, Landsat 8 has collected about 400 scenes of the Earth's surface per day. Each of these scenes covers an area of about 185 by 185 kilometers (115 by 115 miles)—34,200 square km (13,200 square miles)—for a total of 13,690,000 square km (5,290,000 square miles) per day. An area about 40% larger than the united states. Every day.

https://www.mapbox.com/blog/processing-landsat-8/



http://j.mp/charlie-loyd-rake

charlie-loyd.rake

https://www.mapbox.com/blog/processing-landsat-8

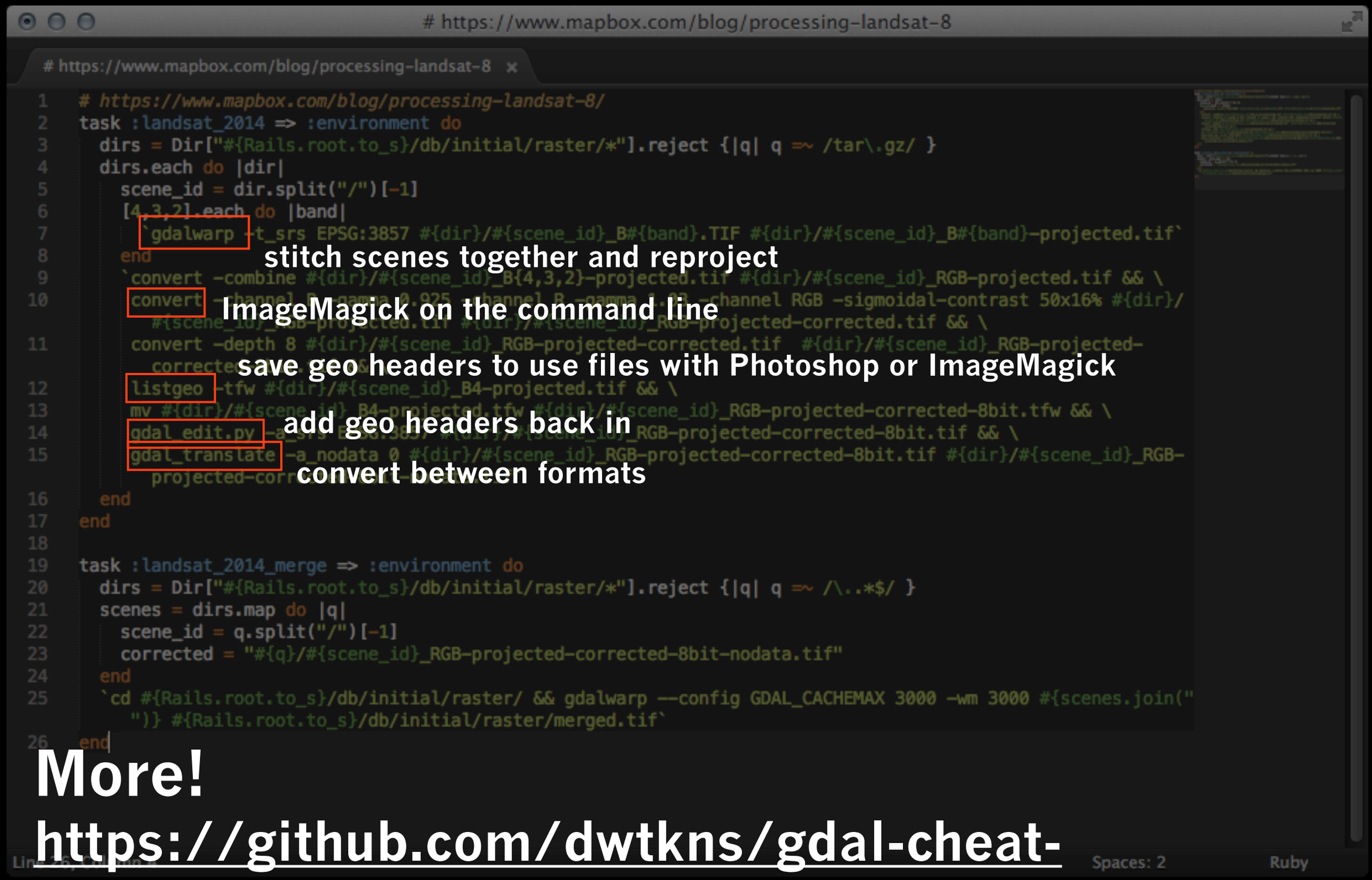
https://www.mapbox.com/blog/processing-landsat-8

```ruby
# https://www.mapbox.com/blog/processing-landsat-8/
task :landsat_2014 => :environment do
  dirs = Dir["#{Rails.root.to_s}/db/initial/raster/*"].reject {|q| q =~ /tar\.gz/ }
  dirs.each do |dir|
    scene_id = dir.split("/")[-1]
    [4,3,2].each do |band|
      `gdalwarp -t_srs EPSG:3857 #{dir}/#{scene_id}_B#{band}.TIF #{dir}/#{scene_id}_B#{band}-projected.tif`
    end
    `convert -combine #{dir}/#{scene_id}_B{4,3,2}-projected.tif #{dir}/#{scene_id}_RGB-projected.tif && \
     convert -channel B -gamma 0.925 -channel R -gamma 1.03 -channel RGB -sigmoidal-contrast 50x16% #{dir}/
       #{scene_id}_RGB-projected.tif #{dir}/#{scene_id}_RGB-projected-corrected.tif && \
     convert -depth 8 #{dir}/#{scene_id}_RGB-projected-corrected.tif  #{dir}/#{scene_id}_RGB-projected-
       corrected-8bit.tif && \
     listgeo -tfw #{dir}/#{scene_id}_B4-projected.tif && \
     mv #{dir}/#{scene_id}_B4-projected.tfw #{dir}/#{scene_id}_RGB-projected-corrected-8bit.tfw && \
     gdal_edit.py -a_srs EPSG:3857 #{dir}/#{scene_id}_RGB-projected-corrected-8bit.tif && \
     gdal_translate -a_nodata 0 #{dir}/#{scene_id}_RGB-projected-corrected-8bit.tif #{dir}/#{scene_id}_RGB-
       projected-corrected-8bit-nodata.tif`
  end
end

task :landsat_2014_merge => :environment do
  dirs = Dir["#{Rails.root.to_s}/db/initial/raster/*"].reject {|q| q =~ /\..*$/ }
  scenes = dirs.map do |q|
    scene_id = q.split("/")[-1]
    corrected = "#{q}/#{scene_id}_RGB-projected-corrected-8bit-nodata.tif"
  end
  `cd #{Rails.root.to_s}/db/initial/raster/ && gdalwarp --config GDAL_CACHEMAX 3000 -wm 3000 #{scenes.join("
    ")} #{Rails.root.to_s}/db/initial/raster/merged.tif`
end
```

Line 26, Column 4 Spaces: 2 Ruby

charlie-loyd.rake



stitch scenes together and reproject

ImageMagick on the command line

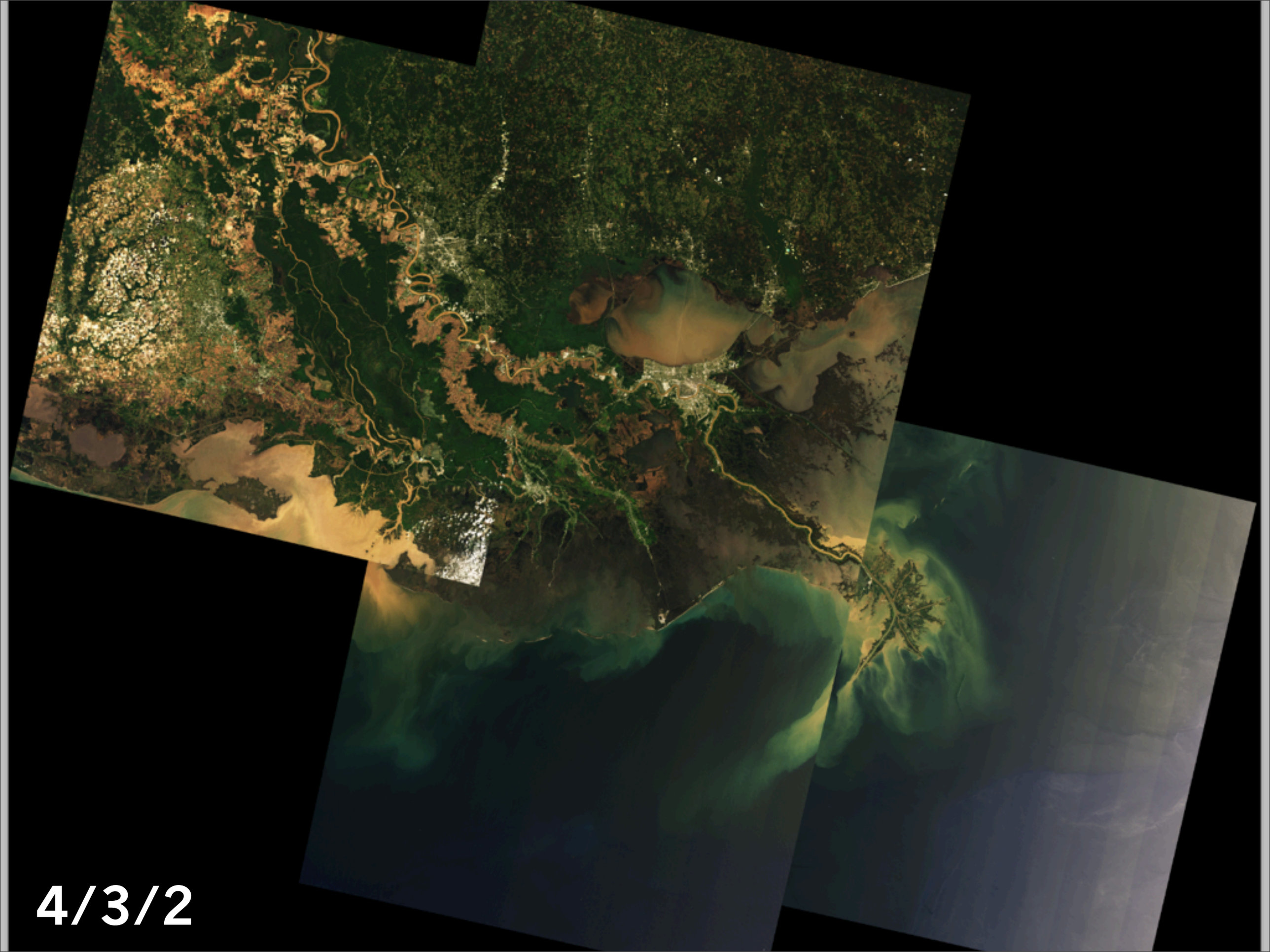
save geo headers to use files with Photoshop or ImageMagick

add geo headers back in

convert between formats

More!

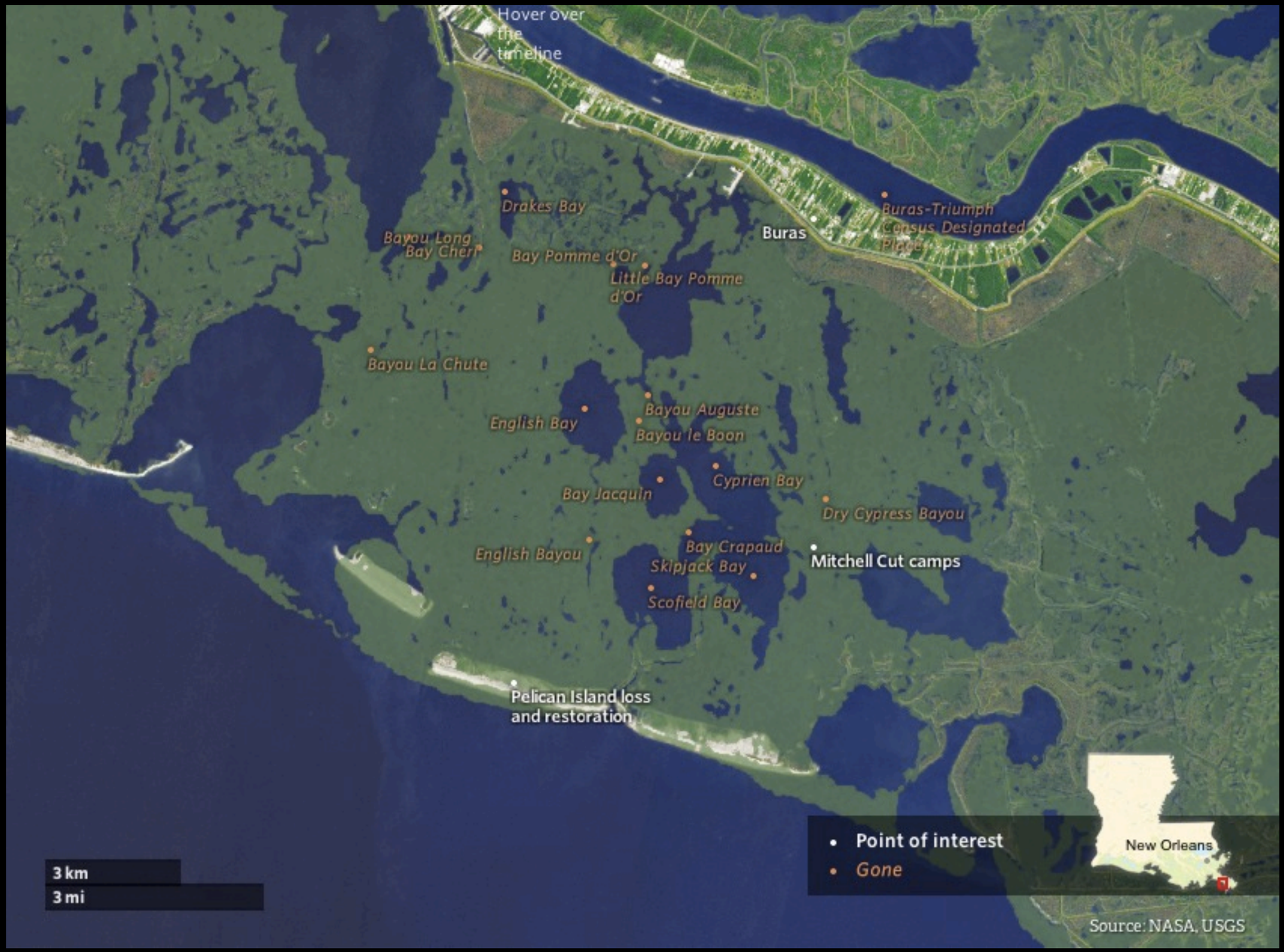
https://github.com/dwtkns/gdal-cheat-sheet#raster-operations


4/3/2

7/5/3

4/3/2 + 5 mask

Creating “land”



Buras, La. land loss 1932 to present via USGS, over 2014 Landsat 8

Creating “land”

Buras, La. land loss 2009 via USGS, over 2014 Landsat 8

Figure 6. Linear regressions of land area change trends in coastal Louisiana by hydrologic basin (as defined by the Coast Restoration Act Program, n.d.), 1985–2010; negative measurements indicate land loss, while positive measurements indicate l effects of the hurricanes of 2005 and 2008 are shown for comparison.

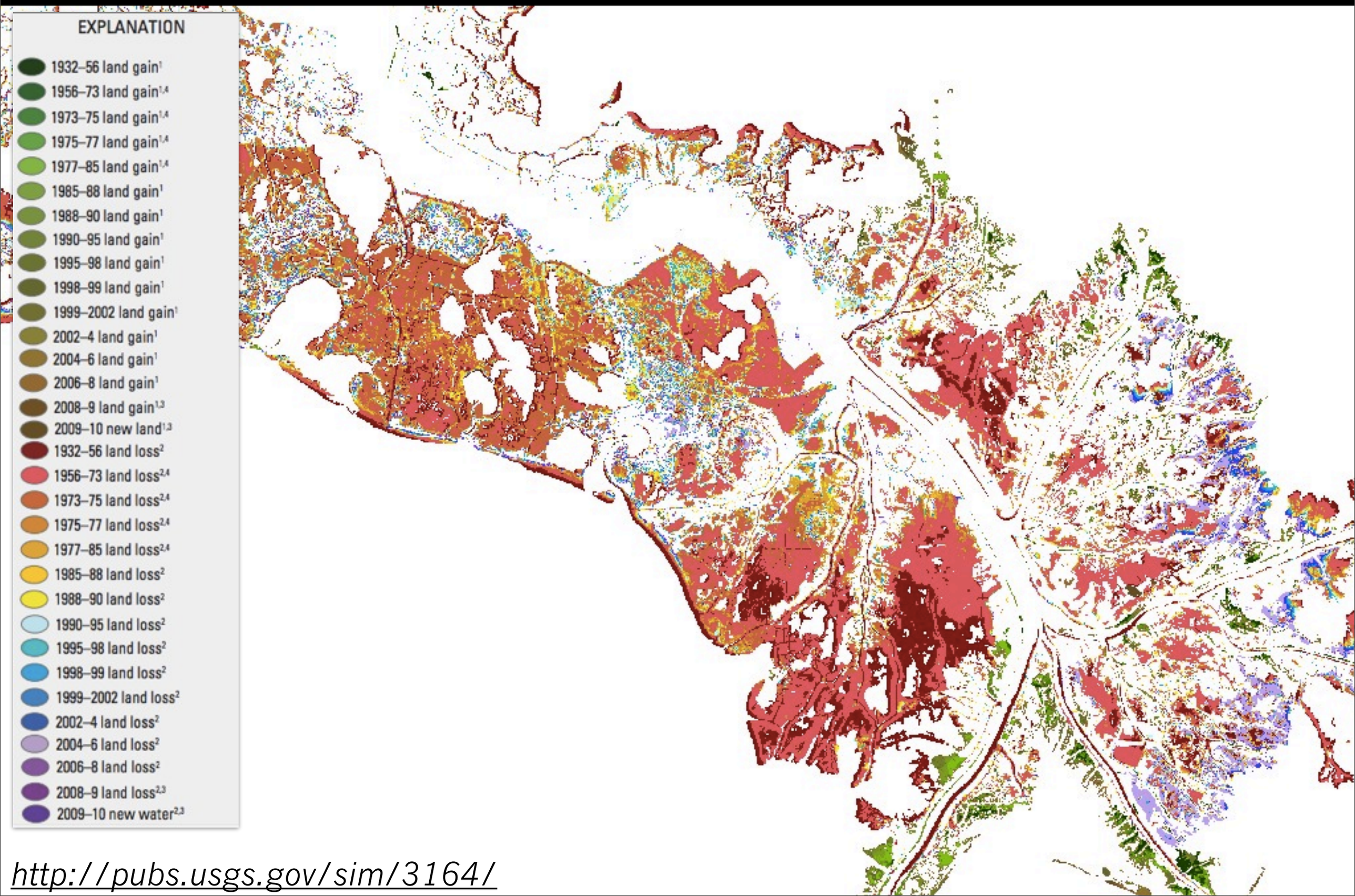
Land area · Excluded data points, 2005–8 · Regression trend line, 1985–2004 · Regression trend line, 1985–2010 · 95 per cent

Lake Maurepas
Lake Pontchartrain
Lake Saint Catherine
Lake Borgne
Mississippi
Louisiana
Pontchartrain Basin
Chandeleur Sound
Breton Sound
Breton Sound Basin
New Orleans
Lac des Allemands
Lake Cataouatche
Lake Salvador
Lake Lery
Little Lake
Barataria Bay
Barataria Basin
Gulf of Mexico
Lake Verret
Lake Pelourde
Lake De Cade
Lost Lake
Lake Mechant
Caillou Lake
Lake Felicity
Terrebonne Bay
Timbalier Bay
Port Fourchon
Terrebonne Basin
Mississippi River
Kilometers
10 5 0 10 20 30 40

l frequency of land change
udy is allowing scientists to
the causal mechanisms of the
urred. These investigations
ved information to develop
osystems, forecast possible
protection and restoration

http://pubs.usgs.gov/sim/3164/

Creating “land”



http://pubs.usgs.gov/sim/3164/

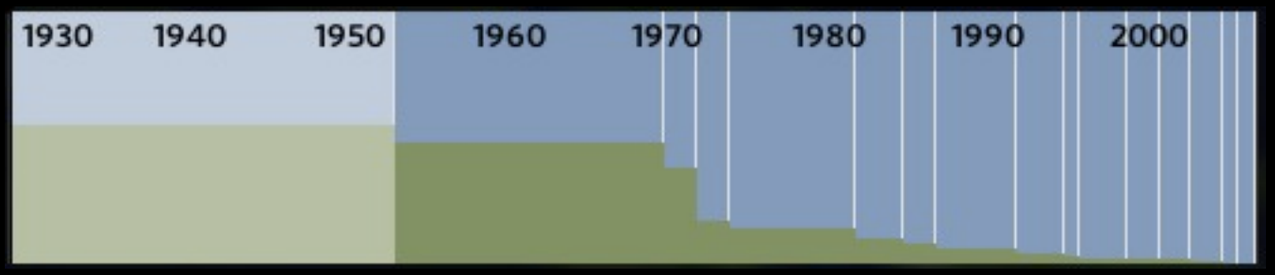
Creating “land”

```
colors = {
  "1932-1956-gain"   =>   "srgba(0,66,0,1)",
  "1956-1973-gain"   =>   "srgba(28,102,0,1)",
  "1973-1975-gain"   =>   "srgba(51,135,5,1)",
  "1975-1977-gain"   =>   "srgba(76,168,10,1)",
  "1977-1985-gain"   =>   "srgba(102,201,15,1)",
  "1985-1988-gain"   =>   "srgba(109,165,28,1)",
  "1988-1990-gain"   =>   "srgba(109,150,33,1)",
  "1990-1995-gain"   =>   "srgba(107,135,38,1)",
  "1995-1998-gain"   =>   "srgba(102,119,40,1)",
  "1998-1999-gain"   =>   "srgba(96,107,45,1)",
  "1999-2002-gain"   =>   "srgba(112,114,45,1)",
  "2002-2004-gain"   =>   "srgba(135,132,43,1)",
  "2004-2006-gain"   =>   "srgba(147,117,43,1)",
  "2006-2008-gain"   =>   "srgba(153,104,43,1)",
  "2008-2009-gain"   =>   "srgba(104,79,33,1)",
  "2009-2010-gain"   =>   "srgba(114,79,33,1)",
  "1932-1956-loss"   =>   "srgba(137,0,0,1)",
  "1956-1973-loss"   =>   "srgba(239,71,84,1)",
  "1973-1975-loss"   =>   "srgba(211,94,43,1)",
  "1975-1977-loss"   =>   "srgba(219,132,35,1)",
  "1977-1985-loss"   =>   "srgba(229,165,25,1)",
  "1985-1988-loss"   =>   "srgba(255,198,17,1)",
  "1988-1990-loss"   =>   "srgba(244,242,10,1)",
  "1990-1995-loss"   =>   "srgba(168,255,255,1)",
  "1995-1998-loss"   =>   "srgba(2,191,201,1)",
  "1998-1999-loss"   =>   "srgba(5,163,229,1)",
  "1999-2002-loss"   =>   "srgba(10,130,234,1)",
  "2002-2004-loss"   =>   "srgba(76,30,242,1)",
  "2004-2006-loss"   =>   "srgba(198,153,239,1)",
  "2006-2008-loss"   =>   "srgba(168,38,204,1)",
  "2008-2009-loss"   =>   "srgba(130,51,137,1)",
  "2009-2010-loss"   =>   "srgba(107,7,168,1)"
}
```

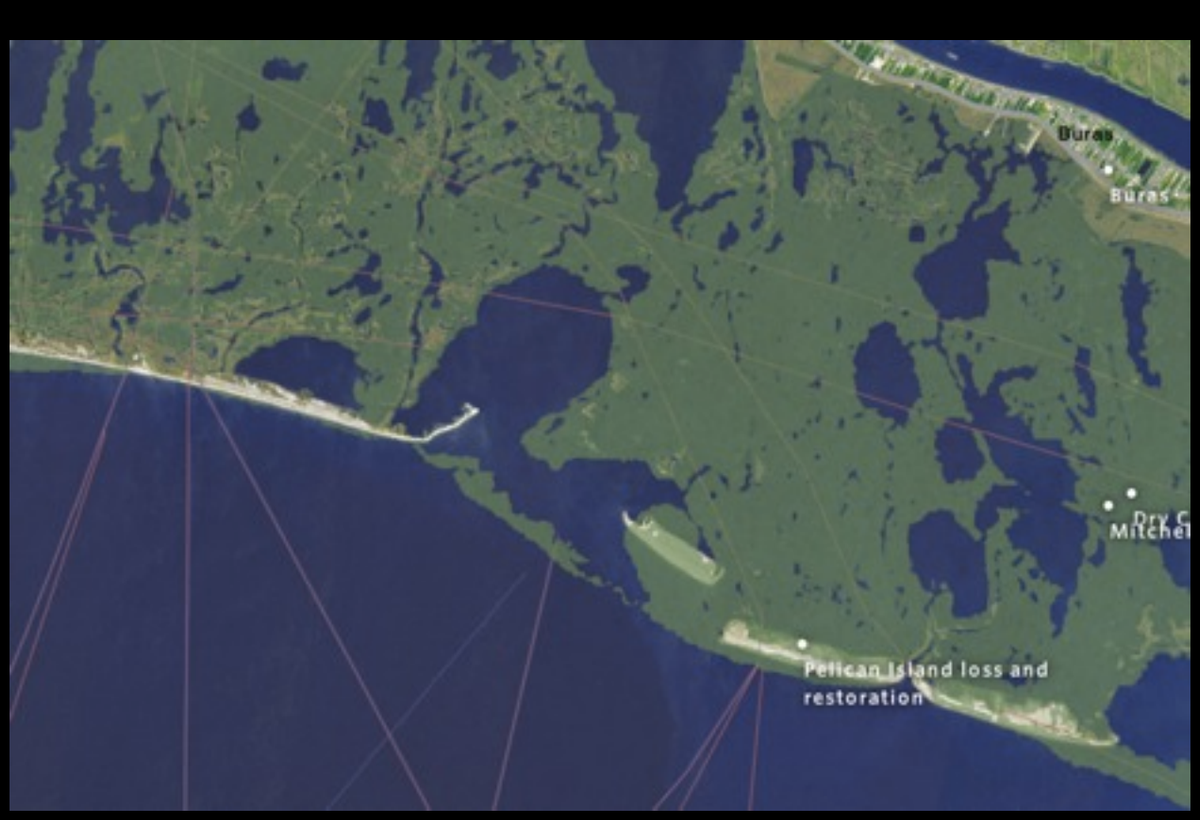
Creating “land”

For each time period, create an image by combining land loss from the current period to the last period, and land gain from the first period to the current period

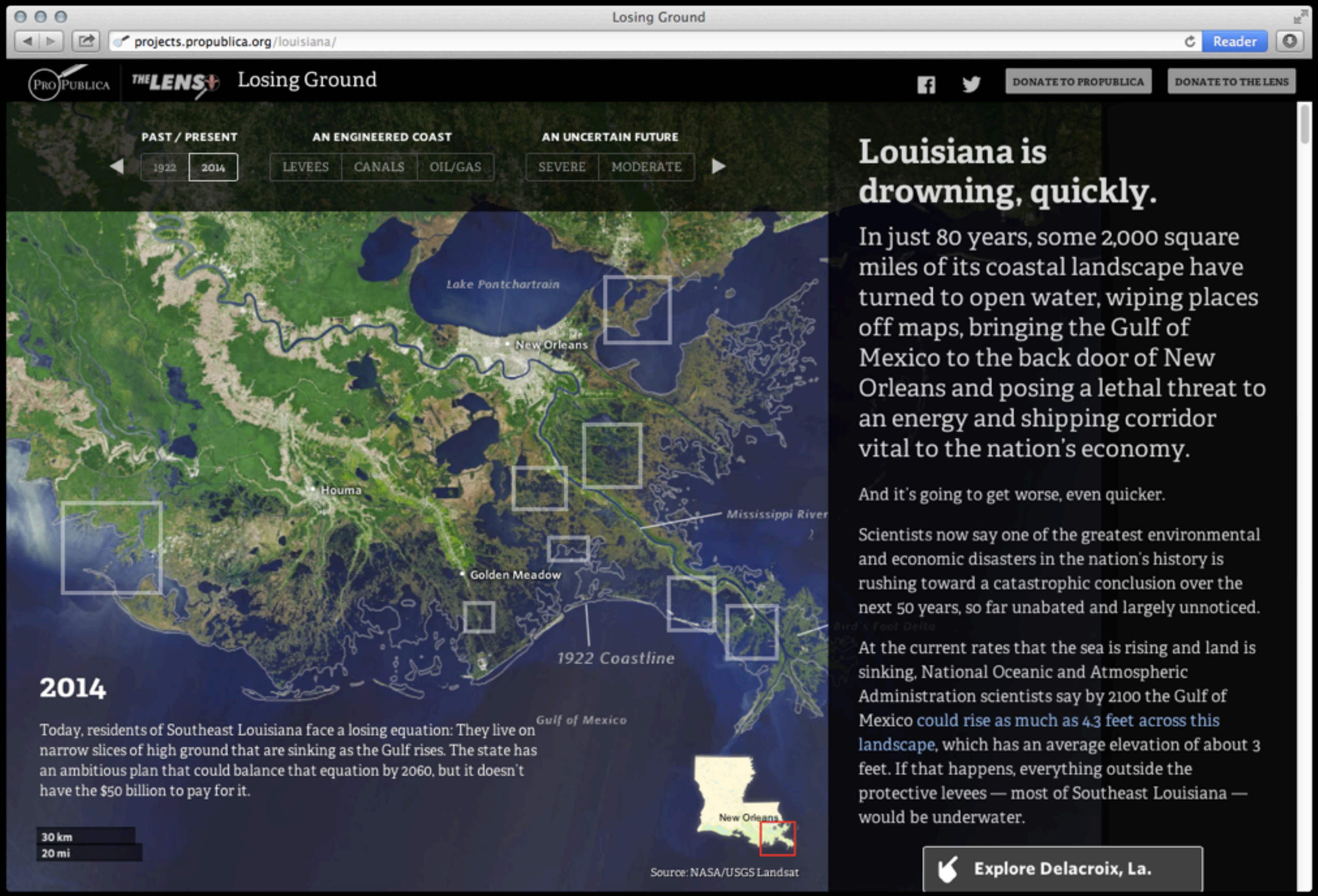
Buras, La.: 1932-2014



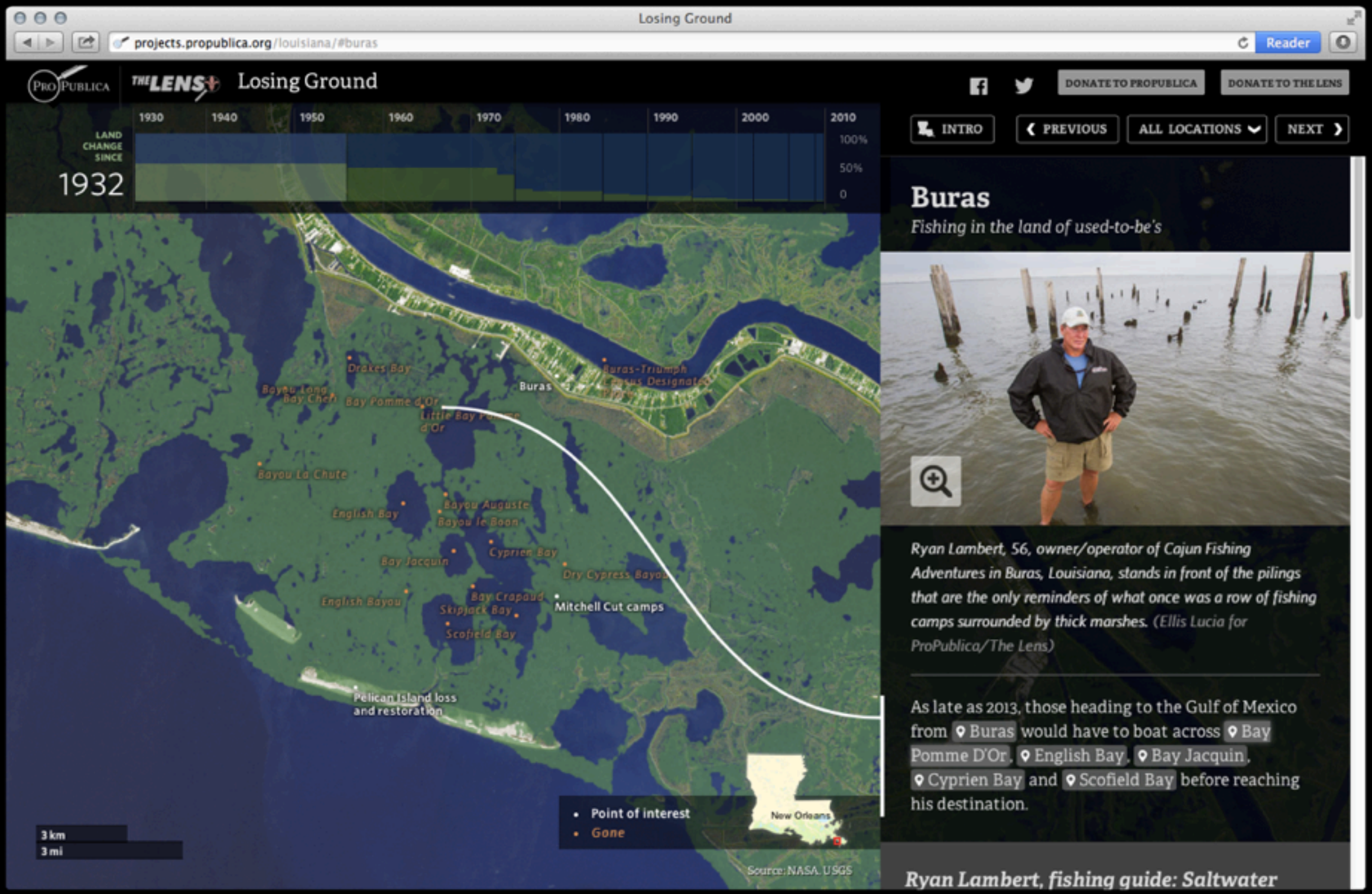

```
pixels = `convert #{file} -colorspace rgb -colors 10 -format "%c"
          histogram:info:`
transPixels = pixels.match(/[^:]*/)
transPct = `convert #{file} -format "%[fx:100*#{transPixels}/(w*h)]%%" info:`
```



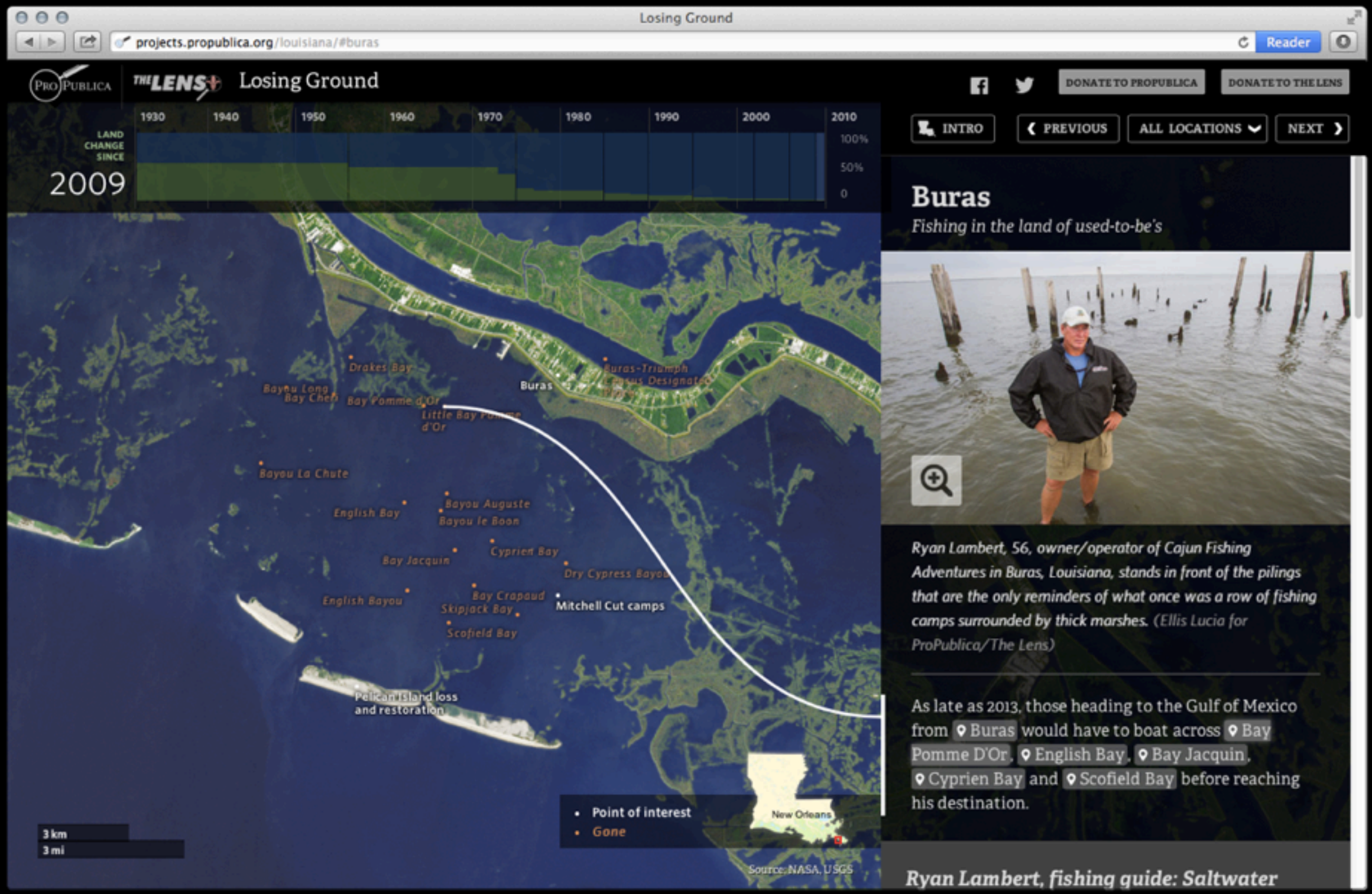
projects.propublica.org/louisiana



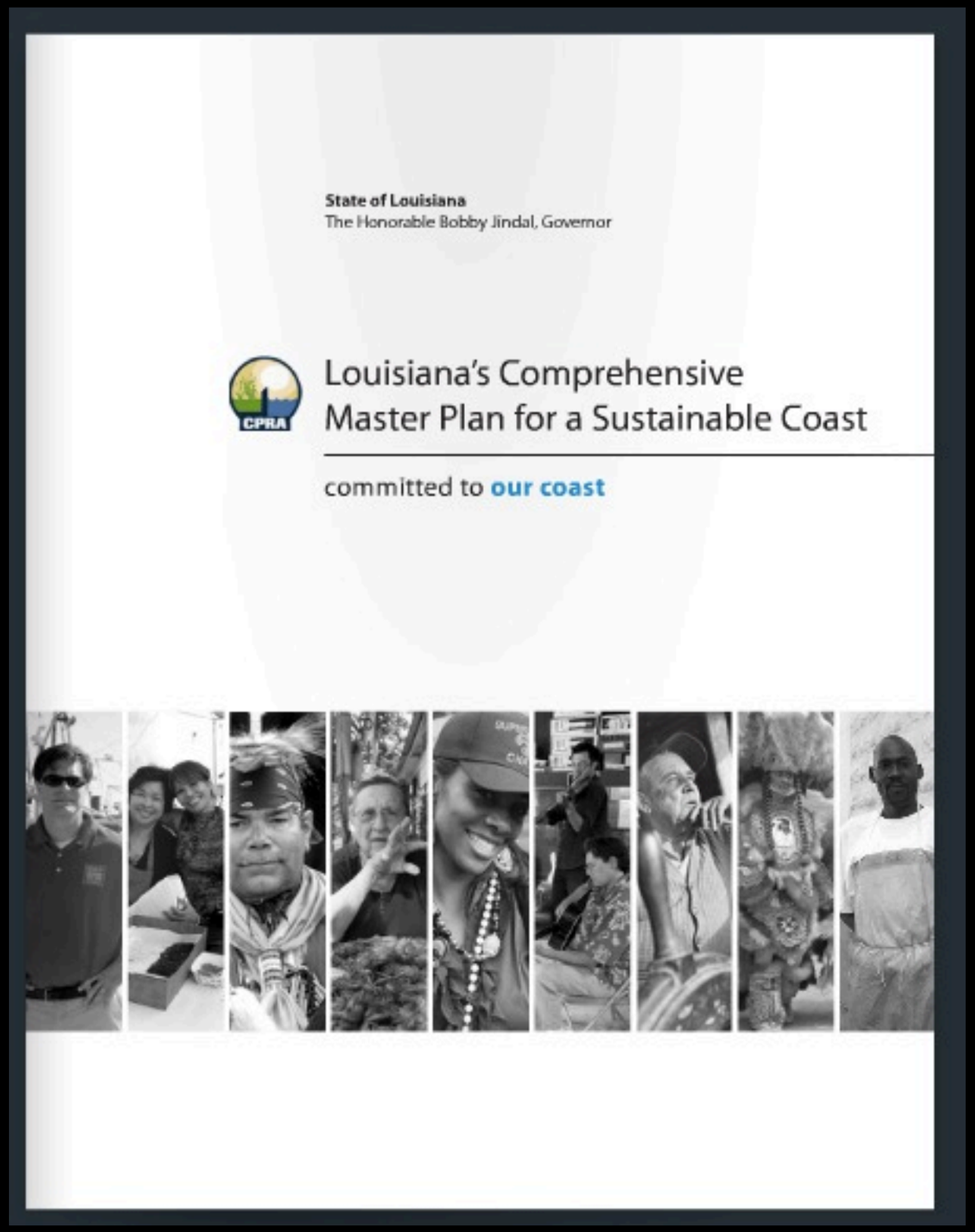
projects.propublica.org/louisiana



projects.propublica.org/louisiana



What is the state doing about this?


State of Louisiana
The Honorable Bobby Jindal, Governor

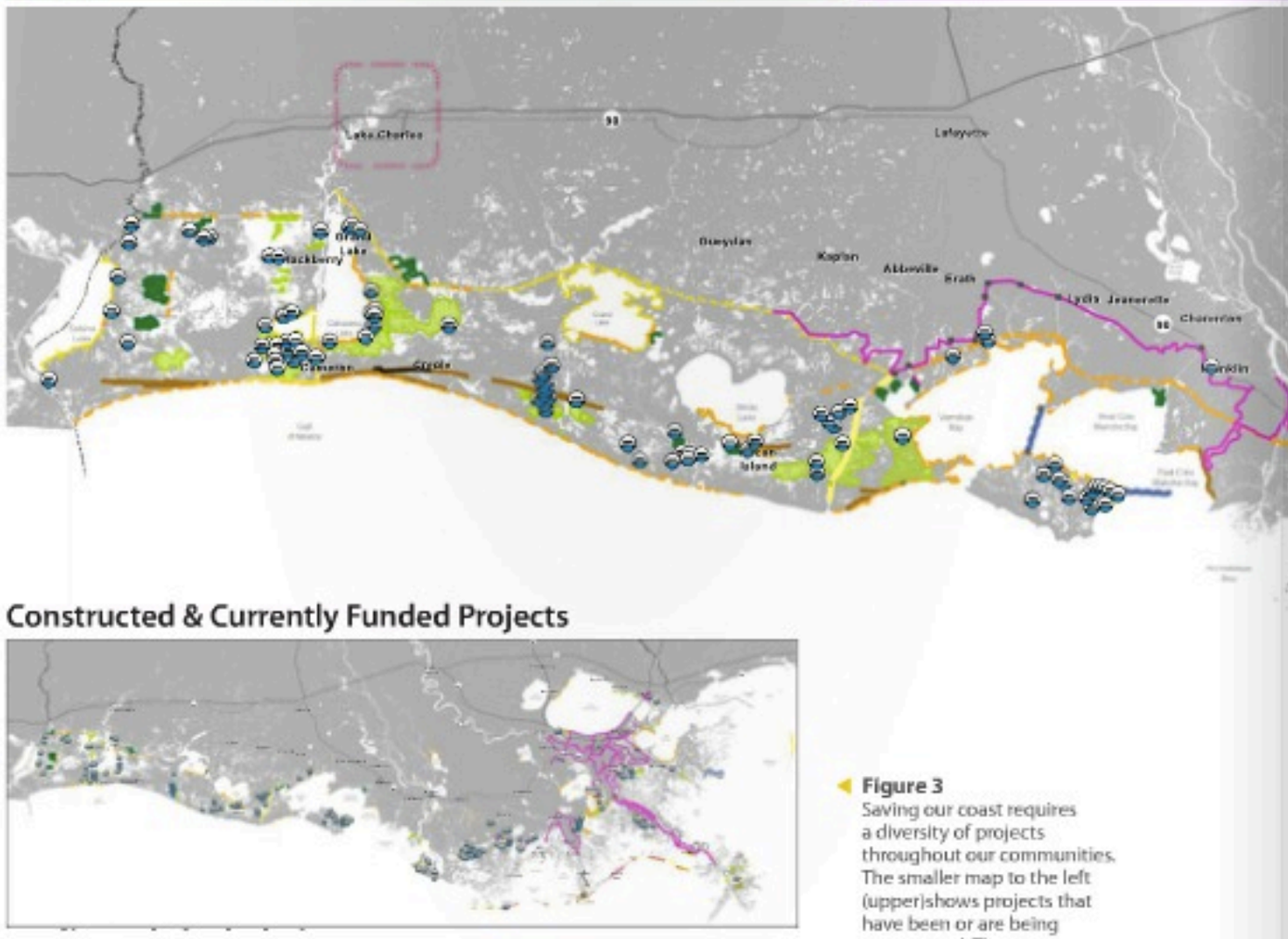
Louisiana's Comprehensive
Master Plan for a Sustainable Coast

committed to **our coast**

http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/

Responding to the Crisis

Louisiana's Coastal Program: Past, Present, and Future



Constructed & Currently Funded Projects

2012 Coastal Master Plan: Future Projects

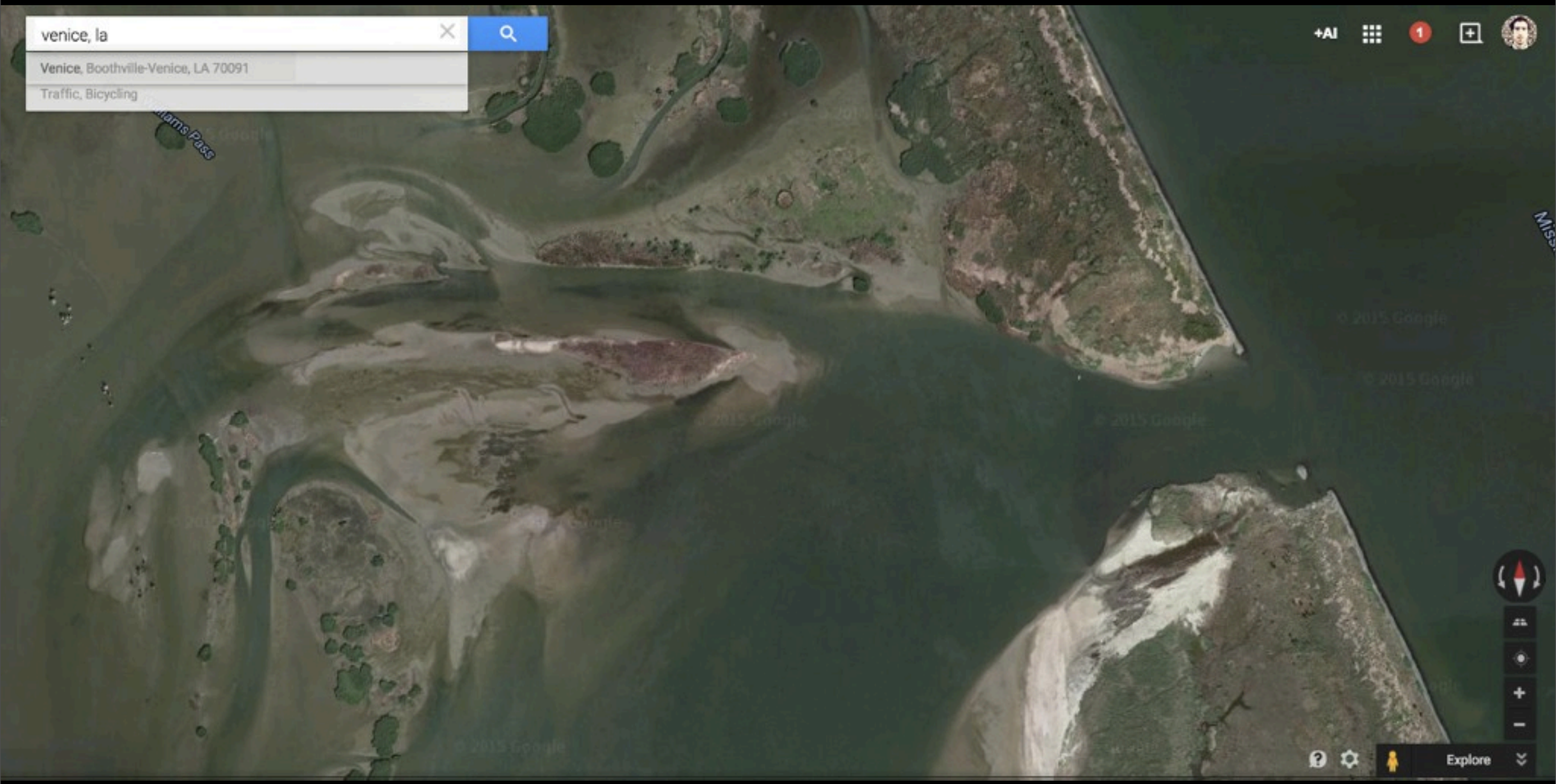
Figure 3
Saving our coast requires a diversity of projects throughout our communities. The smaller map to the left (upper)shows projects that have been or are being constructed. The map to the left (lower) shows future projects in the 2012 Coastal Master Plan. The large map combines both sets of projects to show the complete scope of the state's work for Louisiana's coast.

http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/

Marsh Creation: Lake Hermitage

Google Maps (2012 USGS imagery)

Sediment Diversions: West Bay



Google Maps (2012 USGS imagery)

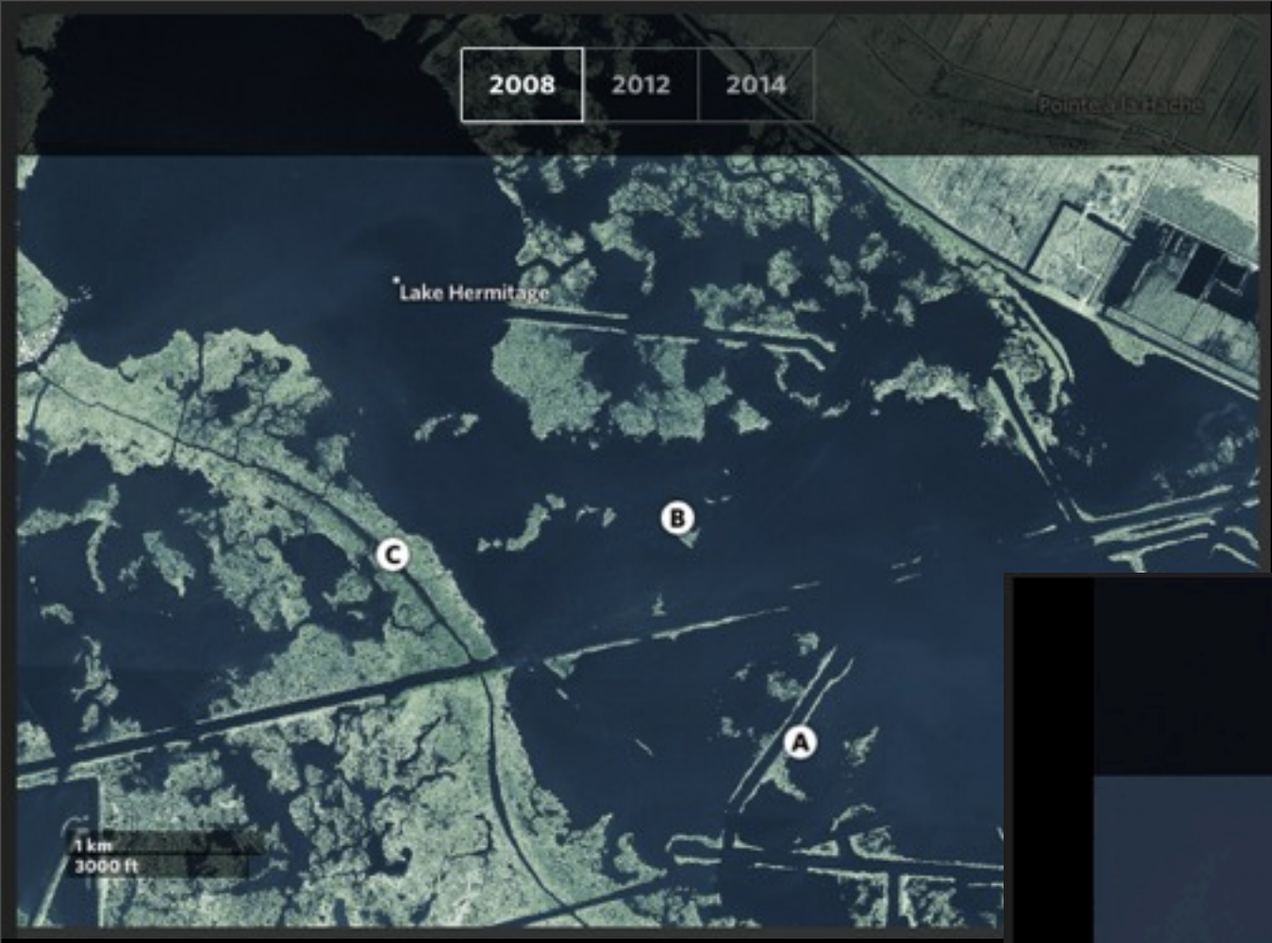
Imagery: 2012—now?

Lake Hermitage

Lake Hermitage

http://www.propublica.org/nerds/item/reporting-from-the-youngest-land-in-the-world

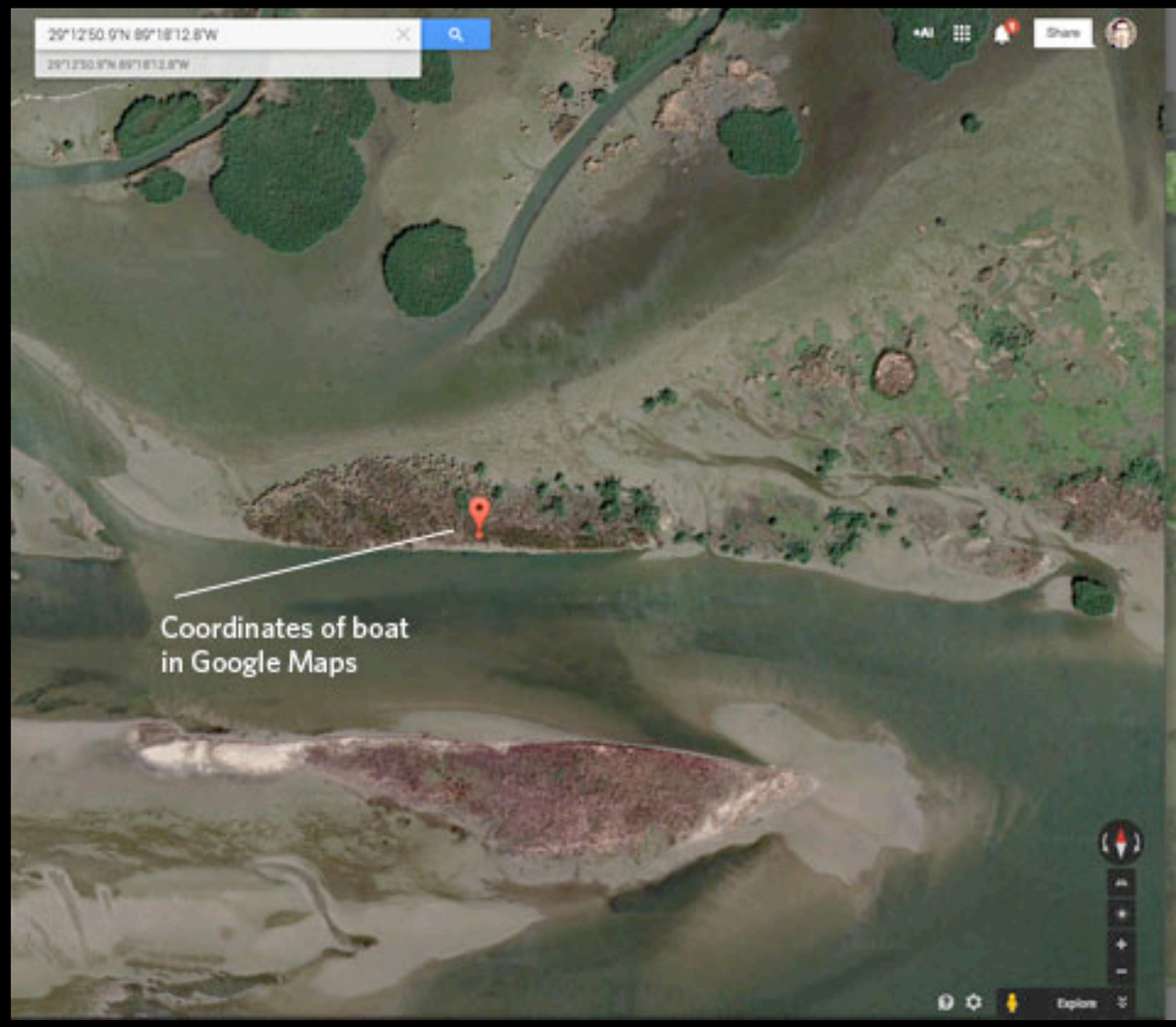
When you have to buy imagery: Digital Globe



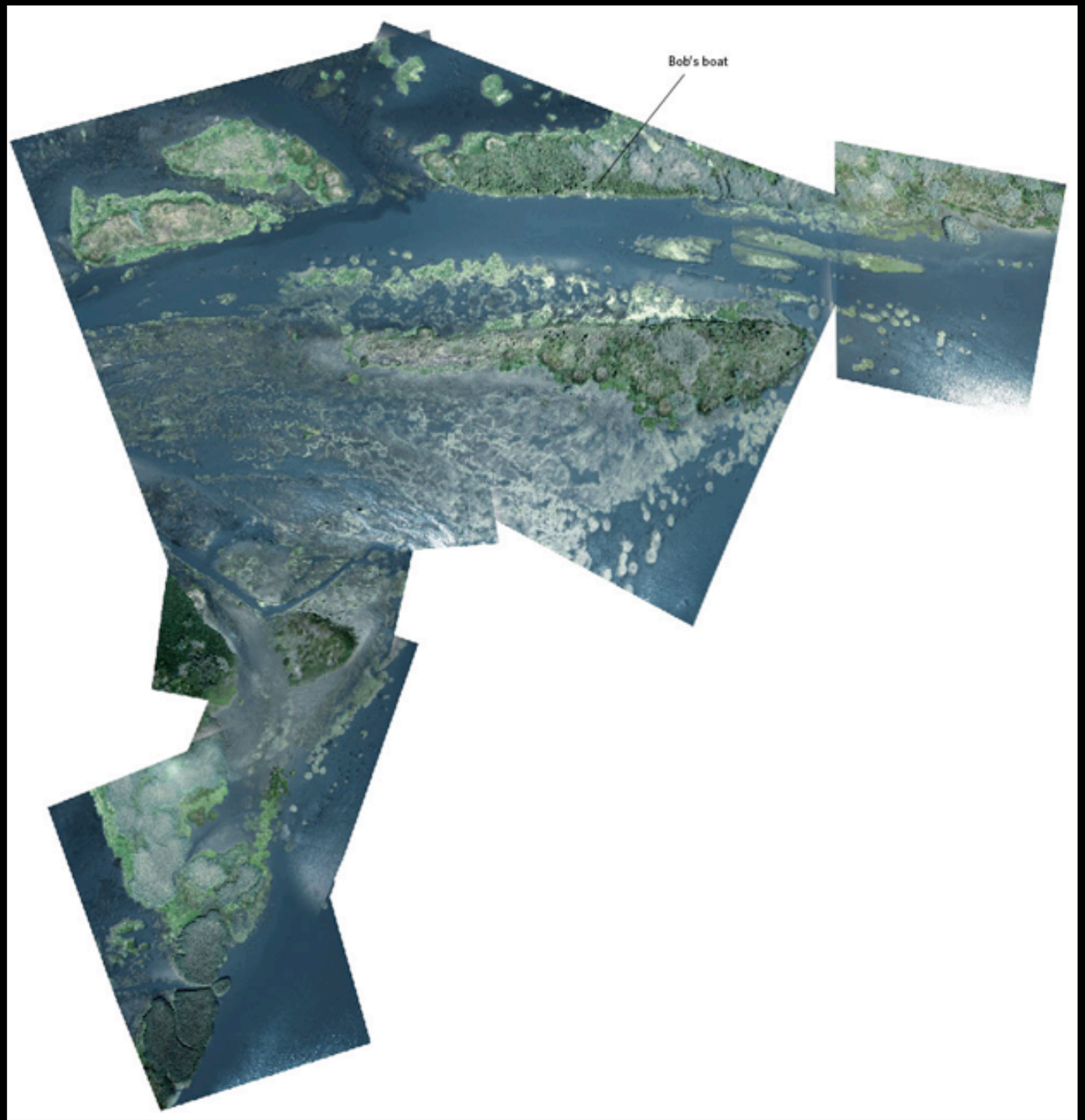
Digital Globe, USGS

West Bay Diversion

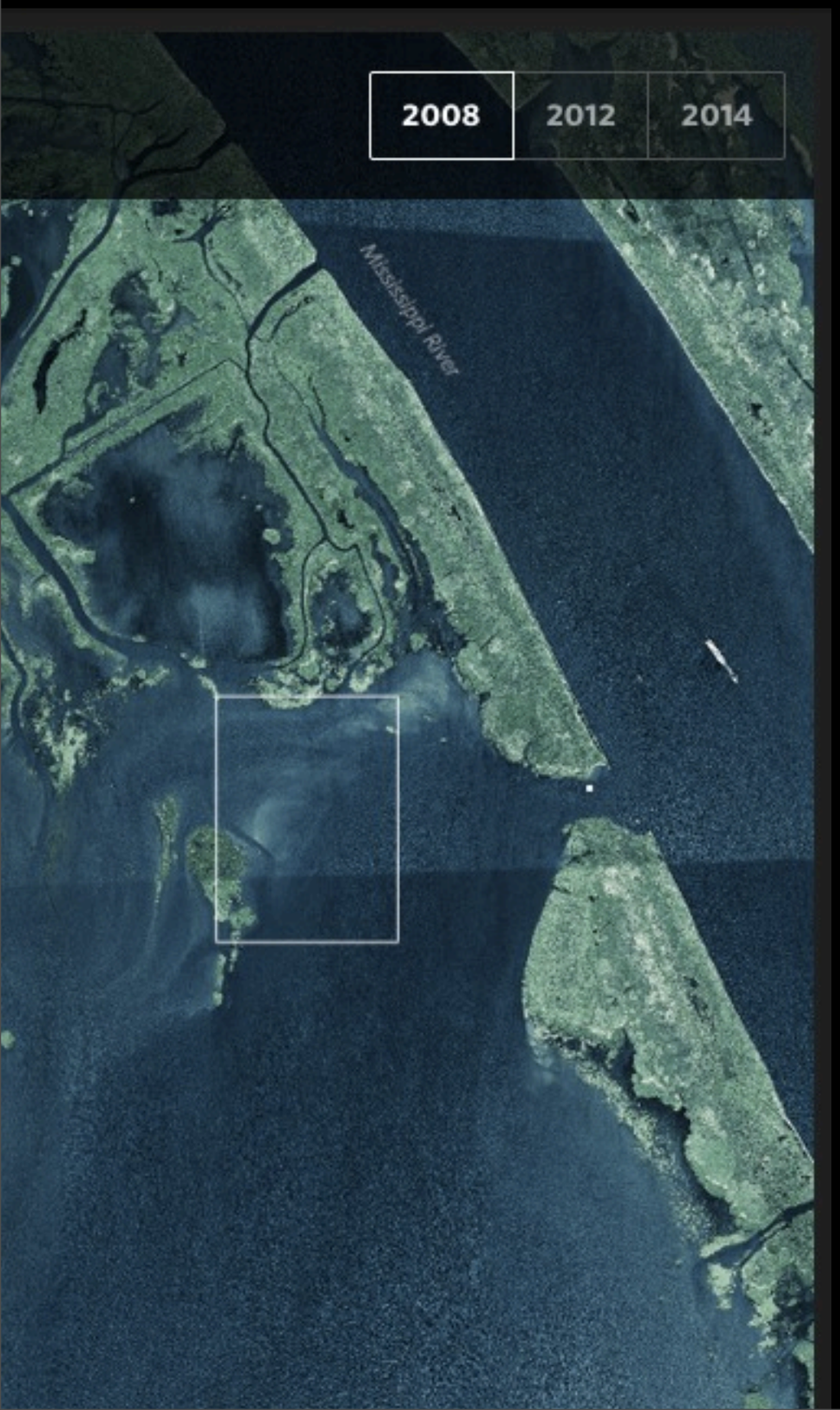
West Bay Diversion

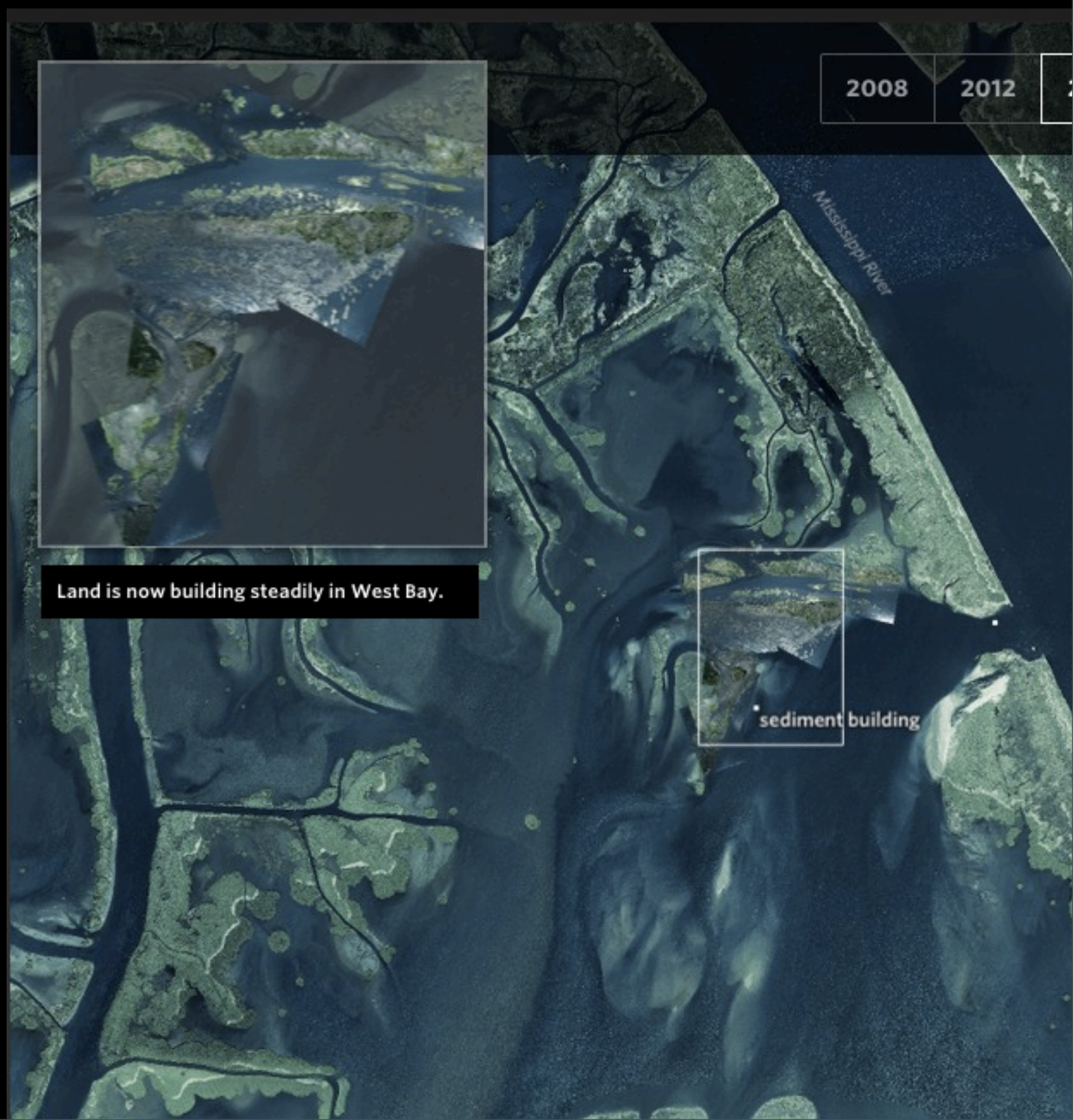


West Bay Diversion



West Bay Diversion



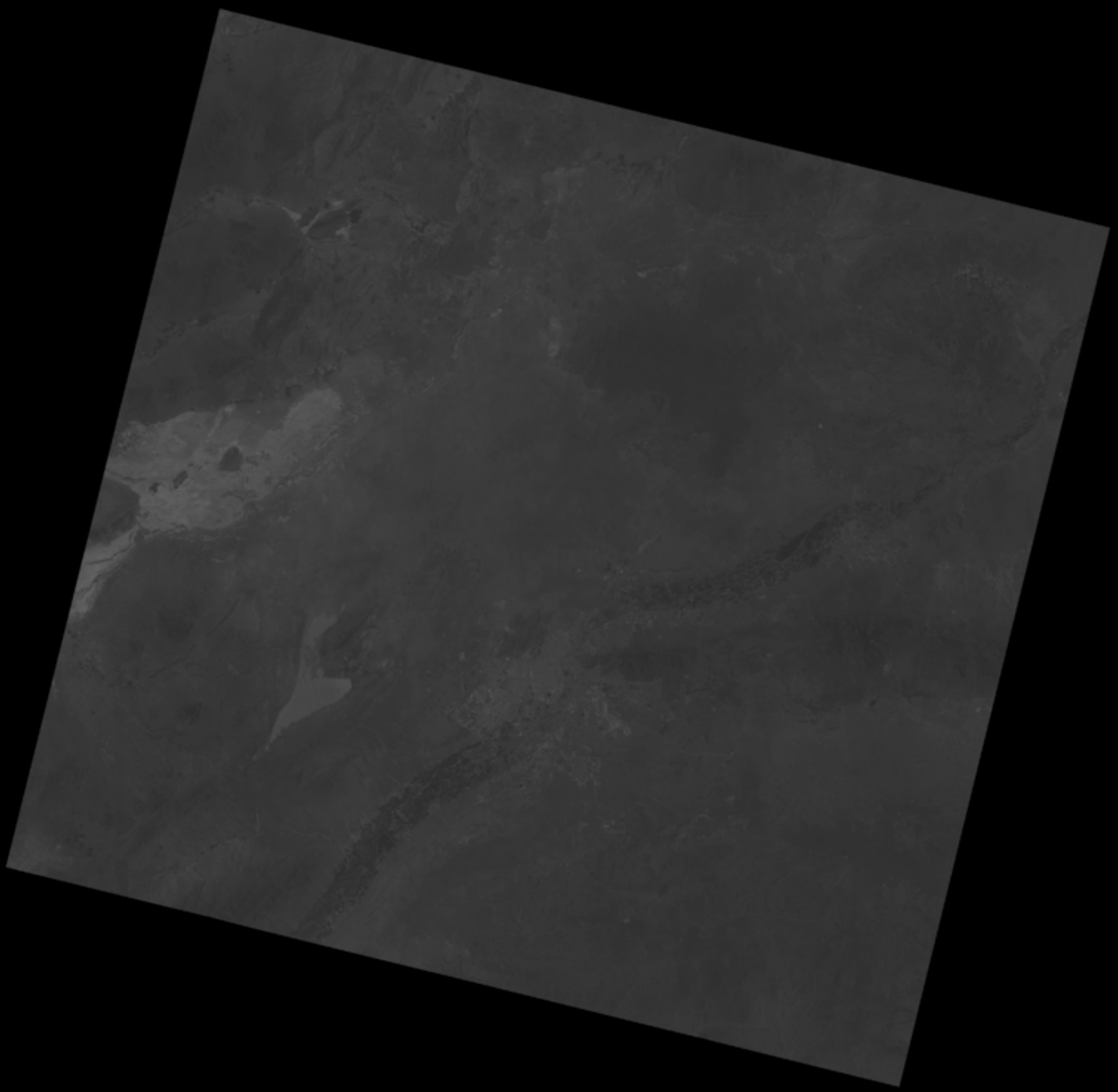


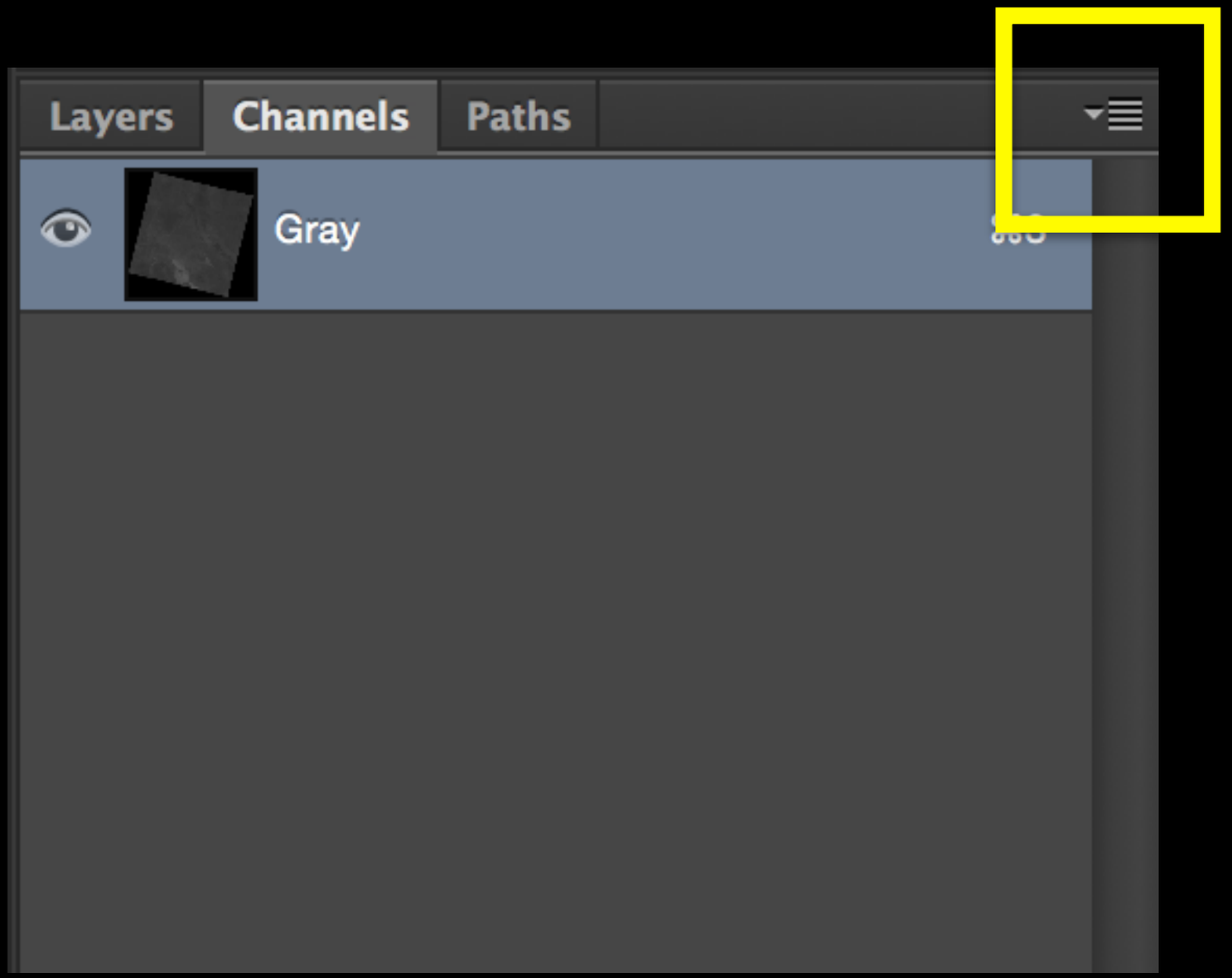
projects.propublica.org/larestoration

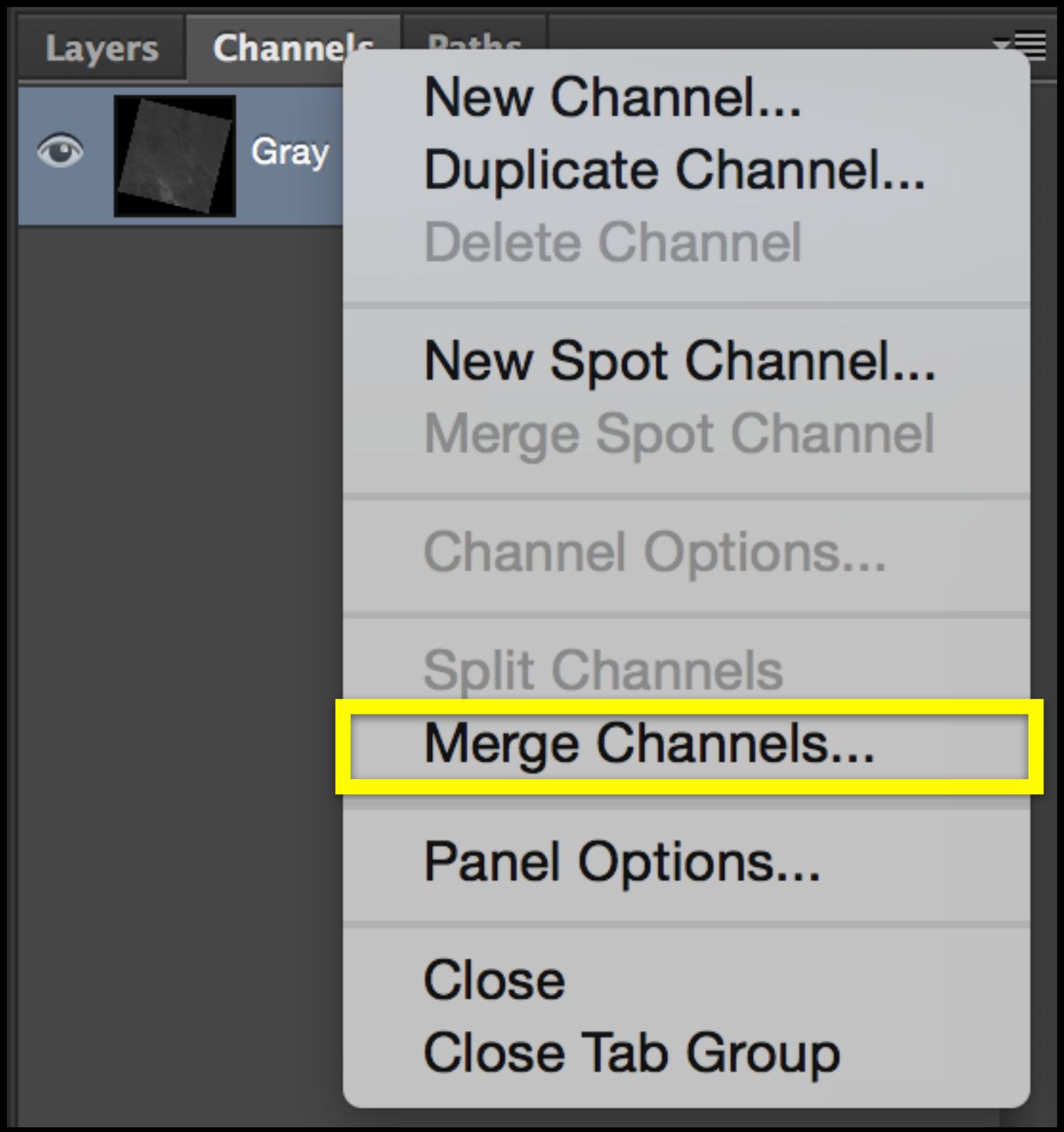
Almost
10,000px

Graphic at
is.gd/UzGntf

- 1500x? euphrates.jpg-75%
  - natural color HI CONTRAST redder
  - baghdad_streets_euphrates
  - undarken
  - water cxn
  - LC817303520141651GN00
    - Curves 5
  - LC817103620141351GN00
    - Curves 12
  - LC817203520132511GN00
    - Curves 6
  - LC817103520141351GN00
    - Curves 2
  - LC817203620140621GN00
    - Curves 7
  - LC817003620140961GN00
    - Curves 11
  - LC816803720141141GN00
    - Curves 8
  - LC816903620141371GN00
    - Curves 10
  - LC816903720141371GN00
    - Curves 9
  - LC817003720140961GN00
- Layer 1

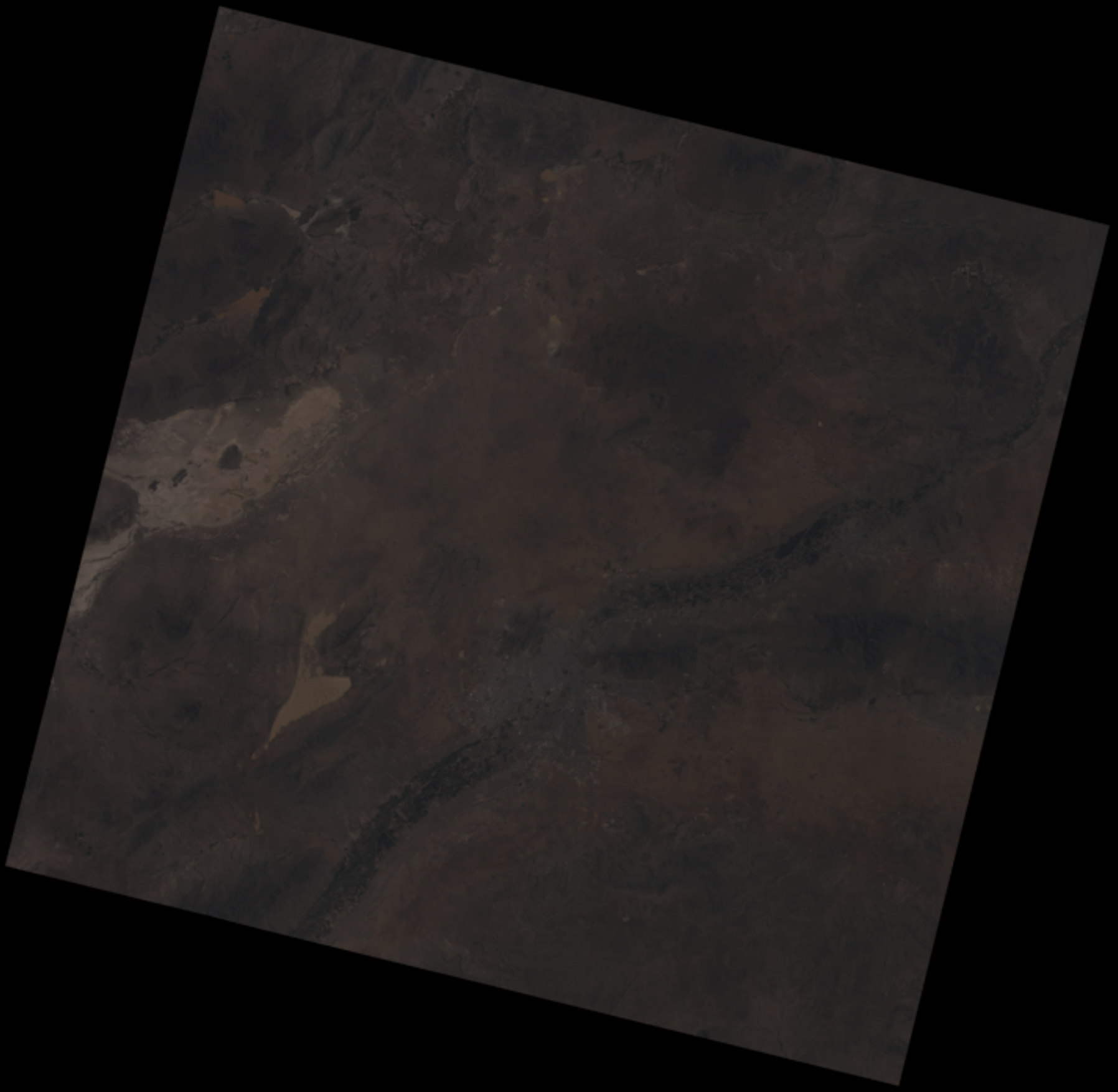



Layers
Channels
Paths
Gray


Layers
Channels
Paths
Gray
New Channel...
Duplicate Channel...
Delete Channel
New Spot Channel...
Merge Spot Channel
Channel Options...
Split Channels
Merge Channels...
Panel Options...
Close
Close Tab Group

For "true color" Landsat 8, use bands

4	3	2
Red	Green	Blue

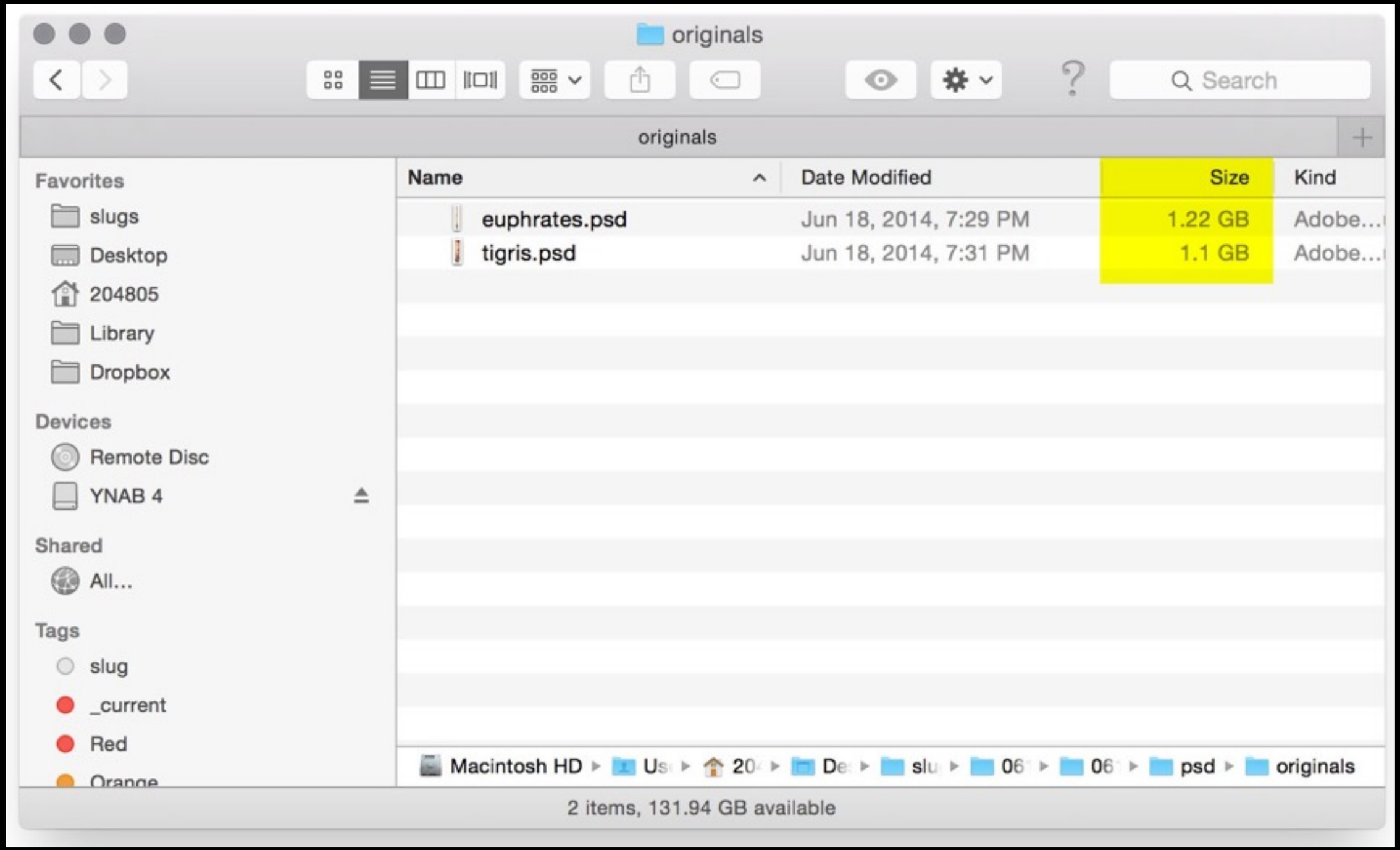


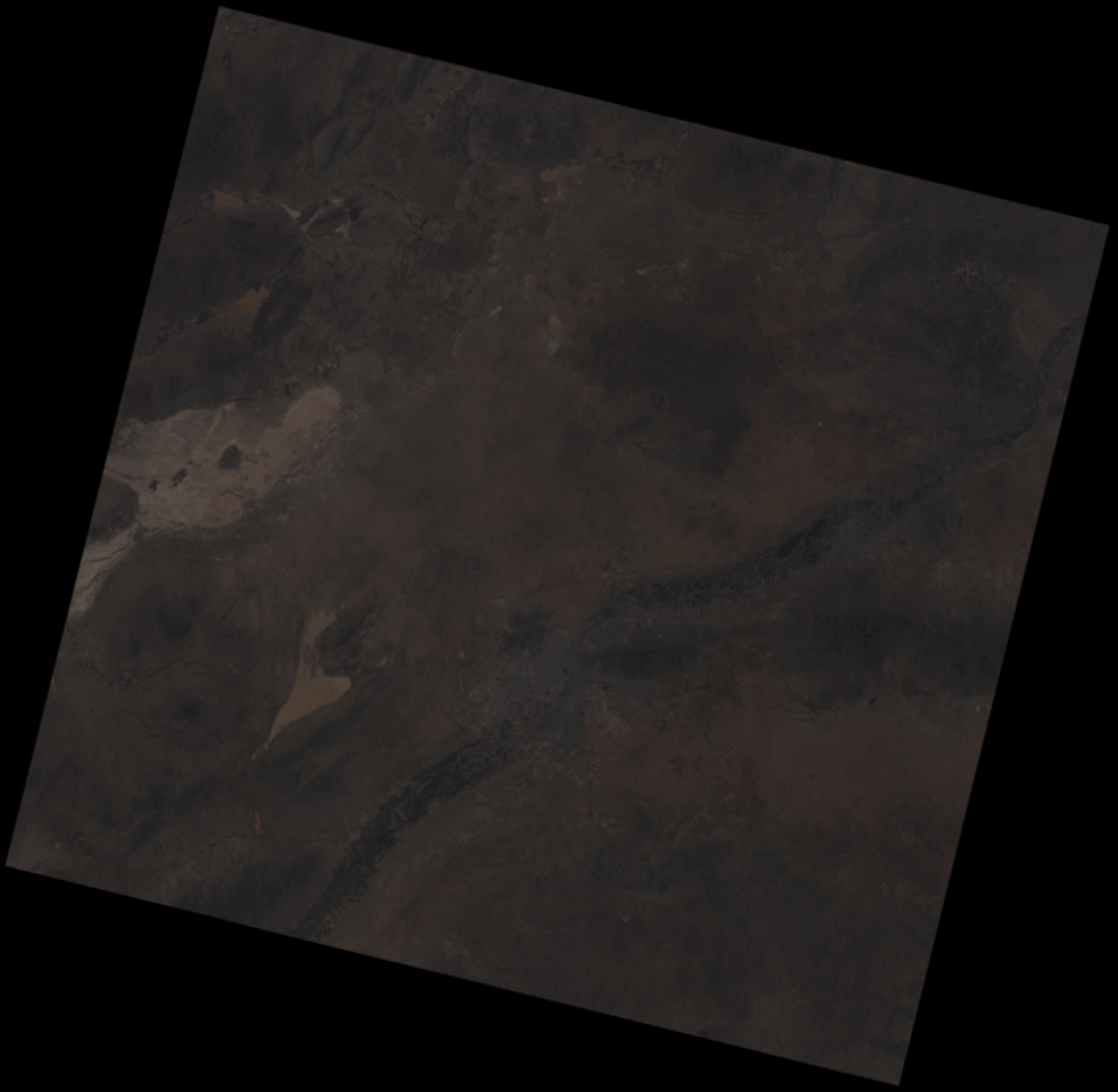
8 bit = 255 shades of **R**, **G**, **B** per pixel.

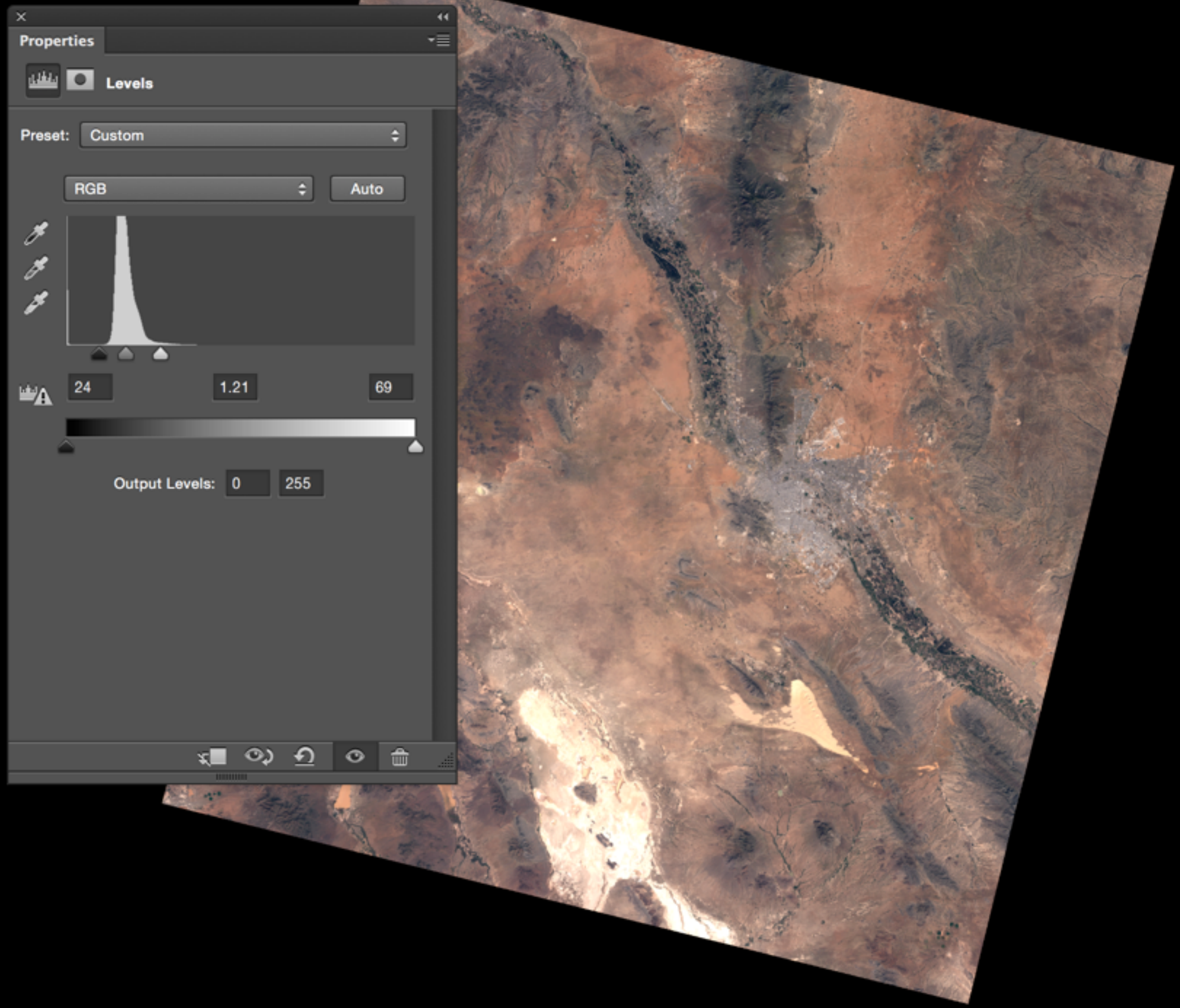
16 bit = 65,536 shades of **R**, **G**, **B**.

More data means more flexibility!

Also see
benefits of using 16bit images in Photoshop.


originals
Search
originals
Favorites
slugs
Desktop
204805
Library
Dropbox
Devices
Remote Disc
YNAB 4
Shared
All...
Tags
slug
_current
Red
Orange
Name
Date Modified
Size
Kind
euphrates.psd
Jun 18, 2014, 7:29 PM
1.22 GB
Adobe...
tigris.psd
Jun 18, 2014, 7:31 PM
1.1 GB
Adobe...
Macintosh HD
psd
originals
2 items, 131.94 GB available




Properties
Levels
Preset:
Custom
RGB
Auto
24
1.21
69
Output Levels:
0
255

Photoshop clobbers geographic metadata.

Before

```
x : gdalinfo raw_landsat_band.tif
Driver: GTiff/GeoTIFF
Files: raw_landsat_band.tif
Size is 7751, 7901
Coordinate System is:
PROJCS["WGS 84 / UTM zone 13N",
```

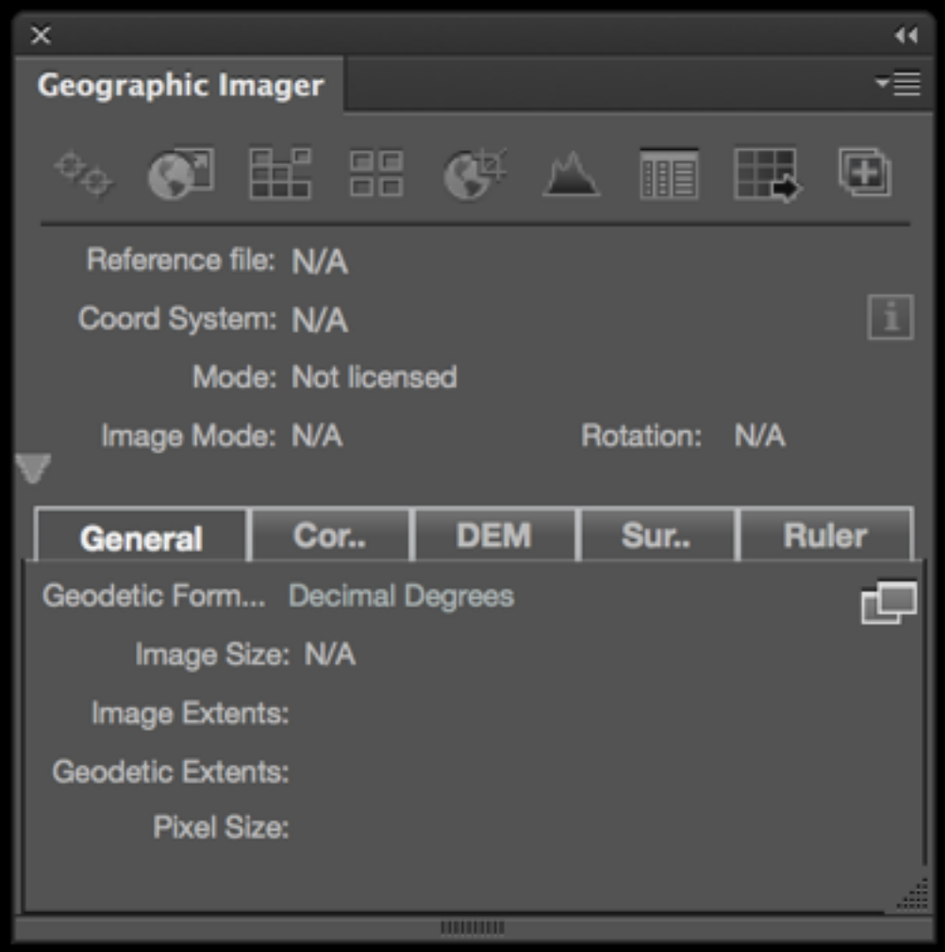
After

```
x : gdalinfo exported_from_photoshop.tif
Driver: GTiff/GeoTIFF
Files: exported_from_photoshop.tif
Size is 7751, 7901
Coordinate System is ``
```

Command line tools can re-attach the metadata to the file.

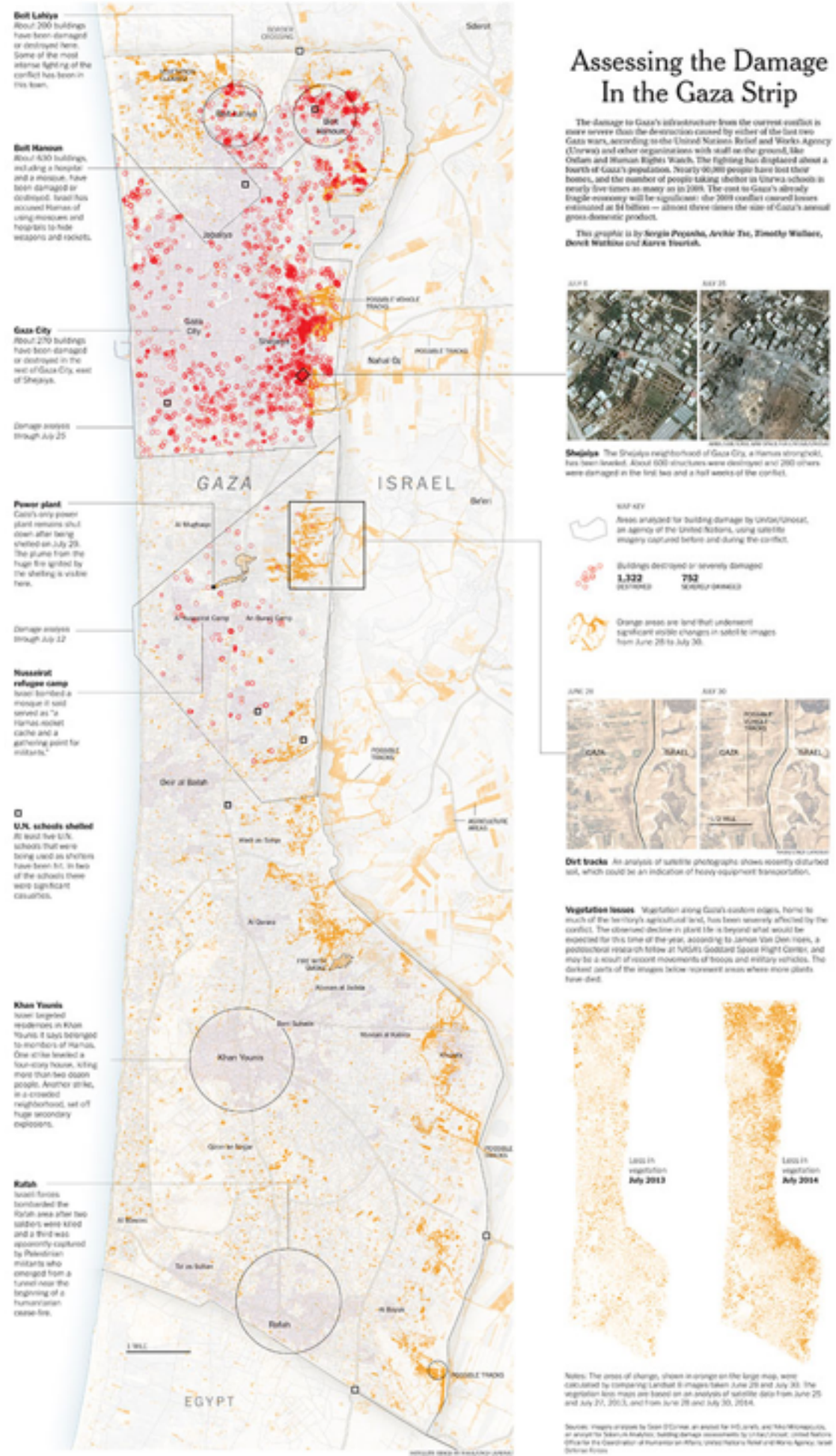
```
x : listgeo -no_norm raw_landsat_band.tif > original.geo
x : geotifcp -g original.geo exported_from_photoshop.tif this_has_geodata_attached.tif
```

There's also the "**Geographic Imager**" plugin ($700).



is.gd/Ik9LrW

CONFRONTATION IN GAZA

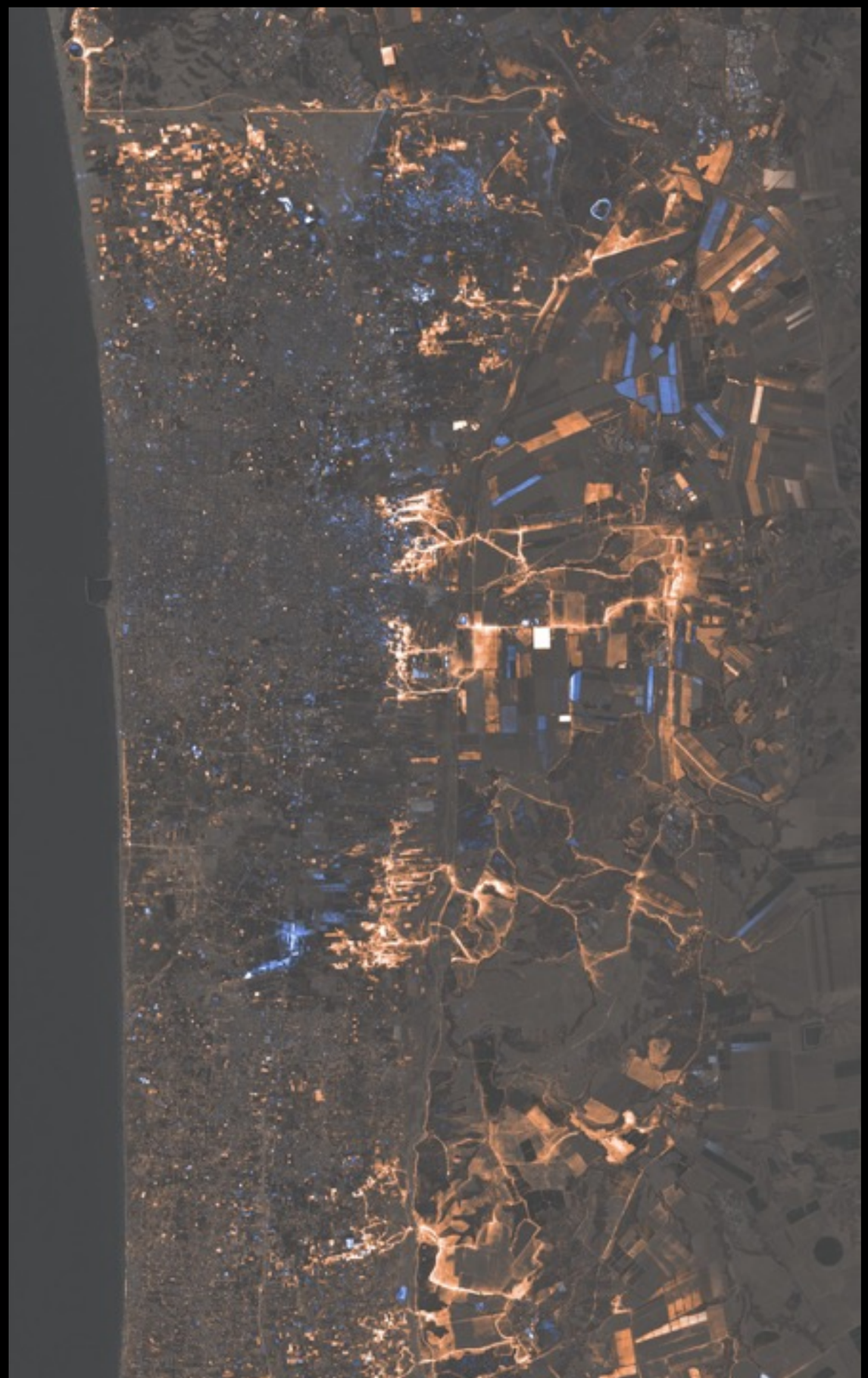


Assessing the Damage In the Gaza Strip

The damage to Gaza's infrastructure from the current conflict is more severe than the destruction caused by either of the last two Gaza wars, according to the United Nations Relief and Works Agency (Unrwa) and other organizations with staff on the ground, like Oxfam and Human Rights Watch. The fighting has displaced about a fourth of Gaza's population. Nearly 90,000 people have lost their homes, and the number of people taking shelter in Unrwa schools is nearly five times as many as in 2009. The cost to Gaza's already fragile economy will be significant: the 2009 conflict caused losses estimated at $4 billion — almost three times the size of Gaza's annual gross domestic product.

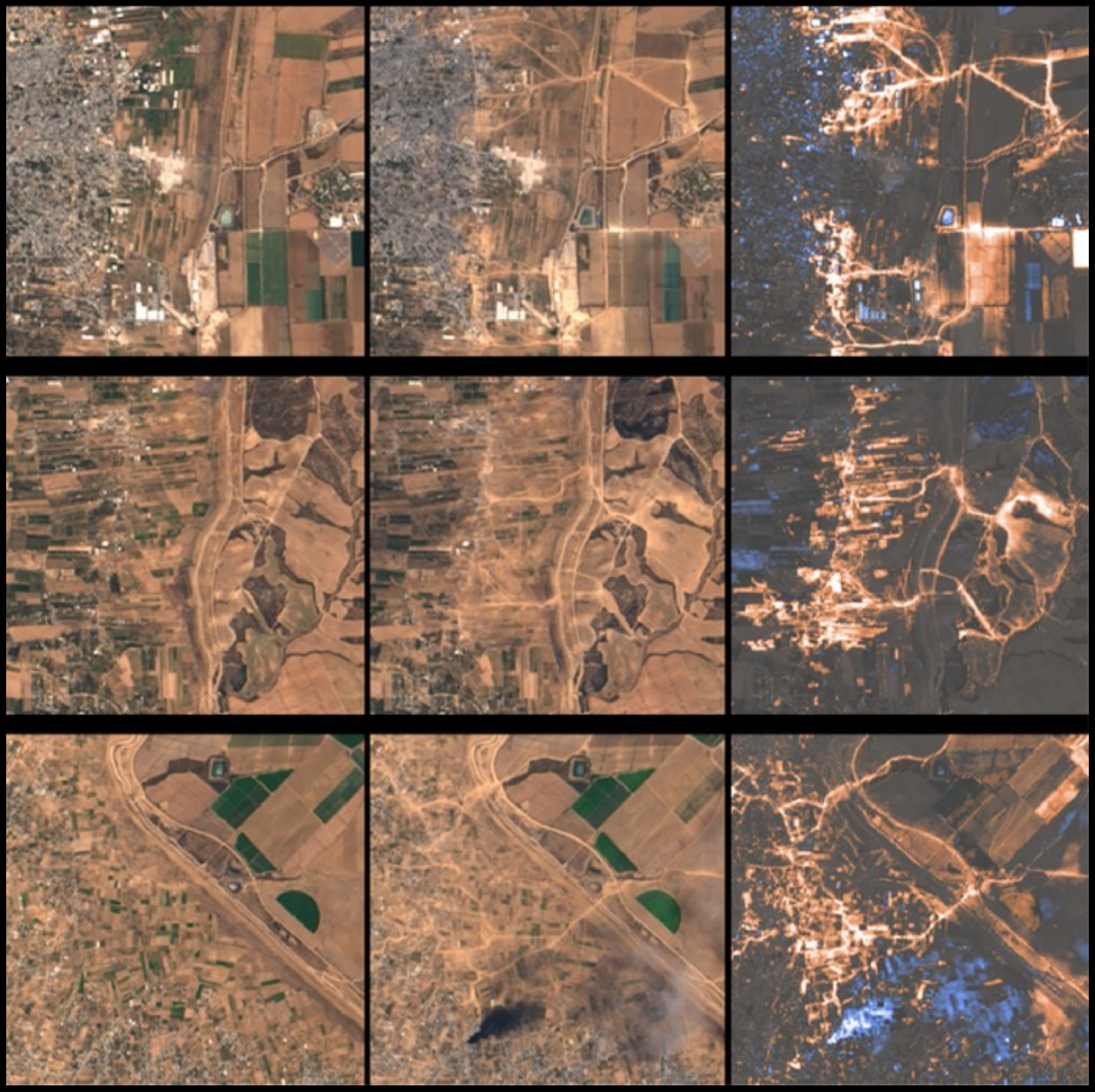
This graphic is by **Sergio Peçanha, Archie Tse, Timothy Wallace, Derek Watkins** and **Karen Yourish.**

Web graphic at
is.gd/9OaZ9I



Over the course of a month,
blue areas
and
in the satellite image.

June 28 | July 30 | Change



using repeat satellite imagery to track tank movements through plantations and across roads. five tanks visible on 4m wide road in upper left-hand corner of image above.
Rafah, Gaza. Aug 1, 2014.

By

QGIS

Open source GIS

ERDAS Imagine

Apparently these folks don't really have a logo

Industrial strength remote sensing software

Vegetation losses Vegetation along Gaza's eastern edges, home to much of the territory's agricultural land, has been severely affected by the conflict. The observed decline in plant life is beyond what would be expected for this time of the year, according to Jamon Van Den Hoek, a postdoctoral research fellow at NASA's Goddard Space Flight Center, and may be a result of recent movements of troops and military vehicles. The darkest parts of the images below represent areas where more plants have died.

Loss in vegetation **July 2013**

Loss in vegetation **July 2014**

NDVI

Plants absorb visible light for energy
But reflect a ton of **infrared** light.

NDVI is a ratio of infrared light to visible light.

So, it can be used to tell **how healthy** plants are.

Vegetation losses Vegetation along Gaza's eastern edges, home to much of the territory's agricultural land, has been severely affected by the conflict. The observed decline in plant life is beyond what would be expected for this time of the year, according to Jamon Van Den Hoek, a postdoctoral research fellow at NASA's Goddard Space Flight Center, and may be a result of recent movements of troops and military vehicles. The darkest parts of the images below represent areas where more plants have died.

Loss in vegetation **July 2013**

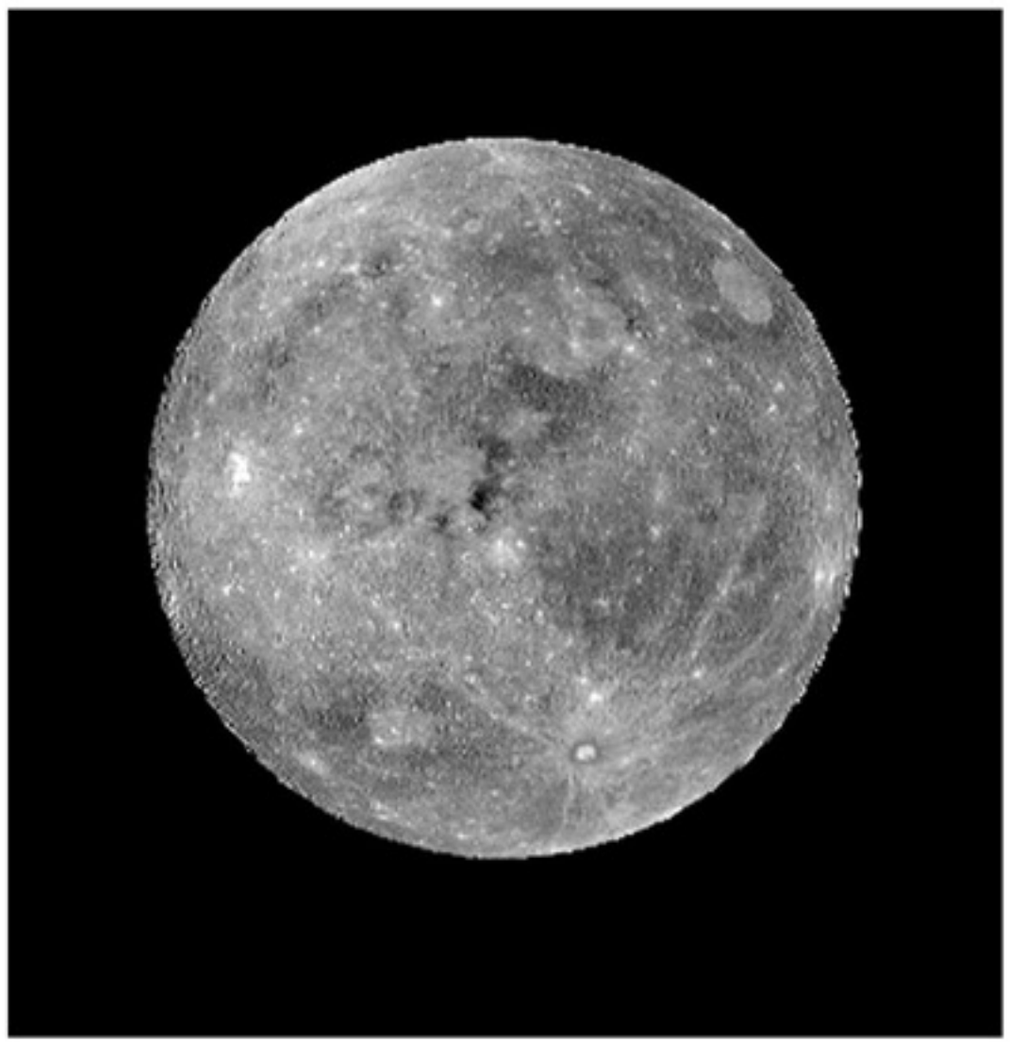
Loss in vegetation **July 2014**

Data or a **picture**?

Charlie Loyd
@vruba

Following

Landsat-derived NDVI of the moon (this'll be hilarious to about 7 people in the whole world; sorry, everyone else):



HOT OSM

Humanitarian
OpenStreetMap

UNOSAT

Imagery analysis branch of
the United Nations

NAIP

National Agriculture
Imagery Program

Planet Labs

Tons of teensy satellites

Skybox

Lots of small satellites;
owned by

Google Earth Engine

Image processing
IN THE CLOUDS

Tutorials for using Photoshop
with Landsat imagery:

"How To Make a True-Color Landsat 8 Image" by Rob Simmon

is.gd/1lT8tn

Tom Patterson's Landsat 8 Photoshop tutorial

is.gd/LlFIa6