

# Using GIS and Remote Sensing for Demonstrating Environmental Change

Integrated Environmental Assessment  
Workshop for the National Reporting Toolkit (NRT)  
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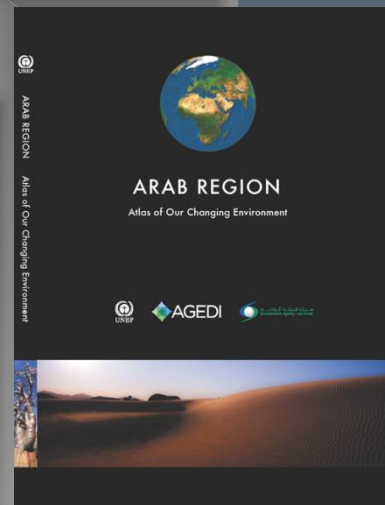
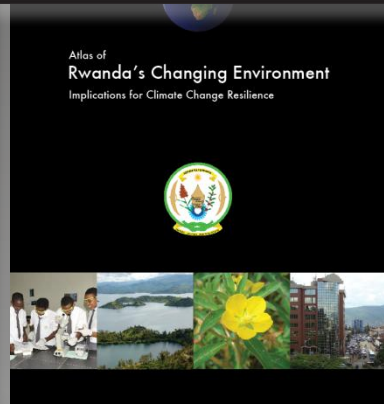
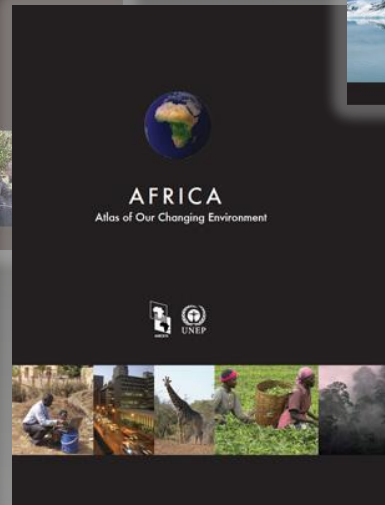
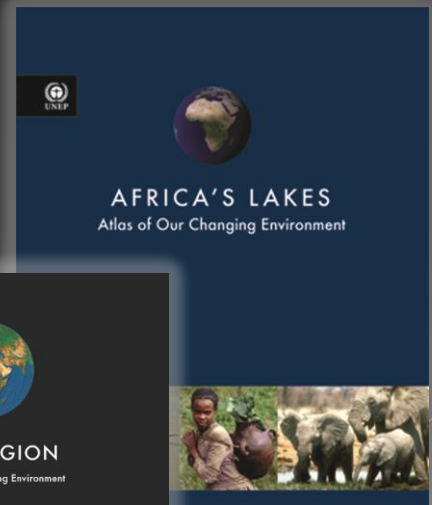
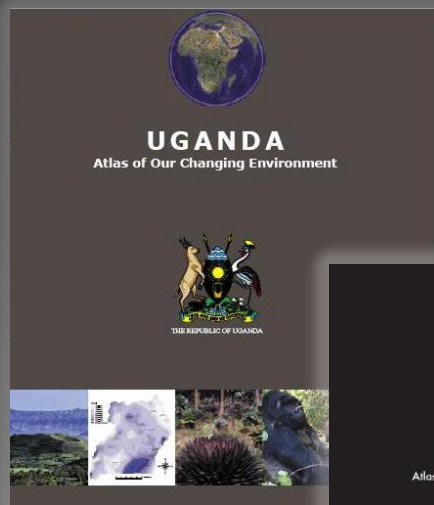
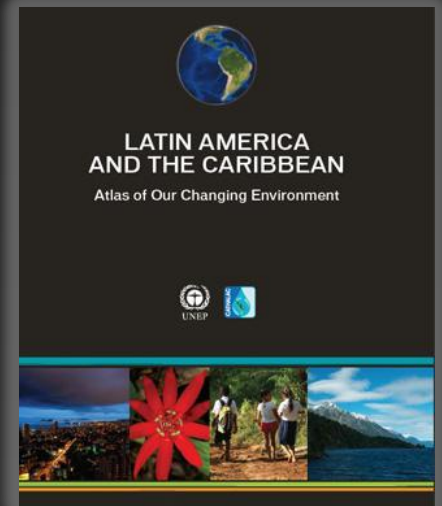
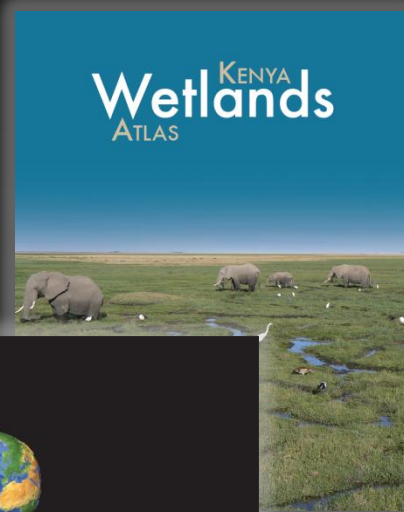
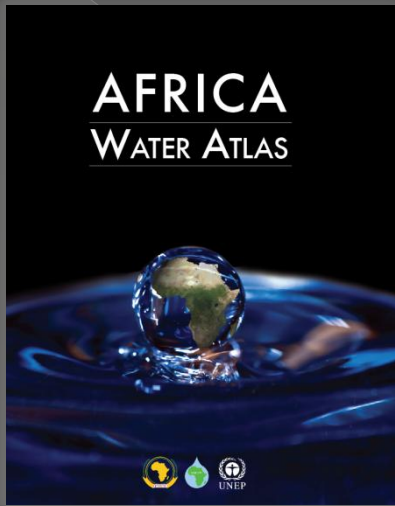
# UNEP/GRID Sioux Falls

- United Nations Environment Programme Global Resource Information Database office
- Located in the United States Geological Survey (USGS) Earth Resources Observation & Science Center in Sioux Falls, South Dakota, USA
- Operational since 1991
- Provides capacity building, remote sensing, website and graphic design support to UNEP and its partners

<http://na.unep.net>

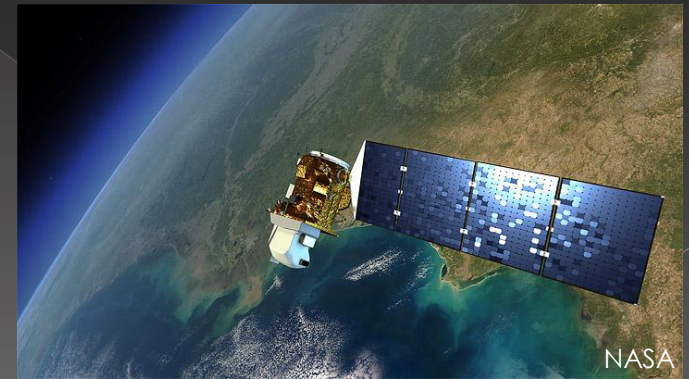
# UNEP Atlas of Our Changing Environment Series

- Atlas series based on local, regional and global environmental change
- Heavily uses GIS and remote sensing technologies to tell the story
- Relatable to general population, policy makers, etc
- Alternative way to present environmental information: Hotspots and “Change Pairs”

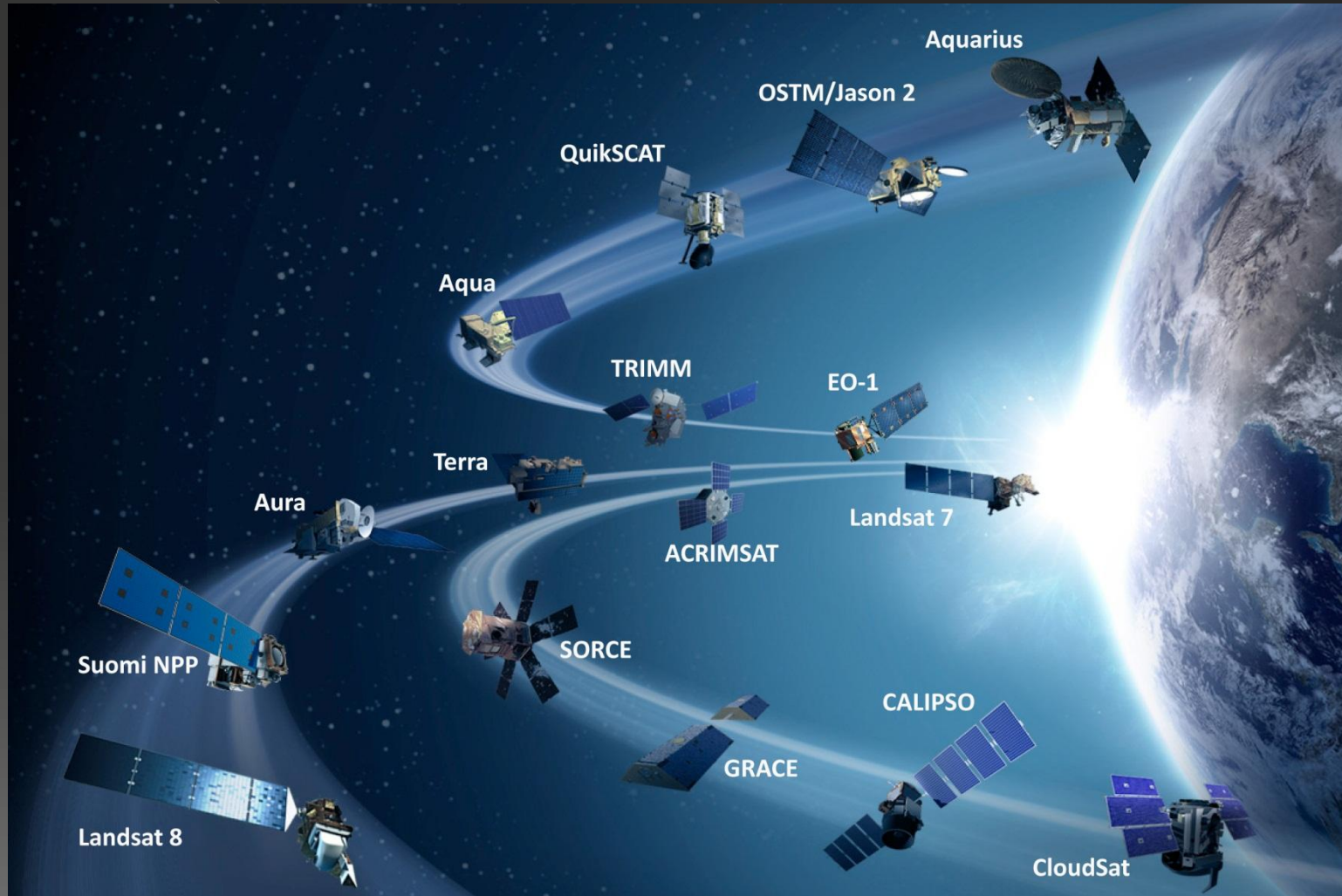


# Role of Satellite Imagery

- Offers a scientific way to measure and visually demonstrate environmental changes
- Easy to interpret by lay people, policy makers, etc.
- Allows for viewing change over an extended period of time
- Many types of imagery are freely available for download or viewing, allowing for access to many types of users



# U.S. Earth Observing Satellites



# Change Pair Selection

*Many types of environmental change, both negative and positive, can be illustrated using satellite imagery...but not all kinds!*

## **ADVANTAGEOUS**

- Forest loss and gain
- Coastal development
- Natural Disasters – dust storms, plankton blooms, volcanic eruptions
- Agricultural expansion
- Wetland loss and gain
- Urbanization

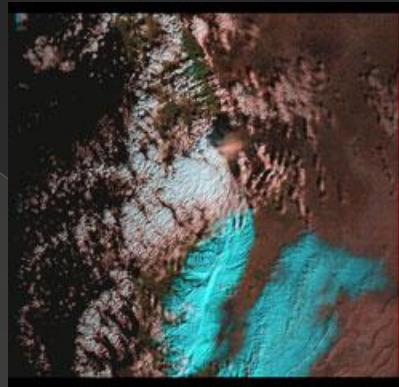
## **NOT AS ADVANTAGEOUS**

- Loss of species richness
- Diffused changes
- Very small scale changes
- Changes in deep ocean ecosystems

# Example: Seasonal Change



Nov 2003



Nov 2004



Nov 2005



Nov 2006



Nov 2007



Nov 2008



# Example: Diffused Change



Early 1970s



Early 2000s

# Creating Images

## STEPS TO TAKE

- Find cloud-free imagery with adequate coverage
- Process and prepare imagery
- Utilize the most suitable bands to demonstrate change
- Enhance and annotate

# Finding Imagery

# Types of Earth Observing Imagery

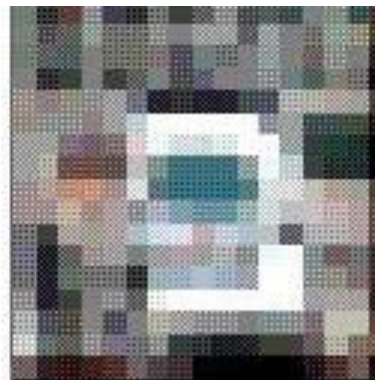
- **High Resolution** < 15 m, submetre
  - > WorldView
  - > IKONOS
  - > Corona
  - > Best for smaller scale changes
- **Medium Resolution** 15m – 100m
  - > Landsat
  - > ASTER
- **Low Resolution** > 100m
  - > MODIS Terra & Aqua
  - > Best for large-scale changes



1 m resolution



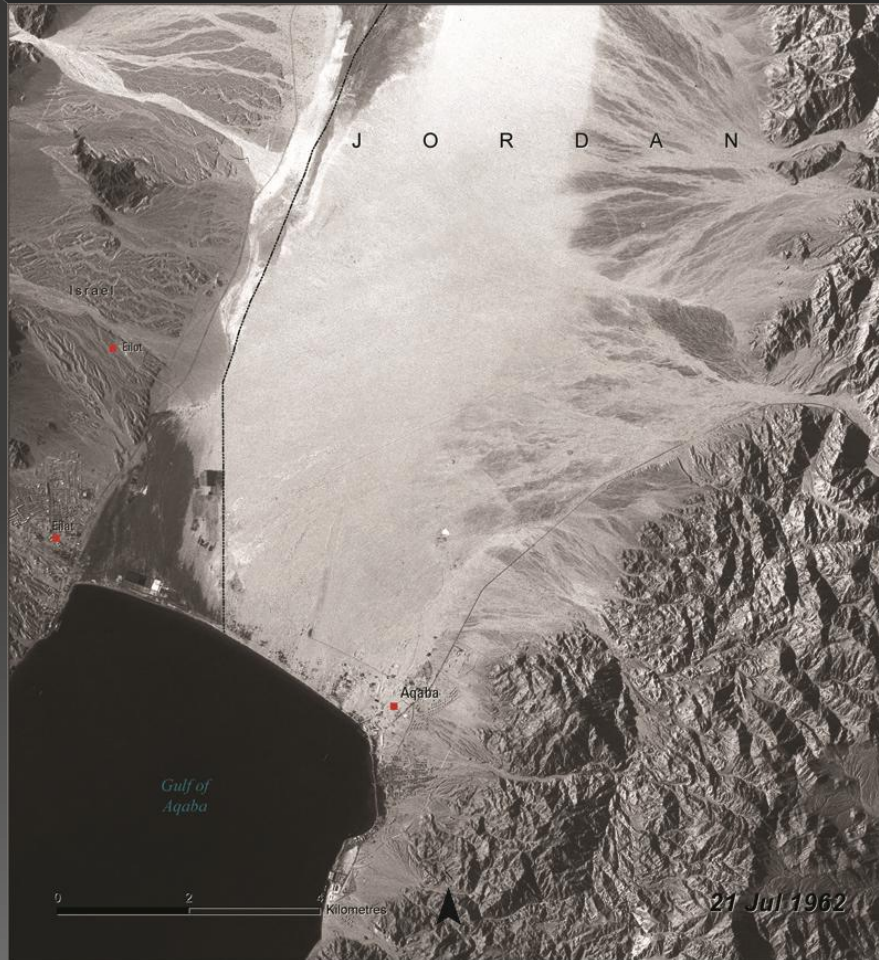
10 m resolution



30 m resolution

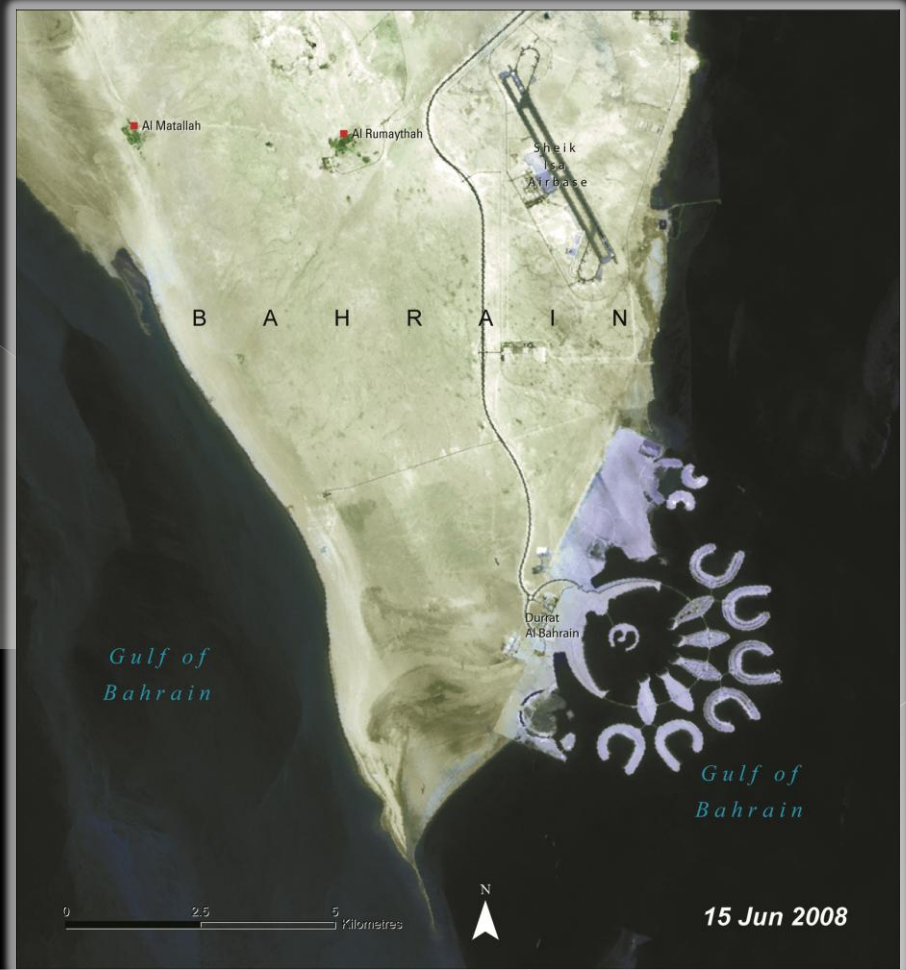
# Corona (KH-1-4, KH-4A, KH-4B)

1.8-12 m resolution  
7 cm x 75.7 cm film size



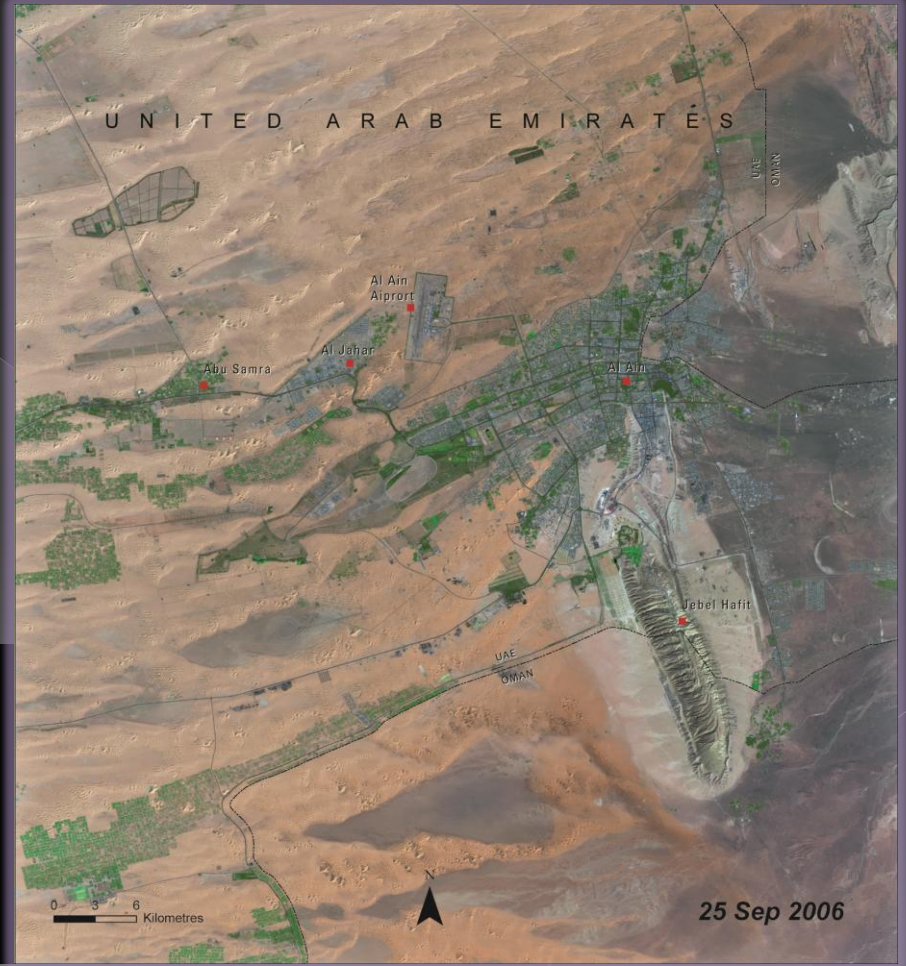
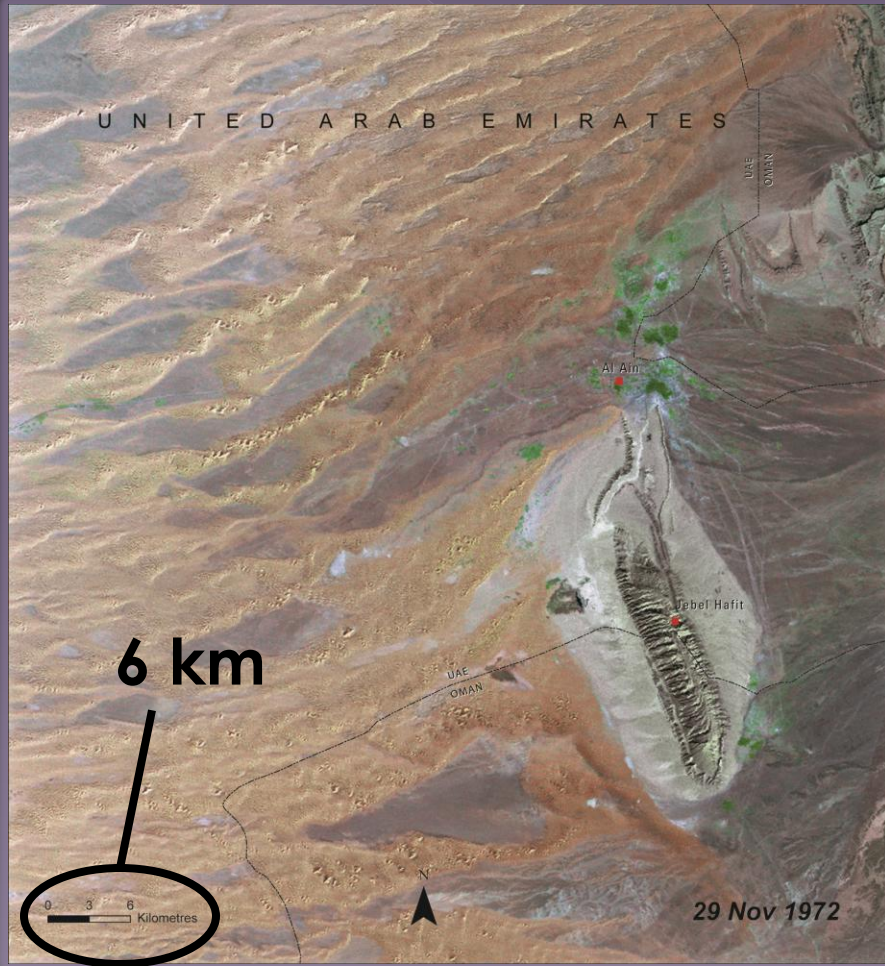
# ASTER

15 m resolution



# Landsat (1-5 MSS, 4-5 TM, 7 ETM+, 8 OLI)

15m – 60m resolution  
185 km swath width



# MODIS (on Terra & Aqua)

250m – 1000m resolution  
2330 km swath width



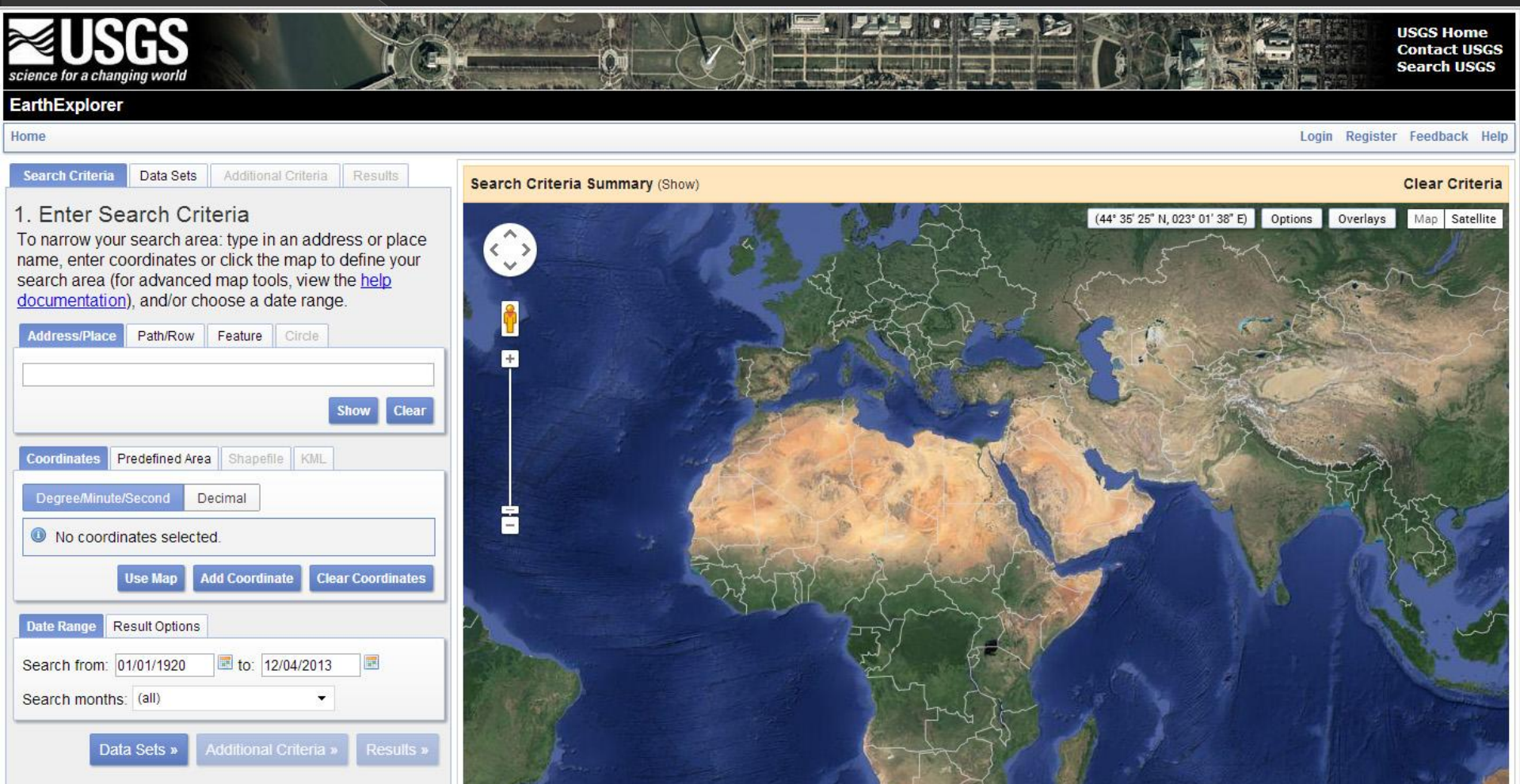
40 km





# Where to find imagery

earthexplorer.usgs.gov



**USGS**  
science for a changing world

**EarthExplorer**

Home Login Register Feedback Help

**Search Criteria** | Data Sets | Additional Criteria | Results

### 1. Enter Search Criteria

To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range.

**Address/Place** | Path/Row | Feature | Circle

Show Clear

**Coordinates** | Predefined Area | Shapefile | KML

Degree/Minute/Second | Decimal

**No coordinates selected.**

Use Map Add Coordinate Clear Coordinates

**Date Range** | Result Options

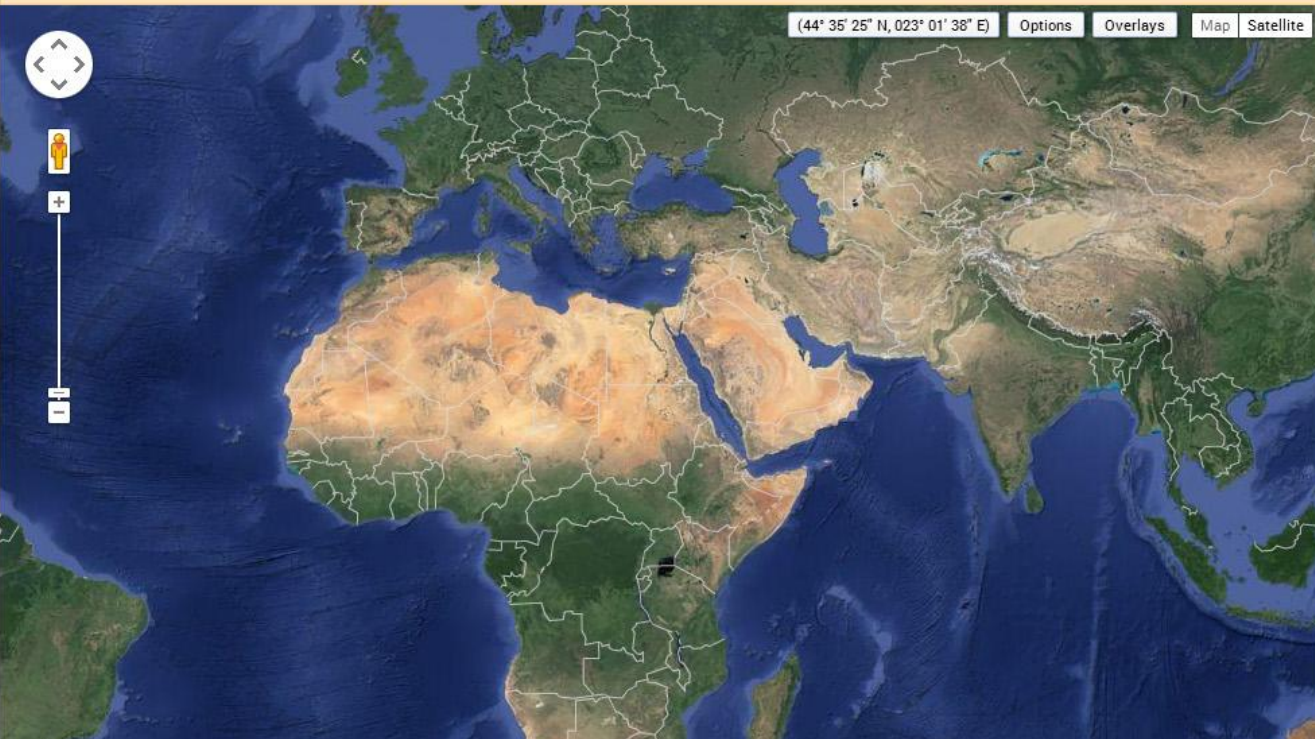
Search from: 01/01/1920 to: 12/04/2013

Search months: (all)

Data Sets » Additional Criteria » Results »

**Search Criteria Summary (Show)** Clear Criteria

(44° 35' 25" N, 023° 01' 38" E) Options Overlays Map Satellite



# Where to find imagery

glovis.usgs.gov



USGS Home  
Contact USGS  
Search USGS

Earth Resources Observation and Science Center (EROS)

## USGS Global Visualization Viewer

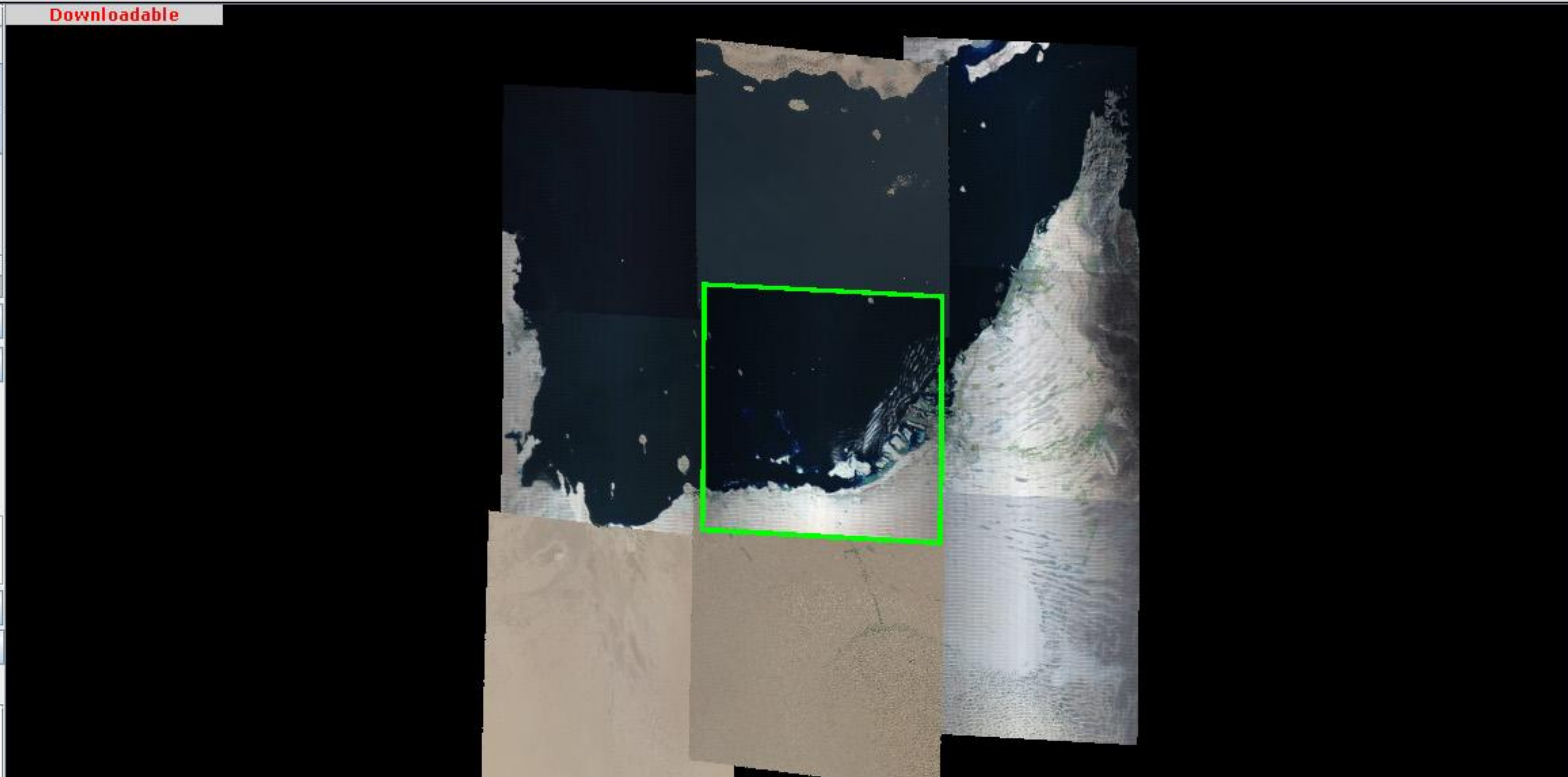
Collection Resolution Map Layers Tools File Help

Downloadable



WRS-2 Path /Row: 161 43 Go  
Lat/Long: 24.6 53.6 Go  
Max Cloud: 100% [up/down arrows]

Scene Information:  
ID: LE71610432013278SG100  
CC: 0% Date: 2013/10/5  
Qty: 9 Product: ETM+ L1T  
Oct 2013 Go  
Prev Scene Next Scene  
Landsat 4 - Present List



# Processing and Preparing Imagery

# Process Imagery

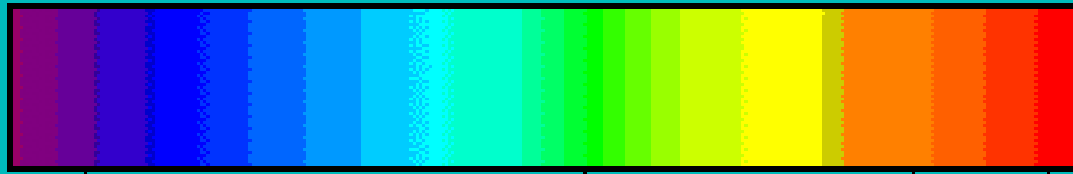
## STEPS TO TAKE

- Ensure images are registered correctly
- Georeference (i.e. ASTER L1A)
- Common projection

## SOFTWARE TO USE

- ESRI ArcGIS
- ERDAS Imagine
- ENVI
- MultiSpec (Open Source)

# Finding the Right Bands



.4

.5

.6

.7

visible

( $\mu\text{m}$ )  
NIR, MIR,  
Thermal IR

$10^{-5}$

$10^{-2}$

3

$10^2$

$10^4$

$10^6$  ( $\mu\text{m}$ )

Gamma

X-Ray

UV

Visible

Reflected IR

Thermal IR

Microwave

Radio



# Bands

Landsat 8			
Band Number	$\mu\text{m}$	Color of Light	Resolution
1	0.43-0.45	Coastal aerosol	30
2	0.45-0.51	Blue	30
3	0.53-0.59	Green	30
4	0.64-0.67	Red	30
5	0.85-0.88	NIR	30
6	1.57-1.65	SWIR 1	30
7	2.11-2.29	SWIR 2	30
8	0.50-0.68	Pan	15
9	1.36-1.38	Cirrus	30
10	10.60-11.19	TIRS 1	100
11	11.50-12.51	TIRS 2	100

MODIS has a total of 36 bands that can be combined in many different ways to analyze not just land changes, but atmospheric and temperature as well.

# Band Selection

Same Landsat 8 OLI



4-3-2 (Red – Green – Blue)



7-5-3 (SWIR 2 – NIR – Green)



# Enhancing and Annotating

# Enhancing & Annotating

Helps to provide more context for the change and prepares images for publication

## STEPS TO TAKE

- Stretch histogram
- Add vector layers
  - > Roads
  - > Lakes
  - > Protected areas
- Labels

## SOFTWARE TO USE

- ArcGIS
- Adobe Photoshop
- Adobe Illustrator

# Final Change Pair



**Research, research, research to  
corroborate story!**