



National Aeronautics and
Space Administration



ARSET

Applied Remote Sensing Training

<http://arset.gsfc.nasa.gov>

Creating and Using Normalized Difference Vegetation Index (NDVI) from Satellite Imagery

Instructors: Cindy Schmidt and Amber McCullum

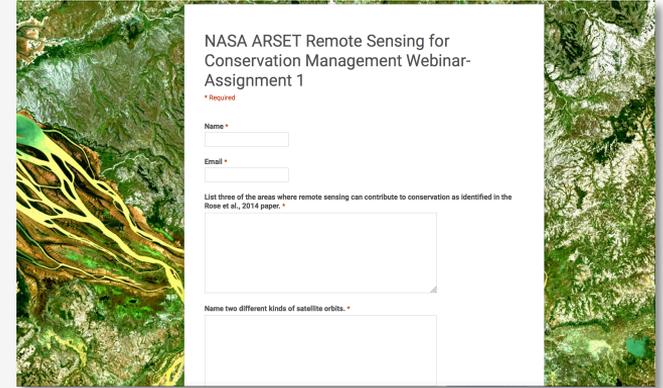
Week 1

Course Structure

- One lecture per week – every Wednesday from February 10 to March 2 at 12:00-1:00pm EST (-05:00 UTC)
 - Lectures
 - In-class exercise
 - Q&A
 - Homework exercises
- Webinar recordings, PowerPoint presentations, in-class exercises, and homework assignments can be found after each session at:
 - <http://arset.gsfc.nasa.gov/ecoforecasting/webinars/advanced-webinar-creating-and-using-normalized-difference-vegetation-index>
- Q&A: Following each lecture and/or by email (cynthia.l.schmidt@nasa.gov) or (amberjean.mccullum@nasa.gov)

Homework and Certificates

- Homework
 - Hands-on exercise each week
 - Answers must be submitted via Google Form
- Certificate of Completion:
 - Attend all 4 webinars
 - Complete all 4 homework assignments by the deadline (access from ARSET website above)
 - **Week 1 Deadline: Wednesday February 24th**
 - You will receive certificates approximately 2 months after the completion of the course from: marines.martins@ssaihq.com



NASA ARSET Remote Sensing for Conservation Management Webinar-Assignment 1

*** Required**

Name *

Email *

List three of the areas where remote sensing can contribute to conservation as identified in the Rose et al., 2014 paper. *

Name two different kinds of satellite orbits. *

Prerequisites

- Fundamentals of Remote Sensing
 - Sessions 1 and 2A (Land)
 - On-demand webinar available anytime
 - <http://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing>
- Download and Install QGIS
 - Install instructions on ARSET website: http://arset.gsfc.nasa.gov/sites/default/files/ecoforecasting/webinars/Advanced_NDVI/Downloading%20and%20Installing%20QGIS_Final.pdf
 - No previous QGIS knowledge needed, but useful to have some geospatial experience

On-Demand Training on Fundamentals of Remote Sensing

These on-demand sessions are intended to provide a basic overview of remote sensing. They are recommended as prerequisites for future courses in land management, wildfires, and water resources.

Session 1 is a general overview applicable to all the application areas mentioned above. There are two different Session 2 recordings specific to A) land management and wildfires and B) water resources. This training can be freely accessed at any time with a short user registration. Users can also download pdf versions of the presentations using the links below. No certificates will be provided for this training.

We hope you enjoy this on-demand training opportunity!

Presentation	Recording
Session1:Fundamentals of Remote Sensing	External Link to Session 1 Recording
Session 2A: Satellites, Sensors, Data, and Tools for Land Mgmt and Wildfire Applications	External Link to Session 2A Land Recording
Session 2B: Satellites, Sensors, Data, and Tools for Water Resource Applications (Coming soon)	External Link to Session 2B Water Recording (Coming soon)



Accessing Course Materials

- <http://arset.gsfc.nasa.gov/ecoforecasting/webinars/advanced-webinar-creating-and-using-normalized-difference-vegetation-index>

The screenshot shows the ARSET website interface. At the top, there are navigation tabs for "Earth Sciences Division", "Applied Sciences", and "ASP Water Resources". Below this is a search bar. A secondary navigation bar includes "DISASTERS", "ECO FORECASTING", "HEALTH & AIR QUALITY", and "WATER RESOURCES". The main content area features a sidebar on the left with "Eco Forecasting" and "Fundamentals of Remote Sensing" sections. The central content area displays the title "Advanced Webinar: Creating and Using Normalized Difference Vegetation Index (NDVI) from Satellite Imagery" with the dates "02/10/2016 to 03/02/2016". Below the title is a world map showing NDVI data for October 2015. The text indicates the webinar is held on Wednesdays from 12:00PM-1:00PM EST (UTC -05:00) on February 10, February 17, February 24, and March 2. Registration closes on February 8, 2016. A course description at the bottom states: "In this advanced webinar, participants will learn how to acquire, use, and derive".

Course Materials

Week	Date	Title	Presentation	Data and Exercise	Recording	Homework
1	February 10, 2016	Introduction to NDVI and QGIS	Week 1 Presentation Week 1 Presentation (Spanish)	Week 1 Data Week 1 Exercise	View Week 1 Recording	Homework 1
2	February 17, 2016	Deriving NDVI from Landsat	Week 2 Presentation Week 2 Presentation (Spanish)	Week 2 Data Week 2 Exercise	View Week 2 Recording	Homework 2
3	February 24, 2016	MODIS NDVI Time Series	Week 3 Presentation Week 3 Presentation (Spanish)	Week 3 Data Week 3 Exercise	View Week 3 Recording	Homework 3
4	March 2, 2016	MODIS NDVI Anomalies	Week 4 Presentation Week 4 Presentation (Spanish)	Week 4 Data Week 4 Exercise	View Week 4 Recording	Homework 4

*Please note that you must register to view all recordings. This includes the requirement to re-register for each separate recording for live webinar participants.

Course materials are provided here using each specified link and will be active after each week

Course Objectives

- Provide understanding of the Normalized Difference Vegetation Index (NDVI)
- Show participants how to acquire Landsat and MODIS imagery
- Provide step-by-step training on how to generate:
 - NDVI images from Landsat and MODIS
 - NDVI time series using MODIS
 - MODIS NDVI anomaly maps
- Conduct live demonstrations of useful NDVI websites
- Provide in-class and homework exercises

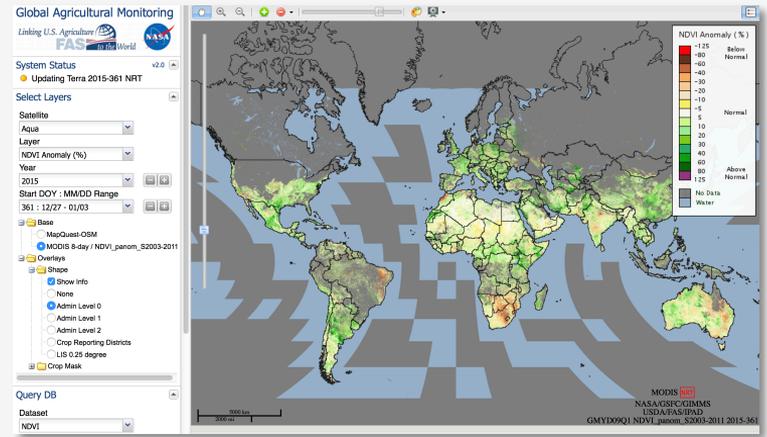
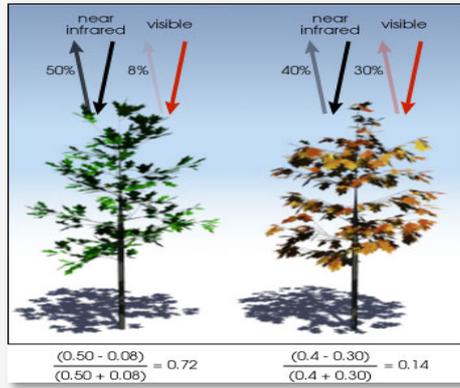


Image Credit: Global Agricultural Monitoring Program.

Course Outline

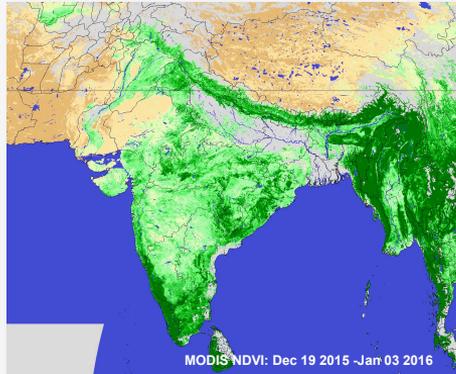
Week 1

Overview of
NDVI and
QGIS



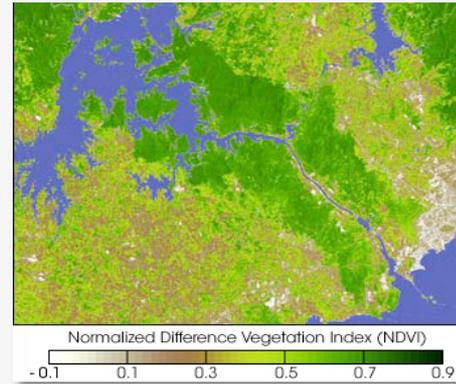
Week 3

MODIS
NDVI Time
Series



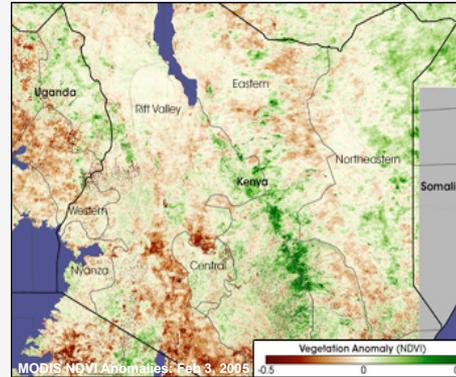
Week 2

NDVI with
Landsat



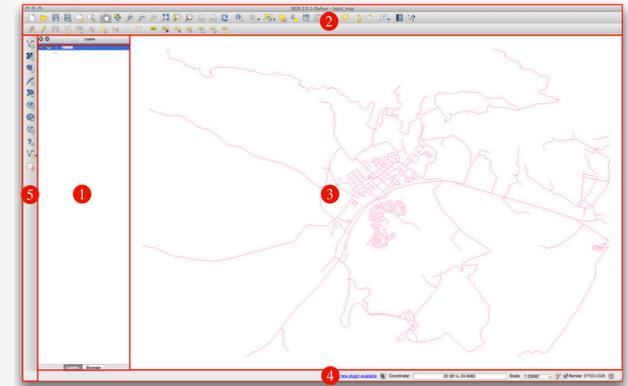
Week 4

MODIS
NDVI
Anomaly
Mapping

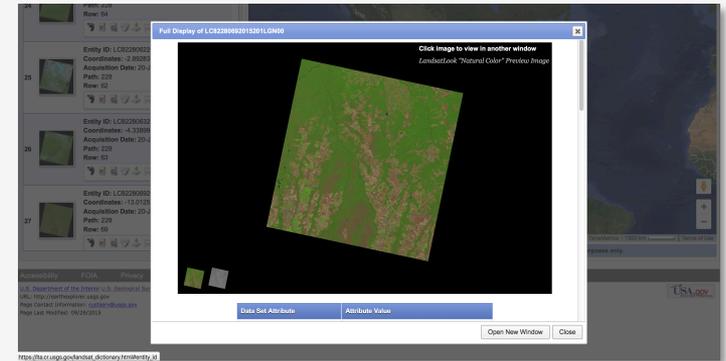


Week 1 Agenda

- Review of NDVI
- NDVI applications and examples
- Overview of QGIS
- In-class exercise: Introduction to QGIS and downloading Landsat imagery
- Q&A



QGIS User interface



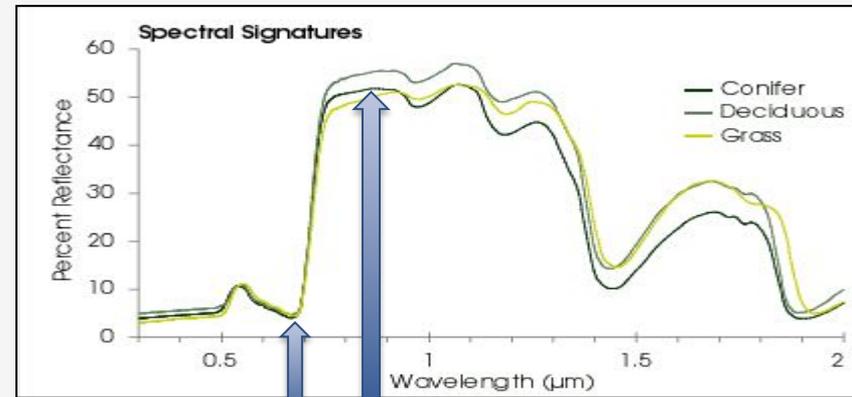
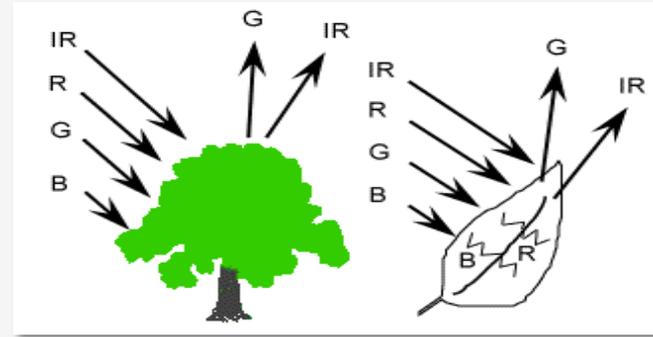
USGS Earth Explorer

An aerial satellite image of a river valley. The river flows from the top right towards the bottom center. The surrounding landscape is a mix of green fields and forested areas. A semi-transparent grey rectangular box is overlaid on the center of the image, containing the text 'NDVI Review' and a horizontal line below it.

NDVI Review

What is NDVI?

- Normalized Difference Vegetation Index
 - Based on the relationship between red and near-infrared wavelengths
 - Chlorophyll strongly absorbs visible (red)
 - Plant structure strongly reflects near-infrared



Red Near-Infrared

What is NDVI?

- NDVI formula:
$$\frac{\text{Near-Infrared} - \text{Red}}{\text{Near-Infrared} + \text{Red}}$$
- Values range from -1.0 to 1.0
 - Negative values to 0 mean no green leaves
 - Values close to 1 indicates the highest possible density of green leaves.

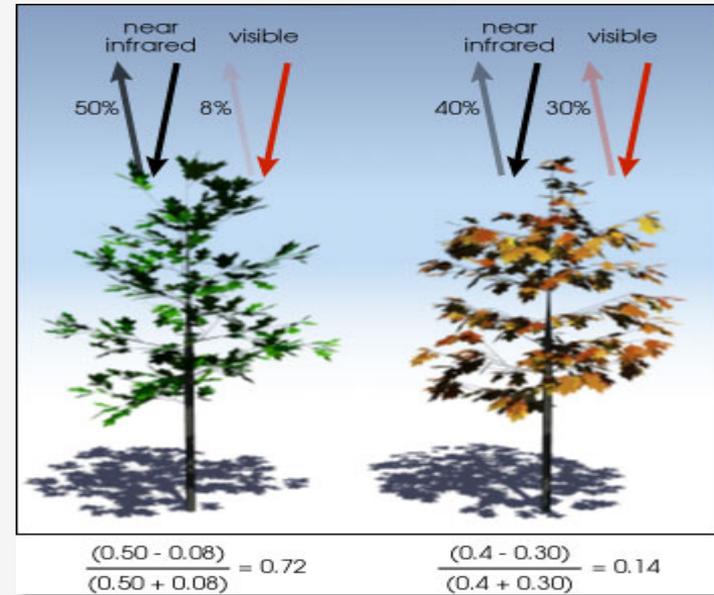
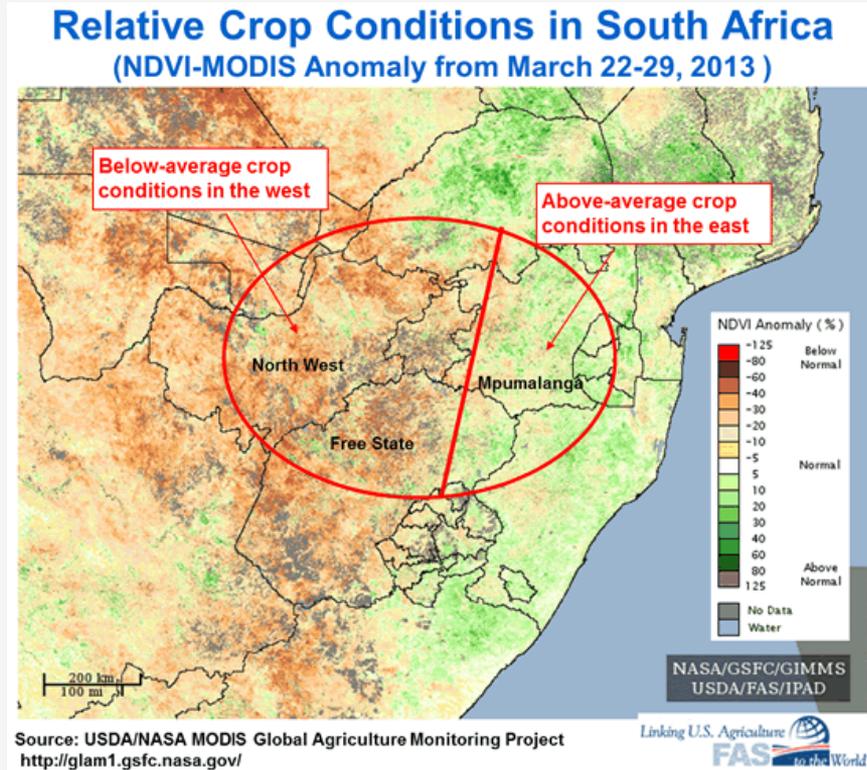


Image Credit: Robert Simmon

NDVI Applications

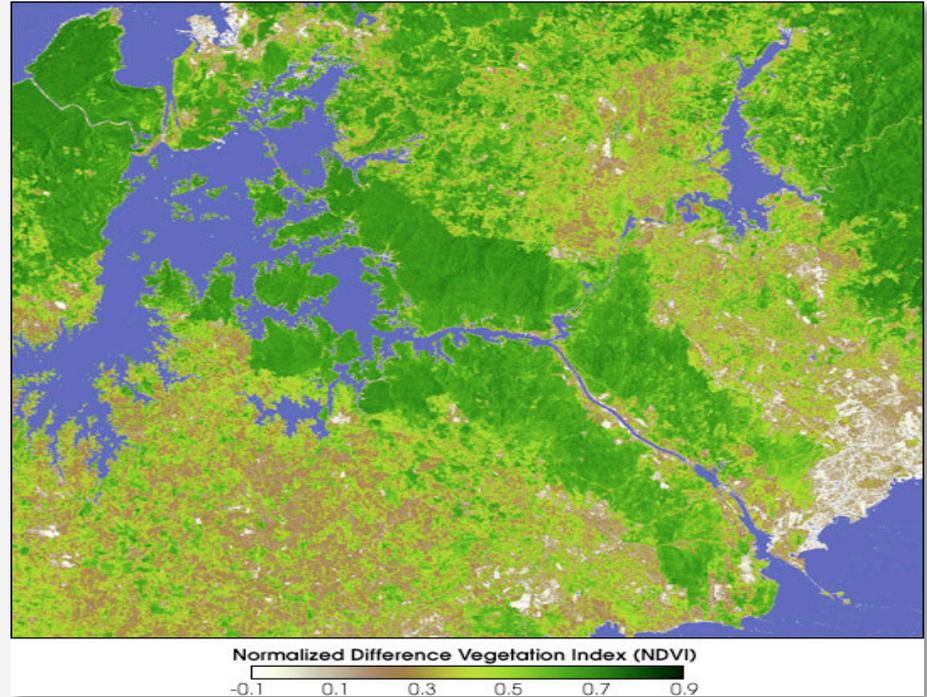
- Vegetation health
 - Crop health
- Phenology
- Drought Indicator
 - Soil moisture
- Leaf Area Index (LAI)
- Carbon Monitoring



South Africa's crop conditions at the end of March are summarized in the NDVI-MODIS anomaly, which indicates below-average crop conditions in both North West and western Free State provinces and above-average crop conditions in Mpumalanga province.

NDVI Example

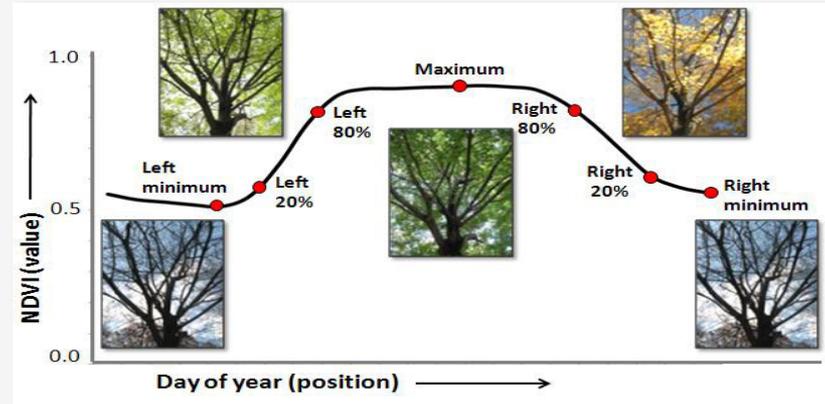
- This is Landsat NDVI image of the Panama Canal watershed
- The darker green the area, the higher the NDVI value, the more green vegetation is present
- This image was acquired in March 2000 during Panama's annual dry season.



Source: <http://earthobservatory.nasa.gov>

NDVI: Phenology

- Remote sensing is used to track the seasonal changes in vegetation
- Monthly NDVI images from MODIS or Landsat can be used to monitor phenology

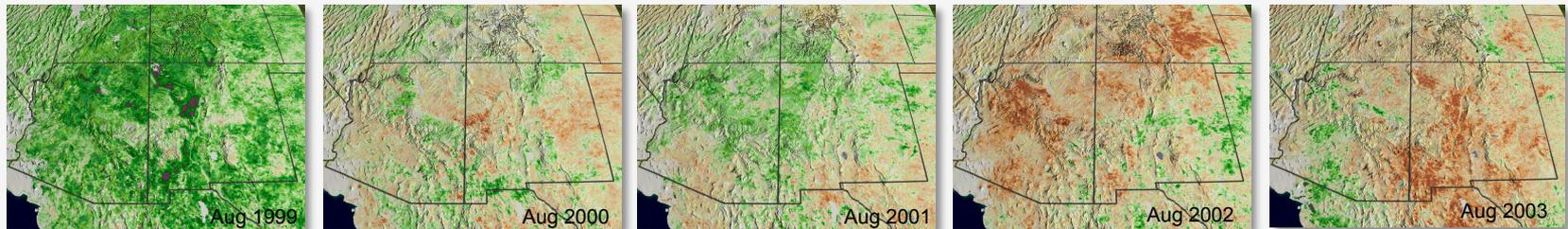


North America NDVI images in winter and summer

Credit: spacegrant.montana.edu

NDVI Anomalies

- Departure of NDVI from the long-term average, normalized by long-term variability
- Generated by subtracting the long-term mean from the current value for that month of the year for each grid cell.
- Indicates if vegetation greenness at a particular location is typical for that period or if the vegetation is more or less green



NDVI Anomalies in the southwestern United States. Image Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio.

NDVI Anomaly Example

- California's Drought
- Image shows the NDVI anomalies from January 17th to February 1st 2014 against average conditions over the same period from the past decade
- Notice the below-average vegetation along most of the Central Valley farmland.
- Vegetation in the Sierra Nevada is greener than usual, this is mainly because of a lack of snow, which is also bad news for California.

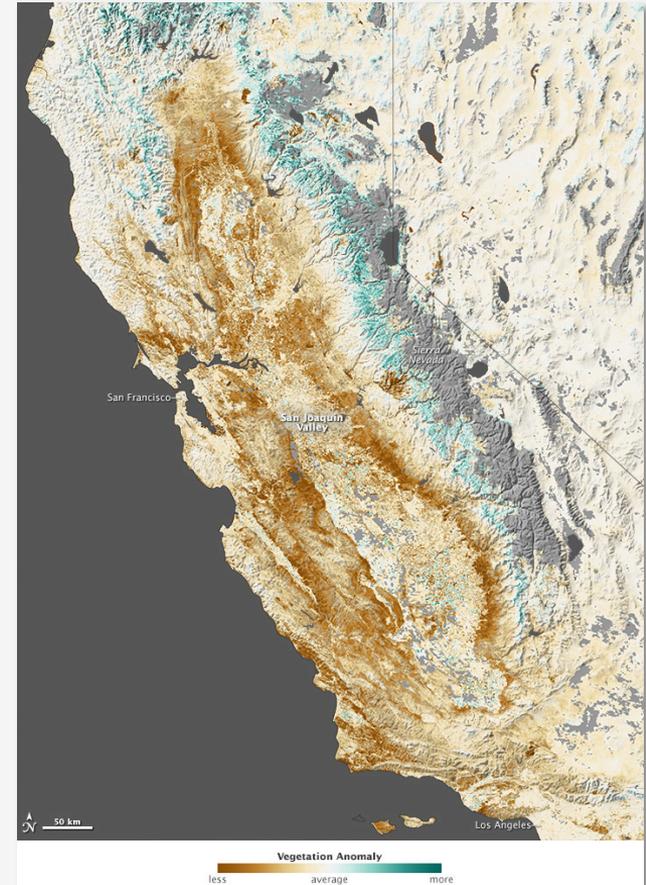


Image Credit:
NASA Earth
Observatory

What is EVI?

- Enhanced Vegetation Index (MOD13Q1) – only from MODIS
 - Improves sensitivity over dense vegetation conditions
 - Uses the blue band to remove residual atmosphere contamination caused by smoke and sub-pixel thin clouds
 - More responsive to Leaf Area Index (LAI)

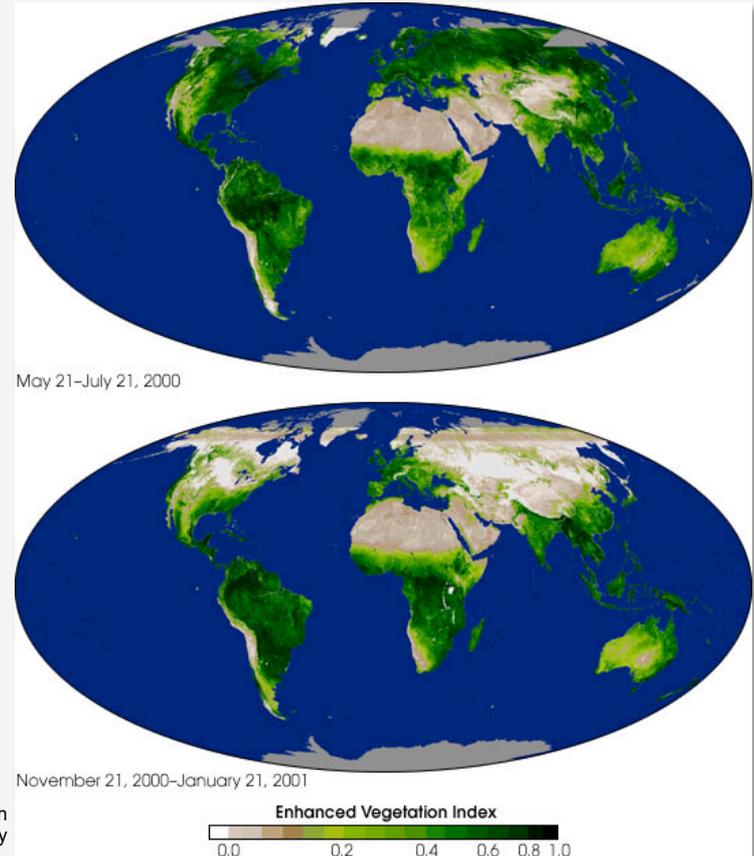
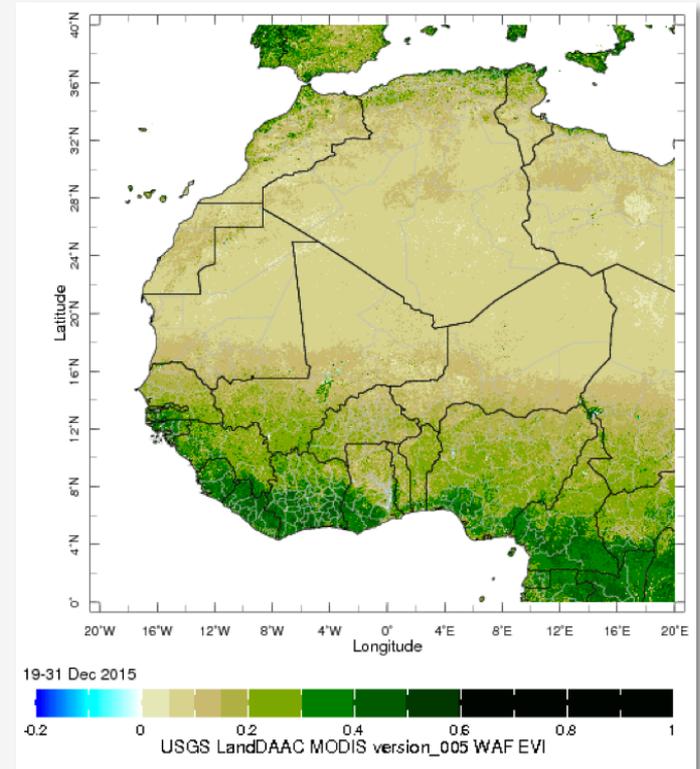
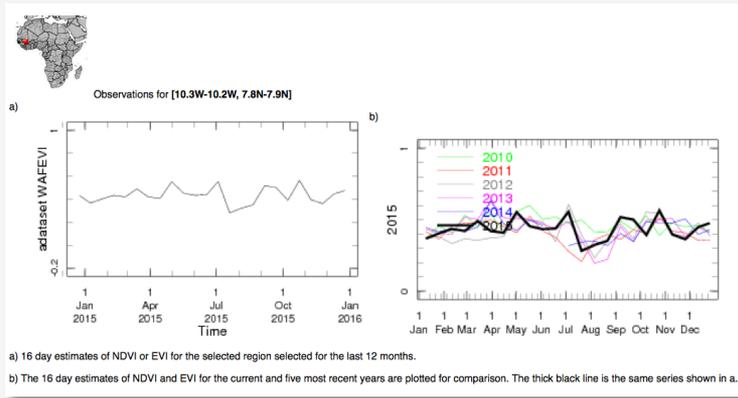


Image Credit: NASA Earth Observatory

EVI Applications

- The International Research Institute for Climate and Society (IRI) has developed a tool to visualize EVI and NDVI data for Africa
- http://iridl.ldeo.columbia.edu/maproom/Food_Security/Locusts/Regional/MODIS/



An aerial photograph of a river valley, showing a winding river and surrounding green fields. A semi-transparent rectangular box is overlaid on the center of the image. The text 'QGIS' is written in white, bold, sans-serif font within the box. A horizontal black line is positioned below the text.

QGIS

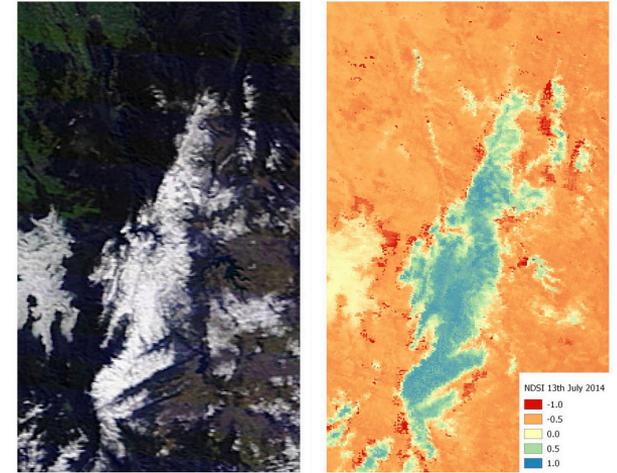
QGIS

- Freely-available open source Geographic Information System (GIS) licensed under the GNU General Public License
- Volunteer-driven project
- Runs on Windows and Mac operating systems
- Plugins allow users to perform advanced geospatial analysis
- Compatible with many data formats including:
 - Shapefiles
 - Geotiff
 - Geodatabases, etc.



QGIS: Support

- User Guide and Training Manual available
 - <http://www.qgis.org/en/site/forusers/index.html>
- User support on StackExchange
 - Use QGIS Tag
 - <http://gis.stackexchange.com/>
- Case Studies
 - Example: Using the processing toolbox to automate snow classification
 - Similar to NDVI classification
 - http://www.qgis.org/en/site/about/case_studies/australia_snowyhydro.html



MODIS Truecolor

NDSI Output

Case study: use of QGIS for calculating the Normalized Difference Snow Index (NDSI).
Image Credit: Andrew Jeffrey.

An aerial photograph of a river valley, showing a winding river and surrounding green fields. A semi-transparent rectangular box is overlaid on the center of the image. Inside the box, the text "QGIS Exercise" is written in a black, sans-serif font. Below the text, a solid black horizontal line extends across the width of the box.

QGIS Exercise

Contacts

- ARSET Land Management and Wildfire Contacts
 - Cynthia Schmidt: Cynthia.L.Schmidt@nasa.gov
 - Amber McCullum: AmberJean.Mccullum@nasa.gov
- General ARSET Inquiries
 - Ana Prados: aprados@umbc.edu
- ARSET Website:
 - <http://arset.gsfc.nasa.gov/>



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Thank You

Next Week:

Deriving NDVI from Landsat