



# ARSET

Applied Remote Sensing Training

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

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

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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](mailto:cynthia.l.schmidt@nasa.gov)) or ([amberjean.mccullum@nasa.gov](mailto: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 24<sup>th</sup>**
  - You will receive certificates approximately 2 months after the completion of the course from: [marines.martins@ssaihq.com](mailto:marines.martins@ssaihq.com)



# 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](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
<a href="#">Session1: Fundamentals of Remote Sensing</a>	<a href="#">External Link to Session 1 Recording</a>
<a href="#">Session 2A: Satellites, Sensors, Data, and Tools for Land Mgmt and Wildfire Applications</a>	<a href="#">External Link to Session 2A Land Recording</a>
<a href="#">Session 2B: Satellites, Sensors, Data, and Tools for Water Resource Applications (Coming soon)</a>	<a href="#">External Link to Session 2B Water Recording (Coming soon)</a>



# Accessing Course Materials

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



Course Materials						
Week	Date	Title	Presentation	Date and Exercise	Recording	Homework
1	February 16, 2016	Introduction to NDVI and QGIS	Week 1 Presentation	<a href="#">Week 1 Data</a>	View Week 1 Recording	Homework 1
			Week 1 Presentation (Spanish)	Week 1 Exercise		
2	February 17, 2016	Deriving NDVI from Landsat	Week 2 Presentation	Week 2 Data	View Week 2 Recording	Homework 2
			Week 2 Presentation (Spanish)	Week 2 Exercise		
3	February 24, 2016	MODIS NDVI Time Series	Week 3 Presentation	Week 3 Data	View Week 3 Recording	Homework 3
			Week 3 Presentation (Spanish)	Week 3 Exercise		
4	March 2, 2016	MODIS NDVI Anomalies	Week 4 Presentation	Week 4 Data	View Week 4 Recording	Homework 4
			Week 4 Presentation (Spanish)	Week 4 Exercise		

\*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

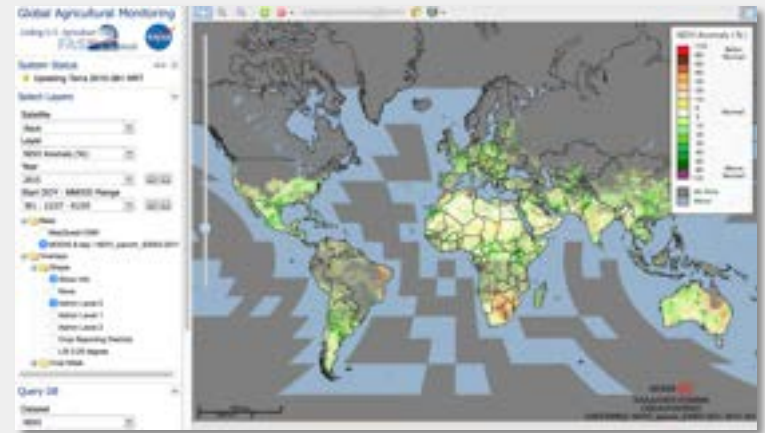


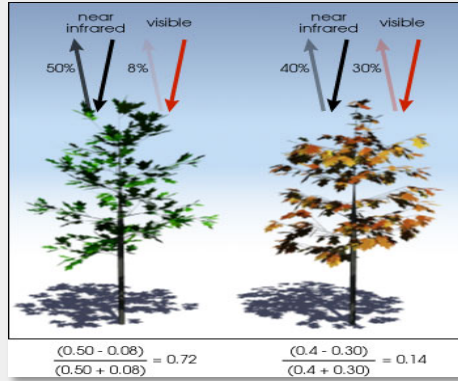
Image Credit: Global Agricultural Monitoring Program.



# Course Outline

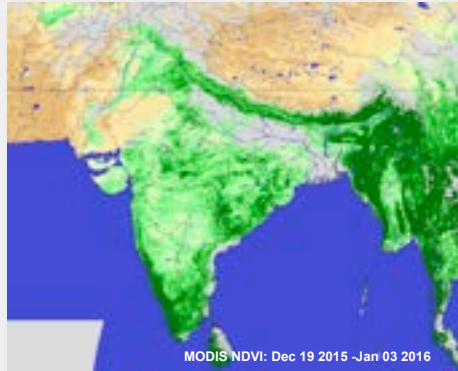
## Week 1

Overview of  
NDVI and  
QGIS



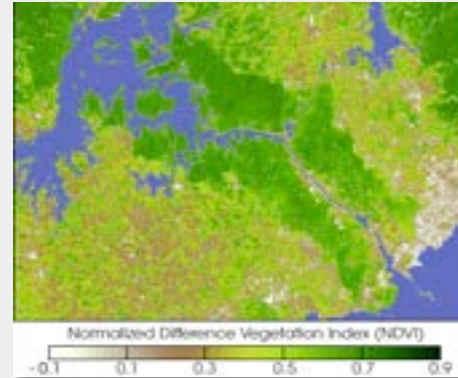
## Week 3

MODIS  
NDVI Time  
Series



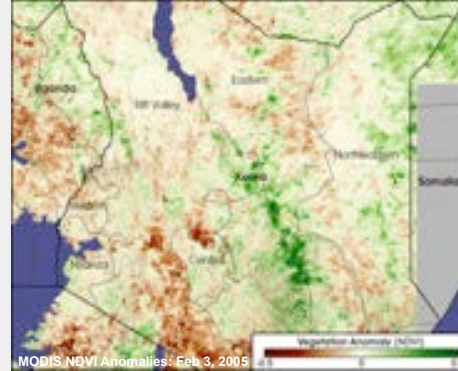
## Week 2

NDVI with  
Landsat



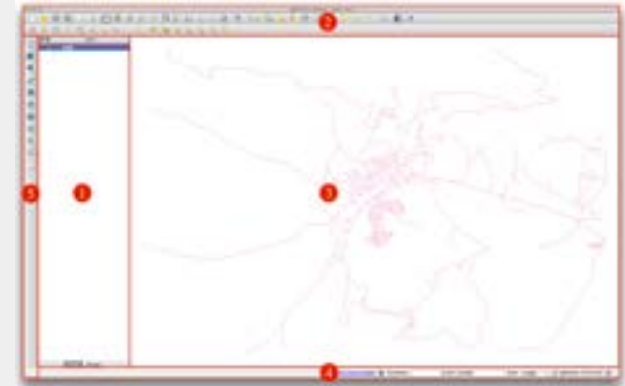
## Week 4

MODIS  
NDVI  
Anomaly  
Mapping

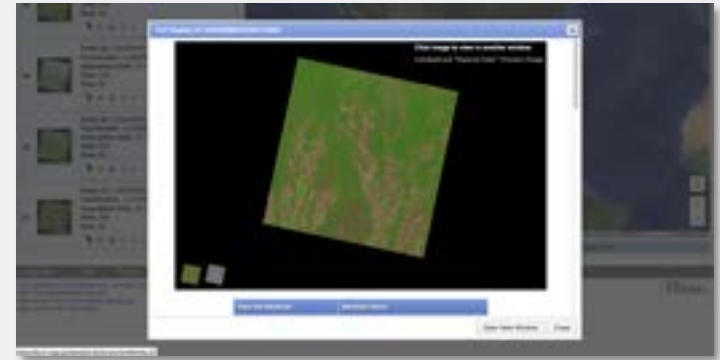


# Week 1 Agenda

- 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



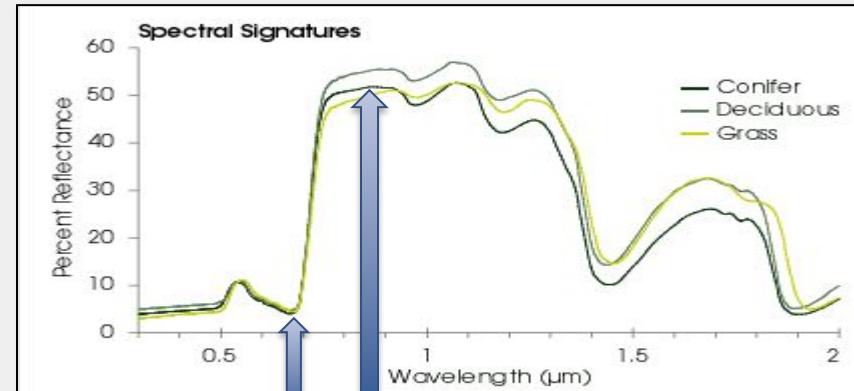
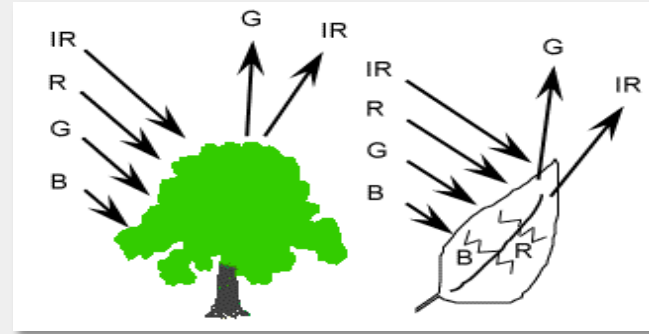
A satellite map of a landscape with a semi-transparent NDVI overlay. The overlay shows a network of light-colored lines and patches against a darker green background, representing vegetation density. The text "NDVI Review" is centered on the left side of the overlay, with a horizontal line extending to the right.

## NDVI Review

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# 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.

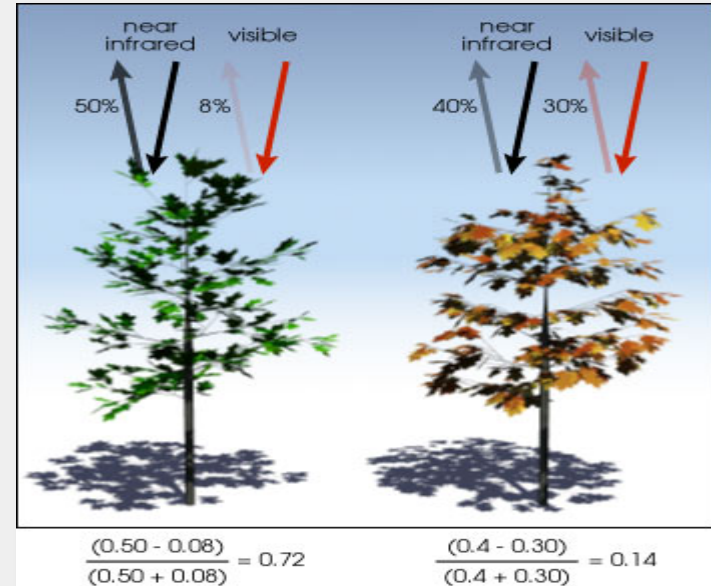
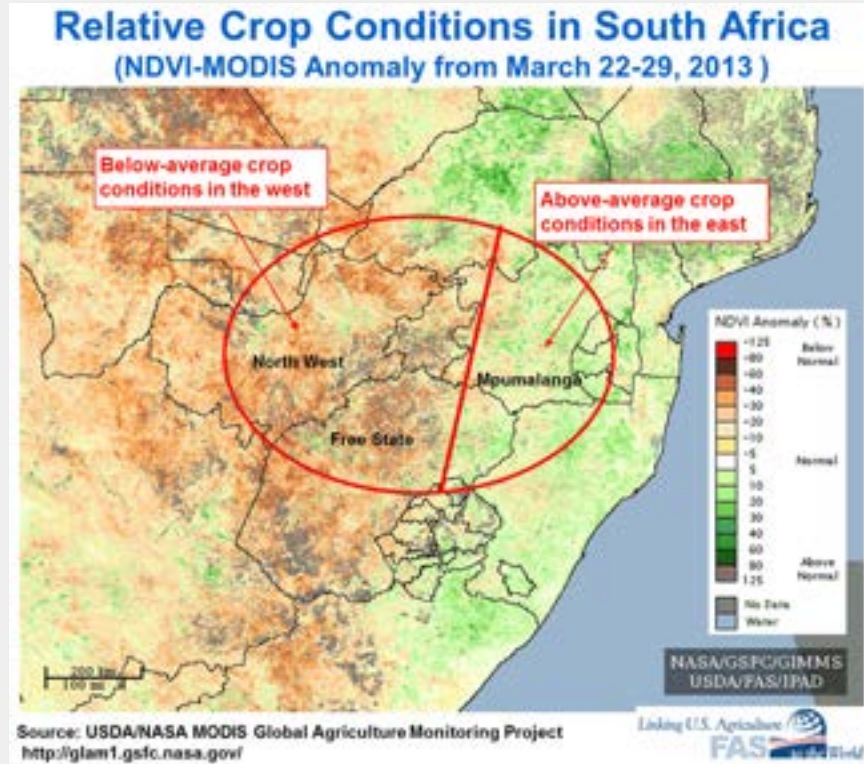


Image Credit: Robert Simmon

# NDVI Applications

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

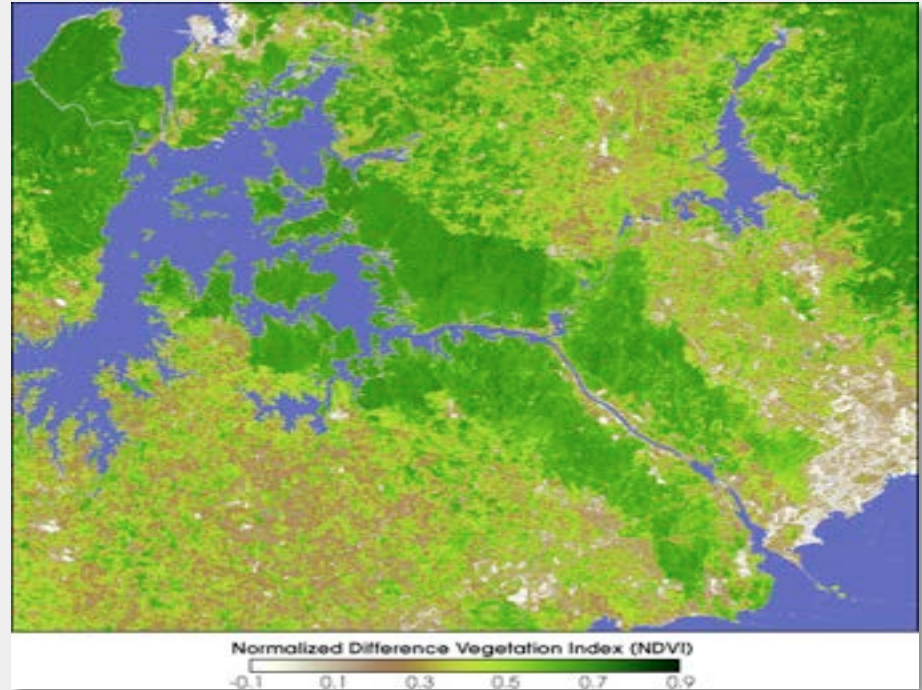


South Africa's crop conditions at the end of March are summarized in the NDVI-MODIS anomaly, which indicates below-average crop conditions in both North West and western Free State provinces and above-average crop conditions in Mpumalanga province.



# NDVI Example

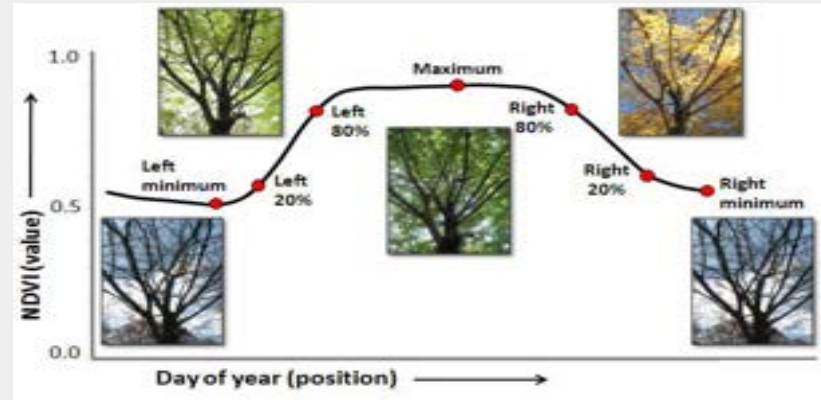
- This is Landsat NDVI image of the Panama Canal watershed
- The darker green the area, the higher the NDVI value, the more green vegetation is present
- This image was acquired in March 2000 during Panama's annual dry season.



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

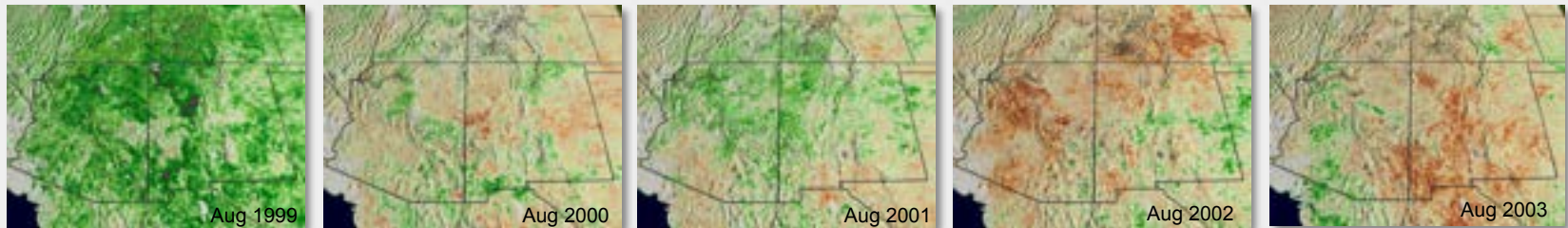


North America NDVI images in winter and summer

Credit: [spacegrant.montana.edu](http://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 17<sup>th</sup> to February 1<sup>st</sup> 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.

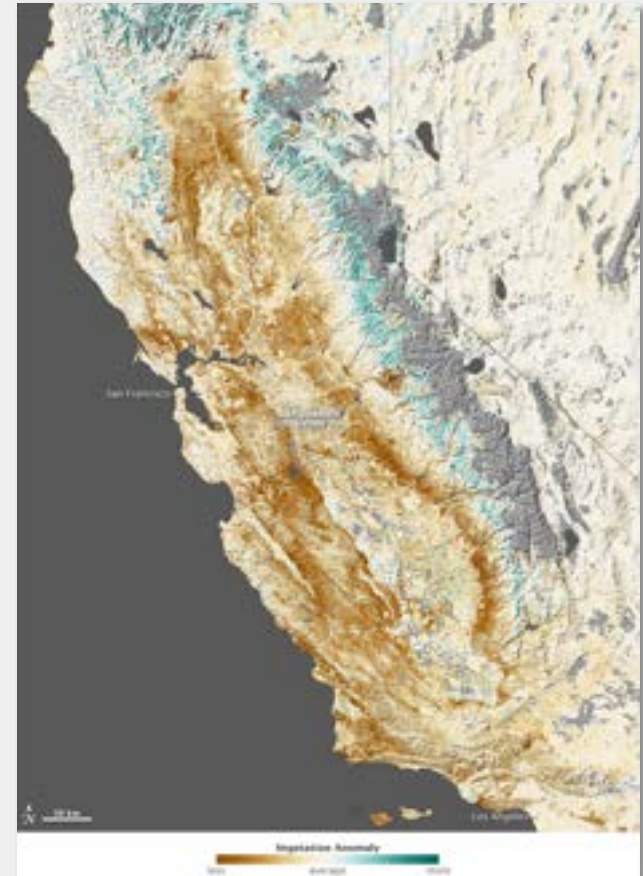


Image Credit:  
NASA Earth  
Observatory

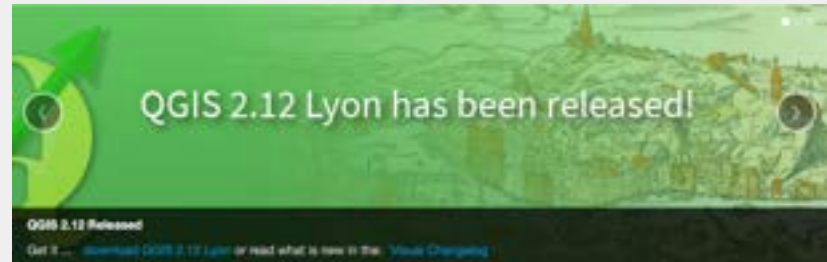
An aerial photograph of a river valley, likely the Amazon, showing a wide river with numerous tributaries and smaller lakes. The landscape is a mix of green forest and lighter-colored cleared land. A semi-transparent rectangular box is overlaid on the center of the image. Inside this box, the text 'QGIS' is displayed in a large, black, sans-serif font. Below the text, a solid black horizontal line extends across the width of the box.

QGIS

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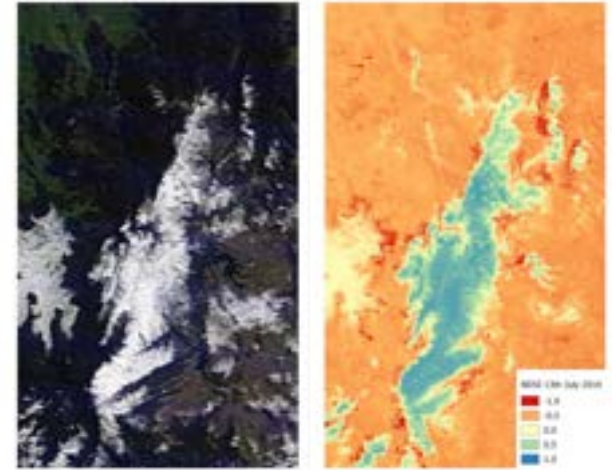
# QGIS

- 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](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 forested landscape with a river and a semi-transparent title box. The title box is a light gray rectangle with a thin black border, containing the text "QGIS Exercise" in a black serif font. Below the text is a horizontal black line. The background is a high-resolution aerial photograph showing a dense forest of green trees, a winding river, and some cleared areas. The title box is positioned in the upper left quadrant of the image.

# QGIS Exercise

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# Contacts

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



## ARSET

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# Thank You

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**Next Week:**

***Deriving NDVI from Landsat***