



iGETT Cohort 2, June 2008

Curriculum Support Document – Outline of Content

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Title of Learning Unit: Using Remote Sensing and GIS to Analyze NDVI Values for Darfur, Sudan

Time: 5-6 Hours (see Instructor Guide for abbreviated version)

Focus Topic: Agriculture and disasters

Description: It has been suggested that the genocide in Darfur, Sudan originated because of regional water shortages. Some have suggested that the water shortage occurred because of recent droughts and the possible onset of regional desertification. Using Darfur, Sudan as a case study, the bigger concern is if conflicts of war and genocide will become more prevalent as natural resources, food, and water become scarcer with a growing global population and climate change. Is it possible to determine if the water shortage in Darfur, Sudan was short term or part of a larger drying of the region using *Normalized Difference Vegetation Index* (NDVI) analysis with remote sensing and GIS? If so, it will become vital for governmental agencies, NGOs, and scientists to spatially and historically analyze – through the use of remote sensing and GIS – the causes that lead up to devastating water shortages and the consequences that could follow.

Outline of Learning Unit: The following is a brief learning sequence of the unit. For greater detail, see the Instructor Guide for this learning unit.

Step 1: Introduction to MODIS imagery and, NDVI Analysis

- Students will develop an understanding of remote sensing?
- Students will understanding NASA's MODIS satellite.

Step 2: Geographic Method along with Drought and Desertification using NDVI Analysis

- Students will compare the geographic method versus the scientific method and be asked to explore the following while going through the learning unit:
 - *What was the geographic question for this assignment?*
 - *What geographic resources did you acquire to complete this assignment?*
 - *In what ways did you explore the geographic data?*
 - *What information did you acquire by analyzing the data?*
 - *How can the information you just learned be applied to a local, regional, and global level?*
- Students will learn the difference between droughts and desertification.
- Student will analyze how NDVI can be used to analyze water shortages in a region.

Step 3: Downloading and Reprojecting MODIS NDVI Imagery

- Students will discover how to download free MODIS imagery from the USGS GLOVIS website.
- Students will understand how and why the imagery must be reprojected before analysis.

Step 4: NDVI Analysis for Western Sudan from January-December 2008

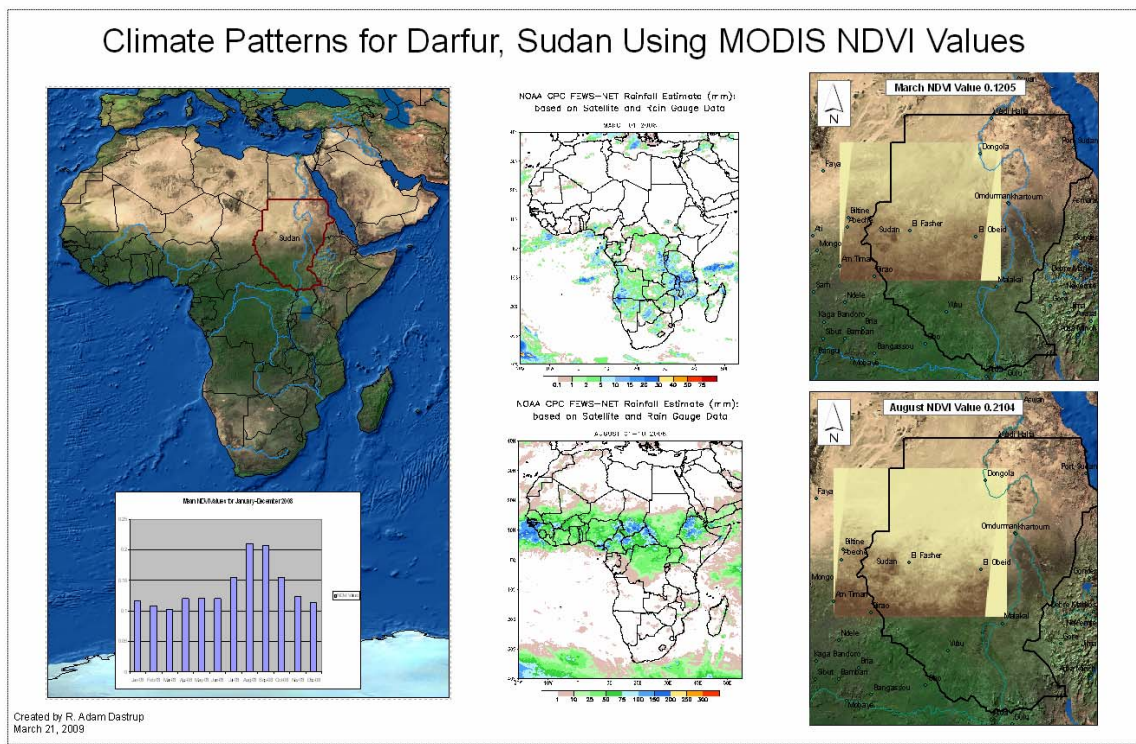
- Students will analyze NDVI statistical means for the region to determine when the wet and dry seasons are.

Step 5: NDVI Analysis for Western Sudan from 2000-2008

- Based on when the wet season is from Step 4, students will use that month and track NDVI values for several years. Based on this, students should be able to see if water shortages were occurring or not around the time of the genocide. Students will also be able to determine if the water shortage was a drought or regional desertification.

Step 6: Loading MODIS NDVI Imagery into ArcGIS

- Students will learn how to save their NDVI images so they can be added to ArcGIS.
- Students will create two maps that show the relationship between precipitation and NDVI values (see image below for an example of their January-December 2008 map).



Step 7: Analyzing the Darfur Genocide

- After analyzing moisture and NDVI patterns, students will go to a website called Eyes on Darfur to view before and after images of Darfur, Sudan using satellite imagery.
- Students will summarize the events that occurred during and after the genocide.

Step 8: Reflection on the Geographic Method

- Students will fill out a worksheet that asks them to reflection on the geographic questions mentioned in Step 2.

Step 9: Assessment

- In terms of assessing student learning, students will be required to turn in the following:
 - Two ArcGIS maps that contain all the information requested.
 - The Assignment Worksheet
 - A reflection page on the geographic method.
 - What was the geographic question for this assignment?*
 - What geographic resources did you acquire to complete this assignment?*
 - In what ways did you explore the geographic data?*
 - What information did you acquire by analyzing the data?*
 - How can the information acquired be applied to a local, regional, and global level?*

Interdisciplinary Learning Unit: This learning unit may be used in a variety of courses and disciplines with varying degrees of difficulty. This entire learning unit is very appropriate for introductory or intermediate GIS courses or an introductory remote sensing course. The learning unit will show students how to acquire, reproject, and analyze NDVI imagery using NASA's MODIS Terra satellite. Students will also learn how to save the imagery from the software called ENVI and load it into ArcGIS.

This module is also appropriate for courses in physical geography, human geography, regional geography, biogeography, ecology, political science, and sociology. It is highly recommended though those students first become acquainted with basic ArcMap skills so they are not learning two new programs at once. For time and efficiency, it is recommended that for these courses the instructor download and reproject the MODIS imagery beforehand so that students can begin on uploading and analyzing the MODIS imagery in ENVI first. By doing so, the time for the learning unit is taken down to 3-4 hours for completion.

Software, Hardware, and Data Resources:

- Learning Unit Student Guide
- Supplemental PowerPoint provided with this learning unit
- Student Assignment Worksheet
- ENVI 4.4 (or higher)
- ESRI ArcGIS 9.0 (or higher)
- MODIS imagery from GLOVIS (data can also be obtained by download from iGETT at <http://igett.delmar.edu/>) or by going to GLOVIS at <http://glovis.usgs.gov/>
 - MODIS imagery of western Sudan from January-December 2008
 - MODIS imagery of western Sudan for the month of August from 2000-2008 (or beyond).
- MODIS Reprojection Tool (unless you download the reprojected data from iGETT).
https://lpdaac.usgs.gov/lpdaac/tools/modis_reprojection_tool
- The following shapefiles or geodatabases of western Sudan (all of the shapefiles can be obtained from ESRI's Data & Maps package which comes with ArcGIS):
 - Major cities
 - Major rivers
 - Countries
 - Satellite/Raster image

Level of Learning Unit: As mentioned above, this unit is appropriate for introductory and intermediate GIS courses to teach students about remote sensing. This course is also very useful in a remote sensing course because it's focus is on MODIS satellite imagery. If this learning unit is used in the other course types mentioned above, it is recommended the instructor download and reproject the data beforehand for the students.

Learning Objectives and Outcomes: By the end of this learning unit, students should be able to:

- Describe remote sensing and how NDVI analysis it is used.
- Explain the geographic method along with its similarities and differences with the scientific method.
- Understand the causes of drought and desertification, specifically in Darfur, Sudan.
- Download specific MODIS data imagery using GLOVIS from the United States Geologic Survey (USGS) and load it into ENVI for analysis.
- Analyze monthly NDVI data for 2008 in the Darfur region to determine the wet and dry seasons for the region.
- Analyze NDVI values for the wet month – the month of August – in the Darfur region from 2000 to 2008 to determine if the genocide occurred during a dry period for the region as many suggests.
- Load the NDVI values into GIS to create a map showing the NDVI values for the region.
- Correlate the relationship between precipitation patterns and NDVI values based on the GIS.
- Explain how water shortages influenced and perhaps initiated the 2003 genocide in Darfur, Sudan.
- Analyze before and after satellite imagery to observe the actual destruction to villages caused by the invasion of the Janjaweed nomad militias into the non-Arab farm lands.

Method of Instruction: This is a very hands-on learning unit, but it is appropriate for instructors to lecture at the beginning about remote sensing, MODIS imagery, and NDVI analysis. Instructors may want to also discuss with students the geographic method versus the scientific method, the difference between droughts and desertification along with a brief introduction to the genocide in Darfur, Sudan.

During the analysis, instructors are encouraged to continuously check on students to make sure they are clear on the instructions and purpose of the assignment. Since this learning unit will take a few class periods, it's always a good idea to begin each session with a review of what they have learned so far along with providing 5-10 minutes at the end for reflection.

Finally, students are asked to reflect on the geographic method based on the learning unit. This is an appropriate time for small group or whole-class discussions on what they learned, the method, and how this can be applied on a local, regional, and international scale.

Correlation to the National Geography Standards

This learning unit meets the following six essential elements of the National Geography Standards:

Essential Element I: The World in Spatial Terms

- How to use maps and other geographic representations, tools, and technologies to acquire process, and report information from a spatial perspective.
- How to analyze the spatial organizations of people, places, and environments on Earth's surface.

Essential Element III: Physical Systems

- The physical processes that shape the patterns of Earth's surface.

Essential Element IV: Human Systems

- How the forces of cooperation and conflict among people influence the division and control of Earth's surface.

Essential Element V: Environment and Society

- How physical systems affect human systems.
- The changes that occur in the meaning, use, distribution, and importance of resources.

Essential Element VI: The Use of Geography

- How to apply geography to interpret the past.
- How to apply geography to interpret the present and plan for the future.