Integrated Geospatial Technology and Training (iGETT)

Student Guide

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- **Land use change in adjacent basins of the Catawba River within Mecklenburg County**

Introduction: In 2008, American Rivers, an advocacy group, named the Catawba River the most endangered river in America. The Catawba River is a tributary of the Wateree River and originates in the Appalachian Mountains and drains into Piedmont, through a series of reservoirs. The river was not evaluated as the most polluted river in the United States, but American Rivers determined that the river that was threatened by trends in urban development and water management. Recent development within the Catawba River Watershed has affected water quality and a common problem is sedimentation. The population explosion in the Charlotte region has put a strain on the river as millions of people visit the Catawba River each year for all types of recreational activities. Starting in the summer of 2007 the Catawba basin fell victim to an extreme drought, which only exacerbated the problems of water quality and water quantity.

Overview: This Learning Unit uses the ENVI software and Landsat data to examine land cover changes in sub-watersheds of the Catawba River Watershed within Mecklenburg County, 1988-2007.

Change detection of Earth's surface features is important for understanding relationships and interactions between human and natural phenomena in order to promote better decision making. Remote sensing data are used for change detection within urban environments. One of the effects of urbanization within deciduous forests, such as found in the eastern half of North America urbanization is a loss of tree canopy. The loss of tree canopy has an important impact on stream water quality. Coincident with the loss of tree canopy is the growth of impervious surfaces, which is often linked to the decline of urbanized watersheds. This project investigates the impact of land cover change for estimating stream quality. The presence of impervious surfaces leads to more stormwater runoff, which in turn raises the risk for water pollution, turbidity and water temperature change. The replacement of natural vegetation with an impervious surface is important as a key indicator of a watershed's health.

There are advantages to conducting land cover change analysis from high-resolution satellite imagery, but the small spatial extents and relatively high price of such images create difficulties for reviewing land cover with areas such as the Catawba Watershed. A less costly and more resourceful approach to the mapping of land cover change is to use medium-resolution images from Landsat, and augment these finding with ASTER data analysis.

Conducting change detection using remotely sensed data requires careful considerations of the sensor, environmental characteristics and processing methods. Accurate spatial alignment of imagery is critical because false results of change detection will be produced if the imagery is not correctly registered. In addition, data should be collected on a consistent temporal cycle, within the same season as a minimum.

Before performing change detection analysis, some conditions must be met:

- Registration of multi-temporal images (assuming the data is not already orthorectified)
- Radiometric consistency between multi-temporal images
- Similar phenological states between multi-temporal images
- Same spatial and spectral resolution images if possible

Part 1 – Overview of Topic

Step 1: You must complete the following tutorials before starting this exercise
Introduction to ENVI, Interactive Display Functions, and Classification Methods

Step 2: **Download data from online sources**

Step 3: Bring data into ENVI, conduct Layer Stacking, Rename, and Reorder data bands

Step 4: Subset Imagery using watershed polygons from shapefiles

Step 5: Conduct a Normalized Difference Vegetation Index (NDVI) measurement

Step 6: Conduct an Iterative Self-Organizing Data Analysis Technique (ISODATA) classification

Step 7: Calculate change statistics on the two data sets

Step 8: Create a file geodatabase and export data / imagery to ArcGIS

This student guide demonstrates the steps to conduct analysis of the Mountain Island Lake and Lake Norman Watersheds, using the Mountain Island Lake Watershed. Each operation will require you to use both periods (September 1988 & June 2008) and both watersheds (Mountain Island Lake and Lake Norman). At a minimum, the following files must be created:

MountainIsland_Lake_SEP1988
MountainIsland_Lake_JUN2008
Lake_Norman_SEP1988
Lake_Norman_JUN2008
Lake_Norman_SEP1988_NDVI
Lake_Norman_JUN2008_NDVI
MountainIsland_Lake_SEP1988_NDVI
MountainIsland_Lake_JUN2008_NDVI
Lake_Norman_SEP1988_ISODATA
Lake_Norman_JUN2008_ISODATA
MountainIsland_Lake_SEP1988_ISODATA
MountainIsland_Lake_JUN2008_ISODATA
MountainIsland_Lake_SEP1988_JUN2008_Change
Lake_Norman_SEP1988_JUN2008_Change
MountainIslandLake_Watershed.shp
LakeNorman_Watershed.shp

Step 1: You must complete the following tutorials before starting this exercise
Tutorial and data for *Introduction to ENVI*, *Interactive Display Functions*, and *Classification Methods* are provided by ITTVIS.

Tutorials are located here:
F:\iGETT\Student Guide\Submission\02 Introduction to ENVI\02_Intro_ENVI.zip
F:\iGETT\Student Guide\Submission\04 Interactive Display Functions\04_Display_Functions.zip
F:\iGETT\Student Guide\Submission\05 Classification Methods\05_Class_Methods.zip

Step 2: **Download data from online sources**
Download Landsat data from the USGS Global Visualization Viewer (GLOVIS) website and shapefiles from North Carolina Center for Geographic Information and Analysis FTP Site

You will begin by downloading two files from the GLOVIS website (LT50170351988265XXX08.tar and LT50170352008160EDC00.tar). The LT50170351988265XXX08.tar dataset is a Landsat scene from September 1988 and LT50170352008160EDC00.tar was taken in June 2008. These two files cover the twenty-year period of our study. The shapefiles will be used to create context for our analysis, and to delineate the Mountain Island Lake and Lake Norman Watersheds. Download, at a minimum, the following files cb100.zip (County Boundaries), huncrb.zip (Hydrologic Units - River Basins), hydromaj.zip (Hydrography - Major), and wsw.zip (Water Supply Watersheds).

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\Download Landsat Imagery\Download Landsat Imagery.html
F:\iGETT\Student Guide\Submission\NC_CGIA_ArcGIS\NC_CGIA_ArcGIS.html

Step 3: Bring data into ENVI, conduct Layer Stacking, Rename, and Reorder data bands
Use Layer Stacking to build a new multiband file from georeferenced images of various pixel sizes, extents, and projections (ENVI Help, April 17, 2008). The stacking of individual bands of your Landsat data into a single file, a "data cube", will make it be easier to work with within ENVI.

During this step, you will open your two image files from SEP 1988 and JUN 2008, create a data cube for each year (1988 and 2008), edit the band names, and reorder the bands 1-7.

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\Layer Stacks\Layer Stacks.html

Step 4: Subset Imagery using watershed polygons from shapefiles
Use ENVI Vector Tools to view vector data such as USGS Digital Line Graphs (DLG), USGS DLGs in Spatial Data Transfer Standard (SDTS) format, DXF files, ARC/INFO Interchange files, and shapefiles. Use Export ROIs to EVF to export ROIs to ENVI vector files (.evf). All of the ROIs selected are exported as separate records in a single layer. If the file associated with the ROI is georeferenced, the vector layer is in the same projection (ENVI Help, April 17, 2008).

During this step, you will use the shapefiles created earlier to subset your watersheds. You will need to have created a shapefile delineating the Mountain Island Lake and Lake Norman Watersheds.

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\Subset Imagery\Subset Imagery.html

Step 5: Conduct a Normalized Difference Vegetation Index (NDVI) measurement
The Normalized Difference Vegetation Index (NDVI) is one of the oldest, most well known, and most frequently used Vegetation Index. The combination of its normalized difference formulation and use of the highest absorption and reflectance regions of chlorophyll make it robust over a wide range of conditions *(ENVI Help, April 17, 2008).*

During this step, you will conduct a NDVI measurement for the Mountain Island Lake and Lake Norman Watersheds to determine "greeness" and a change in "greeness" over time.

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\NDVI\NDVI.html

Step 6: Conduct an Iterative Self-Organizing Data Analysis Technique (ISODATA) classification scheme
ISODATA unsupervised classification calculates class means evenly distributed in the data space then iteratively clusters the remaining pixels using minimum distance techniques. Each iteration recalculates means and reclassifies pixels with respect to the new means. Iterative class splitting, merging, and deleting is done based on input threshold parameters. All pixels are classified to the nearest class unless a standard deviation or distance threshold is specified, in which case some pixels may be unclassified if they do not meet the selected criteria. This process continues until the number of pixels in each class changes by less than the selected pixel change threshold or the maximum number of iterations is reached *(ENVI Help, April 17, 2008).*

During this step, you will conduct an ISODATA unsupervised classification measurement for the Mountain Island Lake and Lake Norman Watersheds to determine the land cover for each period.

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\ISODATA_ClassMapping\ISODATA_ClassMapping.html

Step 7: Calculate change statistics on the two data sets

Use Change Detection Statistics to compile a detailed tabulation of changes between two classification images. The changes detected using this routine differs significantly from a simple differencing of the two images. While the statistics report does include a class-for-class image difference, the analysis focuses primarily on the initial state classification changes; that is, for each initial state class, the analysis identifies the classes into which those pixels changed in the final state image. ENVI can report changes as pixel counts, percentages, and areas. In addition, you can produce a special type of mask image (classification masks) that provide a spatial context for the tabular report. The class masks are ENVI classification images with class colors matching the final state image, making it easy to identify not only where changes occurred but also the class into which the pixels changed *(ENVI Help, April 17, 2008).*

During this step, you will conduct an ISODATA unsupervised classification measurement for the Mountain Island Lake and Lake Norman Watersheds to determine land cover change over time.

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\Change Statistics\Change Statistics.html

Step 8: Create a file geodatabase and export data / imagery to ArcGIS

In many situations, you will want to create a new empty geodatabase (GDB), then add new datasets to the geodatabase by defining their schema and properties and subsequently adding contents to each new dataset (Copyright © 1999-2008 ESRI Help). You can save raster and vector datasets in ENVI to a geodatabase *(ENVI Help, April 17, 2008).*

During this step, you will create a file geodatabase in ArcCatalog and export from ENVI the ISODATA classified data into the geodatabase for use in ArcGIS.

See the attached videos: If files fail to launch, go to the appropriate folder and select the HTML file.
F:\iGETT\Student Guide\Submission\Export Imagery\Export Imagery.html