

## exercise 4

# land cover change in the brazilian amazon

Humans play a role in the change in land cover. To illustrate this in this exercise we will look at the higher resolution 8km NDVI images for an area in Brazil. In the Amazon Basin in Brazil large tracts of land have been converted from forest to grazing land as part of a government program.

We begin the exercise by looking at NDVI imagery for two dates that are several years apart to visualize the change in land cover in the state of Rondonia in Brazil. Next we will perform a simple change detection procedure to highlight those areas that have changed. To better understand the human role in this land cover conversion we will overlay road data on the image. We finish the exercise by looking at high resolution satellite images to see more detail.

### BEFORE YOU BEGIN THIS EXERCISE

make sure you have completed the following steps—instructions for them are in the *Tutorial*.

- Start *SEE Image*
- Configure *SEE Image*

Land cover simply describes the dominant substrate at a given area, typically vegetation amount and type. Alterations to land cover can be due to natural or anthropogenic influences. Often it is a combination of these two influences and it can be very difficult to understand what forces were responsible for modifying a particular area.

In this exercise we will focus on land cover change that was initiated by a policy put in place by the Brazilian government and then made worse by the fact that the soils would not sustain agricultural crops.

The primary data for this exercise are 8km NDVI images of South America. Supplementary data are from the multispectral scanner (MSS) and thematic mapper (TM) sensors onboard the Landsat satellites. These data provide a higher resolution image that allows us to see more details in the structure of the deforestation. The MSS and TM images are made up of combinations of

## A

### opening two rondonia images

1 — Select 'File/Open' and then go to Desktop | HD | SEE Image | Data | Veg | vge4 | Rond0982.TIF. Click on Open. Follow the same steps to open Rond0993.TIF. These are images of the Rondonia region of Brazil taken in September 1982 (Rond0982.TIF) and September 1993 (Rond0993.TIF).

2 — Select the zoom (magnifying glass) icon in the Tools window and click twice on each image to zoom in by a factor of three. To verify you are zoomed in by three times, make sure the factor (3:1) is in the title bar of the image. Place the two images next to each other. You can return the images to their original size by double clicking the magnifying glass.

## B

### ratioing the two rondonia images

1 — Select 'Process/Image Math' to activate the Image Calculator.

2 — Select Rond0993.TIF from the uppermost drop-down menu. Then select Rond0982.TIF from the second drop-down menu (underneath the first one). Select the symbol for division from the Operation drop-down menu. Enter "1" in the box next to the times sign (X) since we do not want to multiply the result by a constant. Enter a "0" in the box next to the plus sign (+) since we don't want to add a constant to the resulting image. Type "1993/1982" in the box next to the equal sign (=). This will be the name of the output image. Select the Real Result check box since the resulting image pixel values will be outside the 1–254 range. Click OK to perform the division.

3 — Select 'Options/Color Tables/Special Ratio' to color the resulting image with a color table that will enhance differences in values.

three image channels that are combined to produce a color image. Each of the component image channels records the reflected light for different wavelengths. The color scheme used for this image is called false color because the colors do not represent the colors that would be seen by the human eye. The false color scheme used in the high resolution images in this exercise is commonly used for images used to study vegetation.

*Do A now.*

### investigating changes in rondonia images

1. What changes are evident from the September 1982 to September 1993 images? What do you think may be responsible for these changes and why?

To see the degree of change in the same area for two images we can "ratio" the images. In this process we compare the values of the same pixel on each image through a ratio calculation. When this is done for all pixels the result is a new image composed of compared values. This can be interpreted to look at relative change and is referred to as a change detection method.

2. Why is it possible to perform mathematical operations on the two images to provide a third image?

*Do B now.*

Move the cursor over various areas in the resulting image.

3a. What colors represent ratio values less than 1?

**3b.** Does the ratio image contain more pixels with values above or below 1?

**3c.** Consider the pixels with ratio values less than 1. What do these ratio values tell you about the difference in NDVI values in 1993 compared to 1982?

**3d.** What do you think has happened to the land cover for this region from 1982 to 1993?

## C

### *overlaying a road layer*

1 — Select Rond082. Locate the Magnifying Glass Tool from the Tools window and double click it to reduce the image to its original size. Repeat the procedure for Rond993.

2 — Select 'File/Open' and then go to Desktop | HD | SEE Image | Data | Veg | vgex4 | roads.tif. Click on Open.

3 — Select 'Edit/Select All' then select 'Edit/Copy Selection'.

4 — Click on Rond0982.TIF to make it active. Select 'Edit/Paste' then select 'Windows/Show Paste Control'. Under Transfer Mode, select Replace and the roads should be overlaid on the Rondonia image. Repeat this step to copy the roads overlay to Rond0993.TIF.

5 — You can zoom in on either image using the procedure in step A.2.

### *Do C now.*

**4a.** How does the change in NDVI value correspond with road development?

**4b.** What is the likely process(es) occurring with road development that may be responsible for the change in NDVI values in this region of Brazil?

With the roads overlaid on the NDVI image one can see that there is a strong link between a road and surrounding deforestation.

## D

### *looking at high resolution satellite images of rondonia*

1 — Select 'File/Open' and then go to Desktop | HD | SEE Image | Data | Veg | vgex4 | MSS72.tif. Click on Open. Repeat this step to open MSS92.tif.

### *Do D now.*

These images were acquired from the Landsat satellite and are much higher resolution than the NDVI images. The first image, MSS72, was acquired in 1972 shortly after the road was cut through the forest. The second image was acquired in 1992. In these images, forests are colored red and the deforested regions are

white and blue-green. With these high resolution images one can see that there are a number of small parallel roads that intersect the main roads.

*Close all images when you are finished. DO NOT save them unless told to do so by your instructor.*

## discussion

Rondonia is a state in western Brazil that shares a border with Bolivia. The deforestation within Rondonia is one of the most extreme cases of deforestation in recent history. Much of the deforestation is linked to changes in policy by the Brazilian government. The government saw the Amazon as a natural resource that could provide a living for a large number of Brazilians that were overcrowding the coastal cities. In addition to these social reasons, Brazil had political reasons to have Brazilians living near its borders.

In order to facilitate this migration of citizens, a network of roads was created. In 1979 only 1,434 kilometers of roads existed in Rondonia and by 1988 that figure had jumped to 25,324. As people poured into Rondonia, a tremendous area of forest was cleared so they could make a living. Deforestation areas in Rondonia increased from about 6,281 square kilometers in 1980 to 23,998 square kilometers in 1988.

Unfortunately the objectives of this resettlement did not work out. Most of the people who settled in Rondonia moved from the south or southwest part of Brazil instead of the large cities. Also, much of the land use that was practiced in Rondonia did not support long-term family subsistence. Typically, a farmer would cut down and then burn the forest to prepare the land for planting crops. After about 4 years the tropical soil was degraded to a point where only grasses would grow at which point cattle were often raised. With continuing degradation of the soil even cattle ranching becomes problematic and more forest has to be cleared.