Digital Elevation Models

Levels V-VI

Grades 9-12

Overview:

Students use ImageJ to create a 3D representation of a digital elevation model, then calibrate the image from known elevations. Using a slightly altered version of the digital elevation model (DEM), students compare what the elevation of the glacier might look like 100 years from now and explore how a DEM can be used to analyze changes in elevations over time.

Objectives:

The student will:

- make a surface plot of a digital elevation model (DEM) image;
- calibrate a DEM using known elevations;
- compare two digital elevation models; and
- make and compare plot profiles of two DEM images

Materials:

- Computer with Internet access
- STUDENT WORKSHEET: "Digital Elevation Model of Mendenhall Glacier"

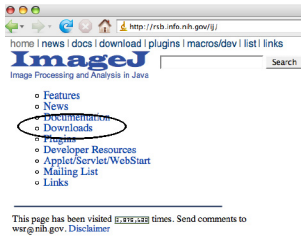
Teacher's Note: Digital elevation model (DEM) images are digital representations of terrain. The relief in the DEM is represented by a shade of gray. The gray level corresponds to a digital number that, in turn, can be calibrated to represent the elevation. The digital number values range from 0 – 255. Low digital numbers represent low elevations and high digital numbers represent higher elevations. The DEM used in this lesson is a section of the Mendenhall Glacier and surrounding area. The image that represents the DEM in 100 years is altered from the original DEM.

To view DEMs in other places, visit the USGS National Map Seamless Server at http://seamless.usgs.gov/.

Activity Preparation:

1. If not already installed, download and install the program ImageJ for each computer. It is available at http://rsb.info.nih.gov/ij/.

   a. To download and install, click Download from the ImageJ website, then click on the appropriate version for the operating system it will be used on to start the download. Save the downloaded file to the desktop.



   b. Once the file has downloaded to the desktop, double click on the compressed file to extract it. Next, move the ImageJ folder to the applications folder. The ImageJ application looks like a microscope. Double click on the ImageJ microscope to launch the application.

Activity Procedure:

1. Distribute the STUDENT WORKSHEET: “Digital Elevation Model of Mendenhall Glacier.” Guide students through directions for downloading the images from the ACMP website.
2. Ask students to launch ImageJ and open the Mendenhall.jpg image. Discuss with the class the type of image they are viewing. Point out the toolbar and how the digital number values change when the cursor is over light shades of gray compared to darker shades of gray.
3. Using the worksheet, have students complete the activity

Answers:

10A. 1178.14 feet.

10B. 2605.73 feet.

10C. 2129.87 feet.

12. The area on the glacier is a darker shade of gray. (NOTE: Difference may not be easily visible on all monitors.)

15. No.

17A. It adds a blue color to the area that is different.

17B. It shows where the two images are different. The blue area is where the glacier is lower.

24A. The Mendenhall100yr.jpg.

24B. It could be possible. (Answers may vary.)

Name:_____

Levels V-VI

Digital Elevation Model of Mendenhall Glacier

Student Worksheet (page 1 of 5)

Grades 9-12

Digital elevation model (DEMs) images are digital representations of terrain. The shades of gray in the images represent different elevations. Dark shades of gray represent low elevations while lighter shades represent higher elevations. The DEM used in this lesson is a section of the Mendenhall Glacier and surrounding area

Directions:

STEP 1. Download the MendenhallDEM.jpg and Mendenhall100yr.jpg image from the ACMP website.

A. Go to the ACMP website at http://www.arcticclimatemodeling.org/.

B. Click on **Classroom Lessons**.

C. Click on **IT exercises** listed under "Other."

D. Scroll down the list of lessons to the "Digital Elevation Model of Mendenhall Glacier" lesson

E. Click the file MendenhallDEM.jpg, and save the image to the desktop.

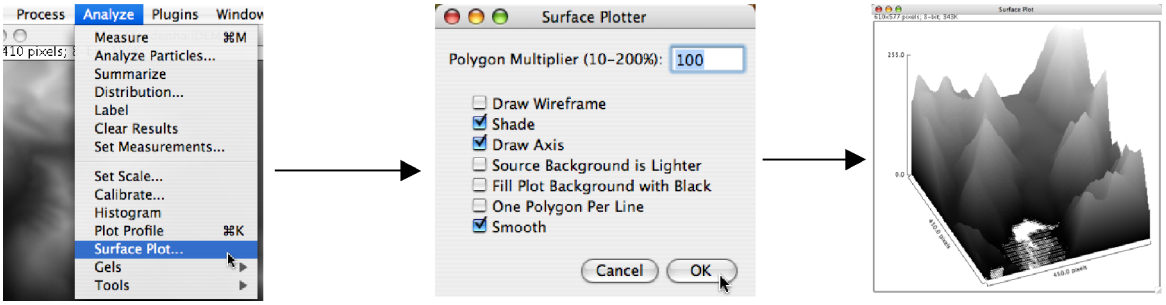
F. Click the file MendenhallDEM100yr.jpg, and save the image to the desktop.

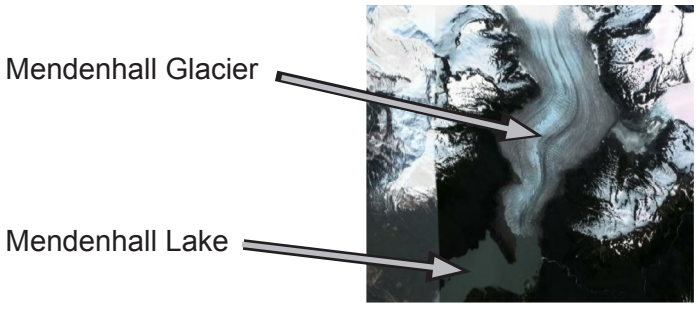
STEP 2. Launch ImageJ by clicking on the application.

STEP 3. On the ImageJ menu select **File** → **Open**, then navigate to the MendenhallDEM.jpg image to open it.

Making a 3D image of the DEM

STEP 4. From the ImageJ menu, select **Analyze**, then **Surface Plot**. On the Surface Plotter put a check mark by the Shade, Draw Axis, and Smooth options, then click **OK**. A new window will open with a 3D view of the DEM.





Aerial view of the same area

Name:_____

Digital Elevation Model of Mendenhall Glacier

Student Worksheet (page 2 of 5)

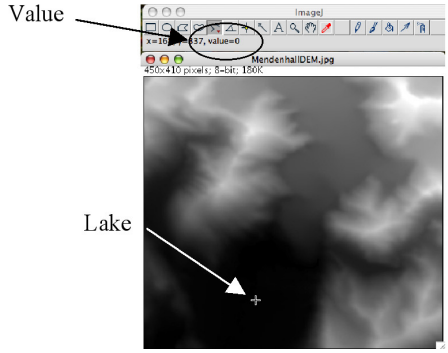
Levels V-VI

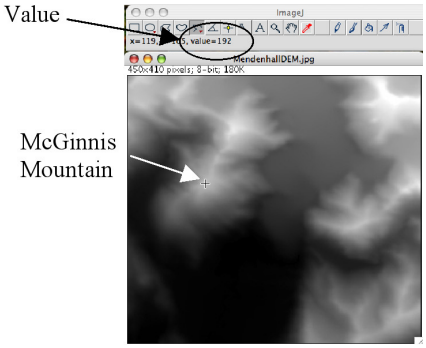
Grades 9-12

STEP 5. Compare the 3D image to the aerial view. Locate the lake, glacier, and surrounding mountains, then close the 3D Surface Plot image.

Calibrating the Image

STEP 6. On the MendenhallDEM.jpg image, move the cursor around the lake area and McGinnis Mountain. Note the digital number value in the ImageJ toolbar. The dark areas in the lake have low values, and the light areas in the mountain have high values.



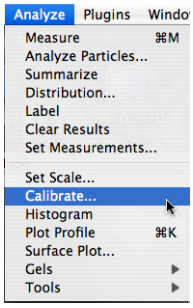


STEP 7. From the menu select **Analyze** → **Calibrate**.

STEP 8. On the **Function** pull down menu, select Straight Line function.

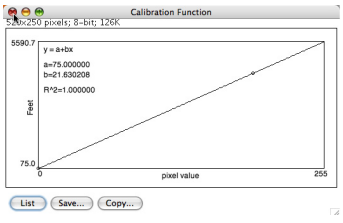
Type "Feet" in the **Unit** section.

Mendenhall Lake is 75 feet above sea level, and McGinnis Mountain is 4228 feet above sea level. Enter the digital number value of "0" for Mendenhall Lake and "192" for McGinnis Mountain in the left column. In the right column, enter "75" across from the 0 of Mendenhall Lake and "4228" across from the 192 of McGinnis Mountain, as shown.



Click **OK**.

STEP 9. A Calibration Function graph will open showing the slope of the function. Close the graph.



STEP 10. Using the mouse, move the cursor to the following locations and answer the questions below. The elevation will be listed next to "value=" in the toolbar. NOTE: The x and y are axes showing location.

What is the elevation at:

10A. x=250, y=200 Value = _____

10B. x=240, y=10 Value = _____

10C. x=300, y=100 Value = _____

Name:_____

Levels V-VI

Digital Elevation Model of Mendenhall Glacier

Student Worksheet (page 3 of 5)

Grades 9-12

STEP 11. Open the MendenallDEM100yr.jpg image. This image is what the DEM of the Mendenhall Glacier might look like in 100 years.

STEP 12. Answer the following question:

Does 100yr DEM look different from the current DEM? Explain any differences you see.

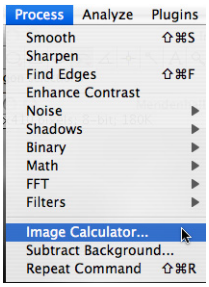
_____

_____

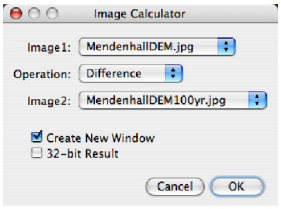
_____

Comparing Images

STEP 13. From the Menu select **Process** → **Image** Calculator.



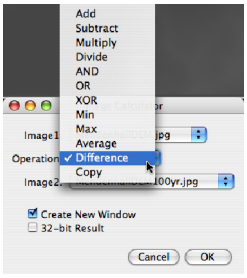
STEP 14. For Image 1, select MendenhallDEM.jpg. For Image 2, select MendhallDEM100yr.jpg.



Use the **Operation** pull down menu to select **Difference**.

The **Create New Window** will be checked by default.

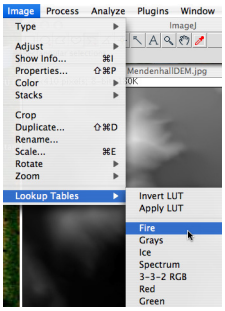
Click OK.



STEP 15. If there is no difference, the image will appear completely black. Answer the following question:

Is the image completely black? _____

STEP 16. On the ImageJ menu, select **Image** → **Lookup Tables** → **Fire**.



Name:_____

Digital Elevation Model of Mendenhall Glacier

Student Worksheet (page 4 of 5)

Levels V-VI

Grades 9-12

STEP 17. Answer the following questions:

a. How does adding the Lookup Table change the image?

_____

b. What does the blue area indicate?

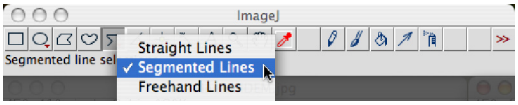
_____

_____

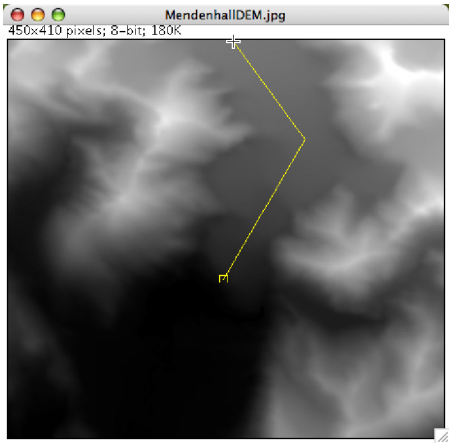
Comparing the Plot Profiles of Images.

STEP 18. Click on the MendenallDEM.jpg image to make it active.

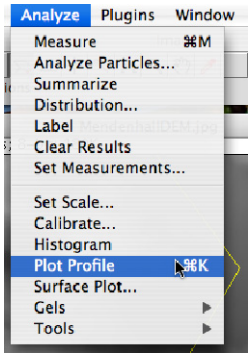
STEP 19. On the drawing toolbar Right Click (Mac: Option Click) on the fifth button from the left. This should be the line. Select **Segmented Lines** under the line tool.



STEP 20. Draw a segmented line from the lake near the terminus (end) of the glacier up the Mendenhall Glacier.



STEP 21. From the menu select **Analyze → Plot Profile**



Name:_____

Digital Elevation Model of Mendenhall Glacier

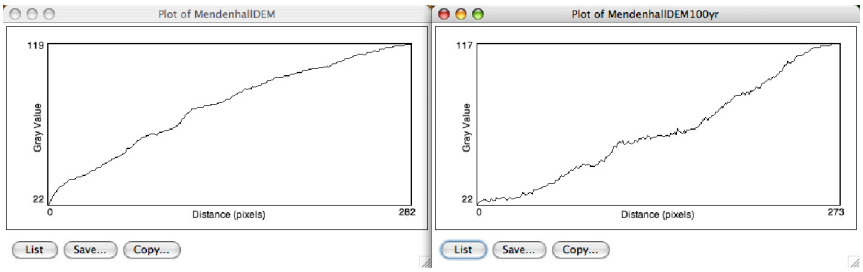
Student Worksheet (page 5 of 5)

Levels V-VI

Grades 9-12

STEP 22. Click on the MendenhallDEM100yr.jpg window, and repeat steps 19 - 21.

STEP 23. Compare the Plot Profiles for both images.



STEP 24. Answer the following:

A. Which Plot Profile shows a decrease in the elevation of the glacier near the terminus?

_____

B. If global warming is taking place, do you think the above profile could be what the elevation of the Mendenhall Glacier would look like in 100 years?

_____