Activity: A Satellite Puzzle

Introduction

Satellites provide unique views of Earth. The imagery acquired by these space platforms reveal weather systems and broad-scale circulation patterns that can be seen in their entirety. Sensors aboard satellites scan the Earth line by line in narrow strips and measure signal strengths generated by reflected sunlight or infrared (heat) radiation for small blocks within each strip. Each block segment, called a pixel, is the smallest picture element in the image. A series of numbers indicating pixel signal strengths is transmitted to receiving stations on Earth where computers reassemble the values into lines of shaded or colored blocks. The lines are added together in sequence to complete the picture. The weather satellite views seen on television weathercasts are examples of such images.

After completing this activity, you should be able to:

- Describe how information is acquired by satellites, sent to Earth, and interpreted to construct images.

- Explain how pixel size influences the detail (resolution) on weather satellite images.

Method

This activity explores the process by which satellite imagery is produced. Imagine that two different sensors scan the same scene and that both sensors measure reflected sunlight. Scanning of the scene produced the two sets of data presented in the accompanying figure. Grids to the right of each data set show the size of the pixels resolved by the two satellite sensors. One sensor is able to resolve pixels whose side-length is one-half that of pixels detectable by the other sensor.

A scale from 0 to 3 is used to indicate the signal strength of the light received by the satellite sensors. The value of 0 indicates no detection of light while 3 indicates the receipt of the most intense light.

Reconstruct the scene based on the sensed pixel values appearing to the left of each grid. The values are in the same relative positions as the pixels they represent. A value of “0” indicates no light being detected, while a “3” indicates the most intense receipt of reflected sunlight from Earth below.

SHADING KEY

0 1 2 3

By referring to the Shading Key, shade in the left grid according to the data given. Then use the same procedure to fill in the right grid with the smaller pixels.

DATA		1	2	3
2 0 2	A			
0 2 2	B			
0 1 0	C			
2 0 2	D			

DATA		1	2	3	4	5	6
3 2 1 0 1 2	A						
2 0 0 0 0 1	B						
1 0 2 2 2 2	C						
0 0 3 3 3 3	D						
0 0 3 0 0 0	E						
1 0 2 2 0 1	F						
2 0 0 0 0 1	G						
3 2 1 0 1 2	H						

Questions

1. What do you guess the original was? (Hint: the scene scanned in this activity was a particular letter or number.) In which of the two views is there greater detail? Why?

   _____
   _____

2. Assume that the two weather satellite sensors used in this activity produce pixels that represent Earth-surface areas 2 kilometers and 1 kilometer on a side, respectively. Assuming that the U.S. mainland is approximately 5,000 km from west to east and 3,000 km north to south, how many pixels would need to be scanned to obtain an image of the U.S. mainland by the:

   2-km pixels? _____ pixels W-E, _____ pixels N-S

   1-km pixels? _____ pixels W-E, _____ pixels N-S

3. What are some of the possible problems of producing weather satellite pictures with far greater detail than currently available? Consider such aspects as engineering, design, cost, politics, time, and other considerations.

   _____
   _____
   _____