TITLE: **INTRODUCTION TO REMOTE SENSING ACTIVITY SET**

EVENT: **REMOTE SENSING**

EVENT KEYWORDS: Geography; Remote Sensing; Electromagnetic Spectrum; Satellite Imagery; A-Train; Satellite; Sensor; Digital Imagery;

BACKGROUND

The Science Olympiad Remote Sensing Event began as a Trial Event in 2001 and was promoted to a full event the following year. The use of images acquired via aerial photography and satellite imagery have long been used as a tool of surveillance by the military and in the exploration of space. Since the late 1950s, the view from above provided by remote sensing imagery has been used by geographers and scientists to identify land use patterns, movement of weather patterns, in archaeology and in monitoring the spread of plant diseases such as Dutch Elm and the progression of invasive species including the Emerald Ash Borer. The use of remote sensing as an investigative tool is established.

An understanding of the physics of remote sensing is also very intriguing in and of itself. An understanding of the electromagnetic spectrum and the properties of light is integral to an understanding of how remote sensing images are acquired and processed. In this way, the event cross-cuts with other Science Olympiad events including Crave the Wave and Optics. Students will also need to be conversant in relevant satellite missions as well as the principles of image interpretation.

The Remote Sensing Event will return in 2017 replacing Geologic Mapping. In this activity, students will be introduced to fundamental concepts such as digital imagery and image interpretation associated with remote sensing that reflect changes in technology that have taken place since the last decade.

NEXT GENERATION SCIENCE STANDARDS CITED

HS-PS4-2 Evaluate questions about the advantages of using digital transmission and storage of information

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy

Science and Engineering Practices

Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set or the suitability of a design

Communicate technical information or ideas in multiple formats including orally, graphically, textually and mathematically

Cross-Cutting Concept

Systems can be designed to cause a desired effect

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COMMON CORE STATE STANDARDS CITED

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

MATERIALS NEEDED

1. Pixel Drawing Pre-Presentation Worksheet
2. Pencil
3. Red/Blue or other colored pencils
4. Calculator (optional)
5. Richmond, Michigan Google Earth Image
6. Ruler (with metric calibration)
7. Interpreting Weather Satellite Images Worksheet
8. Science Olympiad 2017 Remote Sensing Event Overview PowerPoint

PROCEDURES

Activity 1: Creating Images with Pixels

Satellite images are acquired from sensors placed above satellites that orbit the Earth. These sensors capture the reflectance of the electromagnetic energy of objects on Earth that they monitor. The sensors then transmit this data to receiving stations on Earth where it is processed into images that are interpreted and used in a variety of ways. The common measurement unit used to create digital images is the pixel. Rows of pixels are arranged together to create a scene- the term used to describe an image of a location. In this activity, students will create three simple images using pixel squares. You may use any combination of available colored pencils.

1. Students will begin on the left side of the Pixel Drawing Pre-Presentation Worksheet (1) by shading in each of the squares marked '0' with a light shade of pencil (2) and filling in each of the squares marked 'B' with blue (3).
2. Ask students what the drawing likely represents. You should hear answers such as a lake, pond, or lake with a river or stream (upper left corner). What might the areas shaded in pencil represent? Answers might include forests, woods, or cities.
3. Have students complete Drawing 2 by filling in each of the squares marked 'R' with red and each of the squares marked 'b' with blue pencil.
4. All three drawings are an approximate depiction of a fictional location. Ask students why they were asked to color the areas that were shaded in pencil red. Do not reveal the answer just yet.
5. Ask students to complete the final drawing (Drawing 3) by shading squares marked 'R' red and squares marked 'B' blue. But this time, have students use a darker shade of red for those squares marked 'DR' and a darker shade of blue for those squares marked 'DB'

In your discussion, you will want to discuss the advantages of using pixels to process images. Pixels allow the digital storage of data acquired from the satellite or aerial camera and can be easily manipulated during processing. In asking why students colored many of the squares red in Drawings 2 and 3, you may reveal that in the infrared bands of the electromagnetic spectrum- many of which are not visible to the human eye- photosynthesizing vegetation is visible in greater detail than in the normal visible light band

(green). In Drawing 3, students used different shades of color to convey different levels of electromagnetic energy reflected from the target objects. What would the different shades of red indicate (health of plants as lighter shades of red might indicate less-healthy vegetation) or blue (darker blues indicate deeper water while lighter blues indicate shallower water.

Activity 2: Calculation of Area on a Remote Sensing Image

In this activity, students will first calculate the area in square meters of the water found in Drawing 2 and then determine the percentage of the image covered by the large body of water depicted in the image. If scale is known on a remote sensing image or if a calibrated measurement device is available, it may be possible to transfer what is learned from this activity to other area measurement tasks using satellite images or aerial photographs.

PROCEDURES

1. Using their completed Pixel Drawing Pre-Presentation Worksheet (1), have students count the number of red pixel squares and blue pixel squares. The drawing has a total of 96 squares with 65 of them red and 31 of them blue.
2. Multiply the number of blue squares by 100 (the total area in square meters of one pixel square). There are 29 blue squares comprising the lake (less 2 from the river that flows into it in the NW corner), so the total area of the lake in square meters will be 2,900 m^2.
3. To determine the percentage of the lake in the total area of the image divide 29/96 or approximately 30% (030.2).

The calculation of area in remote sensing images is a basic skill used by geographers and others to create data such as percentages of depopulation in selected neighborhoods of an urban area, total area where diseased trees might be located or assessments of damage caused by severe weather systems. Refer to Chapter 8 of the U.S. Army Land Navigation Field Manual (included with this packet) for more information.

Activity 3: Determining Scale and Distance on a Remote Sensing Image

Remote sensing images and photographs differ from maps in many ways. Scale measurement and other key features are often included in a map legend, providing the reader with some concept of distance, directional and spatial measurement between points on the map. Remote Sensing images usually lack a key of scale measurement making it difficult to determine distance between points.

However, image scale can be ascertained using the known measurements of features that may be located on an image. In this activity, students will use the measurements of a known object on the image to determine the straight line distance between two points (A and B) on the image.

PROCEDURES

1. Have students examine the Richmond, Michigan Google Earth Image (5) to locate a natural or man-made feature with a known measurement. Many students will find the football field which measures 100 yards. Have students determine and record with a ruler (6) the measurement in

millimeters (22mm) which is a more precise measurement. Thus the scale of the map can be read as 100 yards= 22mm.
2. Next, have students determine the straight line measurement between Points A and B on the map. This should be approximately 190mm.
3. Divide 190/22. The answer should be 8.636
4. Next, multiply 8.636 by 100 (the number of yards in each 22mm measurement. Your answer should be 863.6.
5. To convert to feet, multiply 863.6 by 3 (the number of feet in a yard). Your answer should be 2,590.8 feet or approximately half a mile.

Activity 3 serves as a follow-up to Activity 2 showing another way that remote sensing images can be used to determine distance and scale. Refer to Chapter 8 of the U.S. Army Land Navigation Field Manual (included with this packet) for more information.

Activity 4: Interpreting Weather Satellite Images

The primary focus of the 2017 Remote Sensing Event will be the use of data obtained via remote sensing activities in the study of weather and climate. In this final activity, students will use simple infrared weather images and concurrent weather maps to identify local weather patterns.

PROCEDURES

1. Read the Interpreting Weather Satellite Images Worksheet and begin with the image shown to the left. Students should write a brief description of the weather likely found in the area of the red, orange and yellow circles.
2. Show the Activity 4 PPT with Slide 63 concurrently as they work and in the ensuing discussion.
3. After students have completed their initial descriptions, display the weather map next to the satellite image on the right side of the PPT slide.
4. The weather found in the red circle is indicative of an occluded or aging low pressure system that has diminished in strength. This often occurs as tropical storms move north and encounter cooler air and water temperatures. North of the Hawaiian Islands, warmer clouds begin to dissipate.
5. Weather found in the Orange Circle is indicative of a high pressure system as indicated by the lack of cloud cover. Note this comparison on the weather map.
6. Weather found in the yellow circle is indicative of an intense squall line with high clouds as indicated by their red/orange color.
7. Next, have students examine the satellite image on the right side of the worksheet.
8. Show the Activity 4 PPT with Slide 64 concurrently as they work and in the ensuing discussion.
9. The cold front is indicated by the letter A on the image. Note the precipitation on the east side of the front. Heavy precipitation often occurs prior to the passage of a cold front.
10. The squall line is indicated by the letter B on the satellite image. Note the high intense clouds associated with the front in the Gulf of Mexico. After students have completed their initial descriptions, display the weather map next to the satellite image on the right side of the PPT slide.
11. Have students compare the satellite image with the concurrent weather map shown to the right of the image on Slide 64.

In your discussion, you will want to highlight the use of infrared bands of the electromagnetic spectrum in producing the image. Infrared images show the relative heat of objects. Colder objects appear brighter in infrared bands while warmer objects appear darker.

BIBLIOGRAPHY

http://www.crsol.com/weather_routing_toolkit/idtoolkit/resources/content/how_to_read_satellite_image_how.htm#_Toc66271863
This outstanding webpage was used to prepare Activity 4 and discusses how to interpret infrared weather satellite imagery.

https://www.youtube.com/watch?v=bjOGNVH3D4Y
Emerson and Wong's version of the Electromagnetic Spectrum Song has been a favorite of mine since 2009. Use it to introduce the concept of the electromagnetic spectrum.

https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=3437
A-Train Observations of Hurricane Debbie used in the PPT presentation.

http://cloudsat.atmos.colostate.edu/education/satellites
Colorado State webpage describing 5 of the 6 A-Train Satellites.