REMOTE SENSING AS ART
USING SILK PAINTING TO TEACH ABOUT
LANDFORMS ASSOCIATED WITH COASTAL WATERWAYS

Based on a similar presentation by
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Art is bringing what is inside of you
    To the outside
And science is bringing the outside world in
    And understanding it.

Lydia Dambekalns
Presentation Objectives:

1. Explore the relationship between the 'self' and the Earth’s environment.
2. Apply the manipulation of remote sensing images to visual artistic expression.
3. Enhance student observation and inferential skills.
4. Meet the visual challenges of using color, design, and style in visual artistic expression.
5. Recognize creative process connections between science and art.
6. Identification of landforms associated with coastlines.
7. Explain physical and cultural phenomena associated with the remote sensing of coastal landforms including the earth processes that created them.

Content Objectives:

1. Students will understand the nature of color including:
   a. The electromagnetic spectrum
   b. Reading and interpreting remote sensing images
   c. False-color imagery by computer
2. Students will understand the nature of design including:
   a. Composition
   b. Emphasis and elimination
   c. Abstraction
   d. Applied principles and the elements of design

Creation of Participant Batik Images Using Remote Sensing Imagery

Identification of Coastal Landforms and Description of Participant Images

Interdisciplinary Applications of the Activity

Resources

1. Remote Sensing Tutorials
2. Remote Sensing Images
3. Coastal Landforms
4. Classroom Sets of Silk Painting Supplies
Science and Art

All Art is but an imitation of nature
Seneca

In the science of Astronomy, we look up to the heavens to learn about stars and planets— their movements, chemical compositions and the laws of physics that may explain their formation, all the while contemplating whether or not we are the only intelligent life in the Universe. In the study of remote sensing imagery, we look beneath us to study the spatial relationships between humans and their physical environment. In both cases, there is an obvious gap between what we can measure and analyze and what we feel to be true.

Art on the other hand provides us with what is often an aesthetically pleasurable representation of an individual’s views of the world and the Universe. Art is a visual or literary expression of the thoughts and feelings about the world and the individual realities of the artist. Yet artistic expressions may appear to be surreal or overly fantastic without some semblance of knowledge of the laws that govern the Universe.

An understanding of creative process connections between science and art greatly enhances our ability to understand and appreciate the world and Universe we live in. Let’s begin by comparing the problem-solving skills used by scientists and artists to express their realities.

<table>
<thead>
<tr>
<th>Scientific Method</th>
<th>Visual Artistic Expression</th>
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<tbody>
<tr>
<td>Question or Problem Statement to be investigated by the scientist</td>
<td>Message or Concept to be expressed by the artist</td>
</tr>
<tr>
<td>Hypothesis or explanation of scientific phenomena</td>
<td>Elements of color and design that will best convey the expression</td>
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<tr>
<td>Experimental Design Elements</td>
<td>Design Composition Elements</td>
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<td>• Subjects</td>
<td>• Subjects or characters</td>
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<tr>
<td>• Characteristics of subjects</td>
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<td>• Consideration of bias</td>
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<td>• Use of experimental and control groups</td>
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<td>• Level of abstraction</td>
<td>• Level of abstraction</td>
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It would appear then that both scientists and artists use similar creative process skills to express the realities that they investigate or create. The use of art is thus a novel, interdisciplinary and potentially enjoyable approach in teaching science to children of all ages. In this activity, you will learn how to use remote sensing imagery to teach students about coastal landforms in an elementary or secondary Earth Science class. You can also apply this activity to geography to identify land use patterns or even in literature classes to storyboard a setting. First, we’ll focus on the ‘science’ of color and its expression in nature and alteration by man.
Remote Sensing and Color

Our normal view of the world is a horizontal one. The light reflected from an image you are looking at travels over a distance until it is ‘captured’ by your eyes. Each of your eyes then sends a signal to your brain where it is recorded and interpreted.

More often than not, what we see horizontally in our normal range of vision is limited to a very localized area with all kinds of obstructions such as trees, buildings, and topographic features. Looking at objects such as planets, stars, and galaxies present other difficulties because of their vast distances from the earth.

Remote sensing is the use of instruments such as cameras, radar, and satellite imagery to capture the spectral and spatial relationships of objects and materials observable Remote Sensing-usually from above them (vertically). Remote sensing expands the capabilities of human sight by allowing us to see a multitude of physical and human features over a wide area of perhaps hundreds of square miles.

For a remote sensing system to operate, there must be a source of radiant energy. This radiant energy is emitted directly from an object, such as the thermal energy generated by a forest fire, or is sunlight that is reflected or scattered from objects.

There must also be a propagating medium such as the atmosphere, which allows the electromagnetic energy to move through it, as well as a sensor or energy detector such as a camera, satellite, or radar device to capture the image. The drawing below illustrates how each of these elements-the source, medium, and sensor interact in a remote sensing system.

Sensor systems can be grouped in two different ways: as active or passive, and as photographic or digital. A passive sensor only receives signals and requires a separate source of energy such as sunlight. Examples of passive sensors include cameras, thermal scanners, and multispectral scanners. Photographic sensors record electromagnetic radiation on film as an image. Digital sensors transform electromagnetic radiation into an electrical signal that can be amplified, recorded, and converted into digital values.
Active sensors such as radar on the other hand both transmit electromagnetic signals and receive reflected signals. Active sensors thus do not need a separate energy source, and are useful for creating remote sensing images at night, or in overcast conditions.

In preparing students for competition in the Remote Sensing event, we will confine our use of remote sensing imagery to the analysis of physical, human, and ecological phenomena on the planet Earth. Students will be trained to look at the Earth and its features from a spatial perspective. Students will also learn about the relationship of the electromagnetic spectrum and digital imagery to remote sensing imagery, and how this knowledge is used in better understanding the world we live in.

A spatial perspective is concerned with the ‘whereness’ of physical and human features. Thinking spatially means having the ability to describe and analyze the organization of people, places, and environments on the surface of the earth.

Geographers refer to the physical features of the Earth’s surface and the activities that take place on Earth’s surface as phenomena.

Physical phenomena include streams, rivers, soils, topography, climates, and vegetation types.

Human phenomena include such things as population growth, urbanization, pollution, transportation networks, the spread of diseases or innovations, or national park development. Taken together, the interaction of physical and human phenomena can form regular and recurring patterns that help us to understand and explain the world at all scales, global to local.

A spatial perspective also helps students to understand and formulate answers to critical questions about past, present, and future patterns of spatial organization and to anticipate the consequences of events in a given situation.

The Electromagnetic Spectrum

In preparing for competition in the Remote Sensing event, students will need an understanding of the electromagnetic spectrum and how it has been used to interpret what you see on remote sensing photos and images. This section will also explain why the colors of photos and images appear as they do.

The smallest unit of light energy is the photon. Any matter that is excited thermally gives off photons. Microwave cooking excites matter thermally by causing food molecules to rub together generating friction. Nuclear processes such as fission or fusion can also excite matter. In remote sensing images however, we’ll be most concerned with photons that exist as reflected or absorbed energy. These photons are emitted from matter at different wavelengths that follow patterns. These wavelengths of light whose energy levels fall within a range of values are collectively termed the electromagnetic spectrum. The diagram shown on the next page indicates where these different photon energy levels are located in the electromagnetic spectrum. Short wave radiation is so named for the very short wavelength of its energy. The length of these ‘waves’ of light is the distance from wavecrest to wavecrest as shown in Figure 6. The number of wavecrests passing a given point
per second determines a wave's frequency. The micron (µm) (one-millionth of a meter) is the basic unit used to measure a wavelength with respect to the electromagnetic spectrum.

At the far left of the electromagnetic spectrum you will find short wavelength, high frequency radiation. Short-wave radiation is so named for the very short wavelength of its energy 'wavecrests'. The atmosphere of the Earth absorbs most of this energy, including potentially harmful solar radiation. Examples of short-wave radiation include X-rays. These are invisible to the human eye. The ultraviolet ranges of light measure approximately $10^{-7}$µm and is invisible to the human eye.

As you move further to the right of the electromagnetic spectrum, the wavelengths enter the visible range of human sight, which measures only .4µm to .7µm. These wavelengths of light correspond to the different colors that our eyes and brains perceive through our sense of vision. Most visible light is reflected back into space. Note the funnel shape of the diagram on the previous page, which shows how the colors seen by the human eye move in a continuum. The colors violet and blue are to the left of the visible spectrum, closest to the ultraviolet wavelength. Colors such as yellow, orange, and red are closest to the infrared wavelength.

Infrared energy is found to the right of the visible range of the electromagnetic spectrum. Reflected infrared energy has a range of .7µm-3.0µm. Much of this energy is reflected back into space. Photographic infrared energy, the infrared wavelength found in remote sensing photos and images has a range of .7µm-.9µm. Note that in Figure 5, this infrared range is closest to that of human sight.

Long wave energy such as that in microwaves and radio bands is measured in centimeters (one-hundredth of a meter). Microwave wavelengths, which are used by radar systems to detect objects, are in the .1cm-100cm range of the electromagnetic spectrum. Radio bands such as VHF (Very High Frequency) and ELF (Extremely Low Frequency) have wavelengths of over 100cm.

Electromagnetic energy can only be remotely sensed by its interaction with matter. The amount of electromagnetic energy reflected back to Earth by an object will depend on the wavelength of the radiation given off by it. Different objects reflect light at different wavelengths. A single object can also reflect different wavelengths of light. In this way, light reflected at different wavelengths can provide a great deal of information about the Earth’s surface including kinds of vegetation that exist in a given area, the effects of natural and man-made disasters, urbanization, pollution, deforestation, and the physical geology of an area. This is termed the spectral reflectance of an object. The diagram to the left shows spectral reflectance as it would be measured by a LANDSAT satellite.
Note the difference in reflectance between the vegetation and the rock. The bare rock has a higher reflectance within the blue-green wavelengths of the visible spectrum, while the vegetation has a higher reflectance closer to the infrared range. Moreover, you should also see that there are differences in how rock and soil are reflected in the diagram.

Differences in the way that rock is reflected may be explained by the presence of different kinds of soils, or minerals. Variances on the infrared energy reflected by vegetation will often depend upon the size of the plant cells, and the thickness of their cell walls. This reflected radiation is thus able to provide a ‘signature’ that helps to identify certain features found on remote sensing images.

In color film, the silver nitrate crystals activate a color coupler that is mixed with the silver in the emulsion. When the film is developed, it is dunked into a solution called a developer that contains color dyes. The excited color couplers grab the color dyes out of the developer solution and lock them into the film in layers.

In a false color image, images made in several broad wavelength bands are combined. To create the image, colors are assigned to each wavelength band, hence the term false color. Table 2 shows the assignment of colors used in false color images.

**False Color Assignment**

<table>
<thead>
<tr>
<th>Reflected Radiation</th>
<th>Color Shown on Image</th>
</tr>
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<tbody>
<tr>
<td>Near Infrared</td>
<td>Red</td>
</tr>
<tr>
<td>What we see as red</td>
<td>Green</td>
</tr>
<tr>
<td>What we see as green</td>
<td>Blue</td>
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</tbody>
</table>

Satellite images are composed of square units called picture elements or pixels. Digital cameras on the satellites contain imaging arrays onto which the lens focuses light. These are computer chips, which contain CCDs or charged coupled devices. When these CCDs are struck by reflected light, they emit an electrical charge that is then turned into binary information by the satellite’s camera processor. A number between 0 and 255, the data range of an 8-bit computer byte, specifies the brightness of each pixel.

Images can be created in a single band, or color composites can be generated by using three spectral bands, with each band being assigned to one of the three basic colors of red, green, and blue. For each pixel in an image, three different intensities for red, green, and blue are respectively combined to form a distinctive color. The process is repeated for each of the three basic colors, but using different spectral bands, which are then combined to form composite images.

When you purchase or download remote sensing images, you might also want to consider the resolution of the image as well. The **resolution** of the image refers to the amount of detail that it has, and this is usually measured in pixels. The more pixels per inch (ppi), the greater the resolution of the image, and hence, it will have more detail. Too little resolution will cause your images to appear fuzzy and lack detail. Too much resolution on the other hand can take a long time to download if you’re obtaining your images off the Internet. High-resolution images also take up much more space in your hard drive, and slow down your printing speed. An understanding of the scientific principles of electromagnetic energy will help us to understand the nature of color as it is used in art.
Art and Color

Quite simply, color originates in light- sunlight to be more specific. We perceive sunlight to be colorless, when in fact all of the colors of the light spectrum between .4µm to .7µm are present in white light. The illustration below shows how light goes from the source of its energy (the Sun), to the object (the apple) and finally to your sensory organs (eyes) and then to your brain where the information is processed.

Keep in mind that all of the colors that you do not see are still shining on the apple, even though you don’t see them. The surface of the apple is just absorbing all of the colored light rays except those corresponding to red. These colors are reflected back to the human eye, where they are sent in turn to the brain, which cries RED!! In the brain, we associate different colors with different things. In our research for this presentation, we discovered that the color blue in particular functions as an appetite suppressant. Weight loss plans suggest putting your food on a blue plate, or even using a blue light in your refrigerator. I also found this very appealing picture of blue food that is a traditional Japanese dish called Musubi, but is also very popular in Hawaii. The ‘pink’ stuff by the way is Spam.

This brings us to our point. Blue food is a rare occurrence in nature. There are no blue leafy vegetables, blue meats or many fruits and vegetables common, we tend to avoid it because we do not associate the color blue with food. It is our brains and the associations we make with certain colors that will in turn influence what we think about an object.

Color Theory 101

The 12-part color wheel shown below is based on only three primary colors (red, yellow and blue) placed around a circle. Between the three primary colors, you will see the secondary colors of green, orange and violet, which are mixtures of the two primary colors they sit between.

Tertiary colors in turn fall between each of the primary and secondary colors. Between yellow and orange, for example you will find yellow orange, between blue and violet blue-violet, etc.

All colors outside the color wheel are saturated colors. They contain no black, white or complimentary colors.

Compound colors are mixtures of the three primaries and include browns and khakis.

The Dyna-Flo dyes that you will be using in this activity are very easy to mix allowing you to create a whole myriad of different colors. In order to mix pigments into clean saturated colors you can include a warm and cool of each of the
primaries in your ice cube tray palette. There is no such thing as a pure primary pigment, so when mixing green for example, choosing a cool blue such as phthalo and a cool yellow such as lemon ensures there is no trace of red in the green. Using a warm yellow like cadmium or a warm blue such as ultramarine would introduce a slight trace of red into the green resulting in a compound color.

In this illustration to the left, the compound mixtures between red and green are shown, as are tints and shades of the color wheel. Tints are made by adding white to a color, shades are made by adding black.

You might find this information helpful as you experiment with different colors in creating your remote sensing silk painting. The Dyna-Flo dyes mix very easily together to combine into fascinating colors for your project.

Other Considerations Made by Artists

Artists also consider these building blocks of design in creating their works:

- **Lines** are the marks you will make with your Resist applicator to ‘draw’ your image on the silk. The diagram to the left shows the different kinds of lines that you can create. Lines may also refer to the edge that is created when two shapes meet.

- **Shapes** are self-contained areas or geometric or organic form. You’ll be drawing and painting lots of shapes on your remote sensing image. What you should be able to do is identify the different physical and human phenomena you will find on your image.

- **Size** is the relationship of the area occupied by one shape to that of another.

- **Gradation** refers to the size and direction of the linear perspective of the piece. Gradation of color from warm to cool and tone from dark to light produce an aerial perspective. Gradation also adds interest and movement to a shape.

- **Contrast** refers to the use of opposing colors such as red/green, blue/orange, etc.

Artists to make certain parts of the work stand out and grab the viewer’s attention use the emphasis of an artwork. In remote sensing, this may be achieved by false color imaging in which computer technology is used to make certain features of the Image stand out.
Silk Painting Techniques

What it is

The silk painting technique that you will be learning is known as the Serti (Closing or Fence) technique where designs are formed with Gutta or other water-based resists that are applied to silk that has been pre-washed, dried and stretched.

To make things easy, from this point on, we'll refer to the Gutta simply as Resist. Once it dries, the Resist acts as a barrier for the dye or paint keeping the color within the outlined areas of the design that you create with it on the silk. This allows you to achieve sharply defined borders. Without Resist, the dye or paint would flow into more abstract or undefined patterns that may be difficult to discern. After the dye or paint has been set, the Resist is removed and the defining line of the color of the original fabric will remain.

The water-color like effects of the silk paintings are achieved by applying the dye to the silk using a paint brush, mist sprayer, or even an eye dropper. Spraying the silk lightly with water before adding the color will increase the flow of the dye or paint. You can also sprinkle silk salt or other salt on the silk after you color it to produce even more interesting textural effects.

What you will need for the activity

- Silk paints or dyes. Dyna-Flo Dye is recommended. It is non-toxic, easy to clean up and a little goes a long way.
- Paint brushes
- Water-soluble Resist
- Applicator bottles for the Resist
- Stretcher Frame (we'll show you how to make several inexpensive versions of Stretcher Frames. You can also purchase ready-made Stretcher Frames)
- A silk scarf to paint on
- Ice Cube Trays make great palettes for the dyes
- Plastic cups for water to clean brushes
- Rubber Bands
- Chinese Silk Stretching pins. After you see these, you may want to opt for safety pins, although the Chinese pins are better.

A complete list of inexpensive classroom sets of all materials for this activity is provided in the Resource section of this presentation.

Preparing for the Activity

Step One: Pre-wash the silk

Pre-wash the silk scarves by hand or in the washing machine on a gentle cycle with warm water and Synthrapol. Rinse, dry and when slightly damp, press with an iron, set to the silk setting. Pressing the silk before applying the dye will improve its flow on the silk.

Step Two: Make a Stretching Frame

You will need a Stretcher Frame to stretch your silk and suspend it off the table or the floor. There are a variety of inexpensive Stretcher Frames that you can make depending on the size of the silk piece that you are dying and the materials that are available to you. You may also
purchase an adjustable stretcher frame system that adjusts to a variety of sizes. We’ll go through group and individual stretcher frames.

**Group Stretching Frames**

If you have a large room available, two or more group Stretcher Frames is an easy way to set up the Silk Painting activity. This might be more comfortable for younger students, as they will be working off the floor.

To make a group Stretcher Frame you will need two 1x3 boards cut to your desired length and six two-hole concrete blocks readily available from local home improvement stores. Then take a bolt of silk cut to your desired length and stretch the silk across the Frame as shown below. You will use safety pins or Chinese silk stretching pins connected to the frame every 4-6 inches along each side of the frame. The safety or Chinese silk stretching pins are connected to the frame using rubber bands. Cut panty hose also works great. Loop the rubber band around the pin to attach it to the Frame. You can also link rubber bands together to extend the length if you need to. The advantage of rubber bands is that the elasticity of the rubber bands will maintain the tension of the silk.

In stretching your silk, you want to create just the right amount of tension so that the silk remains taut as you paint, but not so tight that the silk tears. The silk may sag a bit once it becomes wet with the dye. Just adjust the pinning to maintain the desired tension of the silk as you and your students work. Your frame needs to suspend the silk above the floor so that nothing touches it.

Before beginning, use Resist to divide the silk into equivalent portions as shown below. You should have an equal number of students working on each side of the Stretcher Frame.

**Individual Stretching Frames**

Individual Stretching Frames are useful if students will be working on large tables and have sufficient storage. Individual Frames might be more comfortable for older students and are more portable if students need to take their work home with them.

Old picture frames work well as Stretching Frames, or you can use embroidery hoops or prepared silk scarves with a metal frame around them. Stretching pins are not necessary if you use either method. Embroidery hoops and prepared silk scarves take up less room, but are smaller in scale and therefore not representative of the rectangular shapes of most remote sensing images.

You can also make an inexpensive stretching frame as shown below using two 1x3 boards cut as shown below. Drill holes at each end of the boards and in the center where the boards join together. Use a short machine screw, washer and wing nut to join the two boards at the center. Then use long machine screws, washers and wing nuts at each end of the boards. You will use rubber bands to attach the stretching pins to the silk at each of the four ends of the boards to stretch the silk. These materials are readily available at hardware or home improvement stores.

As with group Stretching Frames, you will need to suspend the silk above the floor so that nothing touches it. If you are using embroidery hoops or prepared silk scarves, you can use paper or plastic cups placed upside down under each corner of the frame.
Step Three: Drawing Your Remote Sensing Image With Resist

Obtain a remote sensing image of a coastal landform with accompanying text. Be sure you can identify all of the features shown in the image. Now you’re ready to begin drawing your image on silk using Resist.

To apply resist to the silk, use even pressure and a steady hand while you hold the applicator bottle vertically with the tip touching the silk. Draw all of the physical and human phenomena shown on the Image. Be sure that there are no breaks or gaps in the line- or the dye will escape. Check the backside of your piece to make sure that the Resist penetrated all the way through. Then let the Resist dry. You can speed up the drying time with a blow dryer.

Step Four: Apply the Dye to the Silk

Use the remote sensing image to determine the colors that you will use.

Dip your brush into the color and apply the dye sparingly to the center of an area that you outlined with the resist by touching the brush to the silk. Let the dye move to the Resist line. It will flow freely and even more so if the silk is wet beforehand. When painting large areas (e.g. background), work quickly and apply wet-to-wet to avoid unwanted lines.

You can also easily combine dye colors to produce unique effects. Use an artists color wheel to determine different combinations or get adventurous and try them on your own. You can also sprinkle kosher, silk, or other salt on wet areas of the piece to create unique spreading affects.

Step Five: Setting the Color

After you finish applying the dye to the silk piece, you will need to ‘set’ the color to allow you to wash or dry the piece without the color washing out of it. The method of setting or fixing the color is going to depend on the chemistry of the dye or paint you are using. Before purchasing dye or paint, read the directions thoroughly to determine if the required setting procedure fits your project and situation.

Setting Dyes with Heat

Heat setting is perhaps the easiest way to set pieces created with Dyna-Flo dye.

Allow the piece to dry for 24 hours before heat setting with an iron if you are using Dyna Flo. Set the piece face down on an ironing board with a press cloth between the silk and your iron. You might want to use a protective cloth on the ironing board as well. Work in small areas at a time, moving in a circular motion so as not to burn the silk, but also so that each section maintains heat for a long enough time to set the dye.

Setting Dyes with Steam

This method is not recommended with Dyna Flo dyes, but can produce brilliant colors with other, more compatible dyes.
**Setting Dyes with a Chemical Fixative**

Some dyes such as Tinfix and Jacquard have liquid fixatives for their respective dyes. The fixative can be painted on the dyes or the piece can be immersed in the fixative. The colors will probably not be as brilliant as they would be if set by steaming. Be sure to follow the manufacturer’s directions for using the chemical fixatives.

**Step Six: Removing the Resist**

Once the dye has been properly set, you can remove the Resist by rinsing the piece in warm water. Once the Resist has been removed, hang dry, then iron lightly while the piece is still slightly damp.

**Identification of Coastal Landforms and Description of Participant Images**

After the pieces have been created, have students identify and describe the coastal landforms they drew on their piece. You may also want them to describe the geologic processes used to create them.

**Interdisciplinary Applications of the Activity**

Try these extensions of the activities and also be sure to include any that you can think of on your own.

1. In a geography class, have students identify land-use patterns in urban remote sensing images. You might also have students create their own city or town and have them explain why certain features were located where they were.

2. Have students create a silk painting of their own neighborhood and explain why certain features are located where they were.

3. Have students create silk paintings of other remote sensing images and the landforms they feature. Include deserts, landforms associated with glaciation and other landscapes.

4. Have students complete the activity using MS Paint or other drawing software.

5. Post the remote sensing art in a display case or on the classroom wall. Number the paintings and have students put them into landform categories such as estuaries, deltas, etc.

6. Read a story or book and have students create a remote sensing silk drawing of what they think the setting of the story looks like from above.

7. Have students calculate the area and distance of features found on the remote sensing image and do likewise with their silk drawing.

8. Have students complete their remote sensing silk drawings in colors other than those shown on the image to develop the concept of false color. Have them explain their choices.
Artistic Resources

The Dharma Trading Company has an outstanding selection of classroom sets of all the resources you will need to complete the activity. The website for the Dharma Trading Company is http://www.dharmatradings.com/silkpainting/beginners.html

Below are pictures of the various resources you will need to complete the activity.

Classroom Set Dyna Flo  Dyes  Embroidery Hoops

Resist  Chinese Silk Stretcher  Resist Applicator

Eye Droppers  Rubber Bands  Clips

The classroom set shown above should have most everything you need to get started. You can also shop around at the local craft stores for materials as well. Don’t forget the ice cube trays and plastic cups.
Remote Sensing Resources

Remote Sensing Tutorials

This is an updated version of links that you might find useful in preparing your team for competition in the remote sensing event. I’ve checked every one of these and for every one that you see there were three or four that I did not include. The tutorials are excellent resources for introducing students to remote sensing and the kinds of questions and activities that I will be using in the competition. Then check out the downloadable NASA images that usually include notes describing each image. Click on the blue underlined text to access each site.

**NASA Remote Sensing Tutorial**
http://rst.gsfc.nasa.gov/start.html
An excellent tutorial of remote sensing basics

**Student Remote Sensing Tutorial**
http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/youthkit/intro_e.html
A 59 page downloadable PDF file from the Canadian Centre for Remote Sensing for students in middle and high schools.

**Remote Sensing Basics**
Another good overview of basic remote sensing concepts.

**How Radar Works**
http://www.howstuffworks.com/radar.htm
Good encyclopedia (remember those?) description of how radar works.

**LANDSAT 7**
A good introductory-level lesson into how the LANDSAT 7 satellite orbits the Earth and acquires remote sensing images. There are some excellent math applications in the lesson on orbits.

**Project Soar-High**
http://csc.gallaudet.edu/soarhigh/
This site has good interactive activities for a science class or practice session using a spectrometer. Be aware that some links on the site are missing or inactive.

**Glossary of Remote Sensing Terms**
http://www.ldeo.columbia.edu/rsvlab/glossary.html

**Look at the Earth From Space**
http://ice.ucdavis.edu/~robyn/sge_ee.html
Good website for environmental education activities, some of which include remote sensing imagery.
SOURCES OF IMAGES

Be sure to comply with all copyright guidelines when downloading and using images from these and from any website.

Earth From Space
http://earth.jsc.nasa.gov/sseop/efs/
With a photography database of over 400,000 images, this is one site you have to check out. Images of cities, landforms, water habitats and geographic regions of all kinds are included. Each image is also annotated.

EarthKam
http://www.earthkam.ucsd.edu/
Includes high quality images taken from the space shuttle and International Space Station (ISS). Be sure to follow the link from Images to Image Collections.

USGS Earthshots: satellite Images of Environmental Change
http://edcwww.cr.usgs.gov/earthshots/slow/tableofcontents
Earthshots shows a variety of remote sensing images with complete explanations of each. The theme of this site is that of environmental changes including natural and man-caused disasters.

NASA Earth Observatory
http://earthobservatory.nasa.gov/
Good global images and descriptions of Earth science phenomena using remote sensing imagery.

NASA's Visible Earth
http://visibleearth.nasa.gov/
Excellent use of remote sensing images in agriculture, oceans, volcanoes, tectonics, natural and man-caused disasters. Be sure to follow the link to oceans-coastal processes.

NASA Imagers
http://imagers.gsfc.nasa.gov
Very elementary school in its audience, but I was fascinated with the excellent quality of the images and the interactive activities.

Also, if you live near a coastal region be sure to check out your local county planning office for remote sensing images.
New Coastal Landform Resource Links for 2005

Use these resources to help you prepare for the 2005 competition. All provide excellent resources to help you understand coastal landforms and their diversity.

http://www.geog.buffalo.edu/~naumov/TA/GEO101/Lectures/Lecture12/notes12.htm#2.2.%20Tides

Coastal Processes and landforms general information website. Includes good diagrams of processes as well as descriptions of the kind of landforms.

http://members.aol.com/rhaberlin/csmod.htm

Coastal Landforms Learning Module with excellent resource links and interactive features

http://www.gsfc.nasa.gov/gsfc/service/gallery/fact_sheets/earthsci/polar.htm

NASA Polar Ice Fact Sheet

http://griots.tripod.com/csm/coasts.html

An older website, but with lots of good resource links


USGS Site describing winter el-nino storms along the California Coast and their effects on coastlines.

http://www.salem.mass.edu/~lhanson/gls214/gls214_coast_intro.htm

Good Introduction to Coasts and lots of good resource links.

http://www.glacier.rice.edu/

A fascinating website looking at landforms associated and glaciation if you are also preparing for the Dynamic Planet event.


An interesting website that looks at the molecular structure of water at different densities.
http://www.csc.noaa.gov/
The National Oceanic and Atmospheric Administration Coastal Resources Homepage

http://solarsystem.nasa.gov/planets/profile.cfm?Object=Io

http://www.whoi.edu/seagrant/education/packet.html
The Woods Hole Oceanographic Institute Outreach Homepage

http://www.gps.caltech.edu/~antonin/spclouds/#fig1
Remote Sensing Images of Saturn’s moon Titan- the only Moon believed to have an atmosphere

http://www.tufts.edu/as/wright_center/
Wright Center website, where I will be posting information regarding the remote sensing event.

Coastal wetlands resources

http://biology.usgs.gov/s+t/noframe/m4146.htm
USGS discussion of Coastal erosion Issues

http://www.chesapeakebay.net/sediment.htm
Discussion of Sediment Trapping

http://www.bayjournal.com/01-01/dams.htm
More Discussion of Sediment Trapping

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