Data, Data Everywhere!

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Data collection, synthesis, and analysis are important for drawing conclusions and making informed decisions in the realms of society, economics, technology, and politics.

Data acquisition and analysis are cornerstones for informed decision making about the environment. Facts and figures are vital to the practical application of systems and products. These data are collected through various means and organized into useful forms (i.e., visual imagery, datasets, and sounds). The International Technology Education Association's (ITEA) *Standards for Technological Literacy: Content for the Study of Technology (STL)* (2000/2002/2007) document states, "When presented with a particular product or system, the technologically literate person should be able to gather information about it, synthesize this information, analyze trends, and draw conclusions regarding its positive or negative effects" (p. 133). Whether collected by persons or obtained from other sources, information is realized through sensing agents. Data-sensing activities in technology education classrooms further opportunities for students to use the design process to recognize environmental issues and trends, and project their impacts.

What is Data and Why is it Important?

Information is knowledge attained not only by sensing, but also through instruction, reflection, and/or investigation and systematic inquiry. Data is organized, factual information that may include symbols, numbers, measurements, amounts, words, sounds, and images (ITEA, 2000/2002/2007). Data can be used to help solve natural and man-made problems. Data collection, synthesis, and analysis are important for drawing conclusions and making informed decisions in the realms of society, economics, technology, and politics. For example, individuals in local areas, society as a whole, and the environment (generally and specifically) can be affected by phenomena such as inclement weather, deforestation, or landslides. Comparing, contrasting, and classifying data from different levels (i.e., satellite data, aerial photography, and ground truthing) allowed data download, data monitoring, and ground data teams to work together,

Student collecting environmental data from a government-operated remote-sensing website.

"revealing that the rate of deforestation in the Amazon was not as rapid as originally thought, though the effects on biodiversity were greater than expected" (National Aeronautics and Space Administration [NASA], 1995, p. 8). This methodology used to expediently gather pertinent information is known as remote sensing.

Remote Sensing

Remote sensing is an integral part of the human experience and lies within a human's five senses. The average person uses his or her senses to experience an environment, synthesize the experience, and make decisions regarding the encounter. Three of the five senses (taste, touch, and smell) require direct physical (in situ) contact with the object being sensed. The other two senses, sight and sound, do not require in situ contact with the object. Both sight and sound are examples of remote sensing, the collection and interpretation of information about an object without physical contact with the object (Clark and Ernst, 2007).

The first account of remote sensing practice occurred in the 1840s. Photographs "were taken from cameras secured to tethered balloons for purposes of topographic mapping" (NASA, 1999, 1). Evelyn L. Pruitt, a geographer who worked with the Office of Naval Research, coined the term "remote sensing" in the 1950s (NASA, 1999, 3). Even though aerial photography was the single standard tool until the early 1960s, the terms "photography" and "aerial" had become insufficient descriptors for upcoming spacecraft remote sensing devices. There were hopes within the scientific community to observe the earth on an ongoing basis from orbiting satellites, and Pruitt's proposal was widely accepted as an encompassing descriptor of the use of these new devices. Today, one such data, service/outreach source, NASA's EOSDIS (Earth Observing System Data and Information System), "supports the daily production of over 2 terabytes (TB) of interdisciplinary Earth system science data…collected by approximately 65 instruments onboard more than 40 satellite and aircraft platforms" (NASA, 2004, 2-3).

Remote Sensing Devices and Applications

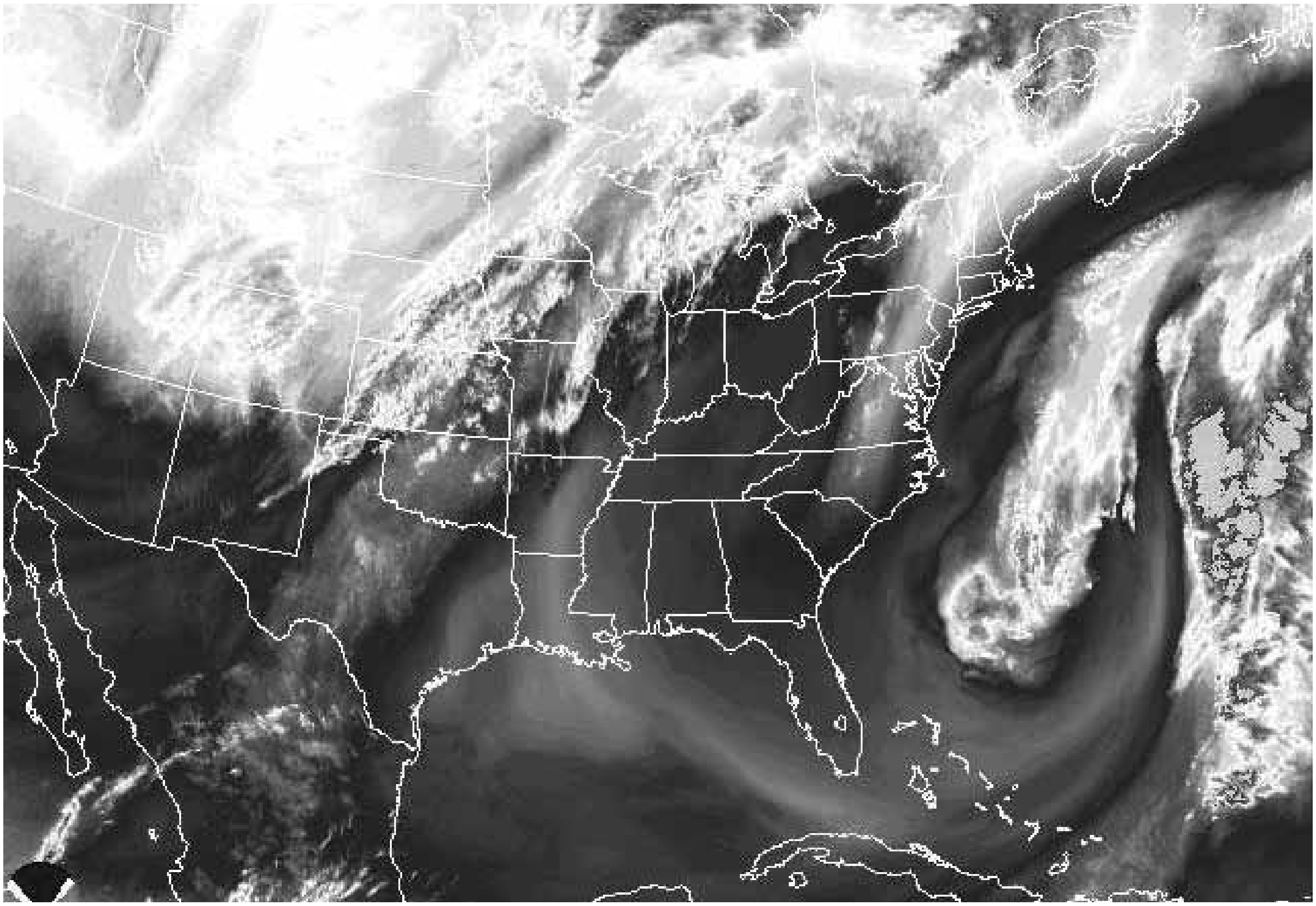
The varieties of remote sensing devices that are used to collect data call for different types of set ups and sensors. Cameras, mechanical scanners, imaging radar systems, satellites, etc. can be configured to remotely collect information. These devices are classified according to whether they are active or passive devices. Active devices beam generated energy to an isolated area or object and document the reflected component, while passive devices detect natural energy from an object (Northern Arizona University, n.d.). Similarly, active remote sensors identify reflected responses from light rays generated by artificial energy sources, and passive remote sensors identify the reflected or discharged radiation from natural sources (GIS Development, n.d.).

NASA is based on the concept of remote sensing (Short, 2007). Aerial photography, digital image processing, satellite imaging, thermal scanning, hyperspectral scanning, and radar scanning are all remote sensing processes used by NASA to study the earth. The application of these technologies allows humans to gather data about the earth's environment (i.e., air, land, and water) and make informed decisions and predictions.

Remote sensing is much more important than many may realize. Through the use of remote sensing technology, scientists study current atmospheric conditions to predict the weather. Scientists also use remote sensing to examine temperature and physical attributes of land masses and bodies of water. They also study biological (plant and animal) attributes found on land and in water. By analyzing these data, scientists have been able to detect global changes in the environment (Center for International Earth Science Information Network, n.d.).

Meteorological, hydrological, and oceanographic data have been collected from satellites since the early 1960s. The collection of these types of data has had major impacts on environmental analysis, weather forecasting, and atmospheric research in the United States and throughout the world (Menzel & Purdom, 1994). Many agencies depend upon remote sensing data to operate. The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service is one such agency. By using these data in conjunction with data from their own systems, they are capable of observing conditions that lead to inclement weather and then making life-saving predictions. They also use these systems to "improve efficiency and accuracy when forecasting weather phenomena (such as hurricanes, tornadoes, floods, etc.) and issuing warnings for severe weather events" (NOAA, 2002, 2). Professionals track and predict the movement of these extraordinary and sometimes surprising events.

For instance, Geostationary Operational Environmental Satellites (GOES) have an extended record of presenting imagery and data, facilitating accurate weather and climate-associated estimates over large spatial domains (Diak, Bland, & Mecikaski, 1996). GOES enable the continual examination essential for concentrated information analysis. GOES has heightened abilities to examine weather systems by supplying recurrent interval infrared imagery of the earth's surface, atmospheric moisture, and cloud cover



Water vapor image courtesy of NOAA, www.goes.noaa.gov/ECWV1.html.

(Menzel & Purdom, 1994). NOAA manages a system of GOES to offer recurrent visible and infrared images of Earth, as well as meteorological data such as approximations of atmospheric temperature, moisture summaries, wind, and precipitation (Weinreb, Jamieson, Fulton, Chen, Johnson, Bremer, et al., 1997).

The National Environmental Satellite, Data, and Information Service (NESDIS) (2008) indicates that GOES orbit the equatorial plane of Earth at a speed matching its rotation (geosynchronous). This permits the satellites to remain constant over one location on Earth's surface. The plane on which GOES synchronously move with the Earth's rotation is approximately 22,300 miles above the surface, enabling the most inclusive view from that position. Atmospheric activity indicators can be highlighted through constant surveillance in efforts to project severe weather conditions. Once severe conditions develop, GOES are able to examine storm progress to follow positions and activities. GOES images are also utilized to approximate rainfall at intervals during severe weather conditions. Data collection assisted by GOES imagery allows accurate moisture content and coverage approximations, which lead to advanced warnings (NESDIS).

Sensing and Data Use

Forecasting is one of the many functions related to remote sensing technology. Images acquired from remote sensing satellites have become an essential source of information for geographical, meteorological, and environmental studies at regional and global scales (Esquerdo, Antunes, Baldwin, Emery, & Junior, 2006). Climate-associated data is documented to determine the rate of change of global temperature, stability of global temperature, and climate impacts as a result of global temperature. Junior, Pinto, and Assad (2006) indicate that many studies involving impact assessment of climate change on agriculture have been, and will continue to be, conducted to further the knowledge base of crop-growth models (identify soil water-holding capacity, length of growth stages, etc.). Agriculture is directly impacted by global temperature and atmospheric change, and this is documented by remote sensing devices. Changes in soil resulting from atmospheric change have huge effects on agriculture. The U.S. Environmental Protection Agency (2007) studies have determined that deforestation and urbanization often contribute to changes in climate affecting agriculture as well.

Conclusion

Remote sensing devices for purposes of data collection enhance abilities to make informed decisions about the Earth's environment. Monitoring climate change is an increasingly important application for remote sensing devices. A true understanding of climate change progression and trends enables researchers to formulate conclusions and make determinations of environmental causes.

Student recognition of technological devices and applications for the remote collection of data assists in understanding the importance of gathering, synthesizing, and analyzing information to draw conclusions. Accessing actual environmental data and structuring it in a usable form can be used in technology education classrooms to evaluate human and natural effects on the earth's climate. Implementing the study and application of remote sensing technologies into technology education classrooms leads to understandings of technology utilization to identify environmental challenges. Through the recognition of these concerns, students will be able to draw conclusions and design solutions to these global problems.

Design Brief:

Using Remote Sensing to Study Climate Change for Application to Agricultural Production

Scenario

Global warming is considered to be causal to recent climate change. While many government and private agencies are concerned with the cause of global warming, others are focused on measuring the effects.

Informational Objectives

- *STL* 13-G: Students will use data to find trends.
- *STL* 13-K: Students will synthesize data to draw conclusions.
- *STL* 15-G: Students will use specialized equipment and practices.

Challenge

You work for a consulting company that makes suggestions to farmers. You have been asked to perform an historical study to verify if global warming is causing changes in weather patterns that affect your clients' agricultural production.

Requirements

Your historical study should span a minimum of 30 years and be based upon data that is collected by remote sensing. The study is to include a series of picture images and number data.

Evaluation

The study indicates 30 years of data	0---- 20%
The data is reported in equal intervals	0---- 20%
The data is obtained from credible sources	0---- 20%
Picture images are present	0---- 20%
Number data represented by charts and graphs	0---- 20%

Design Brief Resources

National Aeronautics and Space Administration: www.nasa.gov/

National Oceanic and Atmospheric Administration: www.noaa.gov/

United States Department of Agriculture: www.usda.gov/

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