Investigating Two Environmental Protocols of the GLOBE Program

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Abstract-**The 2003-2004 GLOBE Program Research Team at Elizabeth City State University in Elizabeth City, North Carolina established and monitored three environmental sites on the campus of ECSU. With these three established sites, the research team conducted investigations in the following areas, which are called GLOBE protocols: atmosphere and soil investigations.**

For atmosphere investigations, we recorded air temperature, minimum, and maximum temperatures from our instrument shelter located behind the Lester Hall building at Elizabeth City State University. With the newly installed digital multi-day max/min/current air and soil thermometer, this device is used to record daily measurements of maximum, minimum, and current air and soil temperatures. We will also record rainfall measurements with our rain gauge system located next to the instrument shelter. We will also test the pH level for our capture rainfall samples.

Further, by collecting environmental data from around the campus that encompass these 2 protocols, 3 pre-service mathematics teacher education students gained a better understanding of Earth and its interrelated cycles which comprise an integrated system.

The team uploaded the collected environmental data to the GLOBE website; the 2003-2004 GLOBE Program Research Team will provide these environmental data that will enable scientists to help study the earth's system.

I. Introduction

GLOBE, or Global Learning and Observations to Benefit the Environment, is a hands-on international environmental science and educational program. Through the GLOBE program, teachers, students, and scientists communicate with each other in concert, in an effort to learn more about the environment we live in, by using data and observations collected by students.

There are three primary goals of the GLOBE program: to enhance the environmental awareness of individuals throughout the world; to contribute to the scientific understanding of the Earth; and to help students reach higher levels of achievement in science and mathematics. With the GLOBE program, students from elementary school through college undergraduates conduct a continuing program of scientifically meaningful environmental measurements. In many cases, students have the opportunity to have their readings transmitted to a central data processing facility via the internet, and collaborate with scientists and other GLOBE students in using the data for educational and research purposes. Further, the measurements taken by the GLOBE students are very important for two reasons. First, scientists actually use the data acquired by students to conduct research and to improve our understanding of the global environment. Secondly, students not only have the opportunity of how to conduct a scientifically rigorous program of Earth observations, but also learn to use their own measurements, together with data from other resources, as a key part of their study of environmental science.

In our research, we focused on two of the GLOBE protocols: atmospheric investigation and soil investigation. We carried these investigations out though the use of an environmental site established during the 2002-2003 research year on the campus of Elizabeth City State University. The purpose of the monitoring of the environmental site was to collect and analyze data. From our findings, we were able to produce a report that reflects the qualitative and quantitative information gathered during the research period.

II. Atmospheric Investigation

A. Atmosphere: The Big Picture and Its Importance

What is the atmosphere, why is it important for scientists and students to conduct investigations into the atmosphere, and how does GLOBE tie into all of this? These three very interesting questions are what we will address our research of atmospheric investigations.

To answer our first question, Earth's atmosphere is a thin layer of gases composed of about 78% nitrogen, 21% oxygen, and 1% other gases, where these gases are argon, water vapor, carbon dioxide, and ozone. In addition, there are also solid and liquid particles called aerosols suspended in this layer of gases. The atmosphere is also held to the planet by gravity (or the gravitational force) with the result that atmospheric pressure and density decreases with height about Earth's surface.

The next question we want to answer is why is it important for scientists and students to study and conduct investigations into the atmosphere? It is important to understand and conduct investigations into the atmosphere because of the many things to which the atmosphere makes contributions. We as human beings live on land, however

we live, move, and breathe in the atmosphere. The atmosphere gives us oxygen we breathe and carries off the carbon dioxide we exhale. The atmosphere is responsible for filtering out most harmful forms of sunlight and traps outgoing heat from the Earth's surface. The atmosphere is also responsible for transporting energy from the equator to the poles, making the whole planet more livable. Additionally, the atmosphere brings the moisture evaporated from lakes and oceans to dry lands so that we have water to drink and to sustain our agriculture. So indeed, this thin layer that surrounds us is endowed with great responsibility, and we as curious people want to know more about how the atmosphere effects our environment.

This leads us to point why both scientists and students are working together through the GLOBE program to study and conduct these important investigations into the atmosphere. It is often implied that scientists know what is happening in all parts of the world, but this is far from true. There are many regions where scientists have only the most generalized information and understanding of environmental factors such as air temperature and precipitation. Even in regions where there seems to be an abundance of data, scientists still do not know for example how much precipitation and temperature vary over relatively short distances. Are the differences of precipitation and temperature great over relatively short distances, or is the difference nominal? Without investigations conducted by students and scientists, we simply just would not know! It is true that official weather monitoring stations, such as the National Weather Service stations in Morehead City, North Carolina and Wakefield, Virginia, have contributed a tremendous amount of data for a century or more in some locations, while at the same time, satellite technology, such as GPS or Global Positioning Satellite devices, has given us pictures of large areas every 30 minutes, and global images at least twice daily for at least a decade. However, despite all of these wonderful efforts, there are still gaps in coverage. Further, the atmosphere varies significantly within these gaps, and that is how GLOBE engages students in environmental studies such as atmospheric investigations, from even as early as elementary school, to college students at Elizabeth City State University! Additionally, scientists who study weather, climate, phenology, ecology, biology, hydrology, and soil study these readings taken.

B. Weather and Climate

Before moving forward, when talking about the atmosphere, most people think about weather and climate, but it is important to make clear or refresh the distinction between weather and climate. Many persons feel that both weather and climate are synonymous, but this is not true. By weather, we mean what is happening in the atmosphere today, tomorrow, or even next week. By climate, we mean weather averages, variability, and extremes over time. Persons also want information about the atmosphere on a long-term basis.

C. Measuring Maximum, Minimum, and Current Temperature

In our research with respect to the atmospheric investigation, we decided to study maximum, minimum, and current air temperature. These measurements were taken from an instrument shelter that was previously established on the campus of Elizabeth City State University by a GLOBE research team during the summer of 2002. The objective of this investigation was to measure maximum and minimum air temperature, and also the current air temperature during a certain time every day. From this investigation, we learned how to read the maximum, minimum, and current air temperatures using a digital thermometer, and understand the diurnal temperature variations.

We have already discussed before how important the atmosphere is to Earth, but how does maximum, minimum, and current temperatures factor into the atmosphere with respect to weather and climate? In regards to weather, have you ever noticed that the daily weather forecasts are not always correct? This is partly because scientists are still trying to learn more about how our atmosphere works. Measurements of air temperature are important to help scientists better understand our atmosphere from day to day. This understanding will enable meteorologists and others to accurately predict the weather for the next day, or even the next seven days! These measurements are also important in understanding precipitation; whether precipitation falls as rain, sleet, snow, or freezing rain depends on the air temperature.

When we are talking about climate, questions can be asked like, "Is this an unusually warm year?" or "Is Earth getting warmer as some scientists have predicted?" To answer these and other questions about Earth's climate, measurements are needed of daily maximum and minimum air temperature, month by month, year by year. This data is used to formulate longitudinal studies of the Earth's climate, such as the type of study the ECSU GLOBE research team is working on.

III. SOIL INVESTIGATION

A. Characteristics of Soil

Soil can be characterized by its structure, color, consistence, texture, and abundance of roots, rocks, and carbonates. These characteristics allow scientists to interpret how the ecosystem functions and make recommendations for soil use that have a minimal impact on the ecosystem. For example, soil characterization data can help determine whether a garden should be planted or a school should be built. Soil characterization data can help scientists predict the likelihood of flooding and drought. It can help them to determine the types of vegetation and land use best suited to a location. Soil characteristics also help explain patterns observed from satellite imagery, vegetation growth across the landscape, or trends of soil moisture and temperature that might be related to weather.

B. Soil Temperature

Soil temperature is an easy measurement to take and the data collected are useful to scientists and students. The temperature of the soil affects climate, plant growth, the timing of budburst or leaf fall, the rate of decomposition of organic wastes and other chemical, physical, and biological processes that take place in the soil. The temperature of soil is directly linked to the temperature of the atmosphere because soil is an insulator for heat flowing between the solid earth and the atmosphere. For example, on a sunny day, soil will absorb energy from the sun and its temperature will rise. At night, the soil will release the heat to the air having a direct and observable affect on air temperature. Soil temperatures can be relatively cool in the summer or relatively warm in the winter. Soil temperatures can range from 50° C for near-surface summer desert soils (warmer than the maximum air temperature) to values below freezing in the winter. Soil temperature has a significant effect on the budding and growth rates of plants. For, example, as soil temperatures increase, chemical reactions speed up and cause seeds to sprout. Farmers use soil temperature data to predict when to plant crops. Soil temperature also determines the life cycles of small creatures that live in the soil. For example, hibernating animals and insects emerge from the ground according to soil temperature. Soil temperature also determines whether water in the soil will be in a liquid, gaseous, or frozen state. The amount and state of water in the soil affects the characteristics of each soil horizon in a soil profile. For example, in cold soils there is less decomposition of organic matter because the microorganisms function at a slower rate, resulting in a dark colored soil. Intense heating in tropical climates causes increased weathering and the production of iron oxides, giving these soils a reddish color. In Northern and Southern latitudes and at high elevations, some soil layers are permanently frozen and are known as permafrost.

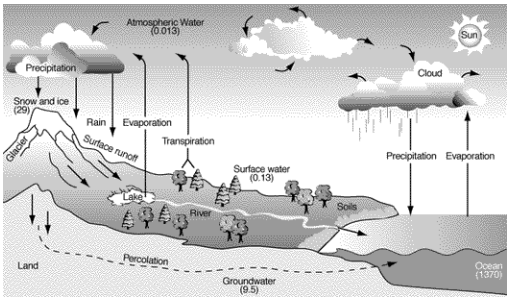
Melting permafrost alters soil structure and horizon thickness, and causes damage to plant roots. At mid-latitudes and mid-elevations, near-surface soil freezes in the winter. Soil moisture evaporates from soil surfaces. The amount of evaporation depends on the vapor pressure of the water in the soil, and this depends on temperature. Once the moisture evaporates, it adds to the humidity of the air, affecting the climate. Understanding how soils heat and cool helps to predict the length of growing seasons for plants, the type of plants and animals that can live in the soil, and the input of humidity into the atmosphere. The amount of moisture in the soil affects the rate at which the soil heats and cools. Wet soils heat slower than dry soils because the water in the pore spaces between the soil particles absorbs more heat than air. Soil temperature data can be used to make predictions about how the ecosystem will be affected by warming or cooling global temperatures. Scientists use soil temperature data in their research on topics varying from pest control to climate change. By collecting soil temperature data, GLOBE students make a significant contribution to the understanding of our environment.

IV. HYDROLOGY INVESTIGATION

A. Hydrology: A Deeper Look at Water

What is Hydrology? Why should scientist and students conduct investigations to study this protocol? Also, how can a mathematical analysis of the investigation be produced?

Hydrology is the science that treats the waters of the earth, their occurrence, circulation and distribution, their chemical and physical properties, and their reaction with the environment including their relation to living things. The study of hydrology is also concerned with the ways in which water is stored and transferred over, on, and under the Earth's surface. This study is also known as the hydrologic process or water cycle. In this cycle, water from the Earth evaporates due to the sun's heat. As the water is evaporated, it is cooled in the air. This forms clouds. When the water vapor in the air gets too heavy, it returns to the earth as precipitation and the process begins again. This process is what greatly affects our weather. It gives us precipitation, humidity, and cloud cover just to name a few things. In the Hydrology investigation, GLOBE investigates water in its liquid form.



Picture 1: The Process of Evaporation.

In its liquid form water makes up about seventy percent of the Earth's surface. Although most of the Earth is water, not all of this water is consumable. Water has to go through many chemical reactions to be purified and safe enough for drinking. This is because it's hard to find pure water on Earth that is safe for consumption and the water left carries many natural and human-introduced impurities. These impurities become dissolved or suspended in water and this is what affects the quality of the water. This is why scientist and students conduct investigations on water. Testing water helps scientist and students to develop a better understanding of our local land and water resources. This knowledge can help them make more intelligent decisions about how themselves and others use, manage, and enjoy these resources. Also, by testing water they can assess the extent to which human activities are affecting the quality of water, thus affecting how people will be able to use it in the future.

B. Indicators in a Hydrology Investigation

When conducting a Hydrology Investigation, GLOBE measures several key indicators of water quality. They are transparency, water temperature, dissolved oxygen, pH, electrical conductivity, salinity, alkalinity, and nitrate. For our research, we will take a closer look at pH level.

C. pH Level

pH is a measure of the acidic or basic nature of a solution. The pH of water influences most of its chemical processes. Pure water (has no impurities and no contact with air) has a pH of 7. Water with impurities that does have a pH of 7 has an equal balance of acid and base. The pH of water has a strong influence on what can live in it. A pH range of 6.0 to 9.0 appears to provide protection for the life of freshwater fish and bottom dwelling invertebrates.

D. Acquiring the Data

In getting the data needed GLOBE has guidelines that those conducting the investigation should adhere to. By following these guidelines, errors in the data are reduced and a constant is set for all those who participate in the program. The collection of water temperature has a three part guideline. This guideline consists of selecting a site, calibration of the measurement instrument, and the process by which to measure water temperature.

E. The Site

The site the GLOBE team chose in recording water temperature was the creek adjacent to Griffin Hall on the campus of ECSU. This was a model site because it had seldom disturbance from outside life and it was convenient for all the students on the team to access.

F. Calibration

To record water temperature a standard thermometer is used. This thermometer is filled with liquid mercury and has an indicator that measures in degrees Celsius. To calibrate this instrument the thermometer is placed in ice water and remains there until it reads 0 degrees Celsius. When this temperature is reached, it lets one know that the thermometer is working correctly and it is ready for use. Calibration should be done prior to the first use of the instrument and every 3 months to maintain accuracy of recordings.

V. Results

From this research, we yielded the following results from the three protocols that we investigated:

- As the weather became warmer, the current, minimum, and maximum air temperature increased;
- As the weather became warmer, the soil temperature increased, with an average temperature of 12 degrees;
- As the weather became warmer, the pH level dropped. It was interesting to note that the pH is relatively high, meaning that the water is more of a base than an acid.

These results are very important to the research team because it lays the foundation for further hypotheses that future research teams can use in further study. The research that we conducted is part of a longitudinal study. We collect the data, and then up-load the data onto the GLOBE website. Through our research, we have been able to build the body of knowledge that will be used by future GLOBE research teams.

References

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