Using GLOBE Data to Analyze Land Cover

Purpose

To develop hypotheses about which environmental factors are most important to plants growing in a local Land Cover Sample Site by comparing local GLOBE data to those of other GLOBE schools reporting the same MUC class

Overview

Using GLOBE Visualizations, students will identify two other GLOBE schools that have reported the same MUC class and compare their temperature, precipitation and soil moisture to their own. They will try and identify which environmental factors are similar and which vary, suggesting which are more important in determining plant communities.

Student Outcomes

Science Concepts

Geography

- How to use maps (real and imaginary)
- The physical characteristics of place
- The characteristics and spatial distribution of ecosystems
- How humans modify the environment

Scientific Inquiry Abilities

- Use GLOBE website to gather, analyze and interpret data.
- Identify answerable questions.
- Design and conduct scientific investigations.
- Use appropriate mathematics to analyze data.
- Develop descriptions and predictions using evidence.
- Recognize and analyze alternative explanations.
- Communicate procedures, descriptions, and predictions.

Level

Middle and Secondary

Time

1-2 class periods for data collection, 2 class periods for data analysis. Additional time will be necessary if a report is to be generated.

Materials and Tools

- Internet access
- Paper
- Colored pencils
- Atlas
- *Basic Information Work Sheet*
- *Data Gathering and Organizing Work Sheet*
- *Data Analysis Work Sheet*

Preparation

Choose one of the natural cover MUC classes you have identified in a Land Cover Sample Site.

Make copies of the appropriate *Work Sheets*.

Prerequisites

Complete measurements for at least one natural cover Land Cover Sample Site. This site should have a complete MUC class of at least 3 or 4 digits.

Your school system should have data for several months for Temperature, Precipitation, and Soil Moisture.

Basic understanding of ecosystems

Introduction

An **ecosystem** is a major interacting system that involves both living organisms and their physical environment. As a science, ecology attempts to explain why particular plants and animals can be found living together in one area and not in others; why there are so many organisms of one sort and so few of another; what changes one might expect the interactions among them to produce in a particular area; and how ecosystems function, with particular reference to the flow of energy, the use of organic compounds, and the cycling of chemical elements.[1] It is important to consider the ecosystem as a whole when drawing conclusions about a particular component, such as vegetation type. This activity is an ecological approach to analyzing land cover.

What To Do and How To Do It

This learning activity is organized according to the scientific method:

Scientific Method	This Learning Activity	Level
Research Question and Hypothesis Development	Which environmental factors are most important to plants growing in a local Land Cover Sample Site?	Intermediate and Advanced
Data Collection	Use GLOBE Visualizations and an atlas to obtain GLOBE data from other schools *Basic Information Work Sheet* *Data Gathering and Organization Work Sheet*	Intermediate and Advanced
Data Analysis and Results	Answer questions which analyze the data obtained to compile results or findings *Data Analysis Work Sheet*	Intermediate and Advanced
Conclusions	Summarize your results and expain what your findings mean in a report Conclusions – Project Report	Advanced

This activity is designed for both intermediate and advanced levels. To take this activity to an advanced level, there is a culminating section, *Conclusions - Project Report*, in which the students produce a report summarizing the interactions of the GLOBE measurements and how they affect the type of land cover. It is envisioned as a long-term assignment or final term project. This is a good learning activity to use GIS software if it is part of your school's software library.

Implementation Suggestions

- Complete the *Basic Information Work Sheet* as a class.
- Organize the class into working groups.
- Have each group of students collect and interpret one particular set of data (e.g., Temperature) following the appropriate section of the *Data Gathering and Organizing Work Sheet*.
- Have each group report their results (perhaps photocopy a set for each group) to the whole class to complete the data analysis and conclusions.

[1] Peter H. Raven, Ray F. Evert, and Susan E. Eichhorn. 1992. *Biology of Plants, 5th ed.* New York, NY: Worth Publishers.

Helpful Hints

- Prepare students for this activity by doing a brief ecology unit, discussing the characteristics of your *natural cover* Land Cover Sample Sites.
- During data analysis, periodically pause to review the objectives of this activity and to share insights.
- For a more inquiry-based activity, considering what other measurements your school /school system has conducted, have students develop their own research questions about land cover. They can be questions specific to one other measurement (e.g., precipitation or soil characteristics). They can still follow the appropriate sections of the learning activity for data collection and analysis.

Basic Data Collection

Note: The GLOBE website pages change in appearance from time to time and may not look exactly as they are pictured.

1. Review the MUC code and corresponding land cover type obtained for one of your natural cover Land Cover Sample Sites [MUC level 1, Closed Forest (0), Woodland (1), Shrubland (2), Dwarf-Shrubland (3), Herbaceous Vegetation (4), Barren Land (5), Wetland (6)]. Make sure your MUC is taken to the highest level possible (3 or 4 digits).
2. Obtain the name and location of two GLOBE schools who have reported the same MUC code:
   a. Enter the GLOBE website as you normally do. There is no need to log in.
   b. Go to the GLOBE Visualizations.
   c. Add Land Cover Classification to the map. All sites with Land Cover Classifications will be displayed.
   d. Click on the Data Later name and select View Layer Table from the options. Click the Measured at column to sort by MUC class.

   What To Do If There Are No Matching MUC Classes

   Find MUC codes with the highest level of agreement. For example, if your MUC code is 4133 (tall graminoid herbaceous vegetation with broad-leaved deciduous shrubs), you can use a MUC Code that matches to level 3, such as 413 (tall graminoid herbaceous vegetation with shrubs).

   e. Filling out the *Basic Information Work Sheet*, write down the MUC code, name of the school, city name, country, latitude, longitude, and elevation for the two schools.

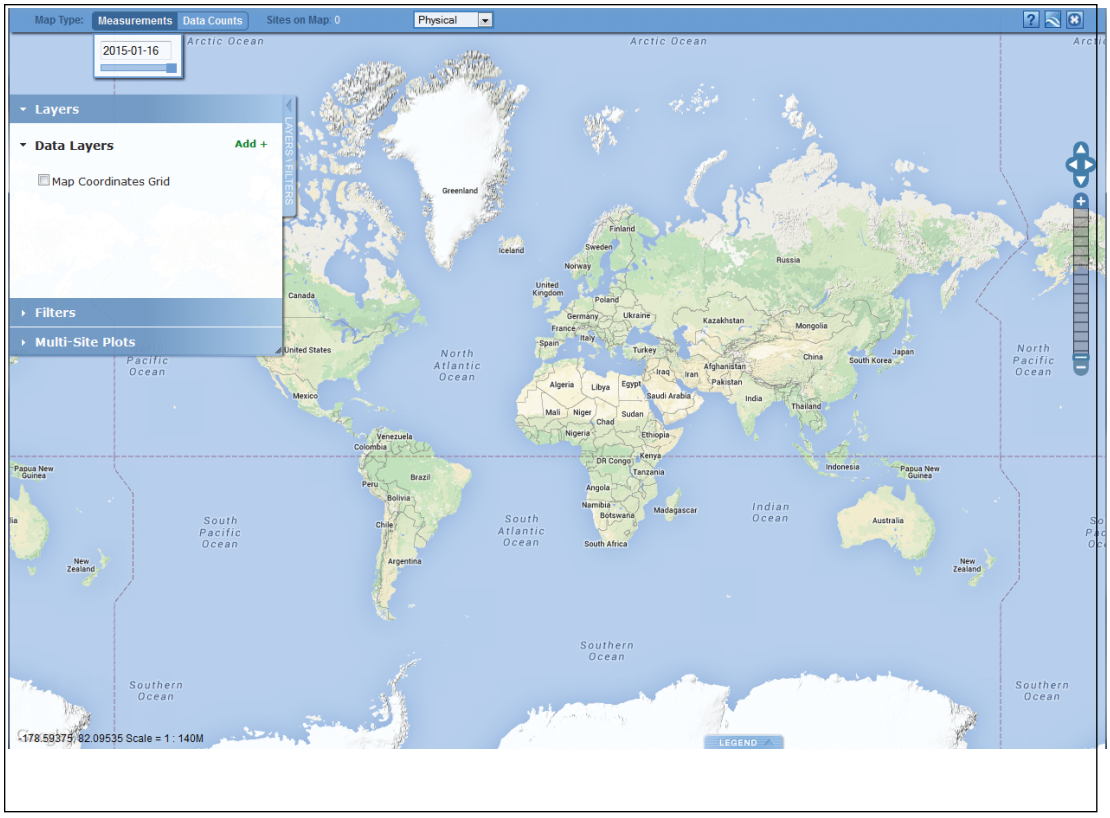
Research Question and Hypothesis Development

Discuss the research question: Which environmental factors are most important to plants growing in a local Land Cover Sample Site? Encourage the development of hypotheses that address this question.

Obtain Other GLOBE Data for These Schools with the Same MUC Class.

Note: If the schools chosen do not have all of the recommended data, try choosing a different school to analyze or work with the data you are able to obtain. Data gaps are a reality of ecosystem science.

1. Enter the GLOBE website as you normally do.
2. Go to GLOBE Visualizations:



3 Click on Add+ next to Data Layers, select the desired environmental parameter and click on the Add Layer button.

4. Select one of the GLOBE parameters and adjust the dates to create *Time Series Plots* for one full year. You can adjust the dates to analyze a few years, one year, one month, etc. Your graph should look similar to the one below.

5. Following the *Data Gathering and Organizing Work Sheet* questions, create *Time Series Plots* for Solar Noon Temperature Dailies, Maximum Daily Temperature and Minimum Daily Temperature (*under Air Temperature Dailies*), Total Liquid Equivalent (*under Precipitation*), and 30 cm soil Gravimetrics Moisture (*under Soil Moisture (Gravimetrics)*).

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Basic Information Work Sheet

Our School

MUC Code: _____ Land Cover Type: _____

Latitude: _____ Longitude: _____ Elevation: _____

Comparison School #1

MUC Code: _____ School Name: _____

City: _____ Country: _____

Latitude: _____ Longitude: _____ Elevation: _____

Comparison School # 2

MUC Code: _____ School Name: _____

City: _____ Country: _____

Latitude: _____ Longitude: _____ Elevation: _____

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Data Gathering and Organizing Work Sheet-1

These questions are organized to help you record the data from GLOBE Visualizations. You might want to download and plot data instead of sketching the graphs from the GLOBE website. You can also save the graphs to your computer.

Temperature

1. Sketch the graph from the *Time Series Plot* for the Solar Noon Temperature Dailies for your school and the others using a different color for each school.
2. Estimate the highest temperature for each school you chose using the Maximum Daily Temperature Time Series Plot.
3. Estimate the lowest temperature for each school you chose using the Minimum Daily Temperature Time Series Plot.

Precipitation (Total Liquid Equivalent)

1. Sketch the graph from the *Time Series Plot* of the Total Liquid Equivalent for the schools using a different color for each school. Total Liquid Equivalent is a liquid accumulation of all precipitation (Rain Depth and the melted portion of New Snow Depth). By knowing where a school is located, it may be possible to determine when the liquid might be rain and when it might be snow. Looking at air temperature values may provide some insight.
2. Estimate which school has the most precipitation.
3. Estimate which school has the least amount of precipitation.
4. How do the schools compare in their amounts of precipitation?

30 cm soil Gravimetrics Moisture

1. Sketch the graph from the *Time Series Plot* of soil moisture at 30 cm for the schools, using a different color for each school.
2. Which schools have the wettest soil? Which schools have the driest soil?

Soil Data Extension

Soil scientists highly recommend the use of additional soil properties for ecosystem analysis of land cover. Soil characterization data can be obtained by retrieving the soil data archive for each school. Additional basic properties you can consider include slope, texture, structure, and pH. For advanced level analysis, you can consider nitrogen, phosphorus, and potassium measurements.

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Data Gathering and Organizing Work Sheet-2

Geography and Topography

Creating a table of this information will help you to summarize this data so you can see likenesses and differences clearly.

Locate the schools in an atlas using the information on the *Basic Information Work Sheet* (latitude, longitude, and country).

1. On which continent is each school located?
2. Which schools, if any, are located near coastlines? Describe each school's direction from the coastline.
3. Which schools, if any, are located near large water bodies? Give the name of the water body and describe each school's direction from the water body.
4. Which schools, if any, are located near mountain ranges? Give the name of the mountain range(s) and describe each school's direction from the mountain range.
5. What is the direction of the prevailing winds for each area?
    a. Does the prevailing wind direction in any of the locations blow so it is likely to cross a mountain range?
    b. Does the prevailing wind blow directly in from the ocean before it comes to the school site?
    c. Does the prevailing wind blow across a large inland waterbody or dry land before it reaches the school sites?
6. Which schools, if any, are located in an area with an arid or wet climate? Indicate these schools and the type of climate.
7. Which schools, if any, are located in heavily urbanized areas?

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Data Analysis Work Sheet-1

This section of the investigation is intended to help you learn how to analyze your data, summarize your results or findings, and interpret your findings to arrive at some conclusions. These may include new research questions or hypotheses. You will also have an opportunity to organize your new knowledge so you can present it for further discussion.

Answering these questions will help you apply the scientific method so you can learn a systematic approach for analyzing and making sense of data. This will help you to understand how the type of land cover in your school's GLOBE Study Area may be related to weather, climate, soils, and geographical location.

1. What are the temperature ranges (min-max), on average, for each of the schools?

2. Are there any patterns in these current temperature graphs for each school? Are the temperature patterns for each school similar? How are the patterns different?

3. Using an atlas, try to identify what the average temperature ranges might be in areas where your land cover classification (MUC class) is found.

4. Analyze your precipitation graph.
   a. Identify the differences and similarities in Total Liquid Equivalent amounts for the period studied. Did all the schools receive the same amount? If not, what are the differences?

   b. Identify the patterns. When did precipitation fall? Were precipitation events concentrated in a particular time period with dry periods, or was precipitation fairly evenly spread over the time period? In which locations did such patterns prevail?

   c. Make a table to compile these data so you can look at it and begin to think about what it might mean.

5. Using an atlas or climate database, identify what average precipitation is reported for similar land cover classes.

6. Do the schools' precipitation patterns differ from the average precipitation for their area? If so, are there deserts, mountains, or waterbodies between the area of prevailing winds and the schools?

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Data Analysis Work Sheet-2

7. What soil moisture patterns do you see for each school?

8. If precipitation events are not evenly distributed across the time period, what do the reported soil moisture data look like during and after these events?

9. Location.
   a. Are all the schools on the same continent? How far apart are they in degrees of latitude and longitude?

   b. Where are they in relation to the equator (include N or S of the equator in your description)?

   c. How much do they differ in elevation above sea level?

10. Which of the areas within the school sites or nearby are likely to have a MUC class that signifies developed land cover, especially urban (MUC 9)?

Answers to the above questions will represent your findings. Summarize these in a short paragraph. Attach the tables you created and refer to them in your summary to help explain your findings.

Conclusions - Project Report

What do your findings mean? What can we say about the relationship between the MUC class, temperature, precipitation, and soil moisture at the three school locations?

In a well organized report, use your data and data analysis to describe how the environmental parameter(s) of an ecosystem (temperature, precipitation and soil moisture) relate to the land cover type in that area. Formulate hypotheses about which environmental parameter(s) are the most important in determining the type of land cover in an area. Justify your answers using the data obtained in this activity.

Remember that your conclusions are based on the data you used.

Be sure to answer the following questions in your report.

- What do your data suggest about possible relationships between precipitation and soil moisture for the study sites?
- What do your data suggest about possible relationships between temperature and precipitation?
- Explain how the amount of soil moisture can influence the type and condition of the land cover.
- If you determined what the prevailing winds in the study areas were, how do you think these might affect precipitation, temperature, or both? Is this explanation likely to account for some differences in data among the study sites?
- What does your data tell you about topographic or other locational differences between the sites?
- How might these differences relate to temperature or precipitation patterns at the various sites?
- What does your data tell you about the likely conditions necessary to support the MUC land cover class which are at the three study sites?
- Are there any major differences in the amount of precipitation, temperature ranges, or soil moisture across the sites for the time period studied? If there were some differences, what hypothesis might explain these differences?
- If there are differences in the amount of precipitation, temperature ranges, or soil moisture across the sites, how could you explain why these areas have the same land cover type?
- How does your data compare with “average” data found in an atlas or other source for these geographic locations? How might local conditions in your study area (topography, location near a water body, direction of prevailing winds) account for the differences?
- What does your data tell you about the relationships between location, precipitation, soil moisture, temperature, and land cover class?
- Are there any questions you feel that you haven’t been able to answer or new ideas (hypothesis) that might need further study to fully answer the above questions? If so, what are they? Do you think you might learn more about this relationship if you were able to compare data over a longer time period?

Some Ways To Share Your Results and Conclusions

- Display on a school bulletin board.
- Submit to the local newspaper.
- Have your teacher share the report with teachers at the other schools you investigated.

Adaptation

Graphing

Instead of sketching the time series plots, students can use the actual GLOBE temperature, precipitation, and soil moisture data recorded by each school to create their own graphs. Following the instructions provided to create time series plots, you can retrieve the data for the schools and time period selected by selecting "**View Layer Table**." It will show all the data reports of the selected parameter for the time period you selected.

Acknowledgment

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School Name	Site Name	Latitude	Longitude	Elevation	Measured Value
Abu Bakr As-Siddiq Intermediate School at Al-Madinah Al-Monawarah	School (shelter):ATM-01	24.2728	39.3937	635	28.5
Ahmad Sameh	GREENHOUSE PATH:ATM-01	31.45	35.13	698.2	20.1
Ain Jaloot	Ain Jaloot2:ATM-02	23.53302	57.16531	3	31.9
Akmenes gimnazija	Akmenes Gimnazija:ATM-01	56.1456	22.4437	54.2	13.4
Alexander von Humboldt Gymnasium	Humboldt Gymnasium Vordereingang:ATM-01	47.667	9.183	367.4	12.2
Alexander von Humboldt Gymnasium	Radolfzell Mogginger Steig:ATM-02	47.449	8.593	386.8	8.7
Al-Fath Secondary School at Abha	ALfatih:ATM-01	18.1208	42.31	2247	23
Aljazeera Intermediate School at Taif	Aljazeera School:ATM-01	21.21266	40.26944	365.2	21
Al Majd Junior High School	School First Floor:ATM-01	32.6047	35.44457	101	22.4
Al Muabila Al-shamaliah Girls school	AL Muabila AL-shamaliah:ATM-01	23.42	58.5147	26	34.5
Al-Murabba School at Yanbu	Al-Murabba Secondary School:ATM-01	25.2311	38.2106	389.8	31
AL Salam Elementary School	School Entrance Garden Yard:ATM-01	31.25	34.46	255	17.5
Alswaiq Basic School	Shltar:ATM-01	23.49411	57.25443	29.7	38.7
Anyksciu raj. Troskunu K. Inciuros vidurine mokykla	TROSKUNA1:ATM-01	55.3522	24.5322	42.7	13
Athens Intermediate School	AIS 2:ATM-02	34.47649	-86.59782	249.2	19.4
AT-Tahawy High School at Al-Hofuf	tahawy climate no1:ATM-01	25.21	49.36	173.8	36.8
Beit -Jan C Elementary School	School Yard Main Entrance:ATM-01	32.58	35.22	912.6	12
Benicia High School	Garden:ATM-01	38.06405	-122.17546	24	27
Bolea Home Citizen Scientist	Bolea Home Citizen Scientist:ATM-01	40.8606	-81.4613	332	18
Bundeshandelsakademie und Bundeshandelsschule Bregenz	School Location:ATM-01	47.49139	9.72331	403	11
Canisius scholengemeenschap	Tuintje aan de kant van de keuken.:ATM-01	52.409	6.779	23	13
Carmit Agriculture Farm	YARD AREA NEAR THE POND:ATM-01	32.46	34.57	17	17
Channel View School For Research	Q262 CVSR:ATM-01	40.5862	-73.8225	4	6.9
Clusius College	Clusius College Heerhugowaard:ATM-01	52.67343	4.83307	-1	14.9
Clusius College VBO-Groenschool Noord Kennemerland	Geitenwei:ATM-01	52.55	4.6667	1	15.4
Complex of Schools in Rudna Wielka	Budka meteorologiczna:ATM-01	50.0874	21.954	174.5	16.5
Complex of Schools Kard. St.Wyszyńskiego in Jadachy	Jadachy - siedziba:ATM-01	50.4926	21.6784	147	14.2
Complex of Schools No 1 in Stalowa Wola	stalowa wola:ATM-01	50.55	22.0505	124.9	18
Complex of Schools No 2 Hetmana St. Czarnieckiego in Włoszczowa	meteo:ATM-01	50.8487	19.9586	242	20
Complex of Schools No 48 in Warszawa	School Location:ATM-01	52.2167	20.9	125	18
Complex of Secondary Schools in Przysucha	OGRODEK:ATM-02	51.367	20.633	200	16.4
Daltonschool Neptunus	Weerstation Dak Neptunus:ATM-01	52.3	[illegible]	-35	12.6
Damstede	School Location:ATM-01	52.3	[illegible]	-1	11
Dietrich-Bonhoeffer-Schule (Staatliche Regelschule)	School Location:ATM-01	51.0027	12.4318	196	16.2