



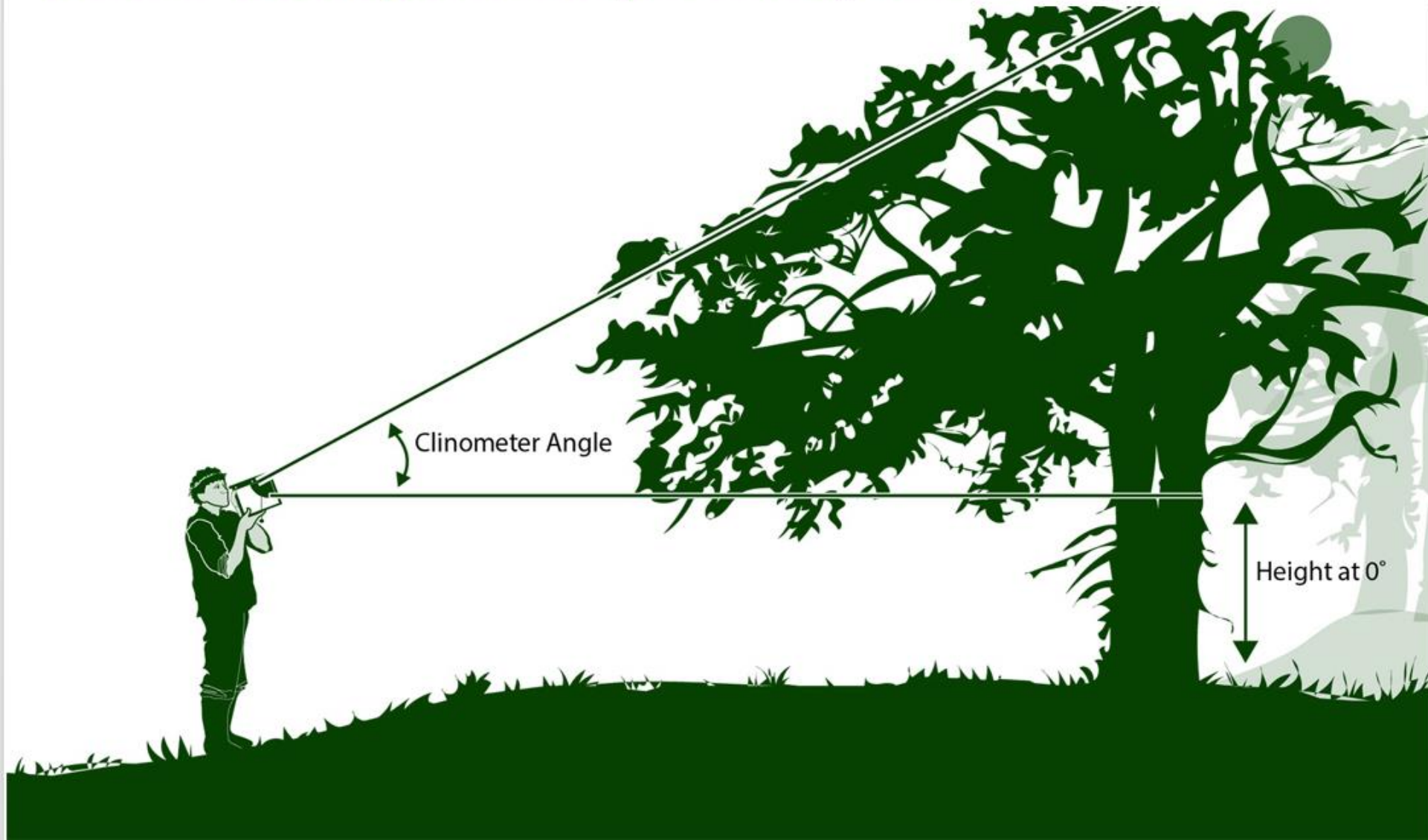
THE GLOBE PROGRAM

A Worldwide Science and Education Program



Biosphere • Biometry Protocol
Graminoid, Tree and Shrub Height

Measure Tree Height on a Slope: Stand by Tree Technique





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

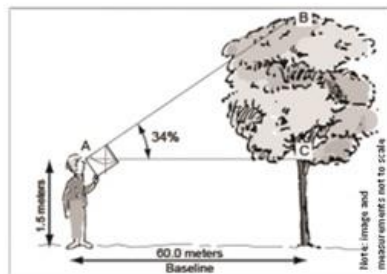
G. Quiz
Yourself

H. Additional
Information

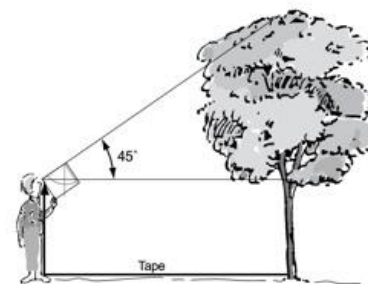
Note about this slide stack

GLOBE uses 5 different techniques to measure tree and shrub height. There is a slide stack for each of the techniques: select the one that best suits your situation, and use that slide stack to learn how to do the measurement.

1. If your feet are level with the tree base, use one of these two protocols



I. Standard Clinometer Technique

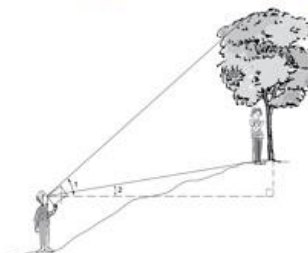


II. Simplified Clinometer Technique

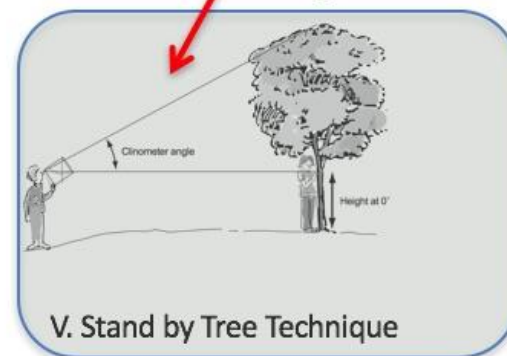
2. If you are measuring tree height on a slope, choose one of these options



III. Two Triangles with Eyes Higher Than Tree Base



IV. Two Triangles with Eyes Lower Than Tree Base



V. Stand by Tree Technique



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Overview

This module:

- Describes how to build a clinometer, the scientific instrument used to obtain tree and shrub height
- Provides a step by step introduction of how to measure the height of grass-like plants
- Provides a step by step introduction of a protocol method that can be used when measuring tree or shrub height when measuring tree height on sloping ground using the Stand By Tree Method

Learning Objectives

After completing this module, you will be able to:

- Define graminoid tree and shrub height
- Describe the importance of quality control steps in the the collection of accurate data
- Explain the difference between accuracy and precision
- Conduct graminoid tree and shrub height measurements in the field
- Upload data to the GLOBE portal
- Visualize data using GLOBE's Visualization Site

Estimated time to complete module: 1.5 hours



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

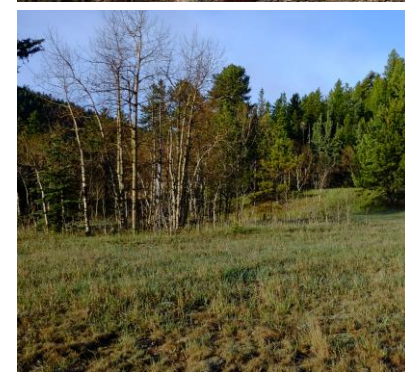
H. Additional
Information

The Biosphere

The Biosphere is Earth's zone of life. Every organism on Earth belongs to the biosphere. GLOBE has several ways to explore and measure components of the Biosphere through investigations in **land cover** and **phenology**. As well, the Hydrosphere investigations include the macroinvertebrates and mosquito larvae protocols.

Like all parts of the Earth system, the **Biosphere** is subject to change. We can quantify these changes by taking measurements over time, and compare what we saw in the past to what we see in the present.

Graminoid, Tree and Shrub Height measurements are part of GLOBE's Biosphere protocols. Graminoid is another word for grass-like plants.





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

What is Biometry?

Biometry is the measuring of living things. A scientist is interested not only in the characteristics of vegetation at a study site, but also how it is distributed. How dense is the forest? Does sunlight penetrate to the forest floor? Is the landscape dominated by grasses? Has there been a recent disturbance, such as a forest fire or flood? These are questions that are answered by taking biometric measurements.

In this protocol, you will be measuring the height of trees, shrubs, and grass-like plants using the measuring **Tree Height on a Slope: Stand by Tree** technique. These measurements will assist you in determining the **MUC classification** of your study site.

GLOBE Biometry Measurements

Land Cover Sample Site

Canopy Cover and Ground Cover

Graminoid, Tree and Shrub Height

Tree Height on Level Ground:
Simplified Clinometer Technique

Tree Height on Level Ground: Standard
Clinometer Technique

Tree Height on a Slope: Stand by Tree

Tree Height on a Slope: Two-Triangle
Techniques

Tree Circumference

Graminoid Biomass



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

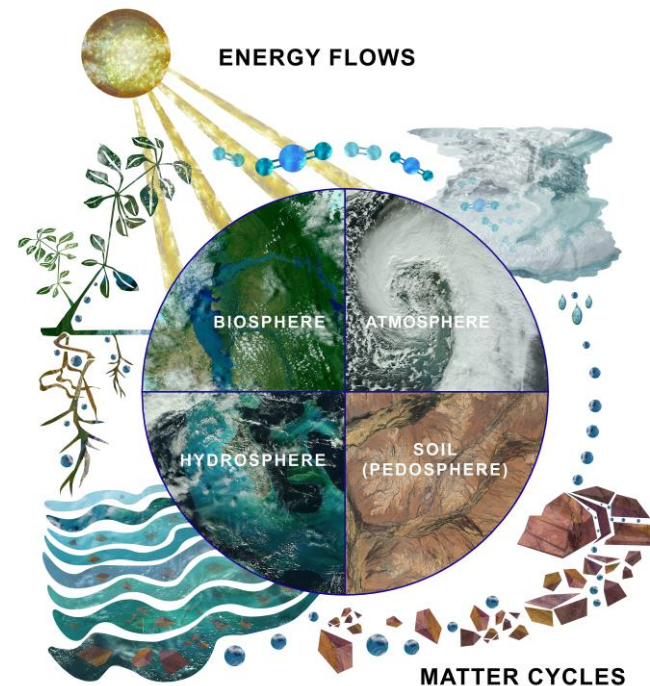
G. Quiz
Yourself

H. Additional
Information

Why Study Land Cover?

Land cover includes both developed and natural areas. All living things depend on their habitat, or land cover, for survival. They find shelter, food, and protection there. Land cover has a direct effect on the kinds of animals that will likely inhabit an area. Therefore, land cover is of great interest to ecologists, who study how plants and animals relate to their environment.

Land cover can influence weather, soil properties, and water chemistry. Different land cover types are all distinct in their effects on the flow of energy, water and various chemicals between the air and surface soil. So, knowing what types of land cover occur is important for a variety of Earth system science investigations.



The Earth System: Energy flows and matter cycles.



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

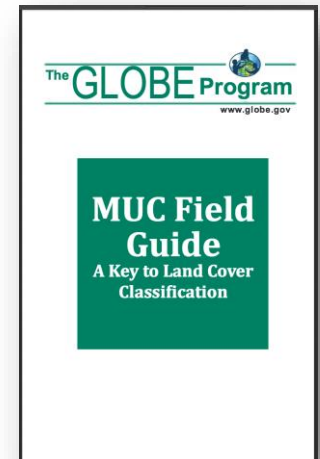
G. Quiz
Yourself

H. Additional
Information

GLOBE Land Cover Investigations

Land cover is a general term used to describe what is on the ground covering the land. Different land cover terms are used to describe the differences we see when we look at the land. Scientists classify land cover based on established criteria. This is done so that there is a consistent use of terms among people. For instance, what one person may call a forest living in the tropical Amazon may be quite different from a person living in northern Canada. Different species of trees live in these places, trees may be of different heights and the amount of ground and canopy cover may be quite different. For this reason, we need a standardized way to describe land cover.

GLOBE uses a land cover classification scheme called [Modified UNESCO Classification \(MUC\)](#). There are many different types of classification schemes used. These are often designed for specific places or regions. MUC can be used around the world and allows people to contribute to a global data base.





A. What Is Graminoid, Tree and Shrub Height?

B. Why Collect Graminoid, Tree and Shrub Height Data?

C. How Your Measurements Can Help

D. How to Collect Your Data

E. Entering Data on GLOBE Website

F. Understand the Data

G. Quiz Yourself

H. Additional Information

What is Graminoid, Tree and Shrub Height?

To describe your Land Cover Sample Site and identify the MUC code, you may need to measure the average height of the vegetation. For low-lying vegetation, such as grasses, and medium height vegetation, such as shrubs, you will take a random sample of plants, measure them, and calculate the average plant height.

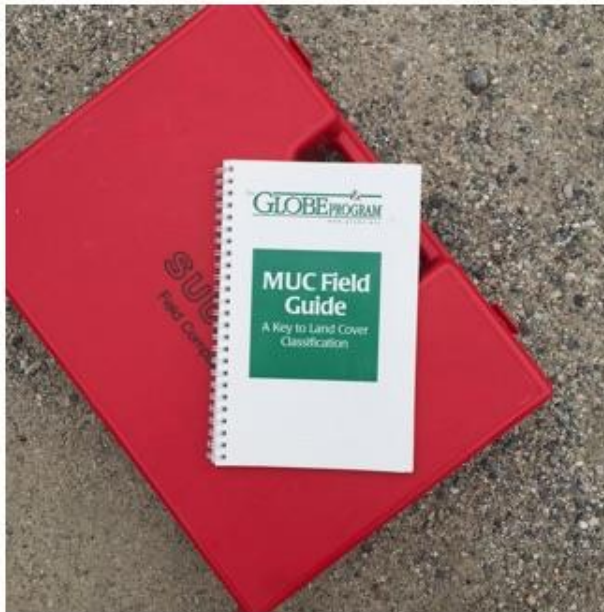
To measure tree height, you will need to use a **Clinometer** to make the measurements. You' will find instructions for building a clinometer in this tutorial.





Why Do We Collect Graminoid, Tree and Shrub Height?

You will need to measure the height of graminoid (grasslike) vegetation, shrubs and /or trees to help determine the MUC class of your Land Cover Sample Site. [MUC](#) stands for **Modified UNESCO Classification** system, an international standard for describing vegetation. Because the MUC system is widely used, it will allow you to compare your study site to others around the globe.





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

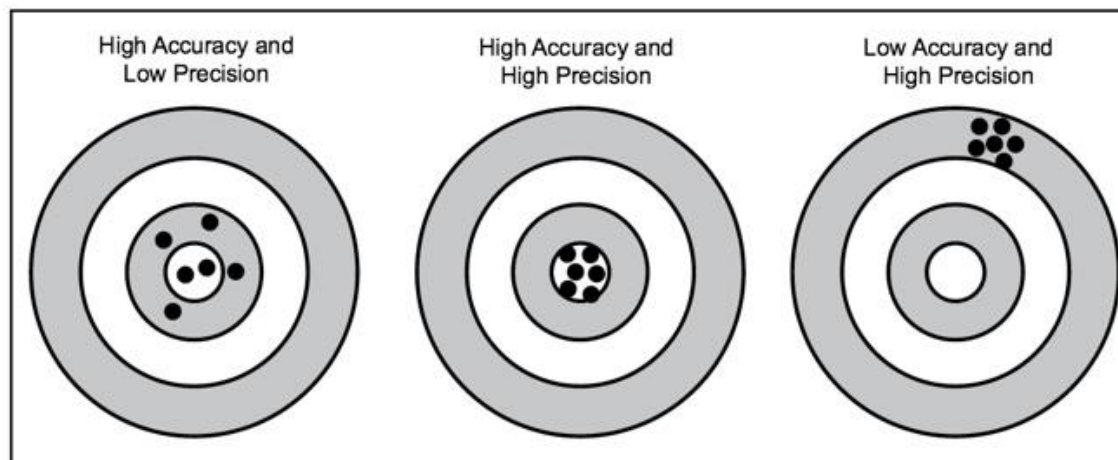
F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Why Collect Biometry Data?

Biometry measurements are useful for scientists who want to use your Land Cover Sample Site data. It helps to make sure that the MUC class you select is correct. Biometry measurements can help them assess how accurate and precise a land cover data set is. **Accuracy** is a measure of how well the data describe a phenomenon. **Precision** is demonstrated when repeated measurements yield the same outcome. In most GLOBE protocols, you are asked to take a measurement 3 times – allowing for you – as well as other scientists – to determine the precision of your data.



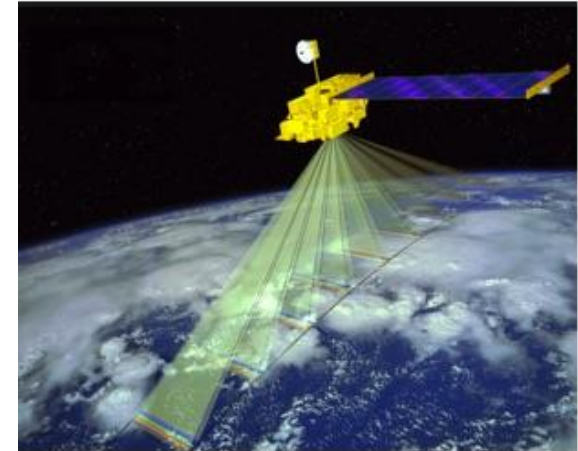


Mapping

An important objective of the land cover investigation to assess the accuracy of maps created by satellite images and aerial photographs.

Remote sensing simply means learning about something without making direct contact with it. We use remote sensing every day by hearing, smelling, and seeing.

With satellites and aircraft, we use machines to be our “eyes” in the sky or in orbit. Remote sensing in space has the great advantages of being able to cover very large areas quickly and to revisit the same area frequently. However, some of the detail that can be seen at ground level may not be detected by a remote sensing system. Therefore, it is beneficial to collect data at sample sites on the ground to accompany remotely sensed data about an area. GLOBE land cover data can contribute to making better, more accurate maps.



Terra's Terra's five instruments provide measurements of plant (vegetation) composition, structure, extent, and change. Image: NASA.



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

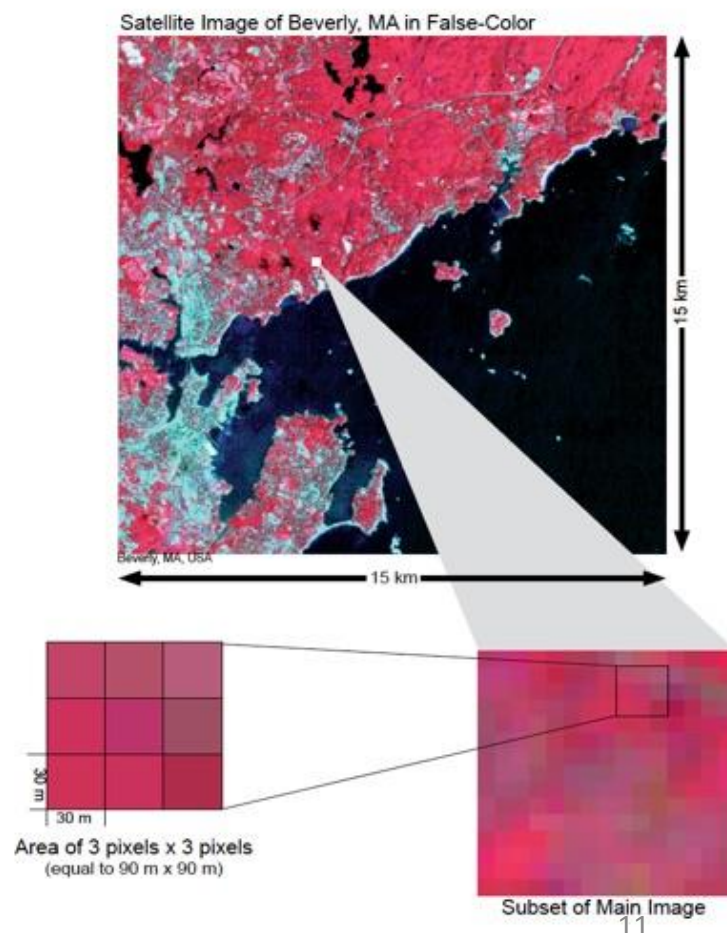
H. Additional
Information

How Your Measurements Can Help: Scientific Importance of Canopy Cover and Ground Cover Data

GLOBE land cover data can contribute to making better, more accurate maps.

Your land cover measurements are used to verify satellite analysis of land cover.

As you zoom in on a 15 km x 15 km satellite image, the pixels (which are 30 m x 30 m in size) become visible. You will be taking field measurements at sites that are 90 m x 90 m (equal to 3 pixels x 3 pixels).





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

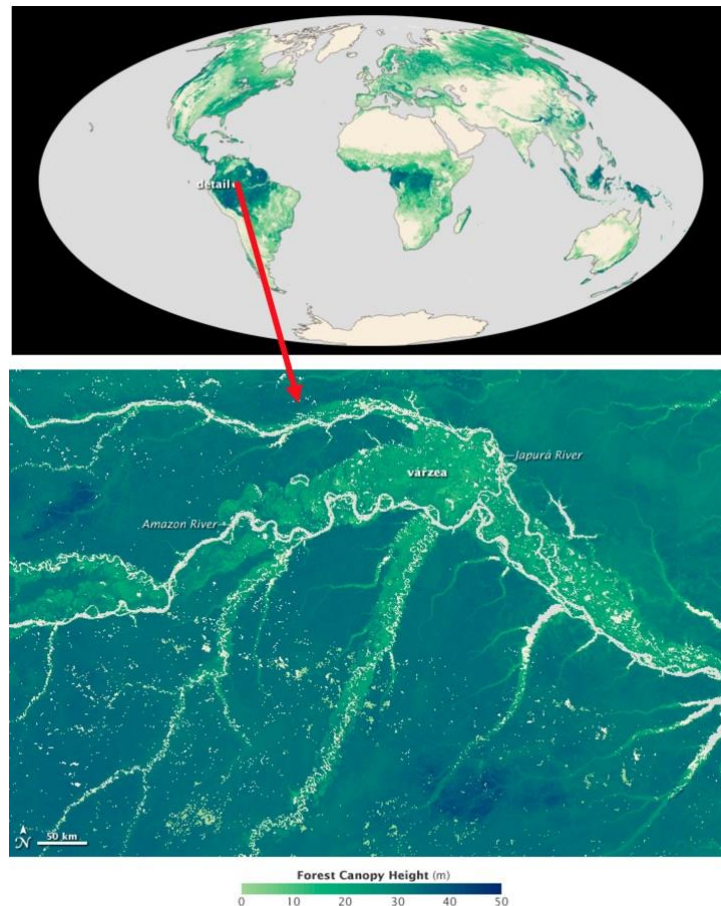
H. Additional
Information

Example: Canopy Height Map Created Using Satellite Data

Here are maps of canopy height derived from satellite data. Overall, the maps show that forest canopy heights are highest near the equator and decrease the closer forests are to the poles. The tallest forests, shown in dark green in the map above, tower higher than 40 meters and are found in a band in the tropics that includes the rainforests of the Amazon, central Africa, and Indonesia.

Both maps are based on data from the [Geoscience Laser Altimeter System](#) (GLAS) from the ICESAT satellite and the [Moderate Resolution Imaging Spectroradiometer](#) (MODIS) on NASA's Terra and Aqua satellites, but the close-up incorporates additional elevation data from the [Shuttle Radar Topography Mission](#) (STRM) and climatology information from both the [Tropical Rainfall Measuring Mission](#) (TRMM) and the [Worldclim database](#).

Ground validation of tree height by GLOBE participants can support a range of analyses, including those developed using satellite data.



Source: [NASA Earth Observatory](#). Research team led by Marc Semard, JPL.



Let's do a quick review before moving onto data collection! Question 1

1. Scientists use biometry to:

- A. Document the characteristics of vegetation of a study site
- B. Describe the distribution patterns in the vegetation
- C. A and B
- D. None of the above

What is the answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data collection!
Answer to Question 1

1. Scientists use biometry to:

A. Document the characteristics of vegetation of a study site

B. Describe the distribution patterns in the vegetation

C. A and B 😊 **correct!**

Were you correct?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data collection!
Question 2

2. Which of the following can be impacted by land cover?

- A. Weather
- B. Water chemistry
- C. Soil properties
- D. A and B only
- E. All of the above

What is the answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data collection!
Answer to Question 2

2. Which of the following can be impacted by land cover?

A. Weather

B. Water chemistry

C. Soil properties

D. A and B only

E. All of the above 😊 **correct!**

Were you correct?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data collection! Question 3

3. Why does GLOBE use the Modified UNESCO Classification System?

- A. Because it is an international standard
- B. Because your study site can then be compared with other study sites around the world
- C. A and B
- D. None of the above

What is the Answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data collection! Answer to Question3

3. Why does GLOBE use the Modified UNESCO Classification System?

- A. Because it is an international standard
- B. Because your study site can then be compared with other study sites around the world
- C. A and B 😊 **correct!**
- D. None of the above

Were you correct?



Let's do a quick review before moving onto data collection! Question 4

4. The image below uses a dart board to demonstrate the concept:

- A. High accuracy and low precision
- B. High accuracy and high precision
- C. Low accuracy and High Precision



What is the answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



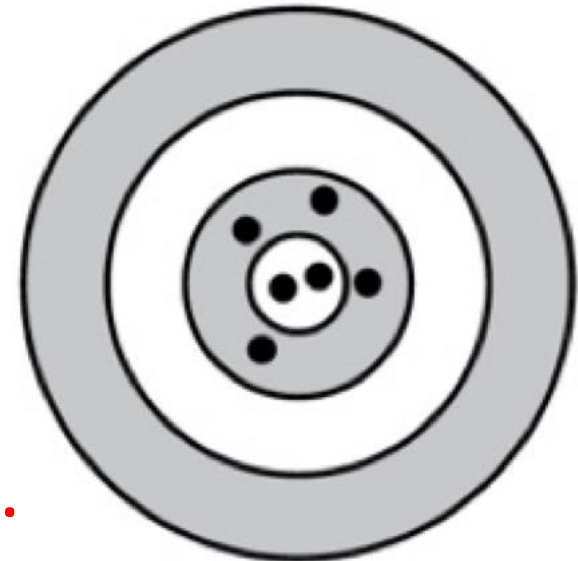
Let's do a quick review before moving onto data collection!
Answer to Question 4

4. The image below uses a dart board to demonstrate the concept:

A. High accuracy and low precision 😊 correct!

B. High accuracy and high precision

C. Low accuracy and High Precision



Were you correct?

Now, let's explore data collection.

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



What do you need to start?

When	During peak growth period, can be repeated annually as desired
Where	A homogeneous GLOBE Land Cover Sample Site
Time Needed	2-3 hours to take measurements
Prerequisites	Biometry Protocols: Canopy Cover and Ground Cover Land Cover Sample Site
Key Instrument	Clinometer
References	Graminoid, Tree and Shrub Height Field Guide Stand By Tree Technique Field Guide

A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information



How to Collect your Data: Timing and Frequency of Data Collection

The frequency of the measurements you decide to take will depend on your research goals:

- You can take biometry measurements only once in a site during peak growth. This will help with the MUC classification. This baseline data is also useful for scientists.
- You can take measurements twice a year, during peak growth and dormancy periods (winter or drought), to measure seasonal change
- You can return to the same study site year after year and repeat the biometry measurements to track changes in site biomass over time

A. What Is Graminoid, Tree and Shrub Height?

B. Why Collect Graminoid, Tree and Shrub Height Data?

C. How Your Measurements Can Help

D. How to Collect Your Data

E. Entering Data on GLOBE Website

F. Understand the Data

G. Quiz Yourself

H. Additional Information

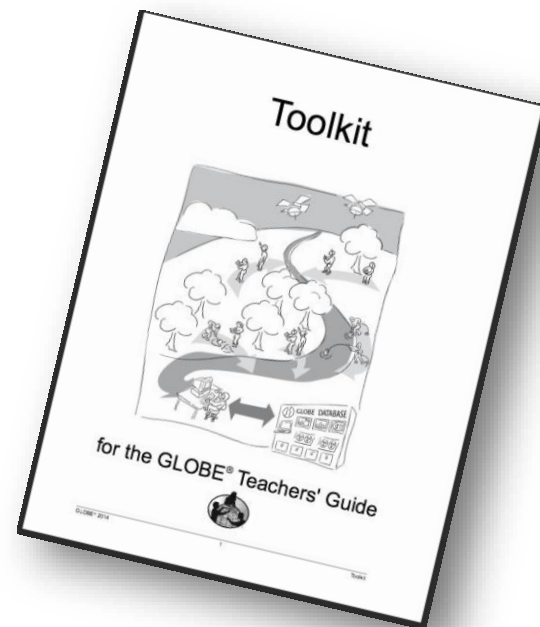


Sources for Equipment You Need

Instructions for making a **homemade clinometer** follow in this tutorial.

For Other Equipment:

The following resources summarize the measurements associated with each protocol, associated skill level, scientific specifications for the instruments, and how to access the equipment you need (purchase, build, or download).



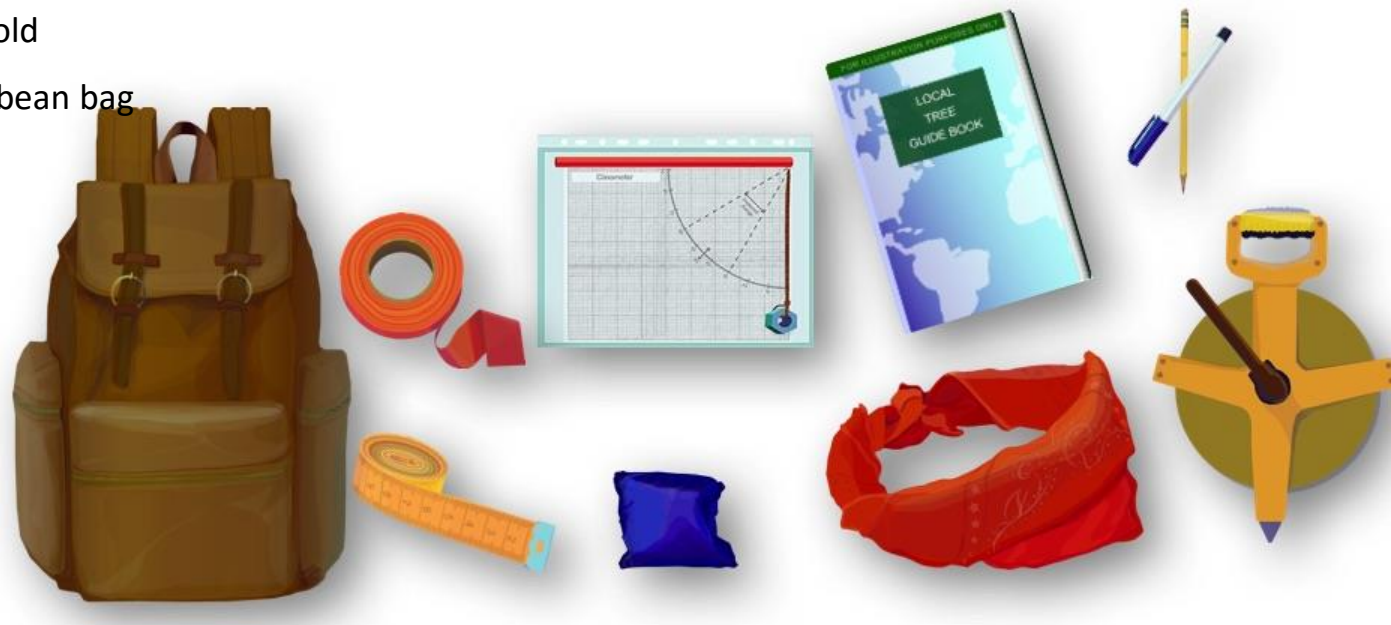
[Where to find specifications for instruments used in GLOBE investigations](#)

[Where to find scientific instruments used in GLOBE investigations](#)



To Measure Graminoid, Tree and Shrub Height, You Will Need the Following Equipment:

- Flexible measuring tape
- 50 m measuring tape
- Pen or pencil
- Clinometer
- Permanent tree markers or flagging (optional, if you plan to return to the site)
- Blindfold
- Small bean bag



A. What Is Graminoid, Tree and Shrub Height?

B. Why Collect Graminoid, Tree and Shrub Height Data?

C. How Your Measurements Can Help

D. How to Collect Your Data

E. Entering Data on GLOBE Website

F. Understand the Data

G. Quiz Yourself

H. Additional Information



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

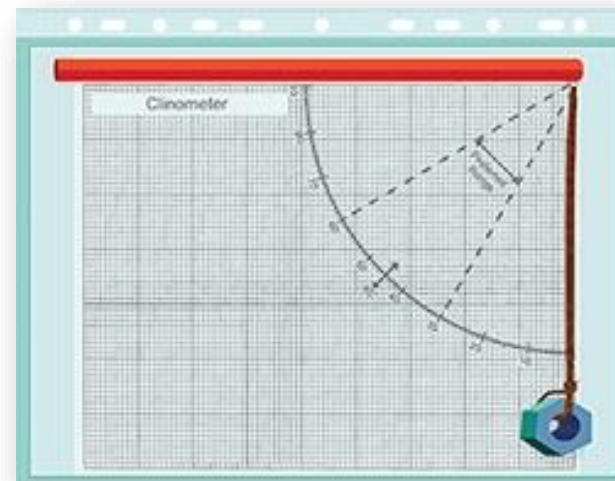
H. Additional
Information

Instructions to Build a Clinometer

A clinometer measures angles to determine the heights of objects without directly measuring them. It is a simplified version of the quadrant (a medieval measuring instrument), and the sextant (an instrument used to locate the positions of ships). Like these instruments, the clinometer has an arc with graduated degree markings that go from 0 to 90 degrees.

Required Material:

- Clinometer Sheet and Table of Tangents (located in Biosphere Appendix)
- Pieces of stiff cardboard at least the size of the sheets referenced above
- Drinking straw
- Metal nut or washer
- 15 cm of thread or dental floss
- Glue
- Scissors
- Something to punch one small hole
- Tape





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

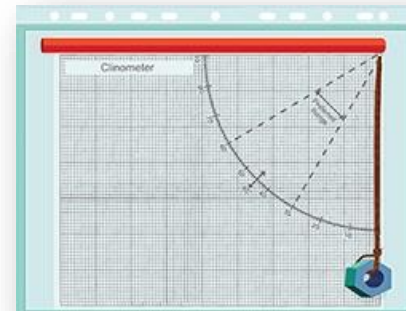
F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Instructions to Build a Clinometer: Steps

1. Gather the materials.
2. Glue a copy of the Clinometer Sheet onto one side of a piece of cardboard of the same size.
3. Glue a copy of the Table of Tangents to the other side of the cardboard.
4. Punch a hole through the marked circle on the Clinometer Sheet.
5. Push one end of the thread or dental floss through the hole and tie or tape it on the Table of Tangents side of the cardboard. Colored thread or floss will allow it to be seen more easily.
6. Tie a metal nut or washer to the other end of the thread so that it hangs in front of the Clinometer Sheet.
7. Tape a drinking straw along the designated line on the Clinometer Sheet, to use as a sighting device.



The cardboard and both the clinometer and table of tangents sheets can be placed in a sheet protector or laminated to ensure longer life. The straw would then be placed on the outside of the plastic and the hole for the thread with the washer would be punched through the entire instrument (plastic cover, cardboard and sheets).



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

To Measure Graminoid, Tree and Shrub Height, You Will Need the Following Documents:

- To be prepared, bring the following documents with you in the Field:
- [Graminoid, Tree and Shrub Height Field Guide](#)
- [Graminoid, Tree and Shrub Height Data Sheet](#)
- [Measure Tree Height on a Slope: Stand by Tree Technique Field Guide](#)

Measure Tree Height on a Slope: Stand by Tree Technique Field Guide

Task

Measure heights of shrubs and/or trees to help determine the MUC class of your Land Cover Sample Sites.

What You Need

- | | |
|--|--|
| <input type="checkbox"/> 50 m measuring tape | <input type="checkbox"/> Pen or pencil |
| <input type="checkbox"/> Flexible measuring tape | <input type="checkbox"/> Permanent tree markers (optional) |
| <input type="checkbox"/> Small bean bag | <input type="checkbox"/> Clinometer |
| <input type="checkbox"/> Measure Tree Height: Stand by Tree Technique Data Sheet | <input type="checkbox"/> Species ID keys and/or other local species guides |
| | <input type="checkbox"/> Blindfold |

In the Field

1. Work in a team of three. One person stays by the tree. You and another partner move away from the base of the tree until you can see the top of the tree through the drinking straw of the clinometer. **Note:** For the best results, adjust your distance so that the clinometer is as close to 30 degrees as possible and you are further from the tree than it is tall.
2. Site the top of the tree using the clinometer. Have your partner read and record the clinometer angle.
3. Using the [Table of Tangents](#), record the TAN of the angle on the [Measure Tree Height: Stand by Tree Technique Data Sheet](#).
4. Keeping the clinometer at 0 degrees, look through the straw and have your partner by the tree locate the position on the tree that you see.
5. Measure the height from the base of the tree to the position on the tree that you see when the clinometer reads 0 degrees.
6. Measure the distance between you and the tree. Have your partner help you using the 50 m tape. Record this in the [Measure Tree Height: Stand by Tree Technique Data Sheet](#).
7. Calculate the tree height using the following formula:
$$[\text{TAN (Angle of the Clinometer)} \times (\text{Distance to Tree})] + (\text{Height to 0 Degrees on Tree})$$



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

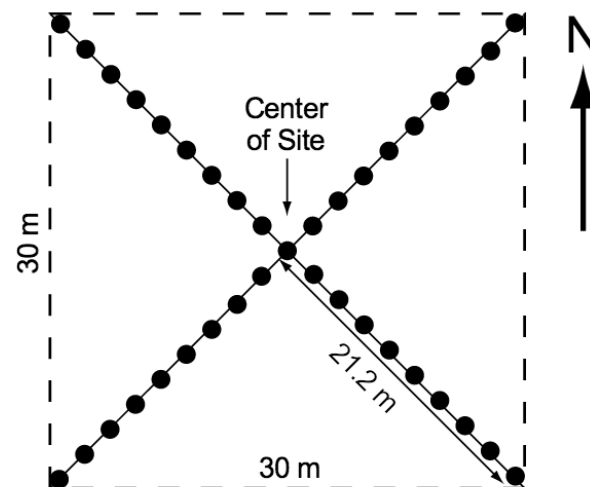
F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Identifying the Center of the Land Cover Sample Site

- Locate the center of your homogeneous Land Cover Sample Site. This is your starting point.



Land Cover Sample Site with the four 21.2 m half-diagonals in the NE, SE, SW and NW directions for sampling.



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

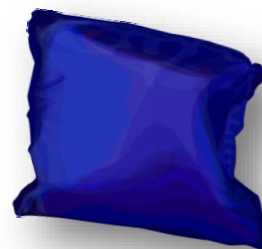
F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

1 a. Measuring Graminoid Vegetation Height

- Stand in the center of your Land Cover Sample Site and blindfold your partner. Have them throw the beanbag somewhere in the site.
- Using a flexible measuring tape, measure the height of the herbaceous vegetation where the beanbag landed. Measure from the ground to the top of the graminoids.
- Record the height on the Graminoid, Tree and Shrub Height Data Sheet.
- Repeat this process **two more times** and average the results.
- You have now completed the Graminoid Height measurement.





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

1b. Measuring Shrub Vegetation Height (0.5 m-5 m tall)

Stand in the center of your Land Cover Sample Site and blindfold your partner. Have him or her throw a beanbag somewhere on the site.

Locate the shrub closest to the beanbag. Measure the height of the shrub from the ground to the tallest branch. Do this with a tape measure if possible. (If the shrub is too tall, measure it with your clinometer, using the directions for measuring Tree height).

Record the height on the Graminoid, Tree and Shrub Height Data Sheet.

Repeat this process **two more times** and average the results

Use this average to determine your MUC class.

You have now completed the steps for Shrub Height





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

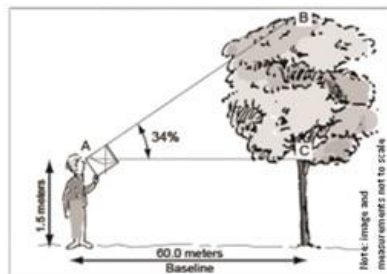
G. Quiz
Yourself

H. Additional
Information

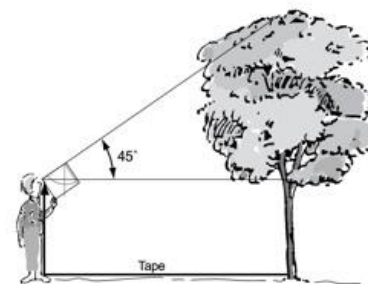
2. Measuring Tree Height Using Standard Clinometer Technique

There are different techniques to measure tree and shrub height. You need to select the one that best suits your situation, and follow that field guide. There is a slide stack for each of the methods below.

1. If your feet are level with the tree base, use one of these two protocols



I. Standard Clinometer Technique

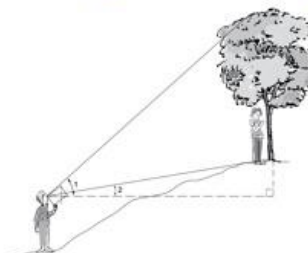


II. Simplified Clinometer Technique

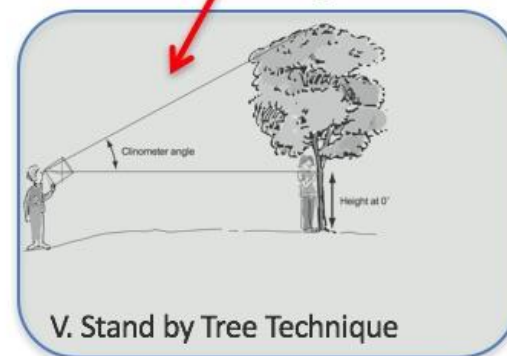
2. If you are measuring tree height on a slope, choose one of these options



III. Two Triangles with Eyes Higher Than Tree Base



IV. Two Triangles with Eyes Lower Than Tree Base



V. Stand by Tree Technique



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

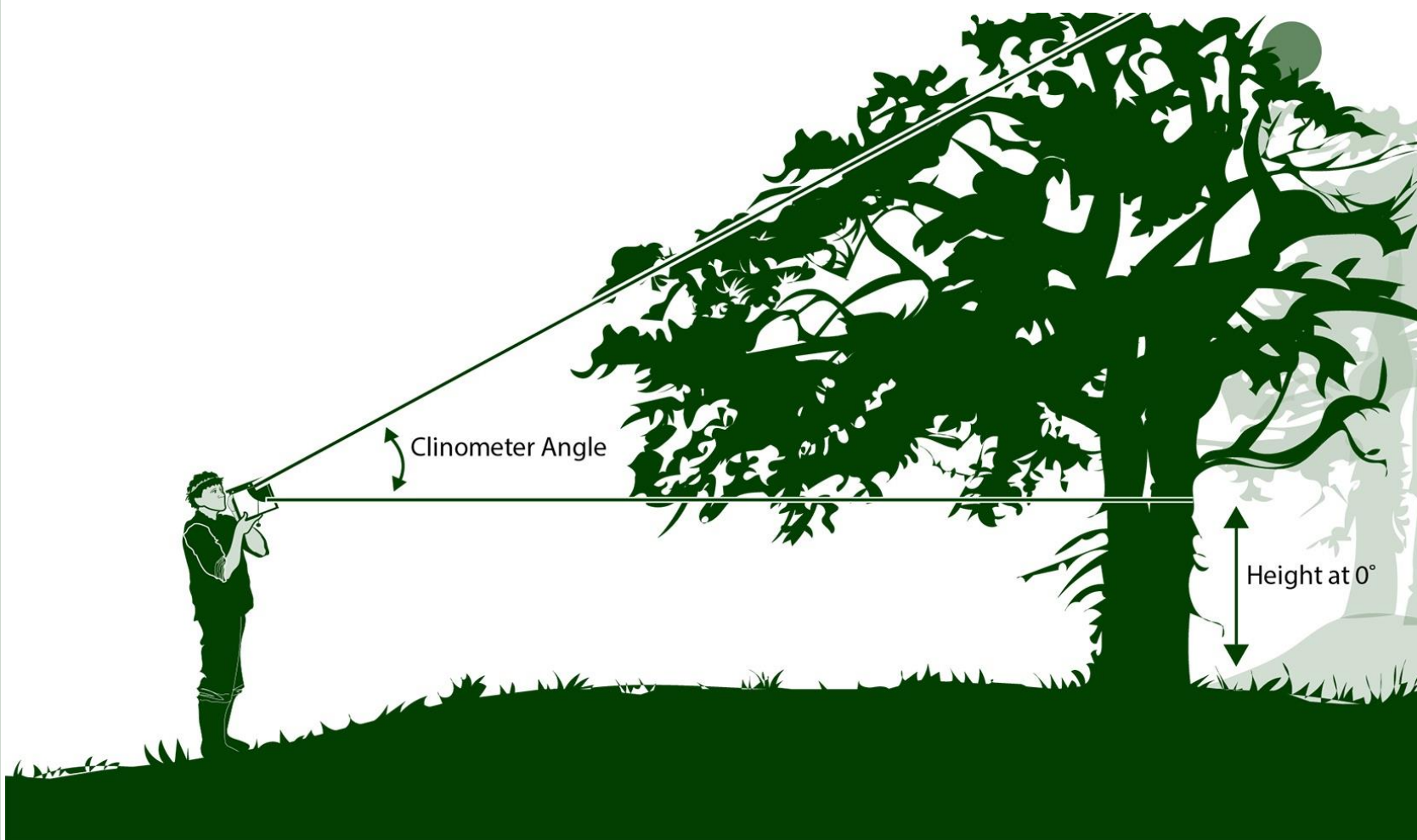
F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

2. Measuring Tree Height

The method you use will depend on the topography of your site. This is the Measure Tree Height on a Slope: Stand by Tree Technique.





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Measuring Tree Height- Determine the dominant species

1. Determine your dominant (most common and co-dominant (second-most common) tree species by counting the number of times each tree species was recorded on [the Canopy and Ground Cover Data Sheet](#). Record the names of the species on the Graminoid, Tree and Shrub Height Data Sheet.



*Dominant tree species in this photo is
Ponderosa Pine (Colorado, USA).*

Land Cover
Measure Tree Height on Level Ground Data Sheet

School Name: _____ Site: _____
Measurement Time: Year _____ Month _____ Day _____ Hour (UT) _____
Recorded By: _____

Clinometer Data							
Tree No.	Latin/Common Name	Clinometer Reading (°)	TAN of Clinometer Reading	Distance from Tree (m)	Eye Height (m)	Tree Height (m)	Dominant or Co-Dominant
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Tree Height = [TAN of Clinometer Reading] x [Distance from Tree (m)] + [Eye Height (m)]

GLOBE 2014 Appendix - 12 Biosphere



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Measuring Tree Height- Choose your Trees

- 2. **Select 5 trees to sample, including:**
 - The tallest tree of the dominant species
 - The shortest tree of the dominant species that still reaches the canopy.
 - Three trees that have heights in between the tallest and shortest of the dominant species.
- 3. Permanently mark number and label the trees if you plan to return to this site to take measurements over time.



Adjust your distance from the tree so that you are at least as far away from the tree as the tree is tall. For the most accurate measurement, adjust your distance so that the angle of the clinometer is as close to 30 degrees as possible.



Be sure to be on level ground so that your feet are at the same elevation as the base of the tree. If you are standing on a slope, you need to use an Alternative technique to measure tree height



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

V. Measuring Tree Height on a Slope: Stand by Tree Technique

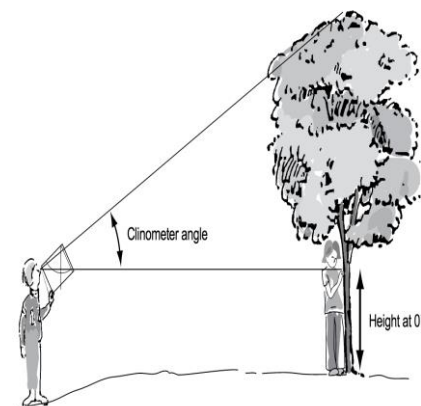
For this situation, use [the Measure Tree Height on a Slope: Stand by Tree Technique Data Sheet.](#)

- **In the Field**

- 1. Work in a team of three. One person stays by the tree. You and another partner move away from the base of the tree until you can see the top of the tree through the drinking straw of the clinometer.
- 2. Site the top of the tree using the clinometer. Have your partner read and record the clinometer angle.



For the best results, adjust your distance so that the clinometer is as close to 30 degrees as possible and you are further from the tree than it is tall.





A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

V. Measuring Tree Height on a Slope: Stand by Tree Technique-2

- Using the [Table of Tangents](#), record the TAN of the angle on the [Measure Tree Height: Stand by Tree Technique Data Sheet](#).
- Keeping the clinometer at 0 degrees, look through the straw and have your partner by the tree locate the position on the tree that you see.

Angle (°)	Tan.	Angle (°)	Tan.	Angle (°)	Tan.	Angle (°)	Tan.	Angle (°)	Tan.
1	.02	17	.31	33	.65	49	1.15	65	2.14
2	.03	18	.32	34	.67	50	1.19	66	2.25
3	.05	19	.34	35	.70	51	1.23	67	2.36
4	.07	20	.36	36	.73	52	1.28	68	2.48
5	.09	21	.38	37	.75	53	1.33	69	2.61
6	.11	22	.40	38	.78	54	1.38	70	2.75
7	.12	23	.42	39	.81	55	1.43	71	2.90
8	.14	24	.45	40	.84	56	1.48	72	3.08
9	.16	25	.47	41	.87	57	1.54	73	3.27
10	.18	26	.49	42	.90	58	1.60	74	3.49
11	.19	27	.51	43	.93	59	1.66	75	3.73
12	.21	28	.53	44	.97	60	1.73	76	4.01
13	.23	29	.55	45	1.00	61	1.80	77	4.33
14	.25	30	.58	46	1.04	62	1.88	78	4.70
15	.27	31	.60	47	1.07	63	1.96	79	5.14
16	.29	32	.62	48	1.11	64	2.05	80	5.67

Example: Assume you have established a baseline distance of 60.0 meters. Assume that you have measured the tree top to an angle of 34°. From the Table, you will see that the tangent of 34° is 0.67. Therefore, the tree height above your eye height is 60.0 m x .67 = 40.2 meters. By adding your eye height above the ground (1.5 m), the total tree height is 41.7 meters.



V. Measuring Tree Height on a Slope: Stand by Tree Technique-3

5. the height from the base of the tree to the position on the tree that you see when the clinometer reads 0 degrees.

6. Measure the distance between you and the tree. Have your partner help you using the 50 m tape. Record this in the Measure Tree Height: Stand by Tree Technique Data Sheet

A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

V. Measuring Tree Height on a Slope: Stand by Tree Technique- 4

- 7. Calculate the tree height using the following formula:
- [TAN (Angle of the Clinometer) x (Distance to Tree)] + (Height to 0 Degrees on Tree)**
- 8. Record the tree height on the [data sheet](#).
- 9. Repeat steps 1-8 two more times for each tree and report the average values. **You are are done!**

Angle (°)	Tan.	Angle (°)	Tan.	Angle (°)	Tan.	Angle (°)	Tan.	Angle (°)	Tan.
1	.02	17	.31	33	.65	49	1.15	65	2.14
2	.03	18	.32	34	.67	50	1.19	66	2.25
3	.05	19	.34	35	.70	51	1.23	67	2.36
4	.07	20	.36	36	.73	52	1.28	68	2.48
5	.09	21	.38	37	.75	53	1.33	69	2.61
6	.11	22	.40	38	.78	54	1.38	70	2.75
7	.12	23	.42	39	.81	55	1.43	71	2.90
8	.14	24	.45	40	.84	56	1.48	72	3.08
9	.16	25	.47	41	.87	57	1.54	73	3.27
10	.18	26	.49	42	.90	58	1.60	74	3.49
11	.19	27	.51	43	.93	59	1.66	75	3.73
12	.21	28	.53	44	.97	60	1.73	76	4.01
13	.23	29	.55	45	1.00	61	1.80	77	4.33
14	.25	30	.58	46	1.04	62	1.88	78	4.70
15	.27	31	.60	47	1.07	63	1.96	79	5.14
16	.29	32	.62	48	1.11	64	2.05	80	5.67

Example: Assume you have established a baseline distance of 60.0 meters. Assume that you have measured the tree top to an angle of 34°. From the Table, you will see that the tangent of 34° is 0.67. Therefore, the tree height above your eye height is 60.0 m x .67 = 40.2 meters. By adding your eye height above the ground (1.5 m), the total tree height is 41.7 meters.



Let's do a quick review before moving onto data collection! Question 5

5. Which GLOBE protocols should be conducted prior to measuring tree and shrub height?

- A. Canopy Cover and Ground Cover
- B. Land Cover Sample Site
- C. Both A and B
- D. None of the above

What is your answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data collection! Answer to Question 5

5. Which GLOBE protocols should be conducted prior to measuring tree and shrub height?

- A. Canopy Cover and Ground Cover
- B. Land Cover Sample Site
- C. Both A and B 😊 **correct!**

Were you correct?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data entry! Question 6

6. When do you use a blindfold in this protocol?

A. When you use the clinometer

B. When you are doing the Canopy cover and groundcover protocol

C. When you are doing random sampling for grass—like vegetation height measurements

D. A and B only

E. None of the above

What is the answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data entry! Answer to Question 6

6. When do you use a blindfold in this protocol?

A. When you use the clinometer

B. When you are doing the Canopy cover and groundcover protocol

C. When you are doing random sampling for grass—like vegetation height measurements 😊 correct!

D. A and B only

E. None of the above

Were you correct?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data entry! Question 7

7. Which trees do you sample?

- A. The tallest tree of the dominant species
- B. The shortest tree of the dominant species that still reaches the canopy
- C. Three trees that have heights in between the tallest and the shortest of the dominant species
- D. A and B
- E. All of the above

What is the answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data entry! Question 7

7. Which trees do you sample?

A. The tallest tree of the dominant species

B. The shortest tree of the dominant species that still reaches the canopy

C. Three trees that have heights in between the tallest and the shortest of the dominant species

D. A and B

E. All of the above 😊 **correct!**

Were you correct?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data entry! Question 8

8. What can you do to be sure that your clinometer readings are as accurate as possible?

- A. Adjust your distance so that the clinometer reads as close to 30 degrees as possible
- B. In distance, stand further away from the tree than the tree is tall
- C. Both A and B
- D. None of the Above

What is the answer?

A. What is Canopy Cover and Ground Cover?

B. Why collect Canopy Cover and Ground Cover data?

C. How your measurements can help.

D. How to collect your data.

E. Entering data on GLOBE Website.

F. Understand the data.

G. Quiz yourself.

H. Additional information



Let's do a quick review before moving onto data entry! Question 8

8. What can you do to be sure that your clinometer readings are as accurate as possible?

A. Adjust your distance so that the clinometer reads as close to 30 degrees as possible

B. In distance, stand further away from the tree than the tree is tall

C. Both A and B 😊 correct!

D. None of the Above

Were you correct?

Now let's look at data entry!



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Report your Data to GLOBE


Live [Data Entry](#): Upload your data to the official GLOBE science database

Email Data Entry: Send data in the body of your email (not as an attachment) to DATA@GLOBE.GOV

Mobile Data App: Download the GLOBE Science Data Entry app to your mobile device and select the right option.

For Android via [Google Play](#)

For iOS via the [App Store](#)



The GLOBE Program Science Data Entry

The GLOBE mobile app allows GLOBE users to perform data entry on a large number of GLOBE science protocols. To use this app, you will need a GLOBE account.

I have a GLOBE account:

[Sign In](#)

[JOIN GLOBE](#) | [CONTACT GLOBE](#)



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Entering your data via Live Data Entry or Data Entry Mobile App

Identify your
Sampling site

Under Land Cover, select
"New observation"

Welcome to the GLOBE data entry site.

My Bookmarks

You have not bookmarked any investigations yet. Expand the organizations and click the stars next to the investigations to create a bookmark.

My Organizations and Sites

- [University of Nebraska-Lincoln GLOBE v-School](#) [Add site](#)
- [Lefthand Creek](#)
Latitude 40, Longitude -105, Elevation 1600m
[Edit site](#) | [Delete site](#)

Land Cover

Biometry ★

[New observation](#) [Past observations](#)



A. What Is Graminoid, Tree and Shrub Height?

B. Why Collect Graminoid, Tree and Shrub Height Data?

C. How Your Measurements Can Help

D. How to Collect Your Data

E. Entering Data on GLOBE Website

F. Understand the Data

G. Quiz Yourself

H. Additional Information

On the Biometry Page, Input the date to access the form

When you input the date, you will see the rest of the form

When inputting cover values, be sure that each reporting category you identified totals 100%

Submit data

You have finished your submission. You can see land cover data submitted by others using the GLOBE Visualization Tool.



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Visualize and Retrieve Data: Select Land Cover

Your Canopy Cover and Ground Cover measurements will allow you to determine the Land Cover Classification of your study site. GLOBE provides the ability to view and interact with data measured across the world. Select our [visualization tool](#) to map, graph, filter and export Land Cover Classification data that have been measured across GLOBE protocols since 1995. These screenshots show the steps.



Link to step-by-step tutorials on Using the Visualization System will assist you in finding and analyzing GLOBE data: [PDF version](#) [PowerPoint version](#)



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Visualize and Retrieve Data: Select Range of Dates

Select the date for which you need Land Cover Classification data, add layer and you can see where data is available.



Locations
where Land
Cover
Classification
data is
available for
the week you
selected

Link to step-by-step tutorials on Using the Visualization System will assist you in finding and analyzing GLOBE data: [PDF version](#) [PowerPoint version](#)



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

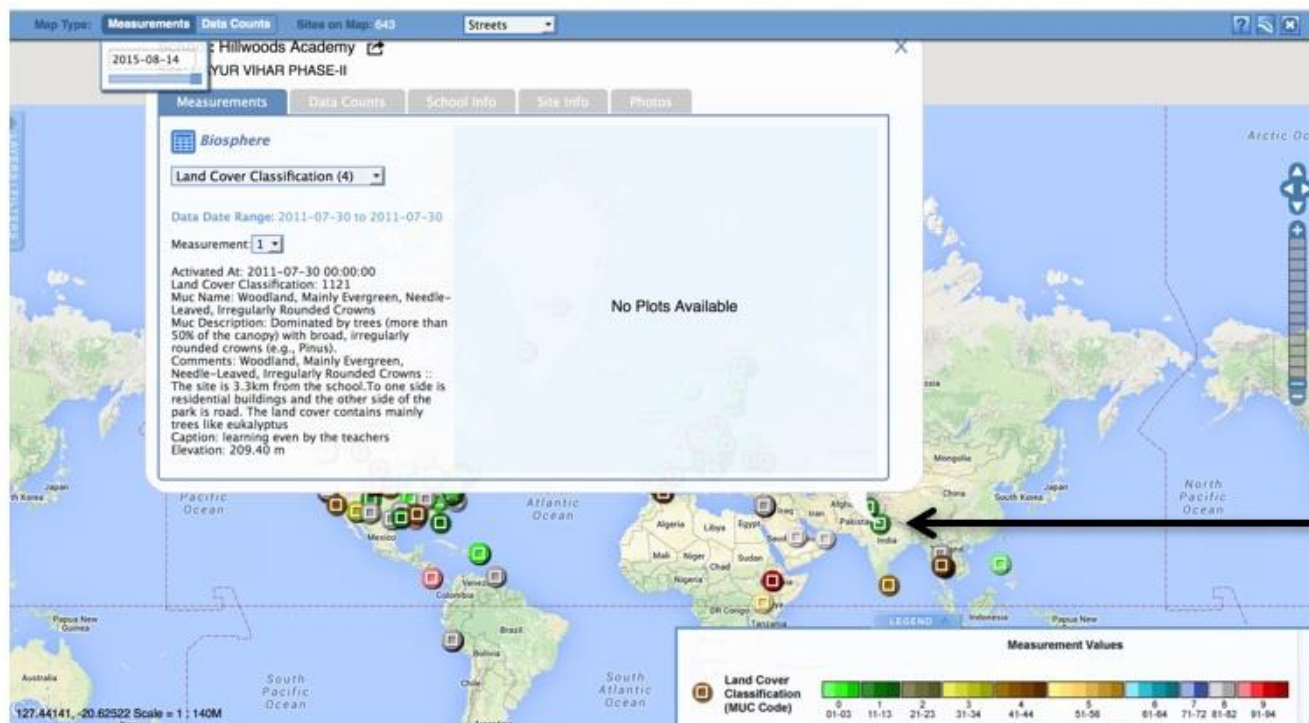
F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Visualize and Retrieve Data: Accessing Data

Select the date for which you need Land Cover Classification data, add layer and you can see where data is available.



Link to step-by-step tutorials on Using the Visualization System will assist you in finding and analyzing GLOBE data: [PDF version](#) [PowerPoint version](#)



Review questions to help you prepare for the Graminoid, Tree and Shrub Height Quiz:

1. Graminoid, Tree and Shrub Height are part of what set of GLOBE Biosphere Protocols?? (slide 3)
2. What is a graminoid plant? (slide 3)
3. What land cover classification scheme does GLOBE use, in order to ensure comparisons between sample sites around the globe? (slide 8)
4. What specialized instrument will you use to determine tree and tall shrub height? (slide 7)
5. What is the difference between the terms *accuracy* and *precision*? (slide 9)
6. What geometric shape will you be identifying to help you calculate tree height using a clinometer? (slide 30-31)
7. How many trees do you need to measure for your sample in the Tree and Shrub Height part of the Biometry Protocol? (slide 33)
8. In determining which of the 5 different tree height measurement techniques to use, what is the most important environmental characteristic to consider? (slide 30)
9. What is the system used by GLOBE to see the geographic distribution of data? (slide 50-52)
10. Do you use the Stand by Tree method when the area between the observer and tree is flat, or on a slope? (slides 30-31)

A. What Is Graminoid, Tree and Shrub Height?

B. Why Collect Graminoid, Tree and Shrub Height Data?

C. How Your Measurements Can Help

D. How to Collect Your Data

E. Entering Data on GLOBE Website

F. Understand the Data

G. Quiz Yourself

H. Additional Information



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Frequently Asked Questions-FAQ's

What if my students are too young to understand the math used to determine tree height?

Use the Simplified Technique for Measuring Tree Height on Level Ground

What if I want to measure the heights of trees on a slope?

There are additional guides for these situations that provide different methods to measure the heights of trees on slopes. The one you choose depends on the topography of your site.

What if the tree is leaning?

If the tree is leaning, just measure to the top of the tree as usual. Measure the baseline distance to a point directly below the highest point of the canopy, which may not be where the trunk of the tree meets the ground

What if the canopy cover is thick and I cannot clearly see the top of individual trees?

A very thick canopy often occurs in areas where many of the trees are very close in height. You may have to move around your area to find a good sight-line to the tops of your trees.



Frequently Asked Questions-2

How accurate is measuring tree heights?

Like any other measurement, accuracy and precision increase with practice and the use of care in the measurement. Three groups measuring the same tree should get results within +/- 1 meter of each other.

What do I do if I do not have a single co-dominant tree or shrub species?

If the co-dominant species is mixed at your site, measure the heights and circumferences for 5 trees or shrubs of different species. Note the species you are using in the Metadata.

What do I do if there are not 5 trees or shrubs of the dominant species at my site? Should I measure any heights and circumferences?

If there are less than five, measure all the trees or shrubs at your site and make a note in the metadata.



A. What
Is Graminoid,
Tree and Shrub
Height?

B. Why Collect
Graminoid,
Tree and Shrub
Height Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
Website

F. Understand
the Data

G. Quiz
Yourself

H. Additional
Information

Please provide us with feedback about this module. This is a community project and we welcome your comments, suggestions and edits! Comment here: [eTraining Feedback](#)
Questions after reviewing this module? Contact GLOBE eTraining: rlow@ucar.edu

Credits

Slides:

Russanne Low, Ph.D., University of Nebraska-Lincoln

Rebecca Boger, Ph.D., Brooklyn College

Cover Art:

Jenn Glaser, ScribeArts

More Information:

[The GLOBE Program](#)

[NASA Wavelength](#) NASA's Digital Library of Earth and Space Education Resources

[NASA Global Climate Change: Vital Signs of the Planet](#)

Version 12/1/16. If you edit and modify this slide set for use for educational purposes, please note "modified by (and your name and date)" on this page. Thank you.

The GLOBE Program is sponsored by these organizations:

