Standard Operating Procedure (SOP) #11

Using a Clinometer to Measure Height and Slope

Version 1.0 (July 17, 2019)

Change History

New Version #	Revision Date	Author	Changes Made	Reason for Change	Previous Version #

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, changes made, and reason for the change along with the new version number.

Purpose

This SOP outlines the procedure to measure height and slope with a clinometer. For the most part this procedure will follow the concepts and steps described in the Suunto Clinometer Instructions. This SOP is not intended as an endorsement of the products mentioned, but simply as description of the procedure to collect height and slope data.

Procedures

Most brands of clinometer will work sufficiently well for this protocol. We will present instructions for the Suunto clinometer as an example of the procedure. To measure tree height with a Suunto clinometer, follow these general steps taken verbatim from the instruction manual:

1. Measure the horizontal distance from the base of the tree (or the position directly beneath the required point) to a position where the required point on the tree (e.g., tree tip) can be seen.

2. Sight at the required point on the tree:

    - Using one eye: Close one eye and simultaneously look through the Suunto at the scale and 'beside' the Suunto at the tree. Judge where the horizontal line on the Suunto scale would cross the tree.

    - Both eyes: With one eye looking at the Suunto scale and the other looking at the tree, allow the images to appear to be superimposed on each other. Note: If you suffer from astigmatism, use the one eye approach.

1. Read from the percent scale and multiple this percentage by the horizontal distance measured in step 1.

2. Site to the base of the tree and repeat steps 2-3.

3. Combine the heights from steps 3 and 4 to determine total tree height:

    - Add the 2 heights together if you looked up to the required point in step 2 and down to the base of the tree in step 4.

    - Subtract the height to the base of the tree from the height to the required point if you are on sloping ground and had to look up to both the required point and the base of the tree.

4. Check all readings and calculations.

Tree Height Example

The example below, which is a condensed and paraphrased version of the Suunto Clinometer instructions, provides a more concrete example of how to measure tree height, as defined as the distance from the ground to the upper most point of the tree.

Measure a horizontal distance of 20 meters from the tree to a position where both the top and bottom of the tree are visible. You may need to alter this distance as needed to find a suitable location for taking measurements. Be sure your final position allows you to see both the very top and bottom of the tree (i.e., walk around the tree first before choosing a final position).

Once in a suitable position, hold the clinometer as shown in the right side of Figure SOP 11.1 below.

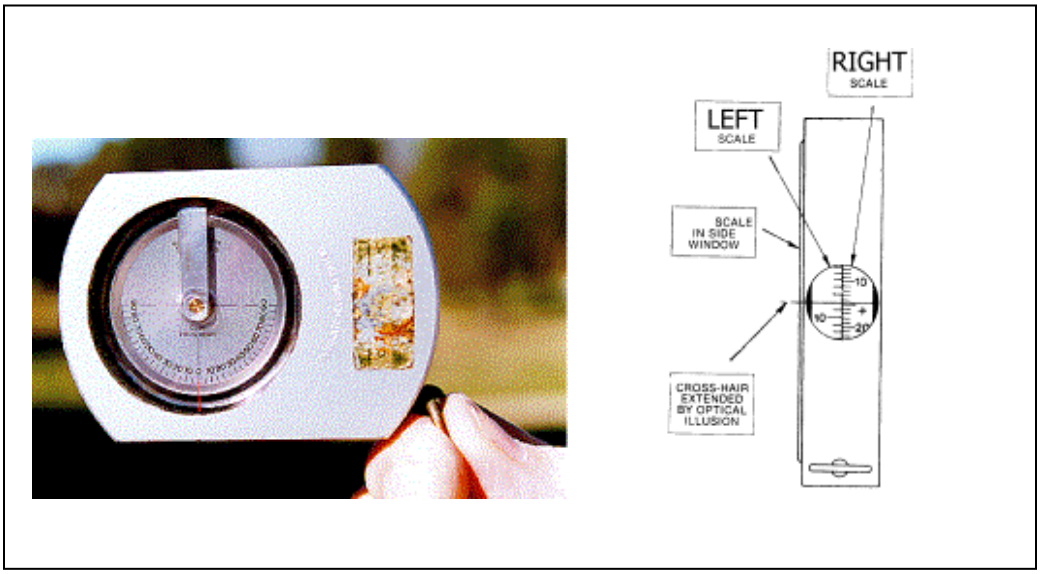

Figure SOP 11.1. Suunto clinometer and scale.

Use the Percent scale, which as you look through the side "peep" hole, will probably be on the left side (it should be labeled on the exposed side). When you look through the "peep" hole, keep BOTH eyes open at all times. This will produce an optical effect that transposes the cross hair onto the tree in question. If you tilt the clinometer up and down as you look through the "peep" hole you will notice the scales have both positive (+) and negative (-) numbers. Always note whether the number is positive or negative.

With both eyes open tilt the clinometer until you superimpose the cross hair on the very top of the tree. Then read the proper scale and sign. This will be your upper reading. Then tilt the clinometer down until you get the number that coincides with where the tree meets the ground. Assuming a distance of 20 meters, use the equation below to get the tree height:

Total height (meters) = (Top measurement – bottom measurement) * 0.20

For example, suppose the top measurement (to the highest point on the tree) is +100 and the bottom measurement (to the base of the tree) is -10 (see Figure SOP 11.2). To compute tree height, substitute the percent values into the equation as follows:

Total height (m) = (100 – (-10)) * 0.20 = 110 * 0.20 = 22 meters

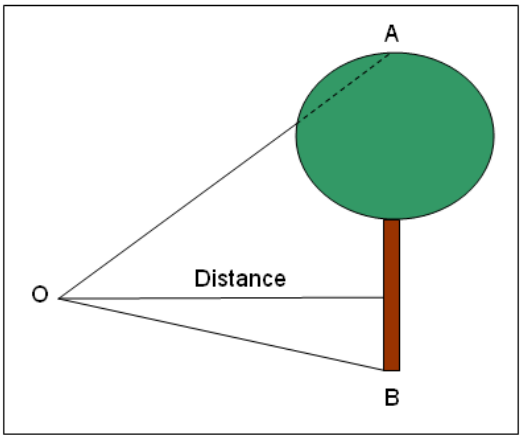

Figure SOP 11.2. Schematic diagram of the measurements from a field crew member ("O") to the highest ("A") and lowest ("B") points on a tree. According to the Suunto manual, the most common mistake in measuring height is not using the true tree top. If side branches are mistaken for the top, an overestimate of height will occur. Note how the above angle measurement to the top of the tree ("A") sights through the crown of the tree.

If you use a different distance than 20 m then the total height equation changes accordingly. For example, if you use a horizontal distance of 50 m then the total height equation becomes:

Total height (m) = (Top measurement – bottom measurement) * 0.50

The general form for the total height equation is:

Total height (m) = (Top measurement – bottom measurement) * (Distance /100)

Measuring Slope

Plot slope and centerline slope are general characteristics noted on the "Plot Location" data form in Appendix E. To measure slope accurately, look through the clinometer and locate an upslope object or person that is the same height as your eye level. Read and record the angle using the technique described above. This angle is the slope of the surface.

Literature Cited

Suunto. 2001. Suunto Clinometer Instructions. Vantaa, Finland.