Using a Topcon Laser Level to Survey Elevation

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Introduction:

The purpose of this write-up is to give a brief guide to using a laser level to survey topography in a salt marsh.

In August 2008, I measured the elevation of vegetation observation points in 3 San Francisco Bay salt marshes using these methods. This was done as part of a project to examine how the growth of an invasive plant, *Limonium ramosissimum*, varies with inundation in marshes.

The Topcon laser level provides a fast, easy way to determine the relative elevation of survey points. The laser level is well suited for relatively flat areas, like marshes, with only subtle changes in topography. The Topcon measures points up to 250 meters from the laser level and surveys can be done with one person.

What you will need:

- Laser Level (in case), with charged or fresh C-cell batteries.
- Sensor (in case)
- Sliding Bracket for attaching sensor (in case)
- Flat-topped tripod, with 5/8” threaded mount
- Direct-reading Stadia Rod – the really tall one rectangular one with a black rail.

Setting Up the Laser Level and a Control Point:

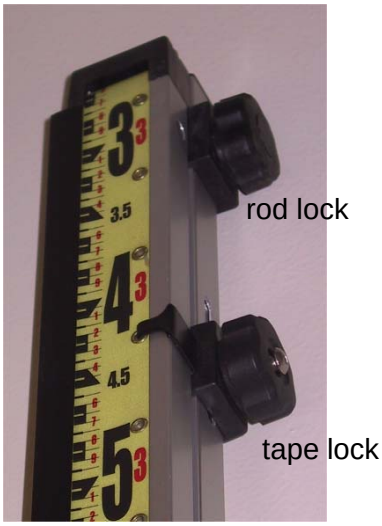
First, chose a location to set up the tripod where the ground is solid and the laser will reach as many planned survey points as possible. Set up the tripod so it’s roughly level and press its feet into the ground. Attach the laser level via the screw mechanism on the tripod. Turn on the laser level and wait for the laser emitter to self-level and start spinning.

Next, choose a location to set up a semi-permanent observation point (ie. a stake) to serve as a control point for your survey. If you do not know its elevation, assign this point an arbitrary elevation (ie. 10.00 m) and all points you survey will be measured relative to that control point. Often you’ll need to move the tripod and laser level to access your entire survey area or measure the vertical distance to a benchmark with a known elevation. When you do, you’ll set the stadia rod to the control point again so whatever you measure next will be relative to what you’ve already surveyed.

Setting up the Stadia Rod:

First attach the laser sensor to the rail bracket and slide it down the rail on the stadia rod. There are two brackets in the case; the other one has a bubble level and can also be attached to the rod to level it. The ***sensor lock***, a black knob at its base of the rail bracket, secures it at one position on the rail.

The stadia rod for the laser level is a direct-reading type, meaning that higher elevations get higher readings. If you look at the markings, you can see why: the numbers increase from top to bottom – this will make sense as soon as you make readings – rods on a higher surface are read closer to the bottom, while rods on a lower surface read closer to the top. The rod has two large black knobs at the top: the upper ***rod lock*** locks the moveable part of the rod, and the lower ***tape lock*** locks the tape to one of the grommets – note that it can be adjusted up and down to pick a suitable grommet.



Now set up the rod on the control point, loosen the sensor lock, and move the laser sensor vertically along the stadia rod until it emits a constant tone, and lock the sensor in place. Then move the continuous tape up or down until the reading corresponds in some way to your known elevation the rod is standing on. For example, if the elevation is 124.2 m, you could set the tape to read 4.2 (little red 4, big black 2) at the sensor mark. *Alternatively, move the sensor to the desired tape reading, lock it down, then move the upper rod up or down until the constant tone is attained.* Maintain that reading by tightening the tape lock to one of the grommets on the tape (you'll need to tilt the rod down to do this unless you're very tall.) Check the reading to make sure you haven't moved the tape.

Conducting the Survey:

You can now make direct elevation readings on other "side-shot" points. With the rod on a point, you can either (a) loosen the sensor and move it up or down to get a reading, or (b) if you need to go higher than you can reach you can lock the sensor, loosen the rod lock and move the rod up and down – you'll see that with the tape locked, this lets you move the sensor high above your head while maintaining the correct reading on the tape. In either case, you move the sensor until it has a continuous tone. Read the tape and record the elevation.

If you need to move the level, you'll need to repeat your setup relative to a new control point elevation. Before you move it, you should do a foresight to a stable turning point, so you can use it as your new benchmark. It helps to draw a picture of what you're doing so it makes sense and you have a record.

Note that there is no 0.0 meter on the rod – it has a 5 m range, with 5.0 corresponding to 0.0. If you're reading something higher than 5, you'll need to add 5 to the reading: 129.2 will also be read as 4.2. Take careful notes to make sure you're getting what you need.

Converting Your Survey from Relative to Absolute Elevation Using a Benchmark:

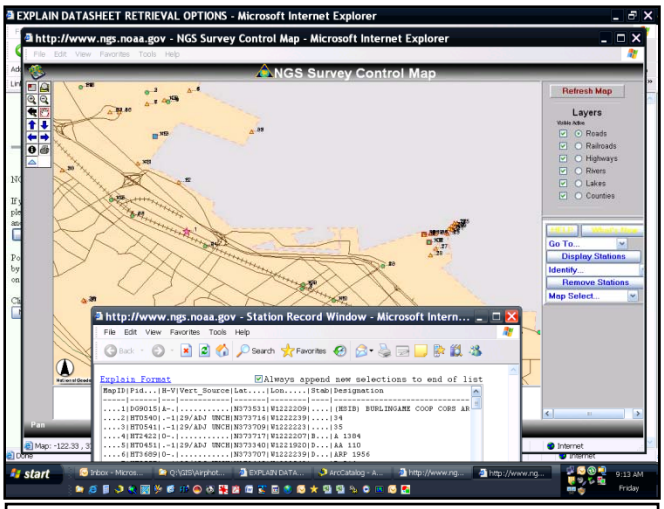
To convert your survey to absolute elevation, measure the difference between your control point and a benchmark with a known elevation. The National Geodetic Survey has created many benchmarks.

To find a Benchmark Near Your Survey:

• Go to: http://www.ngs.noaa.gov/cgi-bin/datasheet.prl

• Click on **map search** link.

• Click **Test Pop-up Windows** to make sure you can download what can download data, then go to **NGS maps.**



Above: ngs.noaa.gov provides an interactive map to find benchmarks.

• Use the interactive map to **zoom** to where you want to find benchmarks.

• When you've zoomed to your area, click **Display Stations**.

• After retrieval is complete, a **Station Record Window** should open.

• **Highlight** the benchmark you're interested in and click **Get Datasheets**.

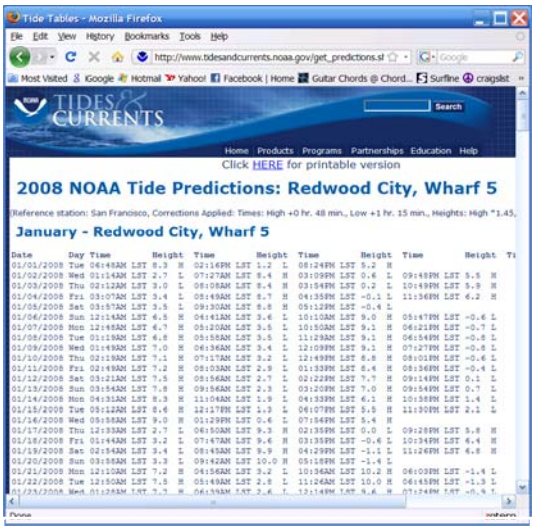
On the datasheet, the line **NAVD88** shows the elevation of your benchmark (in feet and meters). There is also a verbal description of the benchmark's location and the latitude and longitude of the survey point. To pinpoint your benchmark location from the comfort of your computer, go to **GoogleEarth**, zoom to where it is and use the cursor to find the exact latitude and longitude of your benchmark. Place a marker and print the map.

Converting Your Survey from Relative to Absolute Elevation using High Tide:

If you don't have access to a benchmark and you are working near San Francisco Bay, you can convert your survey to absolute elevation by measuring the difference between your control point and the bay water at high tide.

Tidal elevations can be distorted by wind and distance from a tidal station, so this method is not as accurate as measuring to a benchmark or using a GPS with good vertical accuracy.

But, if a benchmark is too far and a tidal station is close, this is a good option. In my case, there was a 6 inch vertical difference between measurements based on the high tide line vs a USGS benchmark.



Above: tidesandcurrents.noaa.gov provides tidal elevations which can be used as benchmarks.

To Find the Elevation of Bay Water at High Tide:

• Go to: http://www.tidesandcurrents.noaa.gov/tides08/tpred2.html#CA

• Click on **California** and navigate to the region of San Francisco Bay you're interested in, then a tidal station.