WOOF3D

A Simplified Process to 3D Print Topographical Maps

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How to 3D Print Topographical Data

Want to make a 3D printed model of your hometown, an island, a mountain, or another recognizable place? You're in luck! This guide will show you how to start with online topographic data and create a 3D printed model of the region of your choice. The best part is that the process is entirely free as long as you have a computer and access to a 3D printer!

We chose Mount Rainier as our example because Mount Rainier is in our backyard and is visible from our University of Washington campus.

Step 1: Download software

Before you can 3D print from topographical maps, you will need to do the following:

A) Download a file unzipping program that can turn a .tar file into a .tif file.
   a. Go to www.izarc.org
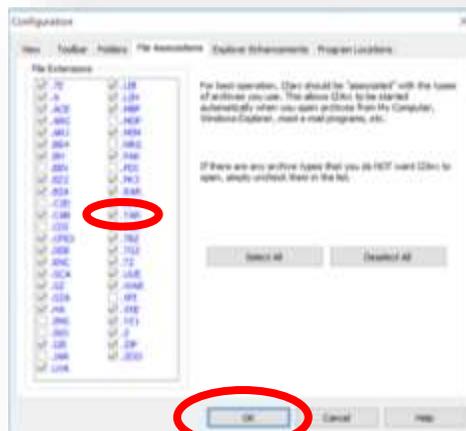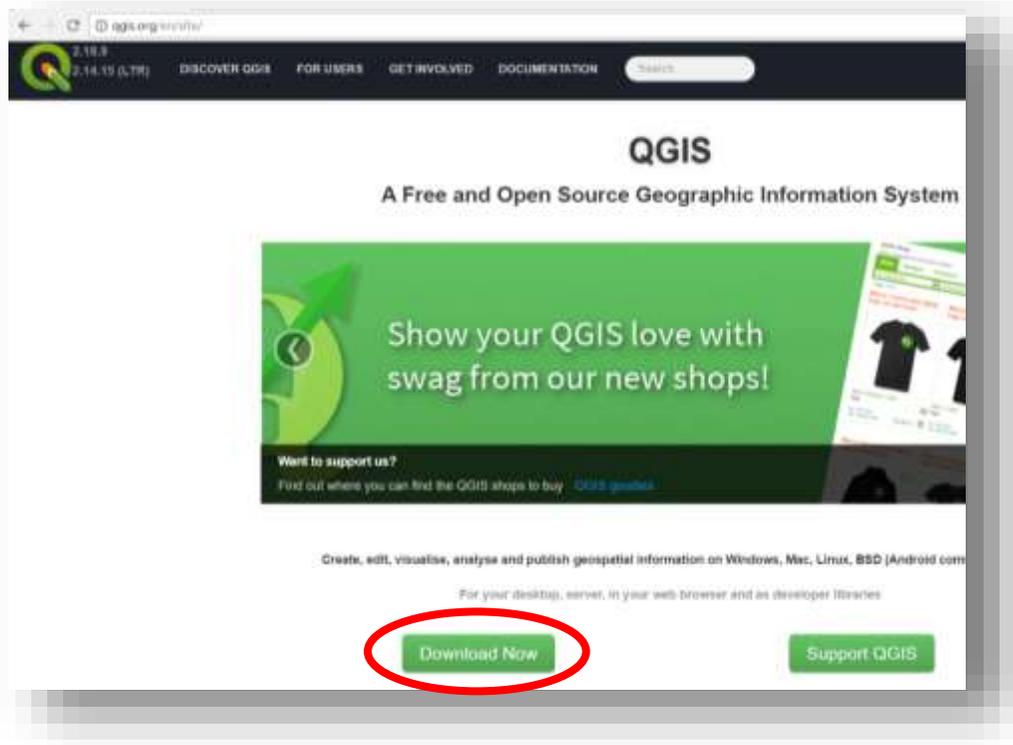   b. Click "Download IZarc 4.3." Be sure to click the correct download box, not any of the ads.
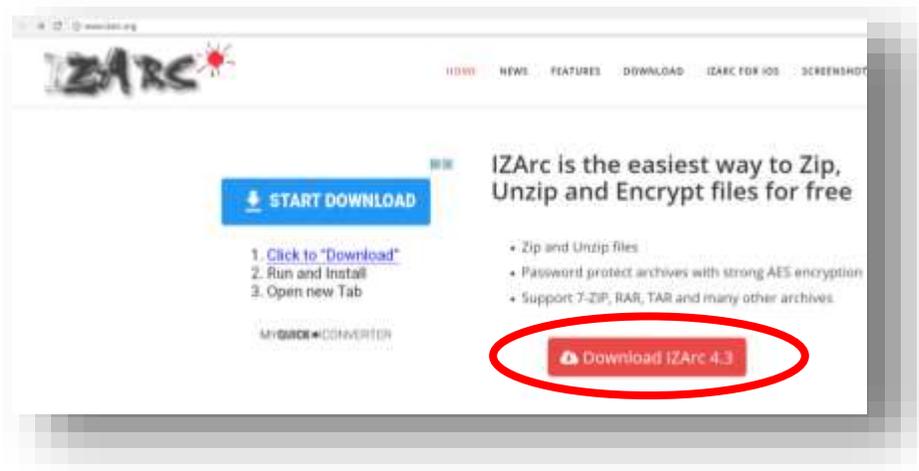
   c. Click "Download" to download the latest version of IZarc.

d. Open your download file and follow the given instructions. When you get to the "Configuration" page, make sure ".TAR" is selected then click "OK."


B) Next download QGIS. You'll use this later to convert a .tif file into a .stl file which can be 3D printed.
   a. Go to qgis.org/en/site/
   b. Click "Download Now"

    c. Find the proper version for your computer's operating system and select that version under "Latest release (e.g. for New Users):"

    d. Open your download and follow the given instructions to complete the download process.

C) Install DEMto3D plugin for QGIS.

    a. Open the QGIS program you just installed.

    b. Click on "Plugins" then select "Manage and Install Plugins…"
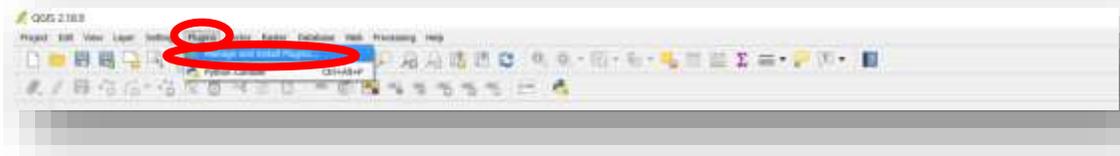
    c. In the box that pops up, scroll down and select "DEMto3D," and click "Install plugin."
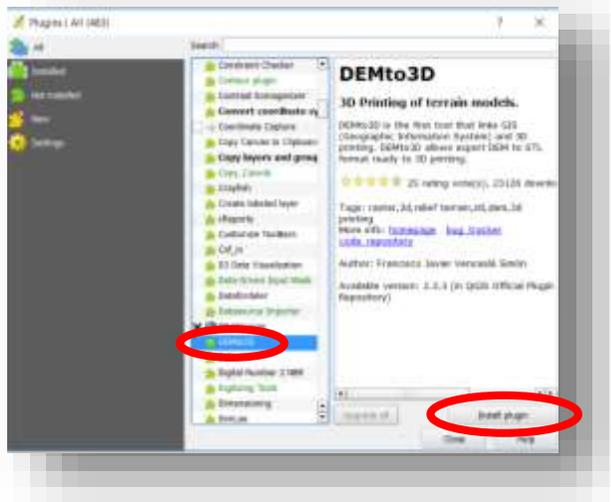
    d.   Once the plugin is installed, exit out of this "Plugins" box. You will not need it any more.

  D) You now have all the necessary software. Proceed to Step 2.

## Step 2: Generate file to print

Once you have downloaded all the software in Step 1, you will never need to do it again; you can return here each time you are making a model. To generate a file to print you will need to find the topographical data online and convert it into a printable format. Here's how:

  A) Choose an area to print.
      a.   Go to www.opentopography.org
      b.   Find DATA at the top of the page, hover over it, and select RASTER.
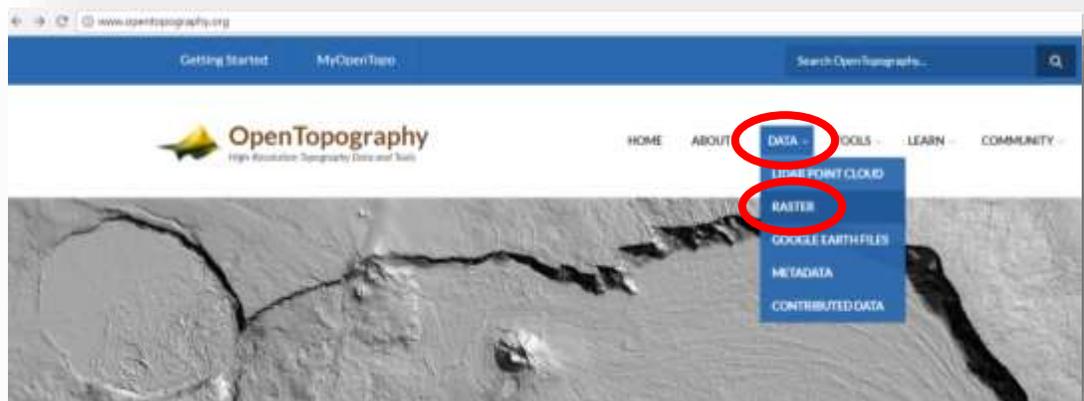

      c.   Here you will see a database of free topography data organized into "High Resolution Raster" and "Global Data." Data from either category will work. The "High Resolution

Raster" will produce more detailed models, however it only has data for certain regions. To start, its easiest to click global data and find your region there.
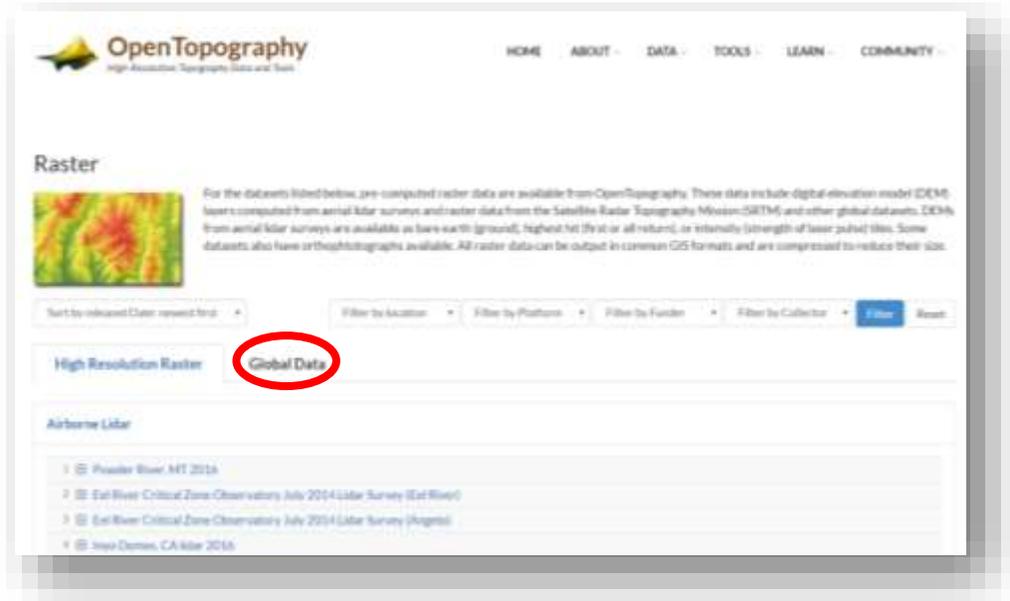

d. There are four "Satellite Data" options on this page. For now, click the third one, "Shuttle Radar Topography Mission (SRTM GL1) Global 30M." Each of these should work, but this is a good place to start. If the region you want to print is not here, try one of the others. Note that 1, 2, and 3 are each accurate to 30 meters while the fourth option is only accurate to 90 meters.
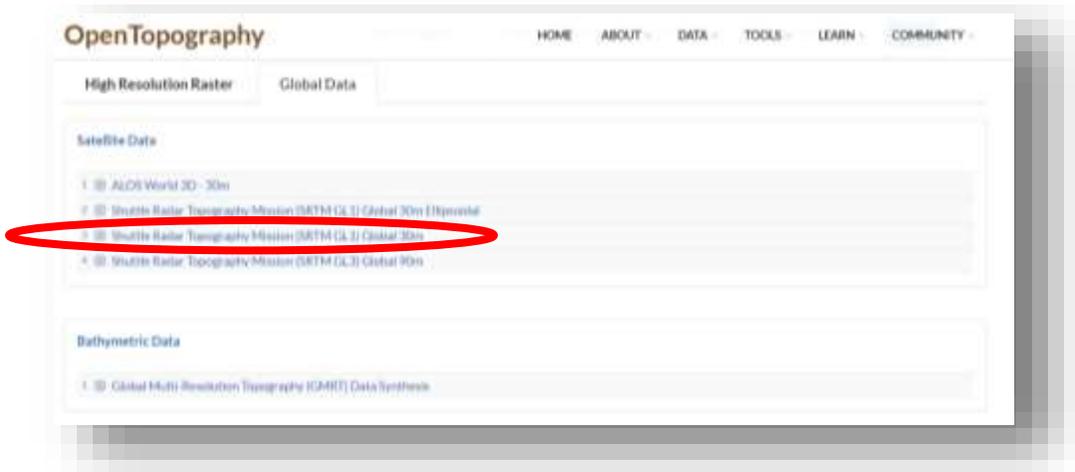
e. Scroll down to the map. Once you are there you can scroll in and out to zoom in and out, and drag the map around with your cursor. Find a region you want to print then click the "SELECT A REGION" box on the left side of the map. You can now use the cursor to select an area.
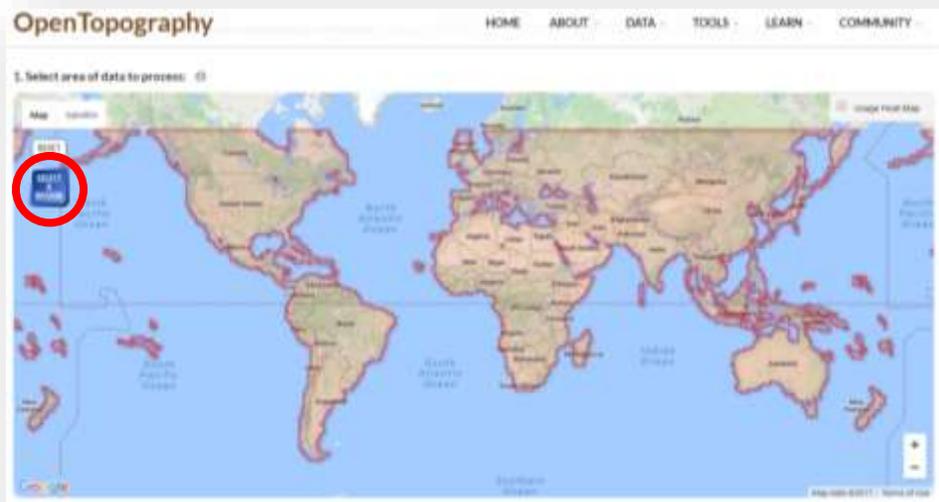
f. Once you have your region selected, scroll down to the bottom of the page and fill out the "Job Description. You are required to enter an email, even though you will never need to do anything with the mail they send you. Click "SUBMIT" when you are done.

B) Convert file with IZarc software.
   a. Once the "Raster Job Report" is completed, click on "rasters_srtm.tag.gz" under "Download Job Results."

   b. Once your file is done downloading, immediately move it somewhere you will not lose it. One way to do this is click the arrow pointing up then select "show in folder" and move it to your desktop or a folder where you can find it again.
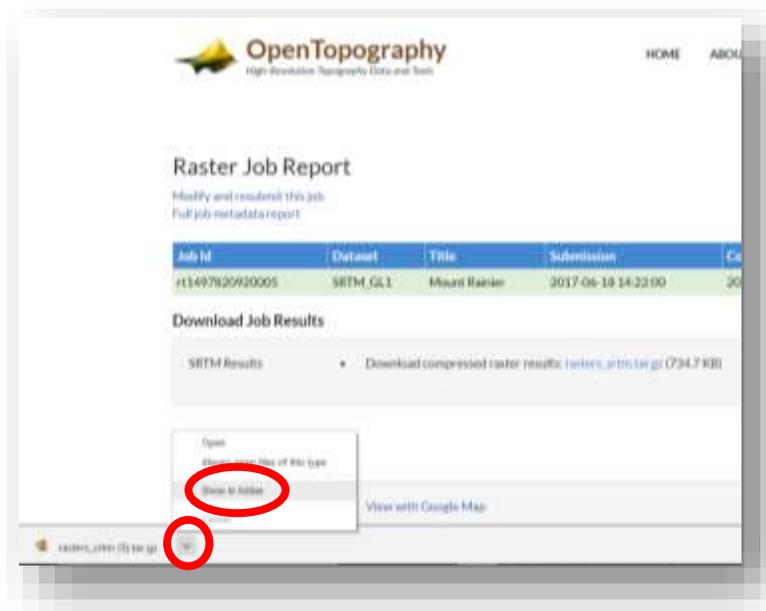
c. Next, go to the location you saved the file and open with IZarc. It should open in IZarc when you double-click on it to open it normally. Otherwise, right click, select "Open with…" and select IZarc.

d. You now need to extract the file. Click "Extract" at the top menu in the IZarc window.
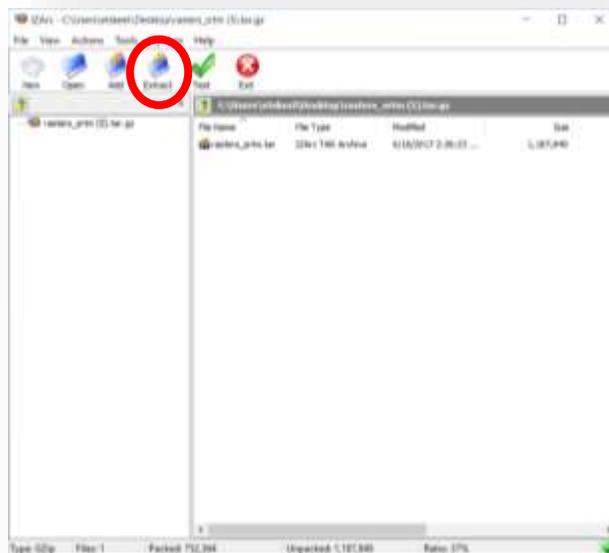
e. Make note of where the file is being extracted to. The default is to make a folder in the same location as the original file. Click extract at the bottom of the window that appeared in the previous step.

C) Convert file to .stl with QGIS software.
   a. Open the QGIS program you installed in Step 1.
   b. You will need to "Enable 'on-the-fly' CRS transformation (OTF)" for the 'project' so your .tif file from OpenTopo.org is not distorted. Go to the "Project tab" (upper left corner of screen) and then select 'Project Properties'.
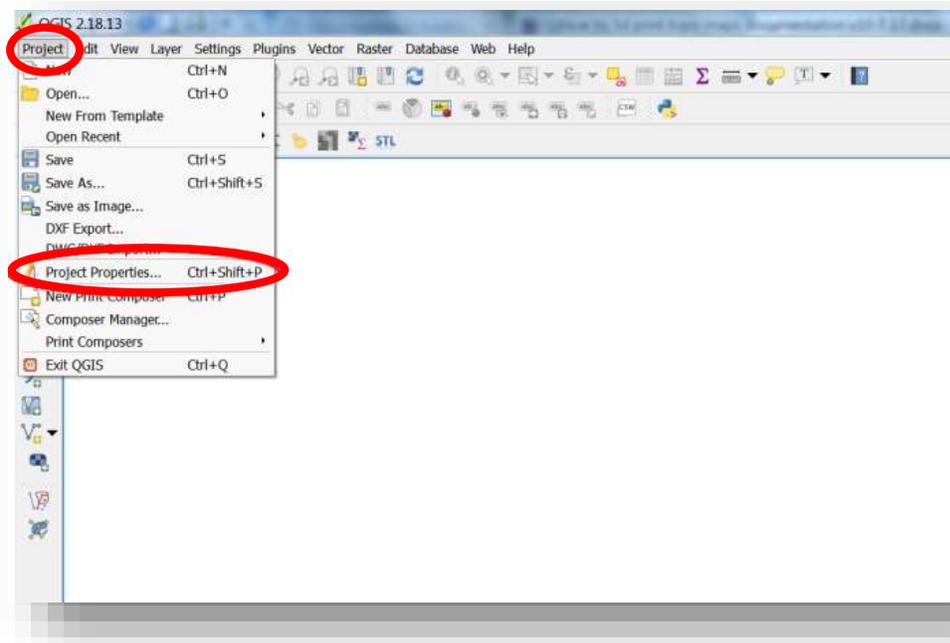
   c. When the 'Project Properties I CRS ' box opens, check the box "Enable 'on-the-fly' CRS transformation (OTF)".
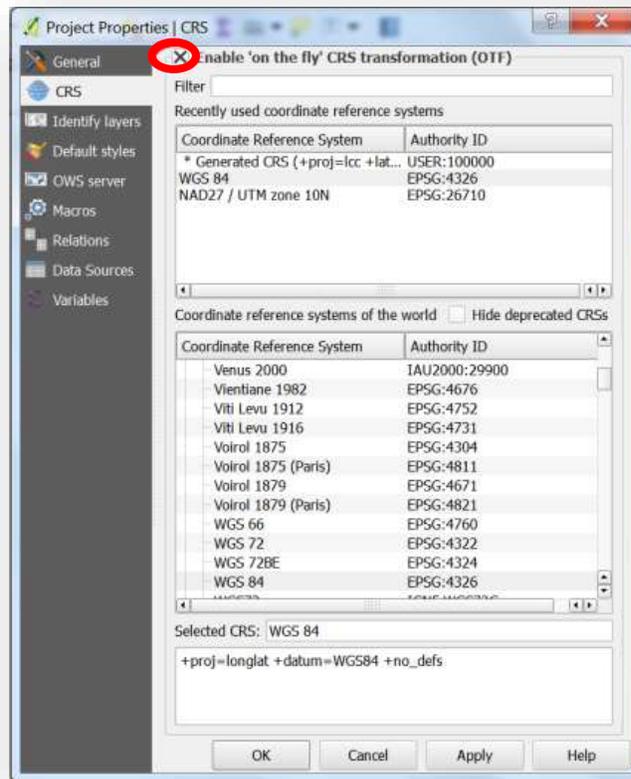
d. Staying in this same Box you will need to set the project's Coordinate Reference System (CRS) and the Universal Transverse Mercator Zone which locates your file within the CRS. In the "Filter" box, type "WGS 84 UTM". This filters out the other CRS's in QGIS. In the "Coordinate Reference System" box below, select "WGS / UTM zone 10N EPSG:32610," then click "OK." EPSG:32610 (OTF) should appear in the lower right corner of the QGIS program. UTM Zone 10N represents an area between Longitude 126^0W and 120^0W, north of the Equator, or approximately the western half of Washington and Oregon.
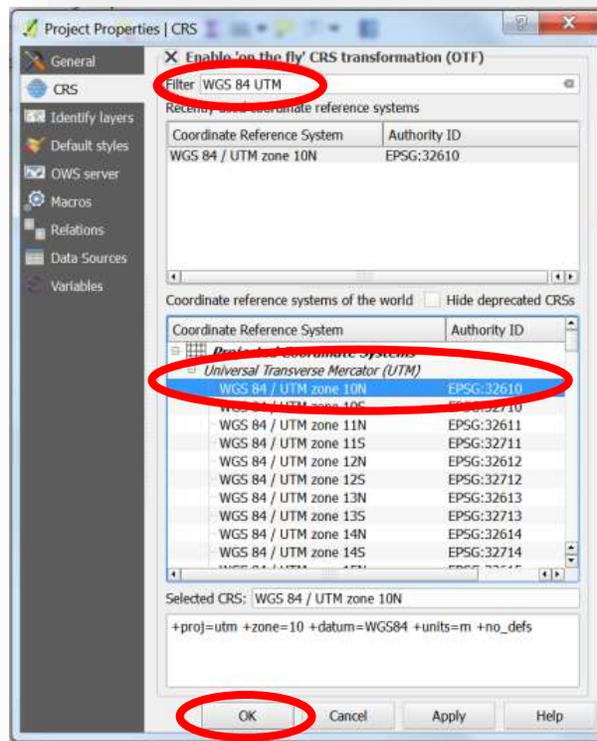
Because OpenTopo.org uses the WGS 84 Coordinate Reference System, WGS 84 will always be selected. Depending on where your topographical map is in the world will dictate which UTM zone you pick. The earth is divided into 60 longitudinal UTM zones every 6 degrees starting at Longitude 180 (International Date Line) heading east. Zones ending in the letter "N" are for maps north of the equator and "S" for south of the equator.

The Following link will help you understand why this is important and how to select the proper UTM Zone:
http://docs.qgis.org/2.2/en/docs/gentle_gis_introduction/coordinate_reference_systems.html

As it relates to selecting a WGS 84 UTM zone in QGIS: Mount Whitney, CA is UTM zone 11N; The Grand Canyon, AZ is UTM zone 12N; Miami, Florida is UTM zone 17N; Sydney, Australia is UTM zone 56S; New Delhi, India is UTM zone 43N; Cape Town, South Africa is 34S, etc.

You must complete the steps above before loading the output_srtm.tif file (or whatever file name you changed output_srtm.tif file to) is loaded or the file will be distorted.

e. Next, open the folder containing your extracted file(s) from the previous step. There should be a file named "output_srtm" (or whatever file name you changed output_srtm.tif file to). Drag this into the QGIS program.

f. In QGIS, click "Raster" then "DEMto3D" and then "DEM 3D printing."
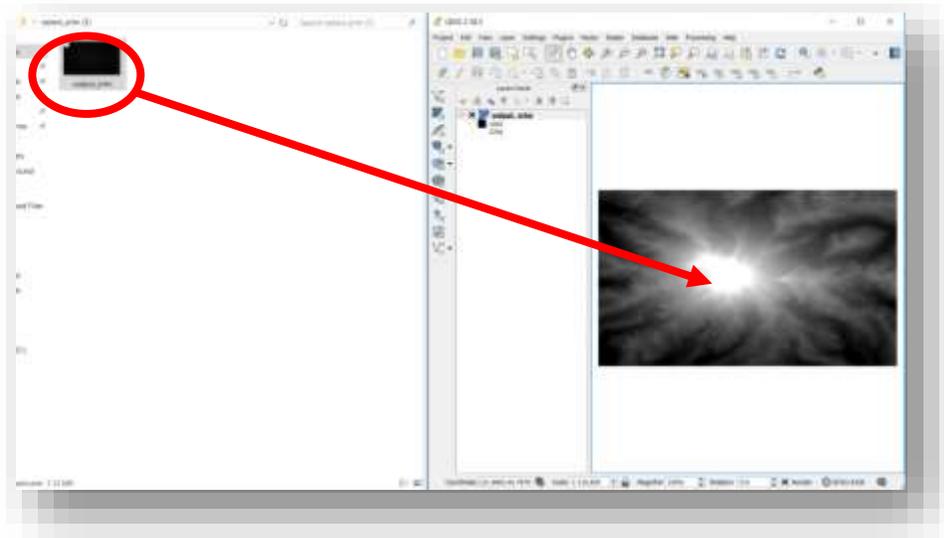
g. In the box that pops up, set the print extent by clicking the icon that looks like a plus sign with 4 arrows.

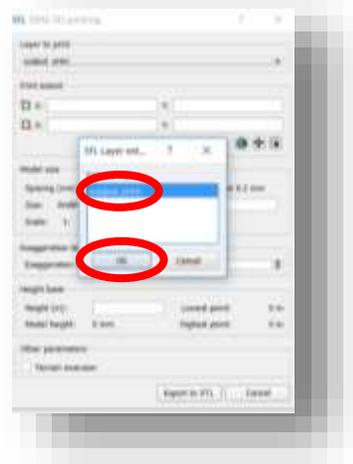h. Another box will pop up. Click "output_srtm" (or whatever file name you changed output_srtm.tif file to) then click "OK". This sets your "print extent" to include the entire region. You can adjust the region you selected manually by entering the min/max latitude and longitude. This can be useful if you are printing a series of maps to piece together for a larger area.

i. In order to set the "Model size," first fill in the "Spacing (mm)" with the "Minimum recommended." Then decide on a width, length, or scale. You only need to type one of these and the others will be generated automatically.
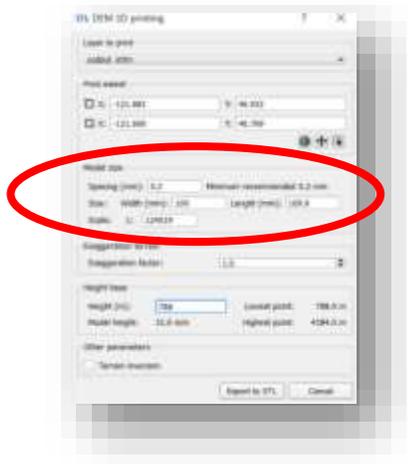
j. Leave exaggeration factor at 1.0 for a 1 to 1 vertical scale. Past experience has shown that people think a 1.5 exaggeration factors "looks" visually accurate. Experiment to see what your preference will be if you want to exaggerate your print for effect.

k. Next choose a height. If you want your model to show the elevation from sea level, type zero '0' here, but if you do not want it to have unnesesarily tall base, it's a good idea to look at what the lowest point is and set that as your height or slightly lower to provide the depth of base you desire. When you have done this, click "export to STL." If you are printing a series of pieces to make up a larger area area you will want the base of each piece to be at the same elevation.

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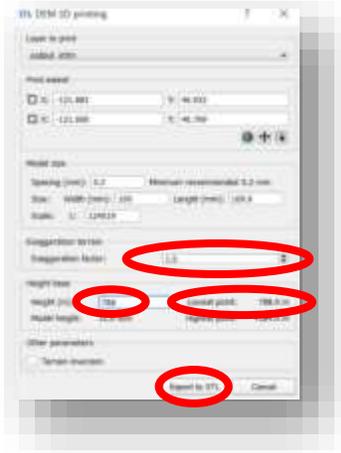
l. Save your newly created ".stl" file. It's a good idea to name it something that makes sense (if you have not already done so) because this is the file you will be using to print your model.
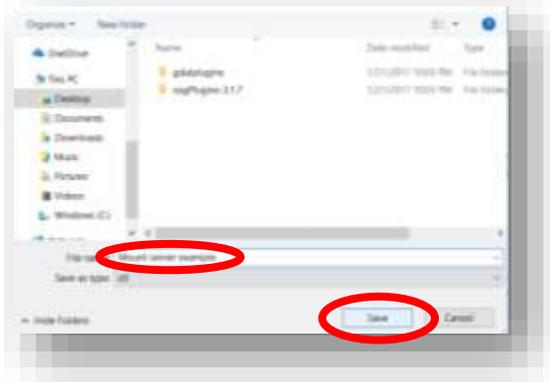
D) You now have a file ready to print!

Step 3: Print the model

Your .stl file is now ready to print based on the printing settings for your particular 3D printer and printable material you will be using.

Additional notes:

As with any process of this nature there are always more things to consider. Here are some things to think about:

- In Step 2: C) f. I say to leave the exaggeration factor at 1. However, since we usually view terrain from low angles, like when you look at a mountain from the surface of the earth, viewing a section of terrain from above could be disappointing. To make the terrain appear to be more appropriately scaled, try changing the exaggeration factor to 1.5 or 2. Experiment to find your desired view.
- If you find that you are unable to drag your file in Step: 2 C) a. you should try clicking the new project icon in the top left corner.
- Some regions may not appear how you would expect. For example, if you are used to seeing a mountain when it is covered in snow you may find that a model you generate is not nicely rounded over as you would expect because the OpenTopography source does not account for snowpack.
- You may be able to use data from places other than the one suggested here. If it can be converted to a file type that the QGIS program accepts, it should work.
- We encourage you to try new ideas with this process. We hope that this serves as a guideline for how to get started!

Background

Steve Weidner, affiliate instructor - Mechanical Engineering, University of Washington and industry advisor to WOOF3D, the 3D printing club at the University of Washington, has a family farm in eastern Washington that has been in his family since 1902. He wanted to 3D print a topographical map of the family farm.

Convinced one can learn anything on YouTube, he started a search to see what he could find. He found number of videos and used an excellent video by Shapespeare (AKA Whitney Potter https://www.copperimpressions.com/) to 3D print his first topographical map. Shapespeare's process used a website to capture the topographical data and four different software packages to create the printable STL files. We would not be at this point without the work of Shapespeare so we would like to acknowledge his contribution to our work.

Next, Steve Weidner explained what he found to the student members of WOOF3D to see if any of their members shared his interest in 3D printing topographical maps. He challenged the students to see if they could improve upon the current best practices available. The members of WOOF 3D improved the current best practices by streamlining and simplifying the process.

Seven students volunteered to form a student team led by Steve Weidner. The team met weekly to explore the possibilities of 3D printing topographical maps. The team consisted of: Arman Naderi, Pathirat Kosakanchit, Wesley Gaskill, Benjamin Eastin, Connor Vidmar, Erik Skeel, and Mercer Peterson.

The team's research found a number of websites to obtain topographical data and selected the http://opentopography.org/ site as the most comprehensive and user-friendly sight.

Arman Naderi set out to figure out how to print water features in a different color, Pathirat Kosakanchit 3D printed 3-dimensional representations of earthquakes, Wesley Gaskill discovered how to go directly from the opentopo.org website to printable STL files in one software package verse four packages achieving the streamlined process outlined below, Ben Eastin and Connor Vidmar set out to print the STL files, and Erik Skeel with the help of Mercer Peterson did an outstanding job documenting the process.

The latest version of the streamlined process to 3D print topographical maps can be found on Professor Mark Ganter's Open 3DP website. http://depts.washington.edu/open3dp/. Professors Mark Ganter and Duane Storti, who head-up the Solheim Lab, are pioneers in 3D printing and are an invaluable source of knowledge and mentorship for all associated with WOOF3D.