

3D Printing Applications in Surveying and Forestry A Beginners Guide

**Oregon GNSS Users Group—
January 17, 2025**

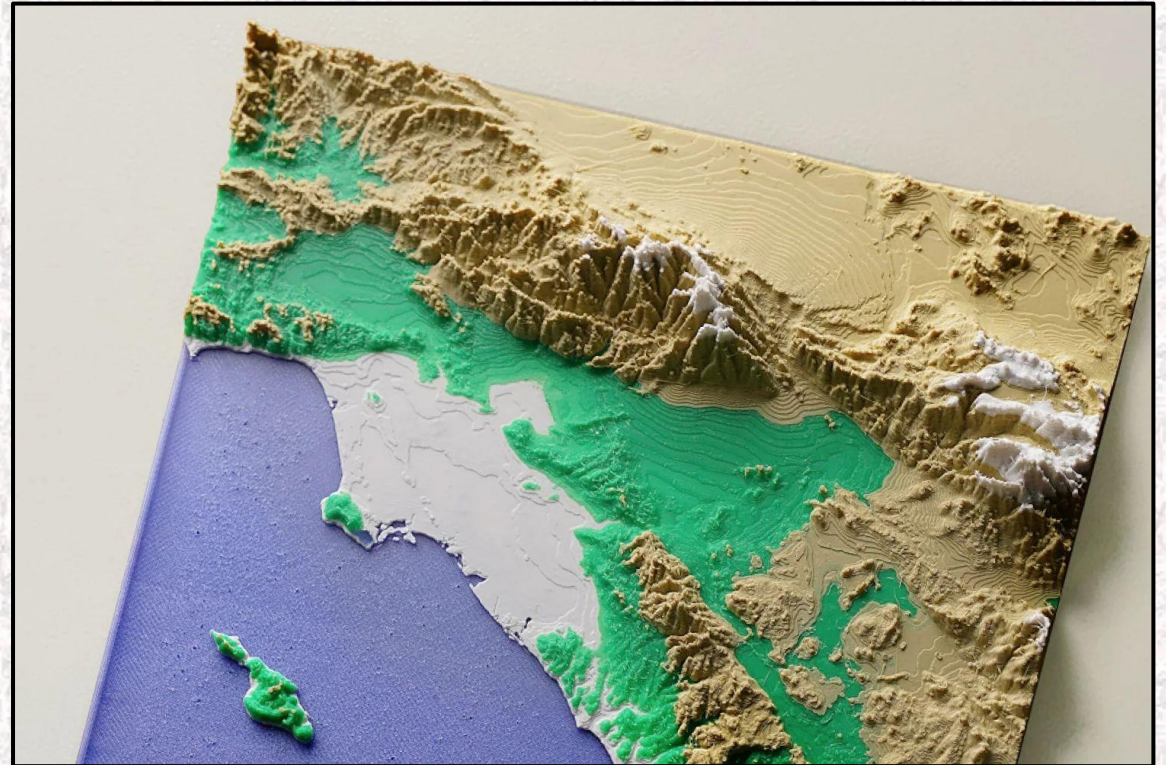
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Review: What is 3D Printing?

- **3D printing is a process of making three-dimensional objects from digital models by depositing layers of material on top of each other.**
 - **Also known as additive manufacturing.**
 - **Most common material is 1.75 mm plastic filament. Also:**
 - **Metal**
 - **Ceramic**
 - **Biological substances**
 - **Concrete**

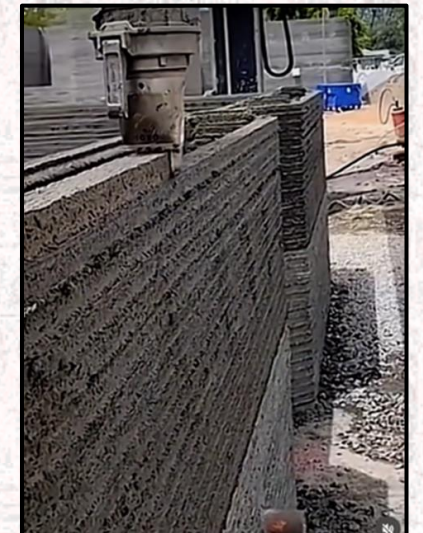
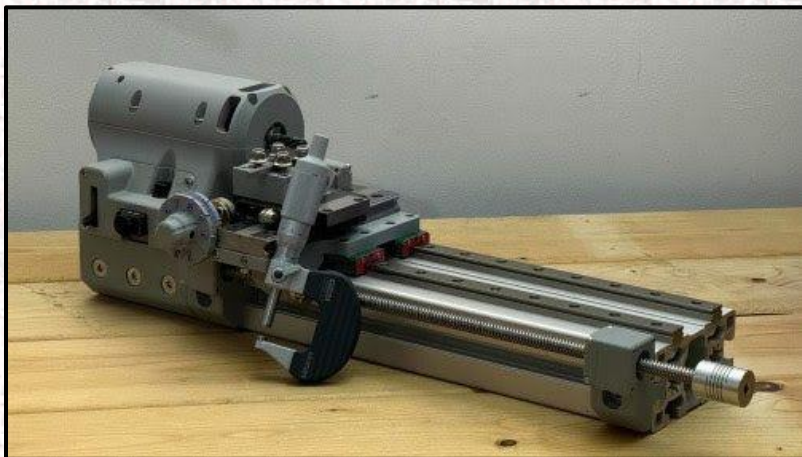


History of 3D Printing

- **Stereolithography (SLA) was invented by Chuck Hull in 1984.**
 - **He founded 3D Systems**
 - **First-ever 3D printer, the SLA-1 (1987)**
- **2009 – Patents expired and 3D printing exploded**
- **Early 3D printers:**
 - **Makerbot**
 - **RepRap**

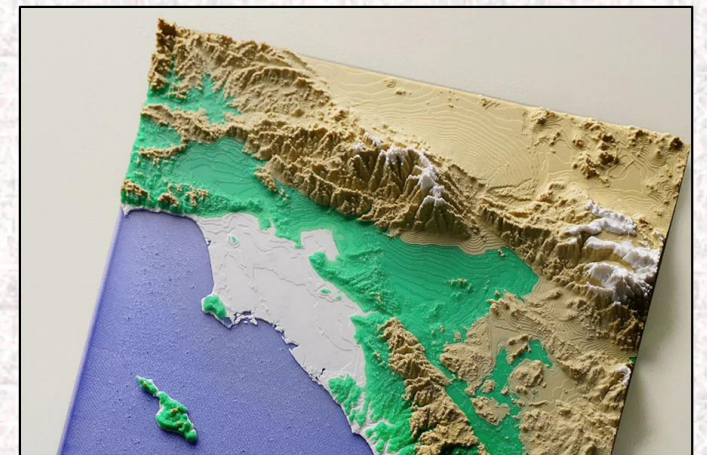
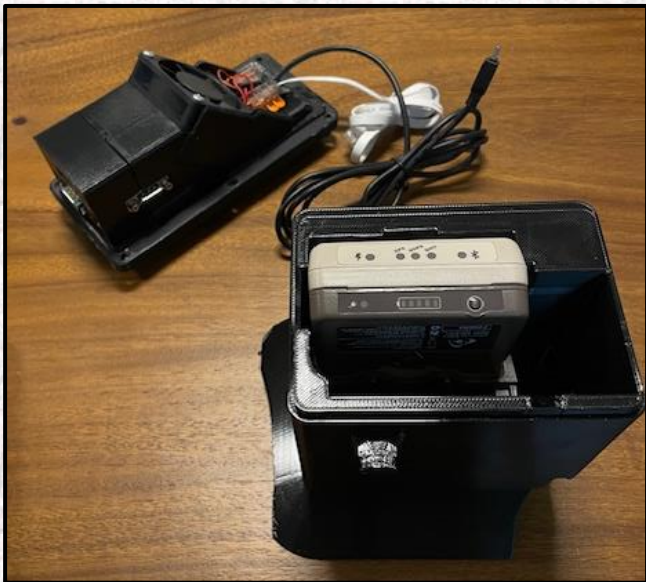
What Can Be 3D Printed?

- Items made from a variety of plastic. PLA, PETG, ABS, Nylon
- Items made from metal welding
- Houses
 - Made from fiber reinforced concrete



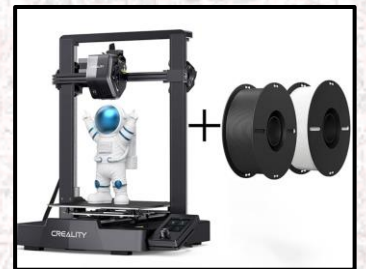
3D Forestry/Surveying Related Print Items

- Data collector brackets & Housings
- Angle Gauges For Timber Cruising
- Topo models
- Replacement parts



How Big Of An Object Can You Print?

- **Bambu Lab X1- Carbon: \$1,099 10" x 10" x 10"**
- **Bambu Labs X1 Mini: \$349 7" x 7" x 7"**
- **Creality Ender 3 V3 SE 3D: \$232 8.66x8.66x9.84"**
- **Prusa MK4S 3D Printer kit: \$729/\$999**
 - **9.84 x 8.3 x 8.6"**
- **Buy a kit and save money?**
 - **Save \$100 to \$200**
 - **Expect to spend 8 plus hours for assembly**



Commercial Printing



Bambu Lab X1- Carbon

Prusa MK4's
Discovery Management



3D Print File Formats

Primary File Format: STL

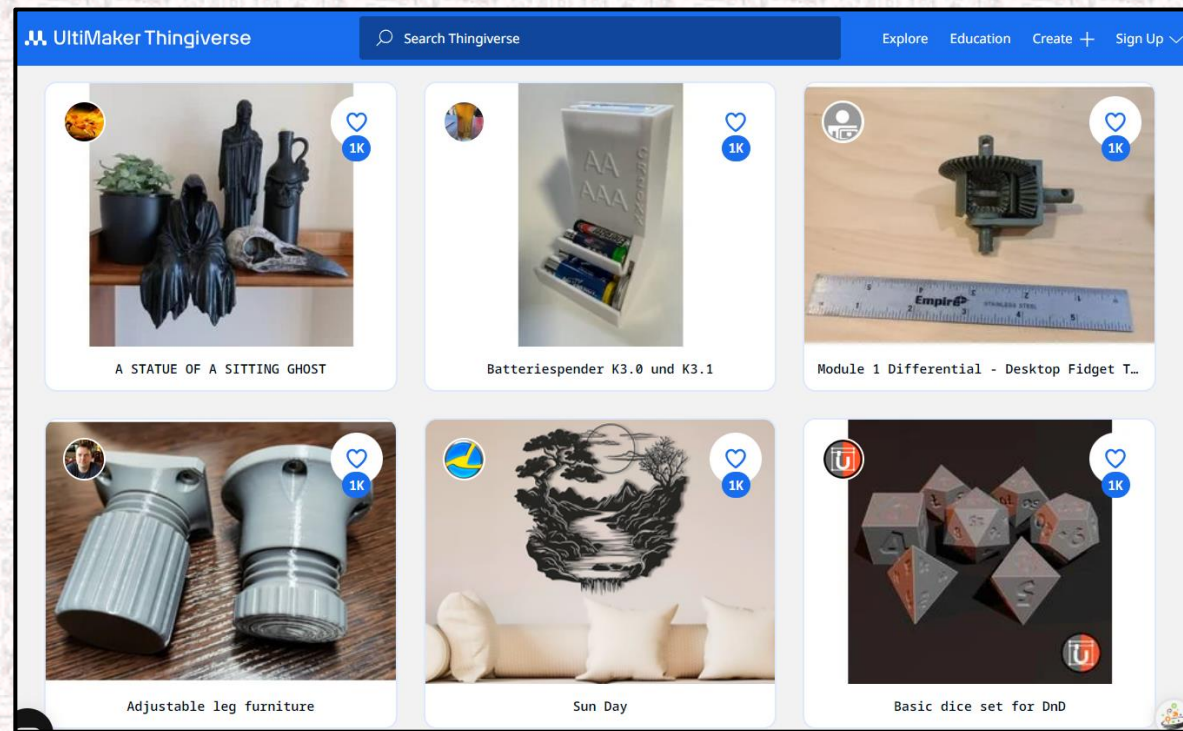
- Standard Tessellation Language or:
- Standard Triangle Language

Other Formats:

- OBJ
- X3G
- PLY
- 3MF
- AMF
- STEP

How Many STL files Are Available To Users?

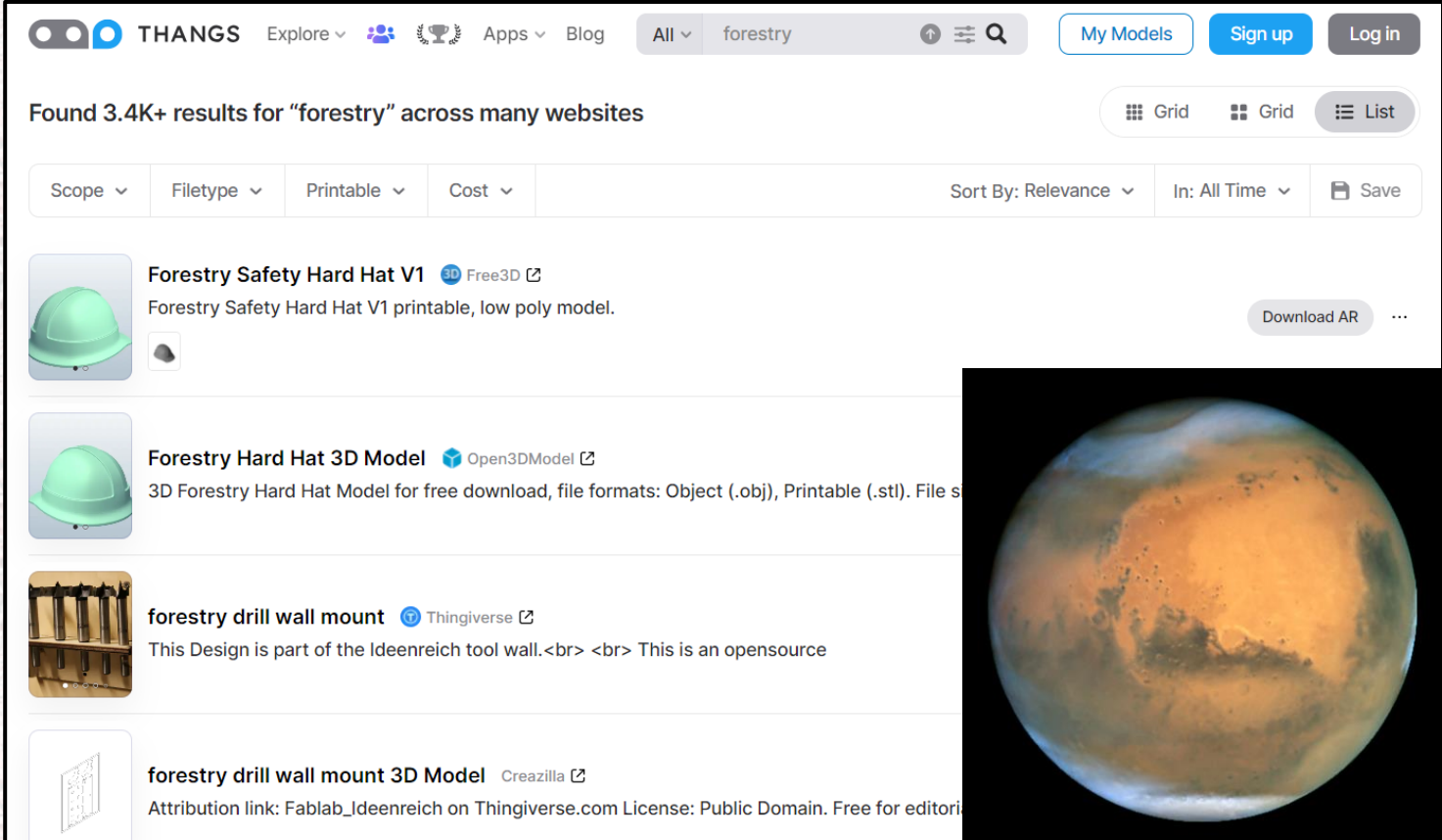
(Free or Nearly Free)



Millions!!!!

3D Search Engines:

- **Thangs.com**
- **Thingiverse.com**
- **Printables.com**
- **Cults**
- **Yeggi**
- **RankRed**
- **NASA**
- **And Dozens more**



The screenshot shows the Thangs.com search results for the query "forestry". The page displays 3.4K+ results across various websites. The search results are filtered by "Scope", "Filetype", "Printable", and "Cost", and are sorted by "Relevance". The results include:

- Forestry Safety Hard Hat V1** (Free3D): Forestry Safety Hard Hat V1 printable, low poly model. Includes a "Download AR" button.
- Forestry Hard Hat 3D Model** (Open3DModel): 3D Forestry Hard Hat Model for free download, file formats: Object (.obj), Printable (.stl). File size: 1.2 MB.
- forestry drill wall mount** (Thingiverse): This Design is part of the Ideenreich tool wall. This is an open source.
- forestry drill wall mount 3D Model** (Creazilla): Attribution link: Fablab_Ideenreich on Thingiverse.com License: Public Domain. Free for editor.

On the right side of the screenshot, there is a large image of the planet Mars.

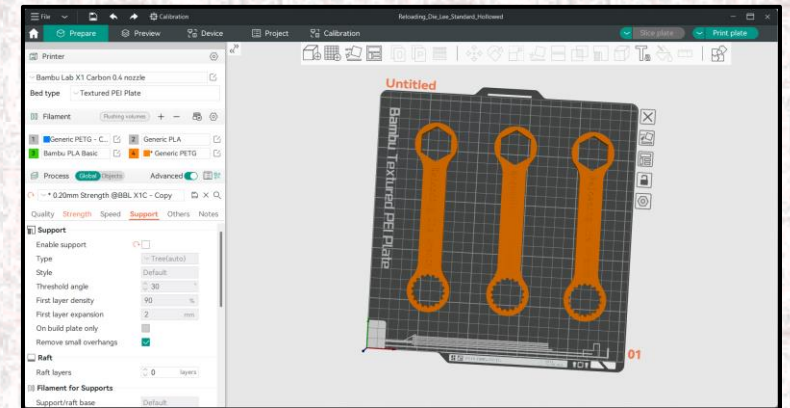
How to Use an STL File

Slicer Software Is Needed

- **Converts 3D models into printer instructions**
- **Tells the printer head where to go and what to do**
- **“slices” digital models into layers to be printed**

Slicer Programs:

- **Many are Free**
- **Often based on open-source software**



Making 3D Terrain Models

- **Terrain2STL**
(<https://jthatch.com/Terrain2STL/>)
- **Touch Terrain**
(<https://touchterrain.geol.iastate.edu/>)
- **QGIS DEMto3D**

Benefits of Making a Topo Model

- **Models help people visualize topo issues better**
- **Giving someone a topo model is impressive.**
- **Topo models can help loggers position equipment when lift issues are present with cable logging.**
- **Making Topo models is very inexpensive and uses very little filament because they are hollow.**

Terrain 2 STL Software

The screenshot displays the Terrain2STL website in a web browser. The browser's address bar shows the URL <https://jthatch.com/Terrain2STL/>. The page title is "Terrain2STL Create STL models of the surface of Earth".

The main content area is split into two sections:

- Map Section:** A topographic map of North America, centered on the Great Lakes region. A red rectangle is overlaid on the map, indicating the selected area for STL generation. The map includes labels for various cities (e.g., Toronto, Montreal, Ottawa, Québec City, New York, Philadelphia) and states/provinces (e.g., Ontario, Quebec, New Brunswick, Nova Scotia, Vermont, New Hampshire, Maine, New York, Massachusetts, Connecticut, Pennsylvania). A "Terrain" legend is visible in the top-left corner of the map area.
- STL Generator Section:** A control panel on the right side of the page. It features the heading "STL Generator" and the subtext "Now with adjustable rectangle shapes!". Below this, there are input fields for "Northwest Corner Coordinates":
 - Latitude:**
 - Longitude:**A "Center to View" button is located below the coordinate inputs. At the bottom of the panel, there are links for "Model Details", "Water and Base Settings", and "Instructions".

At the bottom of the map, there is a footer with the text "Keyboard shortcuts | Map data ©2024 Google, INEGI | Terms".

Getting Started With Terrain 2 STL

The screenshot displays the Terrain2STL website interface. At the top, the browser address bar shows the URL <https://jthatch.com/Terrain2STL/>. Below the browser, the website header reads "Terrain2STL Create STL models of the surface of Earth".

The main content area is split into two sections:

- Left Section:** A 3D terrain map of a region in Idaho, USA, centered on Coeur d'Alene. The map is color-coded by elevation, with green representing lower elevations and brown/orange representing higher elevations. Labeled locations include Garwood, Rathdrum, English Point, Hayden, Hayden Lake, Dalton Gardens, Post Falls, Huetter, Coeur d'Alene, Wolf Lodge, and Eddyville. Major roads like 95, 90, 41, 53, and 97 are visible. A "Terrain" label is in the top-left corner of the map area. Navigation controls (pan, zoom, full screen) are present in the corners of the map.
- Right Section:** An "STL Generator" control panel. It features a sub-header "Now with adjustable rectangle shapes!". Under the "Location" section, there are input fields for "Northwest Corner Coordinates":
 - Latitude:** 44.2
 - Longitude:** -69.09A "Center to View" button is located below these fields. Further down, there are menu items for "Model Details", "Water and Base Settings", and "Instructions".

Select Your Area for Topo

The screenshot shows the Terrain2STL website interface. At the top, the browser address bar displays "https://jthatch.com/Terrain2STL/". The main heading reads "Terrain2STL Create STL models of the surface of Earth". On the left, a map shows a topographic view of a region with a red rectangular selection box. The map includes labels for "Fernan Rod & Gun Club", "West Coast English Springer Spaniels", and "Fernan Lake Village". To the right of the map is the "STL Generator" section, which includes a "Location" field, "Model Details" with sliders for "Box Width" (0.07°), "Box Height" (0.05°), "Box Scaling Factor" (1), "Box Rotation (degrees)" (0), and "Vertical Scaling" (1). Below these are "Water and Base Settings" and "Instructions" sections.

This panel provides detailed configuration options for the terrain model. It includes:

- Terrain Settings:** A dropdown for "Elevation Data source" set to "USGS/3DEP/10m (10m resol...)", a "Transparency" slider, a "Sun direction" dropdown set to "North-West (315 degr.)", and a "Sun angle" dropdown set to "normal (45 degr.)".
- Area Selection Box:** A "Re-center box on map" button.
- 3D Printer Options:** A "CNC?" checkbox.
- Dimensions:** "Width" set to "100 mm" and "Height" set to "90.2 mm".
- Printing:** "Nozzle diameter" set to "0.4 mm" and "Tiles to print (X by Y)" set to "1 by 1".
- Resolution:** "Effective DEM resolution" set to "144.5 m, (source DEM is: 10 m)".
- Other Settings:** "Model Base thickness" set to "1 mm", "Vertical Exaggeration (Z-scale)" set to "x 1.0 (none)", and "File format" set to "STL binary".
- Manual settings:** A field for custom adjustments.

Build The STL File

The screenshot shows a web browser window with the URL `jthatch.com/Terrain2STL/`. The page title is "Terrain2STL Create STL models of the surface of Earth". On the left, a 3D topographic map of a region is displayed with a red rectangular selection box. The map includes labels for "Fernan Rod & Gun Club", "West Coast English Springer Spaniels", "D & B Construction Custom Wood and...", and "Marie Creek Trail". On the right, the "STL Generator" section is visible, featuring a sub-header "Now with adjustable rectangle shapes!". Below this are three sections: "Location", "Model Details", and "Water and Base Settings". The "Water and Base Settings" section contains two sliders: "Water Drop (mm)" set to 0 and "Base Height (mm)" set to 2. A "Generate Model" button is located below the sliders and is circled in red. At the bottom of the page, there is a disclaimer: "Terrain2STL is a free-to-use service, but if you want to help support the site, donations are welcome."

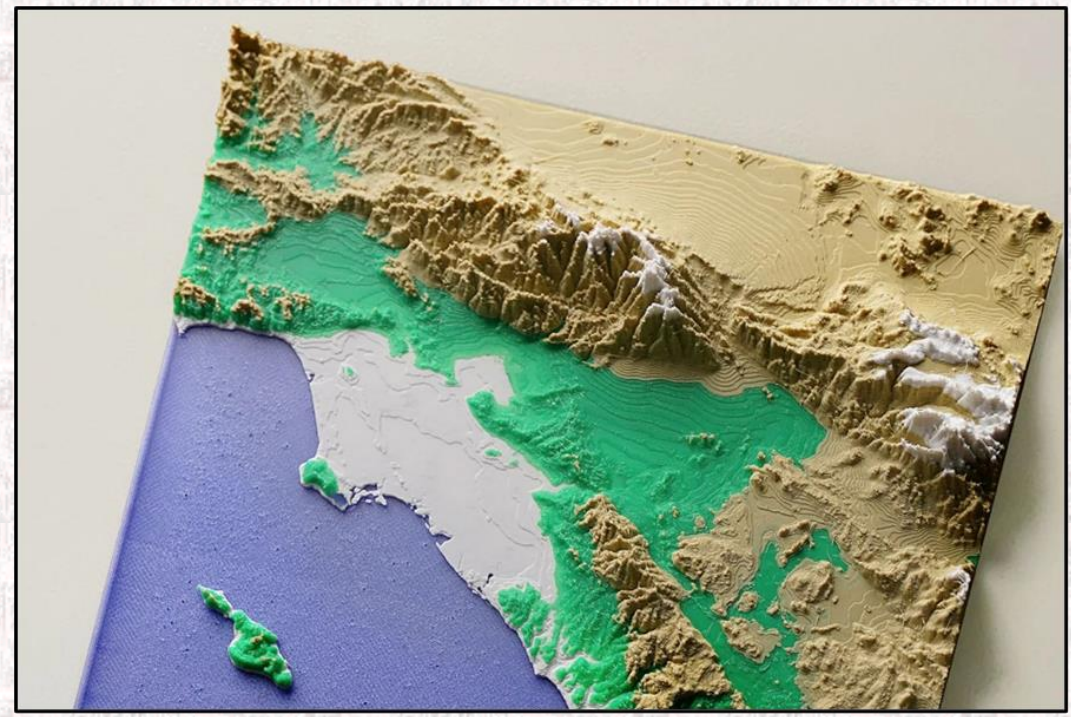
Actual 3D Topo Models



Single Color



Light Color for Contours



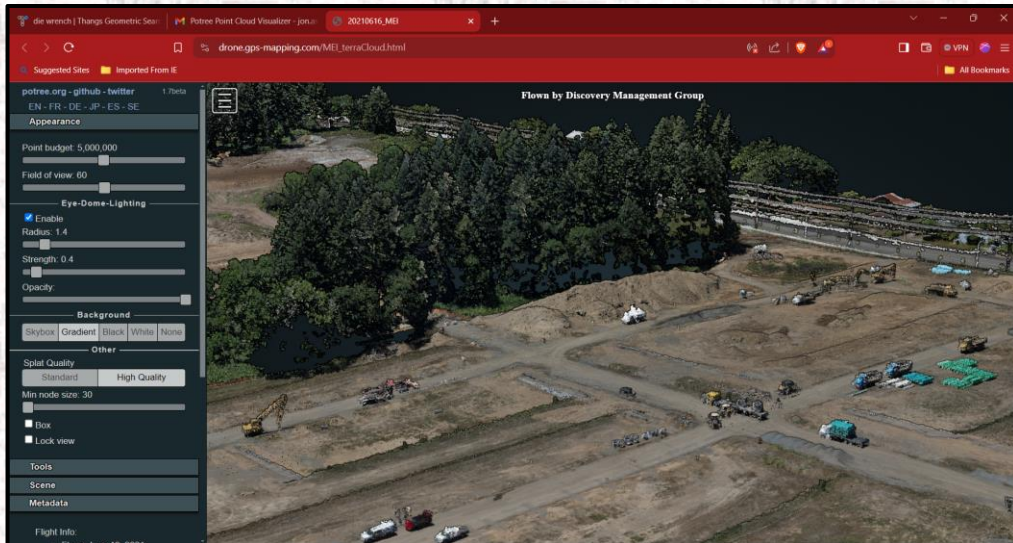
Four Color Model

How to Improve Resolution

- Use a Drone to Collect DEM (6" contours possible)
- Use survey grade GPS unit
- Find available high accuracy DEM files



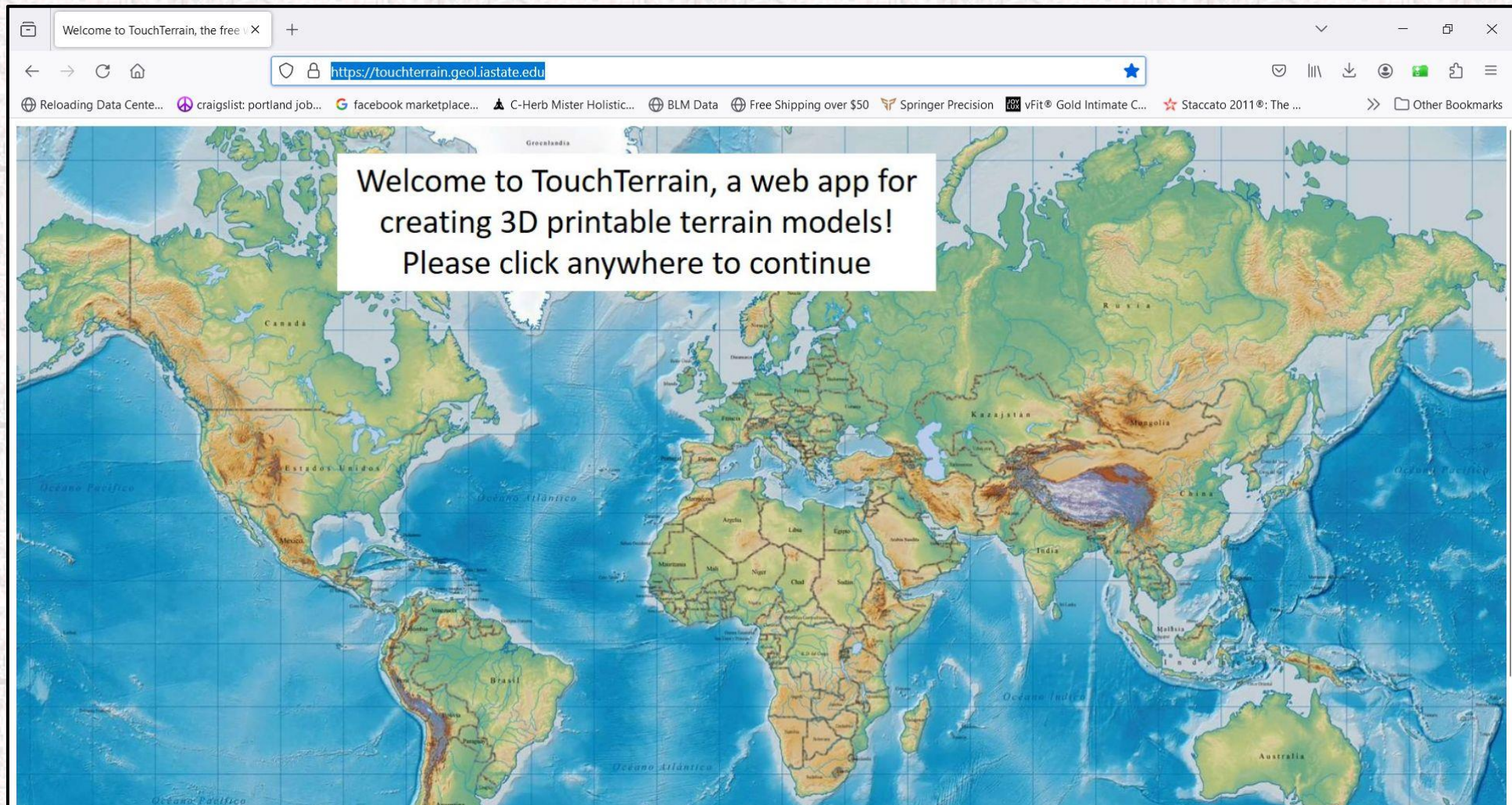
Note: These images are composed of millions of points of X,Y,Z data.
Lidar in drones offers ability to just collect ground level for better contours.



Touch Terrain Software

- **No Cost**
- **Developed by Iowa State University**
- **Terrain models available for entire world**
- **Most of US has 10 Meter DEM Data**

Getting Started with Touch Terrain



Pick Your Area

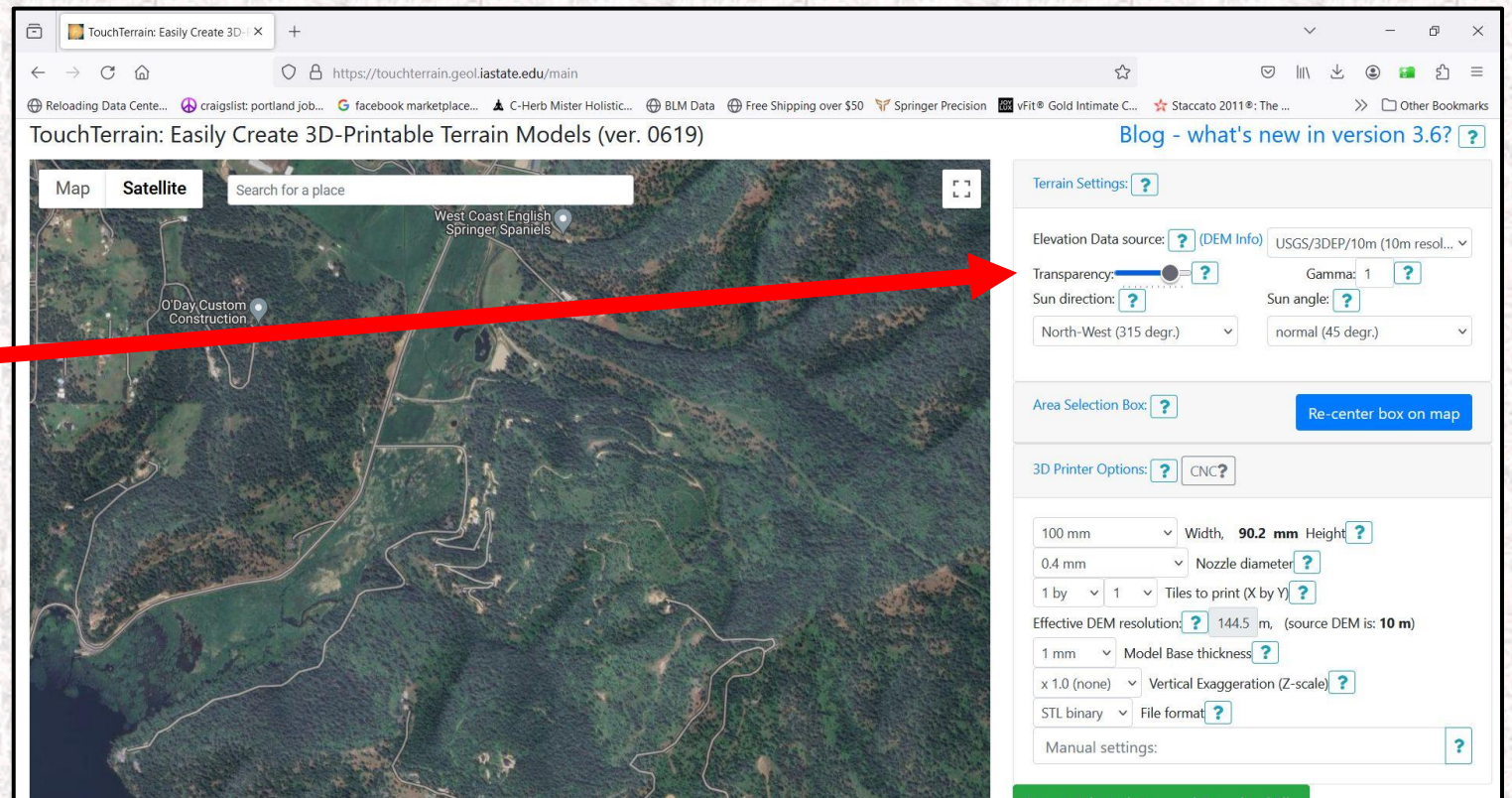
The screenshot displays the TouchTerrain web application interface. The browser address bar shows the URL <https://touchterrain.geol.iastate.edu/main>. The page title is "TouchTerrain: Easily Create 3D-Printable Terrain Models (ver. 0619)".

The main interface is divided into two primary sections:

- Map View:** A 3D terrain map of a region in Idaho, showing topographic features and labels such as Clarksville, Fernan Saddle, Dalton Gardens, Fernan Rod & Gun Club, West Coast English Springer Spaniels, Coeur d'Alene, Fernan Lake Village, Wolf Lodge, Higgens Point, Mineral Ridge Scenic Area, and Mullan Road Historical Park. A search bar at the top of the map area contains the text "Search for a place".
- Configuration Panel:** A sidebar on the right side of the map containing various settings:
 - Terrain Settings:** Includes "Elevation Data source" (USGS/3DEP/10m), "Transparency" (slider), "Sun direction" (North-West), "Gamma" (1), and "Sun angle" (normal).
 - Area Selection Box:** Includes a "Re-center box on map" button.
 - 3D Printer Options:** Includes "Width" (100 mm), "Height" (90.2 mm), "Nozzle diameter" (0.4 mm), "Tiles to print (X by Y)" (1 by 1), "Effective DEM resolution" (144.5 m), "Model Base thickness" (1 mm), "Vertical Exaggeration (Z-scale)" (x 1.0), and "File format" (STL binary).
 - Manual settings:** A section with a question mark icon.

Moving & Zooming in Touch Terrain

- Use Ctrl-Scroll to zoom
- Drag mouse to pan
- Move transparency slider to go between imagery and hillshade



Settings

Terrain Settings: ?

Elevation Data source: ? (DEM Info) USGS/3DEP/10m (10m resol... ▾

Transparency: ?

Sun direction: ?

Gamma: 1 ?

Sun angle: ?

North-West (315 degr.) ▾ normal (45 degr.) ▾

Area Selection Box: ?

Re-center box on map

3D Printer Options: ? CNC?

100 mm ▾ Width, 90.2 mm Height ?

0.4 mm ▾ Nozzle diameter ?

1 by ▾ 1 ▾ Tiles to print (X by Y) ?

Effective DEM resolution: ? 144.5 m, (source DEM is: 10 m) ?

1 mm ▾ Model Base thickness ?

x 1.0 (none) ▾ Vertical Exaggeration (Z-scale) ?

STL binary ▾ File format ?

Manual settings: ?

Elevation Data Source

Source Digital
Elevation Model
10 Meters

Hillshade Imagery

The screenshot displays the TouchTerrain web application interface. The main window shows a 3D terrain model with a hillshade effect, overlaid on a satellite map. The interface includes a search bar, map controls, and a settings panel on the right.

TouchTerrain: Easily Create 3D-Printable Terrain Models (ver. 0619)

Terrain Settings:

- Elevation Data source: [?](#) (DEM Info) USGS/3DEP/10m (10m resol... ▾
- Transparency: [?](#) Gamma: 1 [?](#)
- Sun direction: [?](#) Sun angle: [?](#)
- North-West (315 degr.) ▾ normal (45 degr.) ▾

Area Selection Box: [?](#) [Re-center box on map](#)

3D Printer Options: [?](#) [CNC?](#)

- 100 mm ▾ Width, 90.2 mm Height [?](#)
- 0.4 mm ▾ Nozzle diameter [?](#)
- 1 by ▾ 1 ▾ Tiles to print (X by Y) [?](#)
- Effective DEM resolution: [?](#) 144.5 m, (source DEM is: 10 m)
- 1 mm ▾ Model Base thickness [?](#)
- x 1.0 (none) ▾ Vertical Exaggeration (Z-scale) [?](#)
- STL binary ▾ File format [?](#)
- Manual settings: [?](#)

You Are Ready to Make The STL File

Effective DEM resolution: 144.5 m, (Source DEM is: 10 m)

1 mm Model Base thickness ?

x 1.0 (none) Vertical Exaggeration (Z-scale) ?

STL binary File format ?

Manual settings ?

Export Selected Area and Download File

Developed by Chris Harding Dept. of Geological and Atmospheric Sciences, Iowa State University and Franek Hasiuk, Kansas Geological Survey.

Suggestions? Problems? Send Email!

Visit our [Github repository](#) or get the [Docker Image](#) of the standalone version. [How to cite this work](#)

TouchTerrain: processing finished. 5 x

https://touchterrain.geol.iastate.edu/export

Reloading Data Cent... craigslist: portland job... facebook marketplace... C-Herb Mister Holistic... BLM Data Free Shipping

Processing finished

DEM_name = USGS/3DEP/10m
trlat = 44.745589063409376
trlon = -107.88944145507814
bllat = 44.45224001451772
bllon = -108.34445854492188
printres = 0.4
ntilesx = 1
ntilesy = 1
tilewidth = 100.0
basethick = 1.0
zscale = 1.0
fileformat = STLb

Preview STL Note: This uses WebGL for in-browser 3D rendering and may take a while to load for large models. You may not see anything for a while even after the progress bar is full!

Optional: Tell us what you're using this model for

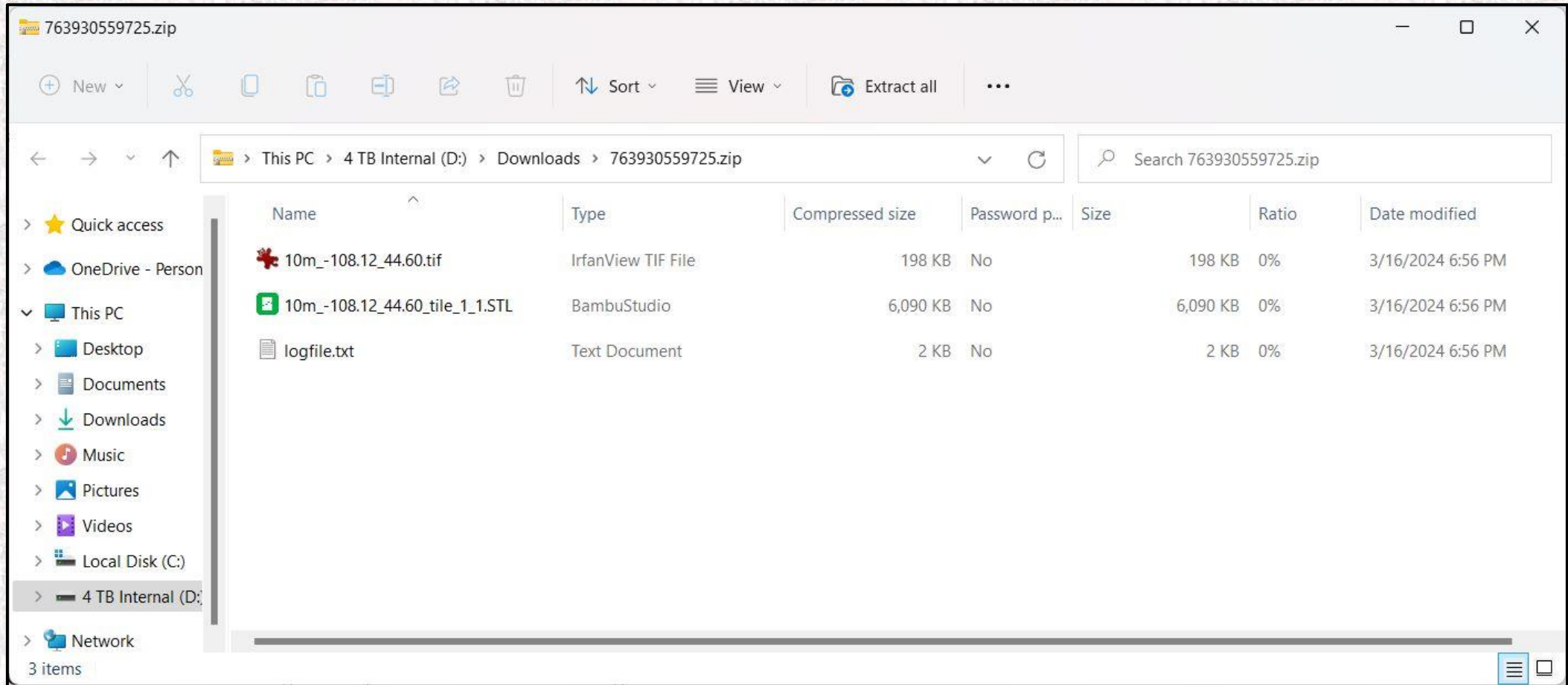
Size: 6.14 Mb (All files will be deleted in 6 hrs.)

If you take picture of your touchterrain 3D prints (or CNC carves) and put them on Instagram why not tag them with #touchterrain

To return to the selection map, click on the back button in your browser once, or on the link below:
<http://touchterrain.geol.iastate.edu/main?trlat=44.745589063409376&trlon=-107.88944145507814&bllat=44.45224001451772&10m&tilewidth=100&printres=0.4&ntilesx=1&ntilesy=1&DEMresolution=144.5&basethick=1&zscale=1.0&fileformat=STLb&>

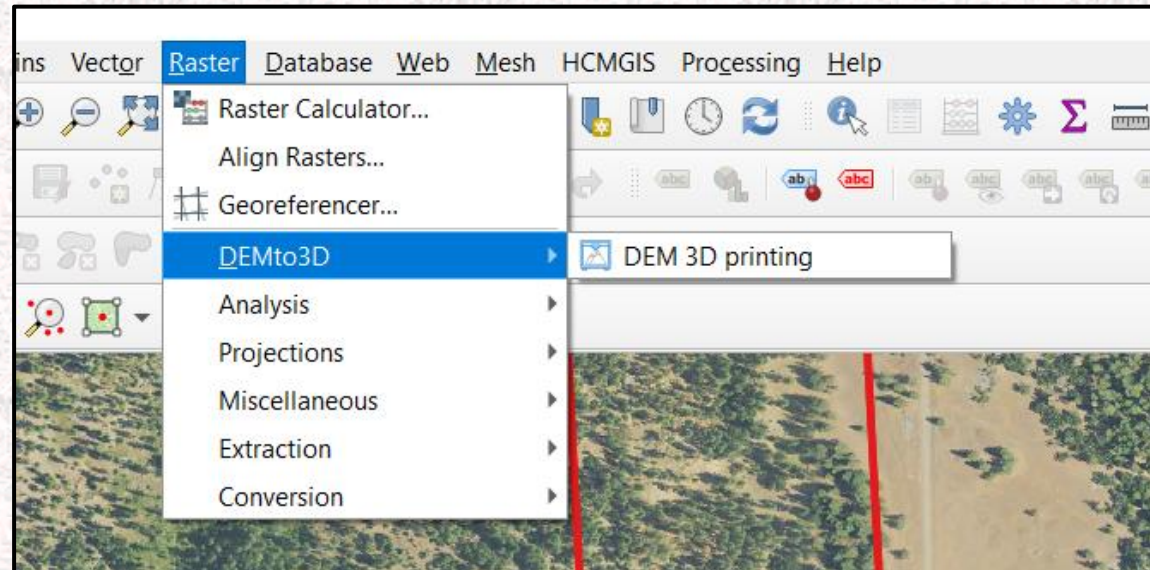
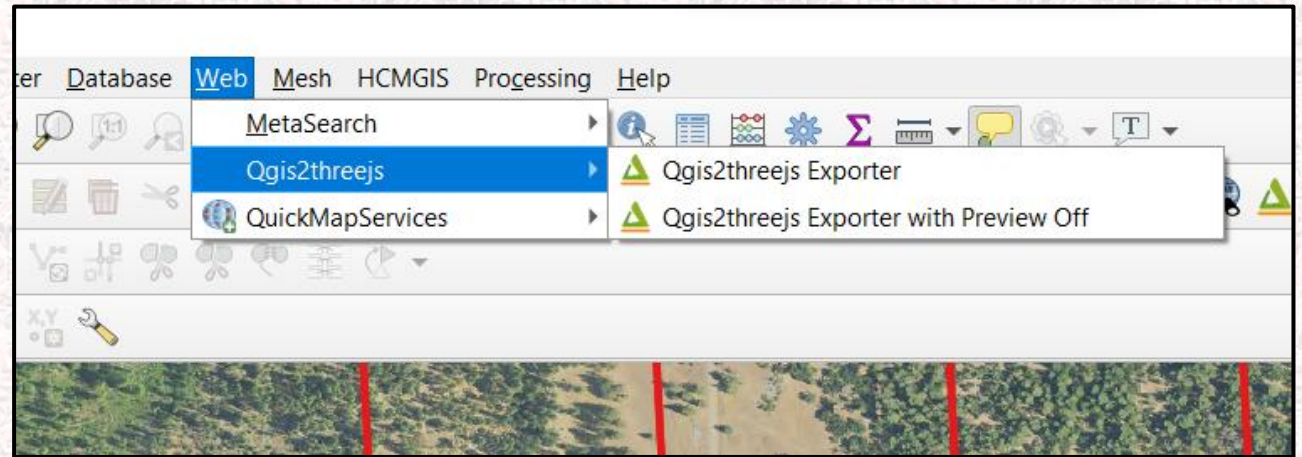
To have somebody else generate the same model, have them copy&paste this URL into a browser

Remember Where You Downloaded the File!



Making STL Files in QGIS

- Load the Plugin called: QGIS2threejs
- Load the Plugin called: DEMto3D (Tested by Jon)
- You have to have your own DEM



DEMto3D in QGIS

DEM 3D printing

Layer extent

Layer: Wasco_DTMAAnalysis_DEM [EPSG:4326]

X: -120.592 Y: 45.591

X: -120.603 Y: 45.585

Show width/length

Model size

Spacing (mm): .2 Recommended 0.2 mm

Width (mm): 175

Length (mm): 107.21

Scale: 1:4674

Vertical exaggeration: x 2.000

Terrain inversion: enable

Divide model: 1 row x 1 column

Model height

Height (m): 458 Lowest point: 458.458 m

Base height (mm): 2.00 Highest point: 476.827 m

Model height: 0 mm

Sides

Build sides Border (mm): 0

0%

Settings Export to STL Close

Coordinates for
NE and SW
corners

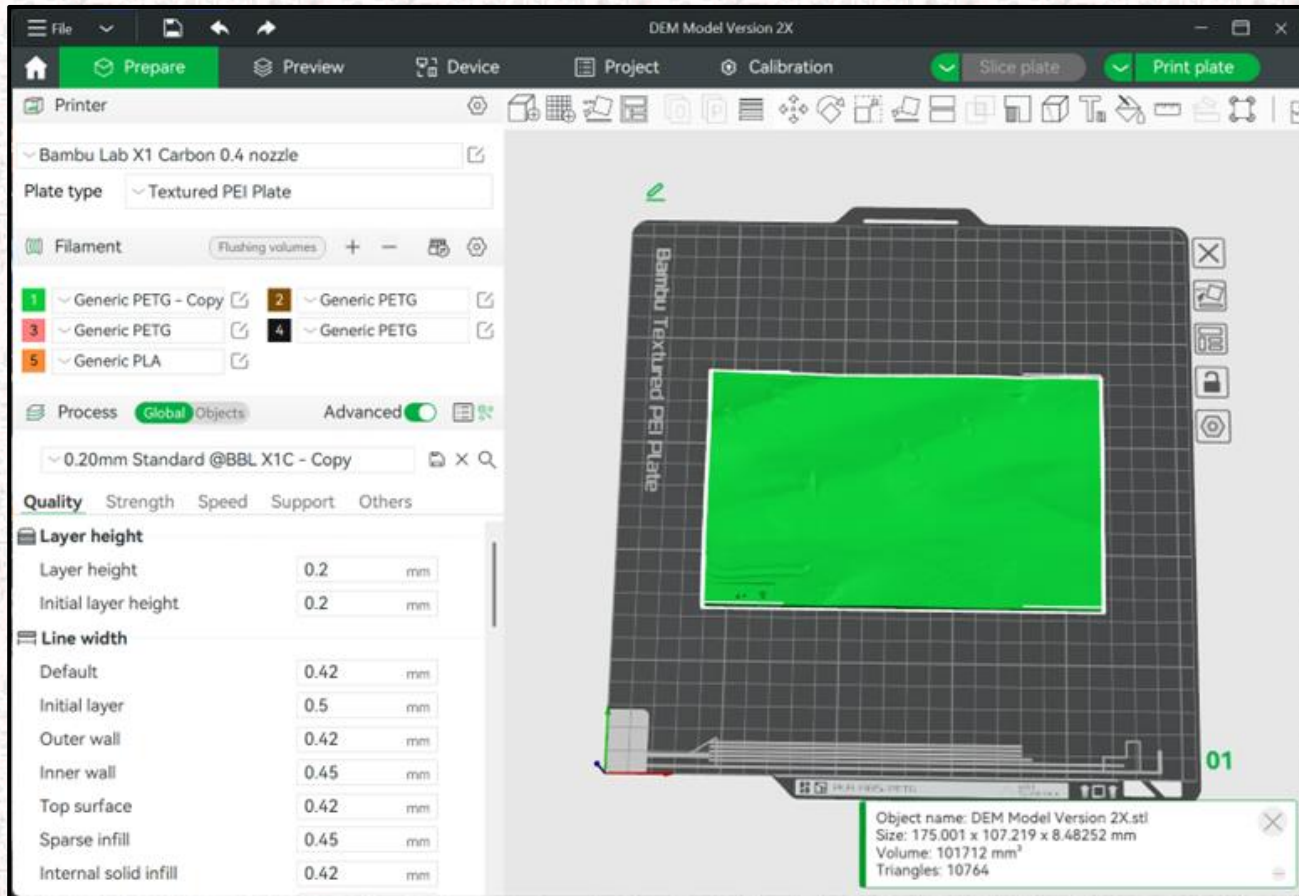
Drag area of
interest.

Fill in .2

Enter width of
STL in mm

Exaggerate Z if
needed

Bringing the STL Topo File Into a Slicer

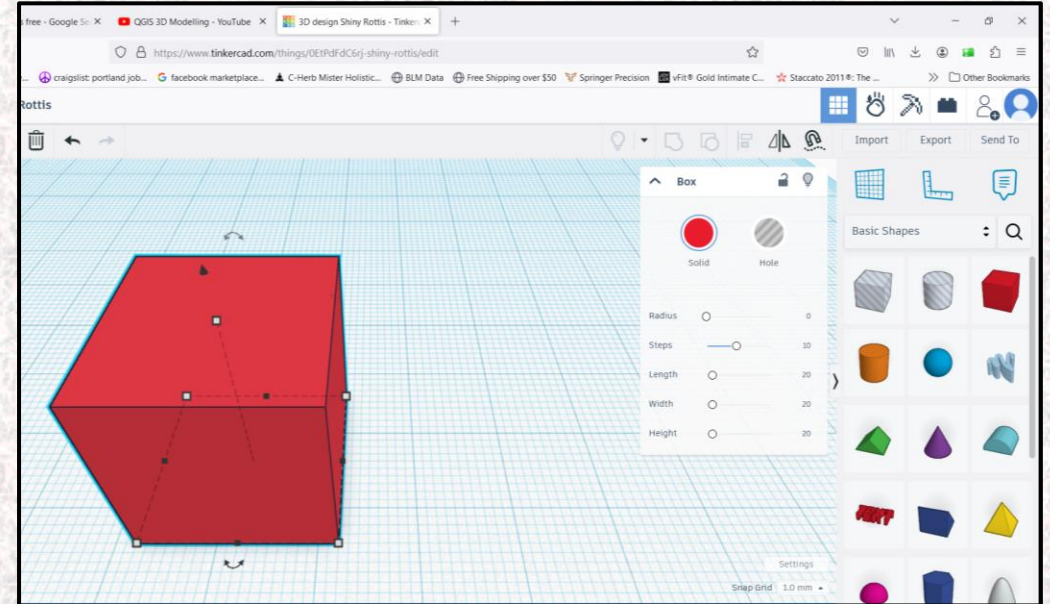


Processing model 'DEM Model Version 2X.stl' with more than 1M triangles could be slow. It is highly recommended to simplify the model. [Simplify model](#)

Object name: DEM Model Version 2X.stl
Size: 175 x 107.21 x 8.47 mm
Volume: 101674 mm³
Triangles: 1885148

How to Design Your Own 3D Print Files

- **Tinker Cad (Free, designed for kids to use)**
 - This is what I use - because it is easy!
- **Fusion 360 (Free, more powerful & cloud based)**
- **FreeCAD (Free)**
- **Solidworks (Not Free)**
- **Hire your 14-year-old neighbor kid**



Licensing of 3D Printed Objects

Model origin

The user re-uploaded this model. The user is not the original author of the model.



Maya Death Whistle (Easy Print, Very Loud)
Tacblades (thingiverse.com)

License ©

This work is licensed under a
Creative Commons (4.0 International License)
Attribution–Noncommercial–No Derivatives

- ✗ | Sharing without ATTRIBUTION
- ✗ | Remix Culture allowed
- ✗ | Commercial Use
- ✗ | Free Cultural Works
- ✗ | Meets Open Definition

Model origin

The author marked this model as their own original creation.

License ©

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Creative Commons (4.0 International License)
Attribution

- ✗ | Sharing without ATTRIBUTION
- ✓ | Remix Culture allowed
- ✓ | Commercial Use
- ✓ | Free Cultural Works
- ✓ | Meets Open Definition

The Best About 3D Printing

- **Most STL Files are FREE**
- **Most Slicer Programs use common notation**
- **3D Printers are relatively inexpensive**
- **Filament is readily available and relatively cheap**
- **Make professional Topo models in minutes**
- **Thousands of new STL files are being made every day**
- **Most 3D printer people are helpful to beginners**
- **3D printer help files are (usually) actually helpful**

The Worst About 3D Printing

- **Getting Started can be overwhelming**
- **3D filament absorbs water from the air**
- **You must be diligent to keep your filament dry**
- **Clogs, blobs, stringing, and spaghetti defects are inevitable. (but fixable)**
- **Searching for STL files can be really confusing**
- **You may become a 3D Printer addict!**

3D Printing: Conclusions

- **3D Printing is viable**
- **FREE STL files are definitely worth the price**
- **Expect to be frustrated at times!!!!**
- **Find a mentor.**
- **Be Persistent!!!**

Thanks!

- **May your nozzles never clog.**
- **May your filament roll last the entire print.**
- **May your filament never absorb moisture**
- **May your 3D print frustrations be much less than your successes**

