3D Printing Maps for The Visually Impaired.

GIS-SIG Annual Conference 2023

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- GIS can produce some outstanding visual maps
- We can use different tools within the software and from other sources that can help with some of the visual limitations such as color blindness or using a screen reader
 - <u>Colorbrewer</u> has colorblindnessfriendly options
 - ArcGIS Pro and QGIS have a colorblind preview option

COLORBREWER 2.0 color advice for cartography





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- We can use different tools within the software and from other sources that can help with some of the visual limitations such as color blindness or using a screen reader
 - <u>Colorbrewer</u> has colorblindness-friendly options
 - ArcGIS Pro and QGIS have a colorblind preview option
 - ArcGIS Pro's tool is found in the View Ribbon
 - QGIS's tool is found in the View Menu
- But none of these tools are for people who have more severe visual impairments
- Using 3D Printing Technology along with GIS we can bridge this gap and make our maps more accessible



The Process of Creating a 3D Printed Map

- The process for creating a 3D printed map is mostly straightforward if you are familiar with Raster datasets
- Currently, there is no direct export for a 3D-printed file format in any GIS software
- But there is a tool in QGIS called DEM to 3D which provides a similar functionality
 - You need to have a processed elevation model with all of the different design elements already embedded into it
- Once you have the 3D print file you will still need to use a 3D modeling software and 3D splicing software to print the model
- 3D printing is not a fast process and depending on your model it can take a while to see the finished product.

The Example

- In this presentation, I will go through the different steps needed to create a trail map that shows the elevation of Oatka Creek Park
 - Some of you may have seen this map at last year's conference
- The layers that will be used are the Monroe County LiDAR, Park Boundary, and Trails available from <u>https://www.monroecounty.gov/gis-Data</u>
- You will also want a Braille font which you can get from https://brailleinstitute.org/freefont
- I did most of the processing and cartography in ArcGIS Pro
 - You will need 3D or Spatial Analyst for the steps
 - You can also use vector data instead of an elevation raster, you just need to have a raster to add layers, much like a layout.
 - ArcGIS Pro's Label Engine works very well for this kind of project
- You can do the process all in QGIS
- 3D Printers also have a limited size/resolution that they can print so make sure to keep that into consideration when exporting files



Area of Interest

- Before you get started using a reference layer (Park Boundary) to create an Area of Interest (AOI) which will limit your processing area
- Using that AOI clip your base elevation layer
- NOTE: Make sure to use good naming conventions throughout the process because you are going to be making a lot of layers





Considerations for Your Base Information

- When starting the process make sure to have a good base of information
- But you can run into issues with too much detail
- I would recommend using a bare earth model if you are using LiDAR over a surface model
- For Vector data make sure to have enough pixels to give good shapes but not too high of a resolution that you are creating large files





Now for the Trail Processing

- First load the trails into the project
- Vector data cannot be added to a raster layer directly so you will need to do some conversions
- The first thing is a line will need to have some kind of thickness
- Run a buffer on the line. Normally a trail may be only 6 feet wide but you need to think in terms of the raster resolution and what you think would be able to be felt by a person
 - This will take some trial and error
- For this example, a 25-foot width worked to give the best detail from the elevation





 Once You have your buffer create a raster of the trails and use the elevation model to populate the cell size

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Cellsize 5	
Build raster attribute table	

- Once You have your buffer create a raster of the trails and use the elevation model to populate the cell size
- Now Reclassify the trail buffer to be the elevation off the surface of the ground
 - I started with 5 feet and ended with some print tests and found 20 feet worked the best

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- This will give a raster that has a 0 value for the background and a 20 value for the trails.
- Now we need to get the elevation data into the trails
- This is a simple addition step





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- Now we need to get the elevation data into the trails
- This is a simple addition step
- Add the Elevation Model to the trail data we just created

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Labeling and Layout

- After getting the data ready and into the elevation model the next step is the labeling and layout.
- This is one of the hardest steps because of keeping it easy to read but also follows the trails and terrain
- For the example here I have one text in Braille and the other in Constantia just to have both forms to see how it work
- The text will need to be raised also at least 20 feet to stand out of the elevation below
- Note: Limit the amount of labels to make it easier to use





Labeling and Layout Continued

- Once you use the automated labels you will need to manually adjust them by converting to a graphic or annotation
- Then add any map decorations
 - I would recommend keeping the text and decorations all one color (black works)
- Turn off all background layers and export the layout as a tiff with world file





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Adding the Labels Back In

- Using that tiff file you just created add it back into the map.
 - The World File will place it right where it belongs.
 - You may need to experiment with the export to have a legible raster
- Next reclass the Labels to have all the text be a value of 20
 - Most of the time a black value in a layout will be a value of 52 in a tiff



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Adding the Labels Back In Continued

- Using the Addition Tool (Plus) again add the trails and the labels together
- This will create the Elevation model of all of the pieces with the text and trails elevated 20 feet

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Adding the Labels Back In Continued





Getting the Map Ready to Print

- Now we need to get our map ready to print
- Take the Final Image from ArcGIS Pro (make sure it is a tiff file) and add it to QGIS
- In QGIS we also need a plugin because the function we want is not included by default
 - To Install the Plugin go to the Plugins Menu and Manage and Install Plugins
 - Search for DEM to 3D

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- Once installed the Plugin will be found under the Raster Tools
- Open the DEMto3D option and then Run DEM 3D Printing





- Once installed the Plugin will be found under the Raster Tools
 - Open the DEMto3D option and then Run DEM 3D Printing
- Now you Load the Layer to Print (Your Elevation Data)
- Set the extent to the full extent of the model (we set this in the AOI
- The Model Size and Spacing will depend on your printer
 - Check the Specifications to find that out
- Lastly the Height in Meters that you want the model
 - This is the real elevation, not the print so use the raster to figure this out
 - The Model will be very thick at this stage
- Once you are all set run the tool

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- After you have the STL it should work for the printer but there are a few finishing touches to do
- First, the model needs to be checked and repaired to make sure it will print
 - I used MeshLab for this
- Then I removed the extra thickness and added some more elements
 using the Windows 3D Builder











- At this point, you are almost all ready to print
- You just need to use a slicing software designed for your printer to create the file that will be used
 - In my case Chitubox
- I also use this process to add supports and hollow out the model for better printing











Lessons Learned

- When starting the process make sure you have plenty of storage to run many attempts
- Printing small test prints are helpful because full-size ones will take hours to do

On the Resin Printer Side

- When Calibrating/Leveling your printer plate use 2-4 sheets of paper and set the 0 to just where you can pull them out.
- Get a Screen Protector for your printing screen because it is very difficult to clean (and if you damage it you will have to replace it)
- A Magnetic Printing Plate makes taking off the print easy
- The software will estimate the cost of each print, but unless you do multiple back to back your cost will be higher
- Make sure to do a good job washing the final product or you will have white masses on the print that will make it hard to read

Questions

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https://bit.ly/JDC2023GISSIG

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