**Initial Setup**

1. Download the Excel (“Gini\_calculation\_spreadsheet\_2023.xlsx”), R markdown (“Gini Analysis.Rmd”), ArcGIS toolbox (2022\_Chase\_et\_al\_volume\_tool.tbx”), and python code (“ArcGIS\_volume\_python\_ASZC.py”) files into the same folder.
2. Keep the original Excel file and make copies with different names for individual Gini analyses. Instructions for using the Excel with your own data are located in gray-italics text in the file and also in-text below. When managing these files, keep all of files in the same folder with the R markdown file for later use (the R markdown will default to the local directory when looking for the Excel file to read, but advanced users can specify the working directory instead).

**Excel File Instructions**

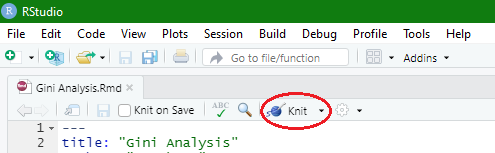
1. Separately prepare your data for analysis (e.g., exporting area from a GIS database, for example, with the “calculate geometry” tool in ArcMap/ArcPro). Ideally, this data will incorporate two columns: 1.) a descriptive name or identifier (e.g., “Site Name”) and 2.) the desired inequality metric (e.g., “plazuela area m2”).
2. Before starting, copy the Excel file and rename it to highlight both the site and the inequality metric for future reference (e.g., change the copied file from “Gini\_calculation\_spreadsheet\_ASZChase\_v5 Copy.xlsx” to something like “Gini\_calculation\_spreadsheet\_Caracol\_plazuela\_area\_m2.xlsx”)
3. Copy and paste the “site name” and “inequality metric” data from the other file into Columns A and B of the renamed Excel file. To do this, highlight cell A4 and paste the new dataset. This will replace the current, temporary data highlighted orange for the file.
4. If the data has not been previously sorted from smallest to largest values, then highlight only the inserted data in columns A and B after row 4 and sort the “Metric <inequality metric>” from smallest to largest. (The “Sort & Filter” button is located on the “Home” ribbon for Microsoft Excel – potentially with custom sort option if the default button does not work.)
5. After sorting, click and select from columns C to M on the 5th row or lower.
6. Once those are selected, click the bottom-right corner of the selection rectangle to select the equations in those cells. Then drag downward while continuing to click until the boxes reach the row of the last value you entered.
7. This should calculate the new Gini and data for the “Basic Stats on Dataset” and “Box-n-whisker Data (not standard)” sub-tables in column P. Graphs should also auto-update.
8. Next enter your site name in cell R9 (e.g., “Caracol”) and your basic inequality metric in cell R14 (e.g., “plazuela area m^2”). This info may also be in the Excel file’s name.
9. Please save your file. You have now filled in your basic data for one inequality metric and can move onto the confidence interval calculation in R; however, there is already a bit of data to consider that has been processed from the spreadsheet.

**Installing R studio and R**

1. To do the final analysis, we are using R – an open source statistical software language. This will require downloading R itself and also the R studio IDE (Interactive Development Environment) for ease of use.
2. To download R (this Compact Section from version 4.1.2) you can use this website [https://mirror.las.iastate.edu/CRAN/](https://mirror.las.iastate.edu/CRAN/%20) (or [others](https://cran.r-project.org/mirrors.html)) and select the version of R that matches your operating system. This page will include additional instructions after selecting.
3. To download R studio (this Compact Section from version 2021.09.1+372) you can use this website <https://www.rstudio.com/products/rstudio/download/#download>.
4. Note: download and install R before R studio.

**Initial R markdown Test Run**

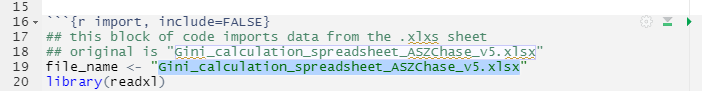
1. Double click the “Gini Analysis” R markdown file to open it in R studio.
2. R studio may have a pop-up message to install “knitr” and other packages. Install those packages; these packages will enable the use of R markdown in the R studio IDE
3. Once installed (and Excel is in the same folder and ready to go) press the “knit” button on the top banner to run this file with the default data for testing. (The default data is the “Gini\_calculation\_spreadsheet\_ASZChase\_v5.xlsx” file.) Note, this may also install additional packages for analysis. Additionally, if the knit fails, then check for a prompt suggesting other packages need to be installed; it may require up to two attempts.



1. If everything worked properly, then you should see a .html pop up with results from pressing “knit” with Gini values that match those in the default Excel file.

**Running your Data with R markdown**

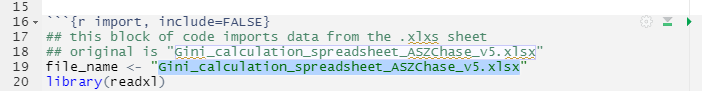
1. To run your own data, have the R markdown file, “Gini analysis.Rmd” open.
2. Go to line 19 in the R markdown file (in the top-left window/quadrant of default R studio application)
3. In line 19, the file this code reads to run analysis is in green text and set between a set of quotation marks. (i.e., this is a character or string data type variable for the code to use)



1. Within the quotation marks, replace the default file name with the file name of the Excel file containing your data. (Ensure that you do not delete anything outside of those quotation marks and that the file name matches exactly. You may want to copy and paste the file name because this will be sensitive to different capitalization, spacing, or file extension text.)
2. After updating line 19, press the “knit” button to run the analysis. (Please note, for larger datasets this may take several minutes to run.)
3. After running a .html file should open. Copy the lower and higher Gini values from the confidence interval table into cells P29 and P30 of the Excel file.
4. Save the results for future use. Click the “open in browser” tab at the top of the html results pop-up. In the web browser you can right-click and press “save as”. In Chrome it is the fourth option down in the pop-up box after a right-click.

**(Extra) To separately save the images from R (if desired)**

1. Open the R markdown file and update the Excel file name in line 19 following the instructions above.

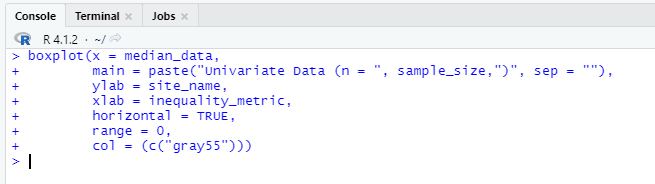


1. Go to line 8 of the R markdown file in the top-left window/quadrant of R studio. In that window/quadrant, look at the right-hand side and there should be a green arrow pointing to the right. Press it and then scroll down pressing each arrow in turn from the top of the file to the bottom. (Note – R markdown stores data separately when running. This process runs the same R code locally in the R studio IDE and saves locally.)

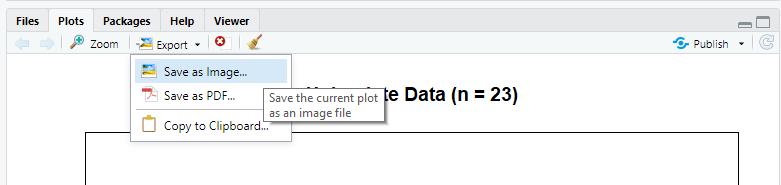
Graphical user interface, text, application, email

Description automatically generated

1. After running each code block, select and copy the lines for the desired plot (lines 64-70, lines 78- 83, or lines 87-93). Then move the mouse cursor to the bottom-left window/quadrant and select the “Console” tab. Paste the copied graph code into the Console and press Enter. It should produce a “Plot” in the bottom-right window/quadrant.



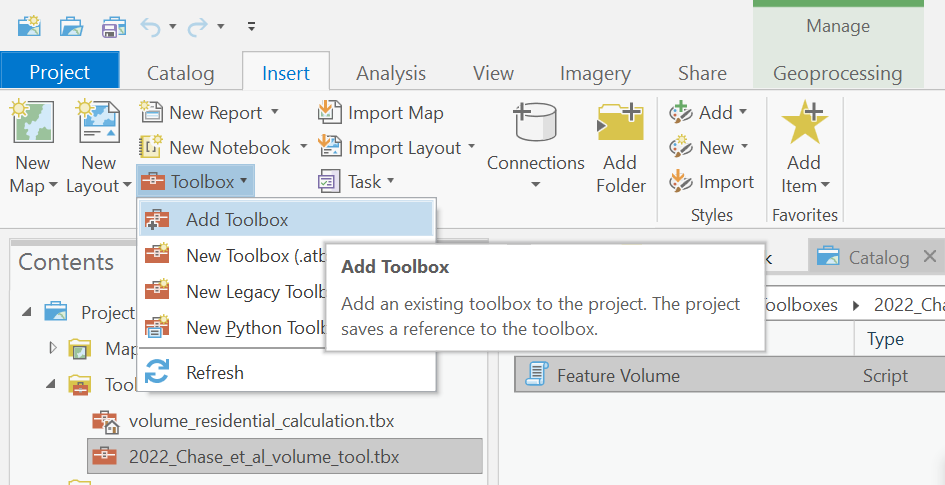
1. After the graph appears, you may use the “Export” button to export a copy of that graph. Some file types are raster (e.g., “.jpeg”) and can be touched up in a program like Photoshop or Gimp and others are vector (e.g., “.svg”) and can be touched up in a program like Illustrator or Inkscape. Use the file type that suits your desires/needs and save it for use or future editing. The output size may need to be specified when images are exported.

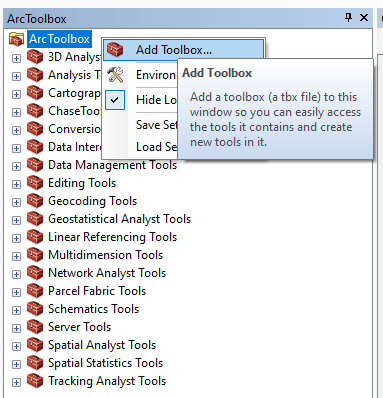




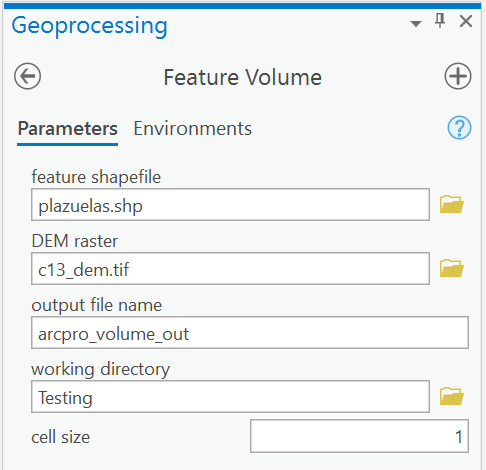
**ArcGIS / ArcPro Volume calculations**

The toolbox for volume calculations has been tested on Windows 10 and 11 with ArcPro 2.9, ArcMap 10.8.1, and ArcMap 10.8.2 for this Compact Section. Please note that while this code works in both ArcGIS programs, ESRI support for ArcMap ends in 2026.  
  
This method takes a polygon shapefile and digital elevation model raster as input, and calculates volume using a nearest neighbor interpolation to construct a non-flat surface under those polygons based on their local topography. The difference between this interpolated surface and the digital elevation model is summed to provide volume per unique feature id in a separate Excel file. This methodology builds on those of Šprajc, I., et al. (2022), Chase, A. S. Z. (2017), Stanton, T. W., et al. (2020), and Ebert, C. E., et al. (2016) or as discussed in the introduction to the Compact Section.  
  
To avoid some potential data-overwriting issues, the algorithm does not modify any of the files given as arguments. Instead, the working directory provided to the algorithm will be used to generate intermediate and final output files. The final result of the calculation will be an Excel file (.xls) using the output file name provided, and volume will be located in the "SUM" field for use elsewhere. After running, we recommend moving the Excel file elsewhere and deleting the other files or the temporary folder used for analysis (the intermediate files could be useful for identifying bugs if issues arise).

1.a.) To add the toolbox in ArcPro, go to the Insert ribbon and use the “Add Toolbox” from the dropdown. Once added, the toolbox appears in the Catalog menu 

1.b.) To add the toolbox in ArcMap, go to the toolbox window and right-click to bring up the option to add a toolbox. After adding, it will appear in the list with the other tools.  


1. To run the volume calculation, double click on the script icon within the toolbox and then fill in the files as you would for a normal tool. Information on how to fill in each field has been provided within the tool as well.

3.a.) Here is an example from ArcPro.  


3.b.) Here is an example from ArcMap.  
