USDA United States Department of Agriculture

Natural Resources Conservation Service

Soil and Plant Science Division

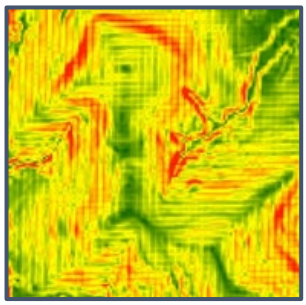
Raster Mastery

Pixelicious Tips for the DSM Practitioner

Issue 2

Resampling: Know How to Treat Your Pixels Right

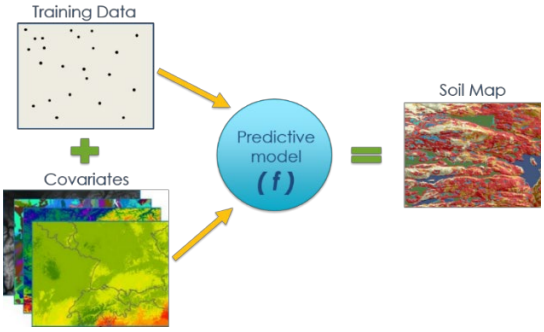
When It All Goes Wrong



Have you ever seen a DEM terrain derivative that looked like the image to the right and wondered why the world had turned into bad plaid? Well, chances are that the wrong resampling algorithm was applied to the data and the result is…well…bad plaid and bad data. For happy data, choosing the correct algorithm for your pixels is key. Read on to find out more!

But First…

Imagine you have embarked on a mapping project, assembled various datasets, and developed ideas for additional ***covariates*** that will be developed and utilized in the project. Using the suggested ***best practices***, you have decided on a common projection and working spatial ***resolution*** of 5 meters as the standard for all covariates. You have determined multiple spatial resolutions exist among the source data. The next step involves resampling your data to 5-meter spatial resolution, and making the critical choice that leads to bad plaid or happy pixels.



Change That Pixel Size

Resampling is simply the process of changing pixel or cell size. Remember that pixels are tiny square polygons and typically represent 5 m, 10 m, or 30 m on a side; although, they can represent other sizes. Resampling changes the dimensions of the pixel to the specified size. You may go from 5 m to 10 m on a side or from 30 m to 10 m. The computer will do what you ask, but it's important to understand the choices you're making and how they may impact your data…especially the resampling algorithm!

GIS software packages, image processing software packages (such as ERDAS Imagine), and, of course, R have tools for resampling data. In some instances, resampling is also part of a reprojection tool. In ArcGIS, the Resample Tool is at **Data Management Tools > Raster >**

Raster Processing Toolbox. In any case, there will be parameters to specify, such as output cell size and, most importantly, Resampling Method or Technique. In most software packages, the list of options consists of at least the following resampling algorithms:

1. **Nearest Neighbor**
2. **Bilinear Interpolation**
3. **Cubic Convolution**

Know Your Data and Use It Wisely

The resampling method you choose will depend on your input raster data type. Remember, we are after happy pixels and not bad plaid! Use the table below to guide your selection depending on the type of raster data you're resampling.

Data Type	Resampling Method
Discrete, Categorical (e.g., geology, vegetation classes)	Nearest Neighbor
Continuous (e.g., DEM, satellite imagery)	Bilinear or Cubic Convolution

The nearest neighbor method does not alter the value of the input cells and should only be used when resampling categorical data, such as surficial geology or land cover data. **Never select the Nearest Neighbor method for continuous data.** It will introduce artifacts in the resampled product (fig. 1) that will also be inherited by all subsequent derivatives (fig. 2)…bad plaid!

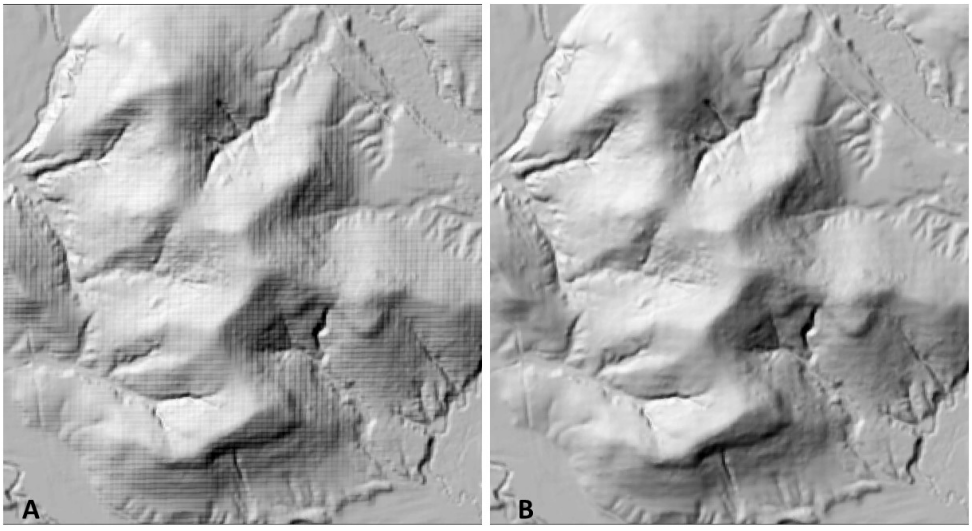


Figure 1.—*Hillshade of resampled DEM using:*
A: *Nearest Neighbor (BAD PLAID), and* ***B:*** *Bilinear (HAPPY PIXELS)*

Always select the Bilinear Interpolation or Cubic Convolution method for continuous data. Keep your sanity, and keep your pixels happy.

Resampling also occurs when projecting data. This can introduce artifacts to unsuspecting users if the incorrect resampling method is specified during the project operation. It is important to inspect data received from cooperators or colleagues and check for the presence of artifacts before charging into the development of derivatives. For elevation data, try the following quick quality assurance workflow.

1. **Create a hillshade from the DEM prior to any processing.**
2. **Inspect the hillshade for processing artifacts, which will appear like those in panel A in figure 1.**
3. **If artifacts are detected, contact the DEM provider to determine the source of the problem and correct it.**
4. **If you have the original DEM, project the data again using the correct resampling technique as specified in the table above.**

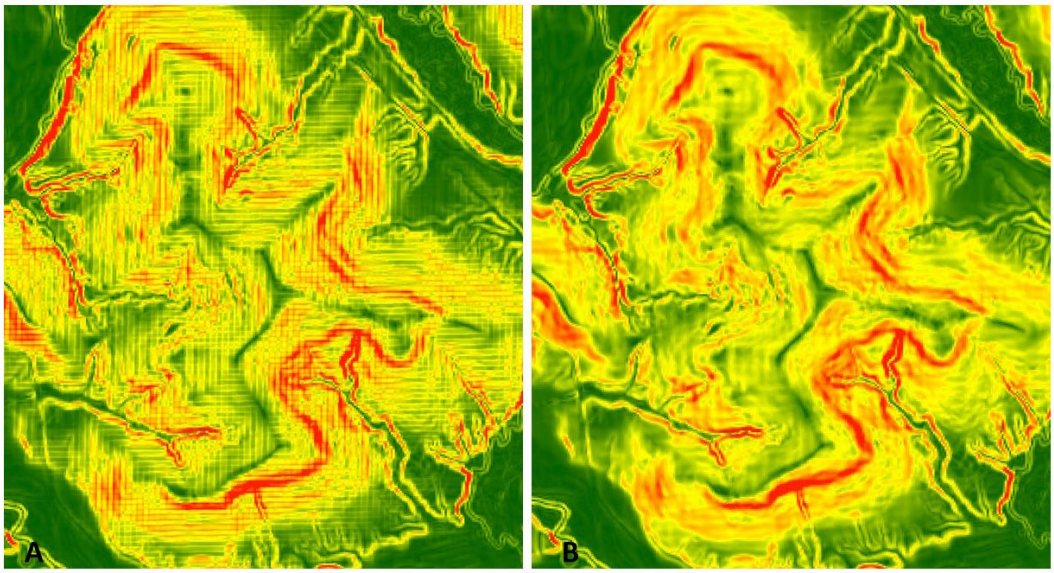


Figure 2.—*Slope gradient derived from resampled DEM using:*
A: *Nearest Neighbor (BAD PLAID), and* ***B:*** *Bilinear (HAPPY PIXELS)*

The Details

Mathematical differences between the Bilinear and Cubic Convolution methods exist that impact processing time and data range outputs. Bilinear uses 4 input cells (simpleton) and Cubic Convolution uses 16 (over-achiever). As a result, processing time will be a bit longer for the Cubic Convolution method. The time difference isn't noticeable with current computing power unless you are working with very large datasets, but you might have time to ask your co-worker where they got that sweet plaid shirt while you wait.

In addition, Cubic Convolution has a greater potential to extrapolate data values compared to the Bilinear method. The Cubic Convolution method yields a smoother surface than Bilinear, which may be a consideration if the input DEM is noisy or the desired output resolution is significantly coarser than the input. The differences in resulting output between Bilinear and Cubic Convolution are typically not detectable or significant for soil survey purposes.

Pixel Humor

If you hung in this long, you deserve a pixel joke!

Q: Why don't pixels like to go to Costco?

A: Because they don't want to be (re)sampled.

Courtesy of raster master Alex Stum (DSM Focus Team member and joke creator extraordinaire)

Get Involved!

Check out the DSM Focus Team website here to learn more and to find out how you can participate. Contact Suzann Kienast-Brown suzann.kienast@usda.gov for more info or to ask questions.

Are you in or out? Have an idea?

Raster Mastery will be gracing your inbox with tidbits, hot tips, and how-tos on all things digital soil mapping on a regular basis, but not too often. If you have ideas for topics or want to opt-in or out, give a shout to raster master Jessica Philippe, jessica.philippe@usda.gov. If you have pixel-loving friends, please share!