THE RASTER CONCURRENCY NIGHTMARE IN ArcGIS

Good Practice & Work Aroun{}d

GCD 5 / ArcGIS 10 Help

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TopiCs

I. Definitions
II. Problem with Ignoring
III. What ArcGIS does
IV. Why is it so hard to fix? The crux of the problem
V. What GCD requires and why?
VI. Good practice & Workarounds
RASTER TERMINOLOGY

• All rasters have the following primary properties
  - Number of columns & rows (must be integers)
  - Cell resolution (grid size)
  - Type (integer, floating point precision)
  - Lower left coordinates (x,y) or Top, Bottom, Right & Left coordinates (i.e. extents)

• From which the following secondary properties can be derived:
  - Width & Height
ORTHOGONALITY

• Orthogonal rasters must:
  - Share exact same grid resolution
  - Share the exact same grid centers (i.e. aligned in both easting and northing)
CONCURRENCY

- Grids are orthogonal and:
  - Share \textit{exact} same extents
MASKED EXTENTS

- Rasters that have the same masked extents, simply have the same nodata cells
- The mask can be derived from a polygon or a raster
- A concurrent raster mask is the most accurate!
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TO DO MAP ALGEBRA, RASTERS NEED TO BE COMPATIBLE (i.e. Concurrent)

- Compatibility defined by orientation, origin and resolution
A cell-by-cell analysis, which requires concurrent grids
WHAT DO I REALLY NEED?

• Orthogonality?
  – Yes, because if not what cell values do I use?

• Concurrency?
  – Helps, but if some cells only exist within extents of one raster, then no calculation is possible

• All cells have a value (i.e. same masked extents)?
  – Sort of… can only do MOST calculations (e.g. subtraction) when all rasters have a value
  – Some operations (e.g. max) may still be possible
SAME NUMBERS & ROWS, BUT...

Same resolution, same orientation, different origin & extents

NOT CONCURRENT

Same resolution, different orientation, different origin & extents (but same width & height)

Different resolution, same orientation, same origin
EVER SEEN SOMETHING LIKE THIS?

- The consistent horizontal and vertical bands are systematic errors!
- They are minor enough, most people ignore them, but they are unnecessary
- They are artifacts of resampling a raster to extents that were not orthogonal to the original raster
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ARC HIDES USER FROM THIS UGLINESS

• If you give ArcGIS two overlapping but non-orthogonal rasters, it just lets you do the raster algebra...

• It does this by a combination of using
  – Environment settings to select extents and a grid resolution; &
  – Resampling to make concurrent grids so raster algebra can be done

• The result is the geoprocessing tool usually works... and the user has no idea what it did behind the scenes
THOSE ENVIRONMENT SETTING DEFAULTS...

- For extents, it tends to take the intersection as default...

- For cell size, it tends to take Maximum of inputs:
EVERY TOOL HAS ENVIRONMENT SETTINGS

- Tools validate parameter values as you enter them...
- They also can override environment settings
Tool environment settings

Tool environment settings inherit from application environment settings: when you open a tool's dialog box and click the Environments button, the application environment settings are used as the initial values for the tool's environment settings.

Note: Tool environment settings only apply to the current run of the tool and do not update the application environment settings.
RESAMPLING... VOODOO

• How?

- Nearest Neighbor
  - Distance weighted average of four nearest cell centers

- Bilinear Interpolation

- Cubic Convolution
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WHERE PROBLEMS COMES FROM

- Most people derive rasters from precise vector data, which introduces unnecessarily specific details.
- ArcGIS is inconsistent in raster geoprocessing tasks whether it gives priority to grid resolution or numbers of rows and columns:
  - If priority is given to grid resolution you’ll often get one extra or one less row or column.
  - If priority is given to rows and columns, you will get rounding errors in grid resolution.
RASTER CREATION

- Let's look at an example...
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WHAT GCD REQUIRES

- Concurrent grids to do change detection without introducing further unnecessary uncertainties
- In GCD 5.0.1 – 5.0.4 BETA, it’s not enforced at Survey Library, it’s enforced at change detection panel (if grids are not concurrent, you get an error message)
WHY WE REQUIRE CONCURRENCY?

• No need to introduce further interpolation errors from resampling that the user is unaware of

• Our underlying code (C++ library) is set up to require this as an input (we don’t use Arc’s geoprocessing for most of the change detection)

• In future (shield user from some of this):
  – We are going to enforce orthognoality upon upload to Survey Library
  – We are only going to enforce concurrency at time of change detection, based on intersection of two orthogonal inputs form Survey Library
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SOME GOOD PRACTICE

- Use even integers wherever possible for extents to simplify orthogonality problems
- NEVER use cell resolutions that are not evenly divisible into width or height of a raster
- ALWAYS, exert explicit control over extents and grid resolution when creating rasters from TINs or Terrains
- Once you get one raster defined, match its extents & cell size in environment settings for all other rasters
- Avoid resampling if at all possible
- If you must resample, be careful not to introduce systematic interpolation errors
TWO EXAMPLE WORKAROUNDS

• Best thing to do is exert explicit control over cell size selection and raster extents at stage of Raster creation from TIN or Terrain, to ensure that raster width and height are evenly divisible by cell size

• That’s not always possible

• Here’s two common problems:
  1. Two non-concurrent DEMs
  2. Two apparently concurrent DEMs, but....