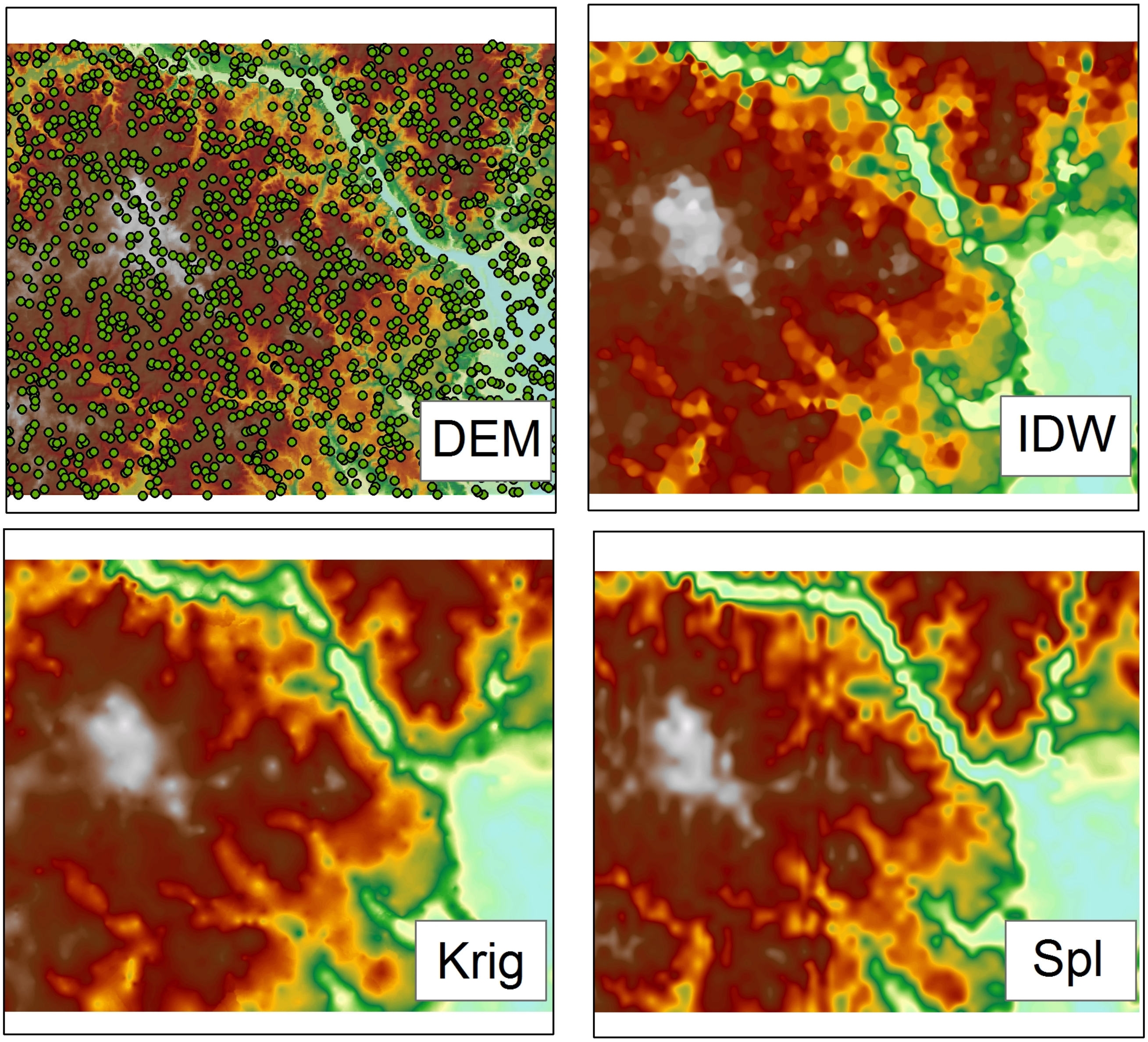
Interpolation and Sampling Methods
by Max Grossman



Legend

Elevation (meters)

Value

High : 160

Low : 0

Randomly Sampled Points

0 2.5 5 10 Miles

N

Source : USGS | Date : 29 Apr 2015
Author: Max Grossman

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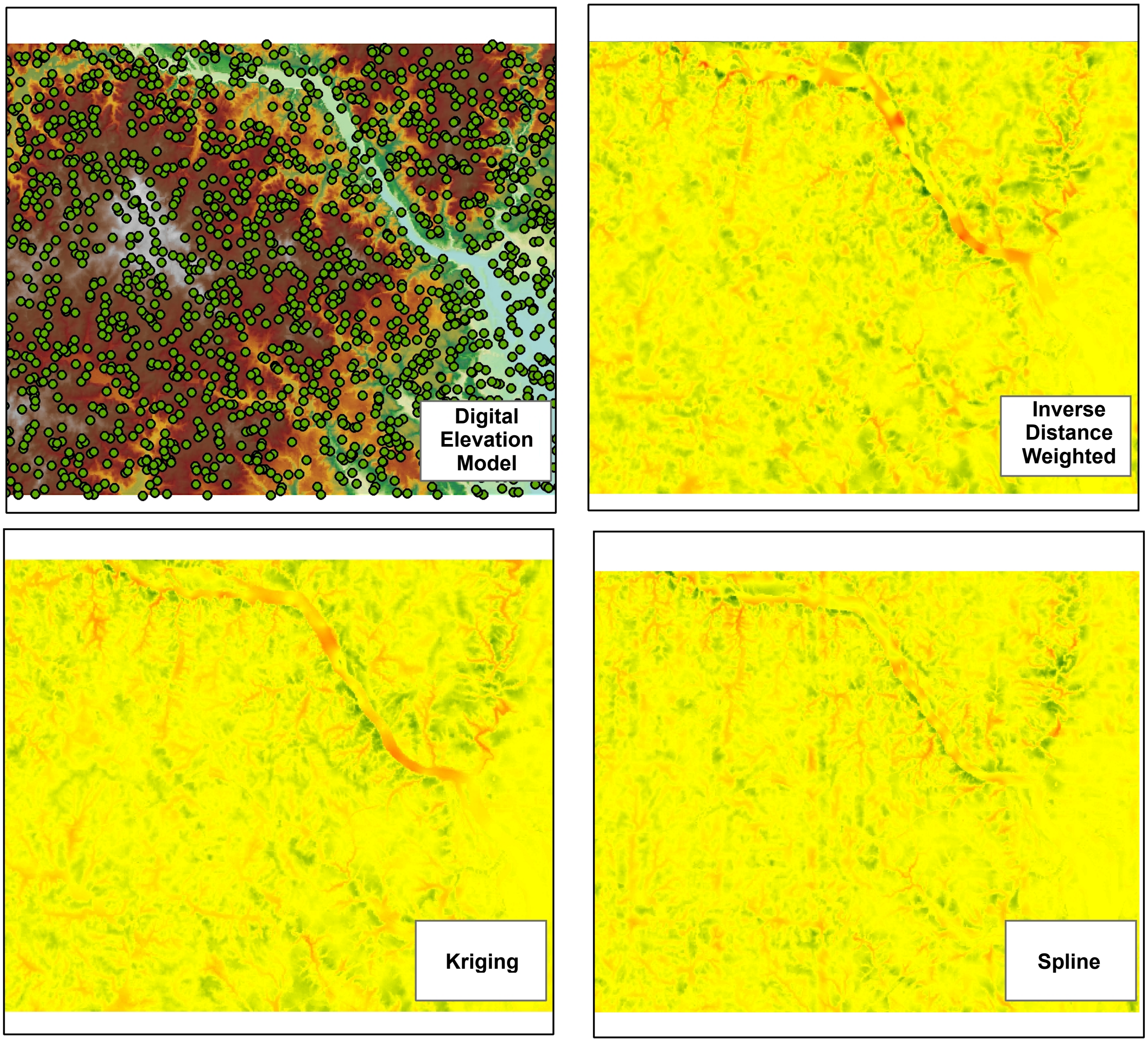

0 2.5 5 10 Miles

N

Interpolations minus DEM Errors

Value

High : 70

Low : -70

Randomly Sampled Points

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Table 1. Summary Statistics for Each Interpolation Method's Errors from DEM

	Mean	Standard Deviation	Min	Max
Inverse Distance Weighted	-.005 meters	8.31 meters	-66 meters	62 meters
Spline	0.011 meters	6.62 meters	-52.7 meters	43.4 meters
Kriging	0.019 meters	7.495 meters	42.5 meters	-47.13 meters

Methodology Summary & Decision for best Interpolation Method

I created three different interpolated maps using the Inverse Distance Weighted (IDW), Kriging, and Spline methods. Interpolation points were collected using two different kinds of sampling methods: random point sample and systemic point sample. 1900 x and 1900 y values were randomly selected and concatenated together make 1900 random x,y points within the map extent. The systemically sampled points were collected at a constant 500-meter interval.

Each interpolation method uses sample points differently to interpolate pixel values. The Inverse Distance Weighted interpolation (IDW) makes sample point's influence on estimated pixel values inversely proportional to its euclidiean distances between estimated values of interest. This makes closer sample points more influential than farther away points. This can be amplified by increasing exponent values within the IDW calculation. IDW has a caveat: because each interpolated value is based on near by points and does not account for trends throughout the data, a so-called "bulls eye" effect occurs. Secondly, the Kriging method was used. Kriging departs from IDW because in addition to accounting for distance between sample points and estimated pixels, it also makes sample point's influence a function of the semivariance between sample points and estimated pixels as well as the its semivariance between sample points and other sample points. This additional consideration makes Kriging maps more accurate, or optimal, than IDW interpolations. Lastly, a Spline interpolation was used, which determines estimated values through mathematic functions that minimize the curvature of surfaces. This makes surfaces smooth. Spline has two different versions: regularized and tension. Tension uses more points to create smoother surfaces.

Changing parameters for each of the interpolation methods changed the output maps. For IDW, the higher the exponential power the truer elevation was to the corresponding areas on the original digital elevation model. For Kriging, changing parameters made indistinguishable differences. Lastly, using the tension version of spline made the interpolation smoother than the regularized option. Additionally, increasing the weight for the tension spline seemed to highlight areas of low elevation like the Potomac's tributaries.

With all this said, the best interpolation method in this case was the spline method, based on the fact that it had the smallest standard deviation (at 6.6m; IDW was 8.3m and Kriging was 7.495m). This suggests that relative to the other two interpolations, Spline's errors are clustered most about its mean. Comparing means, which shows the average error, Spline is also very close to zero (at 0.011 m) suggesting that the method overestimates elevation values only slightly. Notably, IDW does best here with a mean of -0.005m. Kriging does worst at 0.019m. One might be drawn to IDW because it has a smaller mean. However, due to the fact that IDW has a much larger range than Spine, at 128m (compared to Spline at 96m), and a larger mean, Spline's grossest errors are not as extreme as IDWs. Also, Kriging has the smallest range, at 89m. Yet, its standard deviation is larger than Spline's.