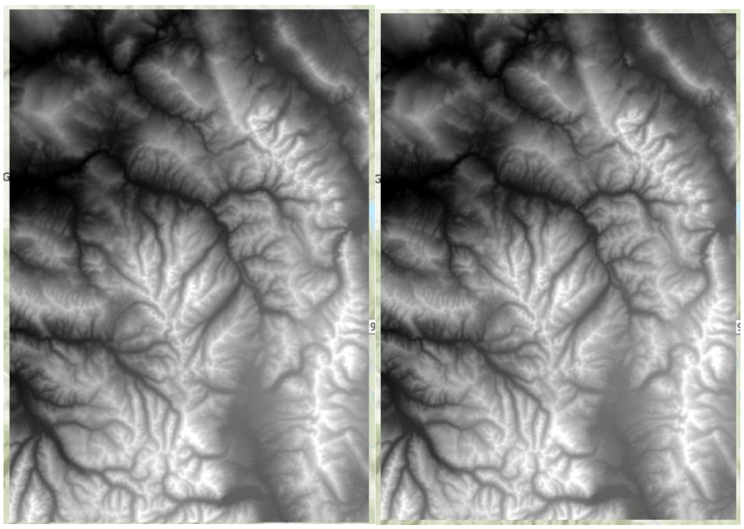
Madyson Bradford

GEOG 475

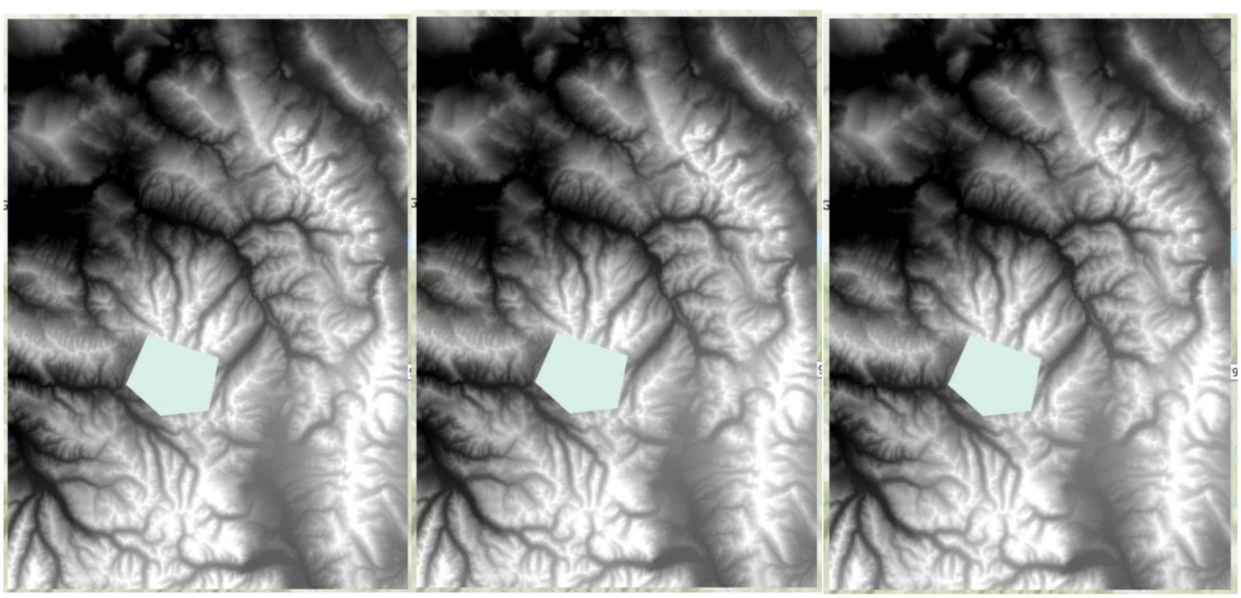
1 April 2021

Lab 3: Terrain Analysis

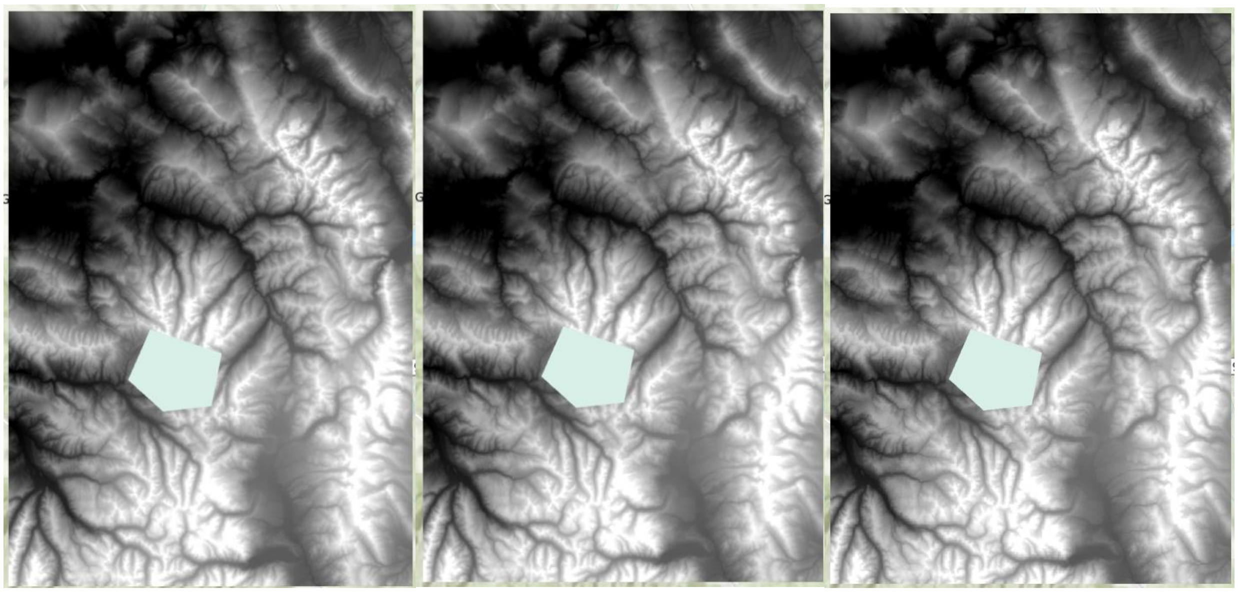
Univariate Statistics



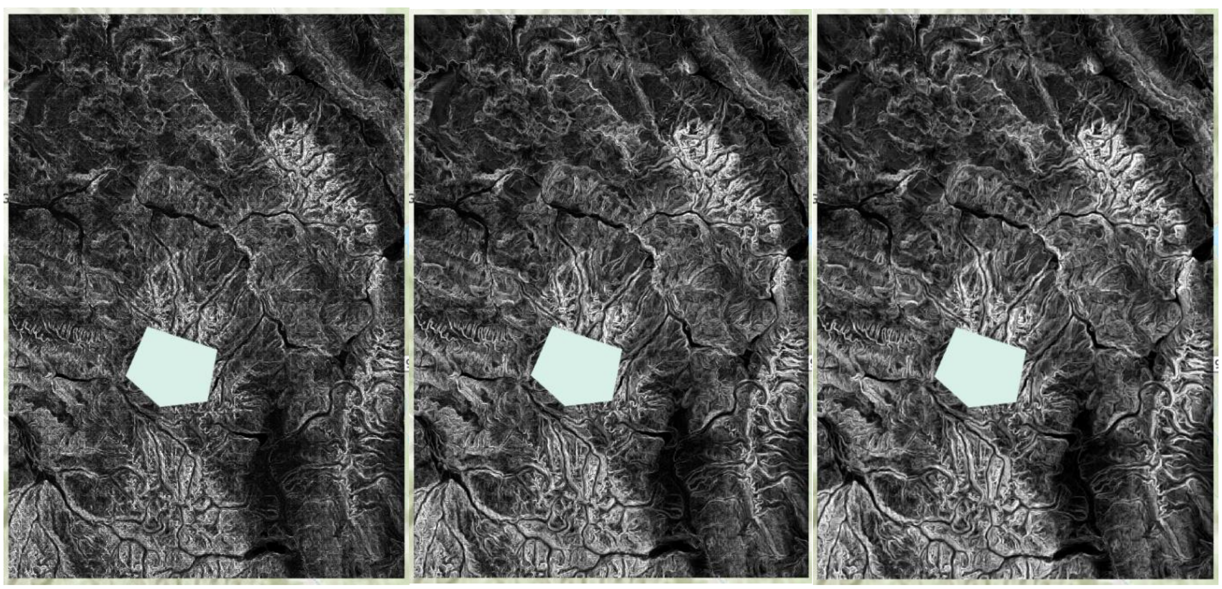
***Left**: DEM 60m resample; **Right:** DEM 90m resample.*



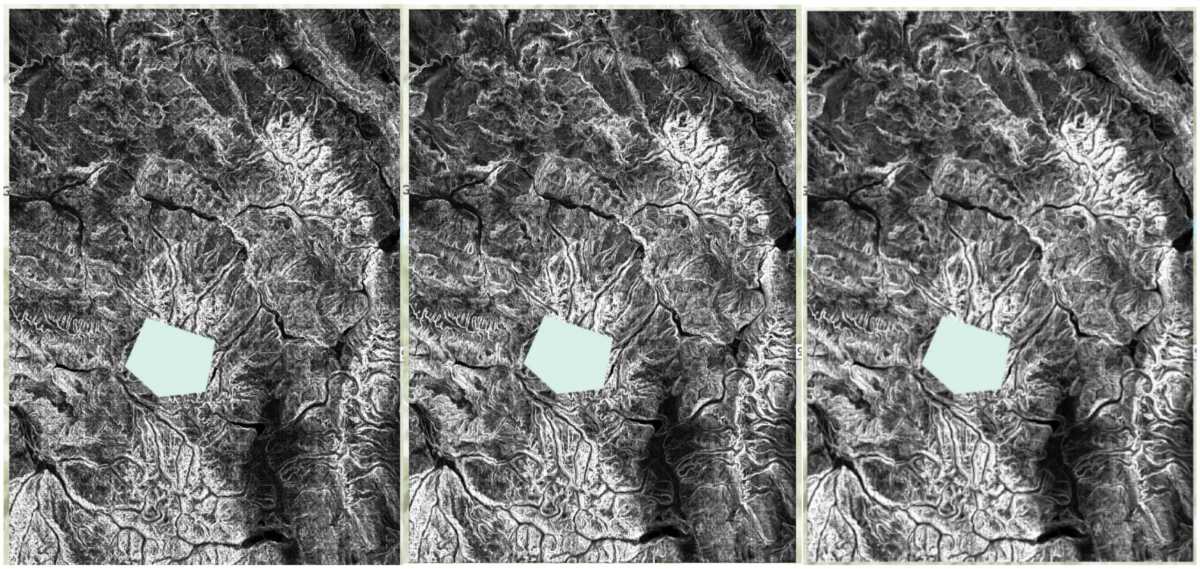
***Left to right:** 30m focal statistics: minimum, 60m focal statistics: minimum, and 90m focal statistics: minimum*



***Left to right**: 30m focal statistics: maximum, 60m focal statistics: maximum, and 90m focal statistics: maximum*



***Left to right:** 30m focal statistics: stdev, 60m focal statistics: stdev, and 90m focal statistics: stdev*



Left to Right: *30m Relief Map, 60m Relief Map, 90m Relief Map*

DEM	OBJECTID *	OBJECTID_1	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	VARIETY	MAJORITY	MINORITY	MEDIAN	PCT90
30m	1	1	194561	175104900	2681	4005	1324	3323.6335	265.96293	646649451	1317	3239	3972	3315	3678
60m	1	1	48639	175100400	2681	4002	1321	3323.8393	265.66082	161668221	1293	3239	2681	3315	3678
90m	1	1	21615	175081500	2681	3998	1317	3323.574	266.00236	71839051	1259	3241	2683	3314	3678

Table of 30m, 60m, and 90m resampled DEM Univariate statistics.

To what degree does the grid resolution influence the magnitude of the statistics? Provide examples and explain the reasons for your results.

The grid resolution influences the magnitude of the statistics in a significant way. The smaller the resolution, the more accurate the statistics calculated are. The 30m DEM includes the highest pixel count (COUNT = 194561), which is more almost exactly 4 x the pixels used for the 60m DEM calculations. Despite this, the minimum remained the same across all three resolutions. However, the arguably more valuable statistics like mean, standard deviation, and range did vary between the different resolutions. The 30m DEM had a standard deviation between the 60m and 90m DEMs (STD = 265.96293), accounting for a more reasonable amount of variability. This more complex representation of the landscape given by the 30m DEM is more likely closer to an accurate characterization of the topography than a more generalized approach with a lower resolution, which did not take into account the higher maximum value the 30m DEM calculated (MAX = 4005).

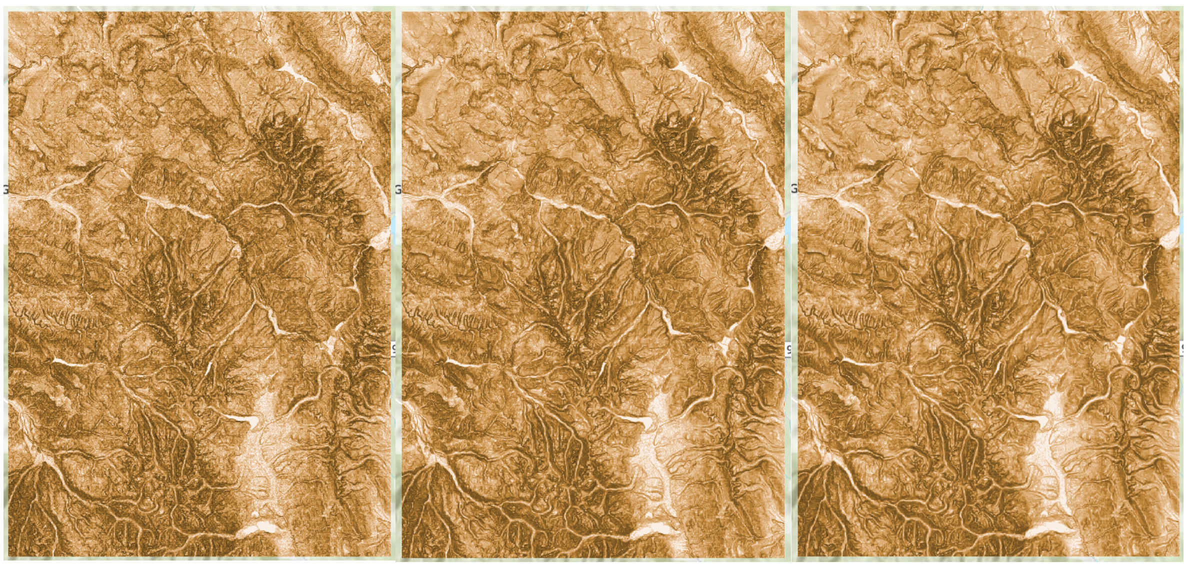
Examine the relief, standard deviation and surface area maps. Describe the spatial distribution of those parameters/properties (e.g., what areas are highlighted by the largest values).

For each calculated parameter, the highest value (brightest) is the highest value calculated for that parameter, showing the lowest value (darkest) in contrast. For the relief map, the highest values (brightest) represent the highest elevation values, the highest levels of relief. The lowest elevation values appear darker than high elevation values. This is similar to the standard deviation map, which has the highest standard deviation values represented with the brightest pixels and the lowest standard deviation values represented with the darkest pixels. Areas with the highest standard deviation in the distribution represent areas of the highest topographical complexity.

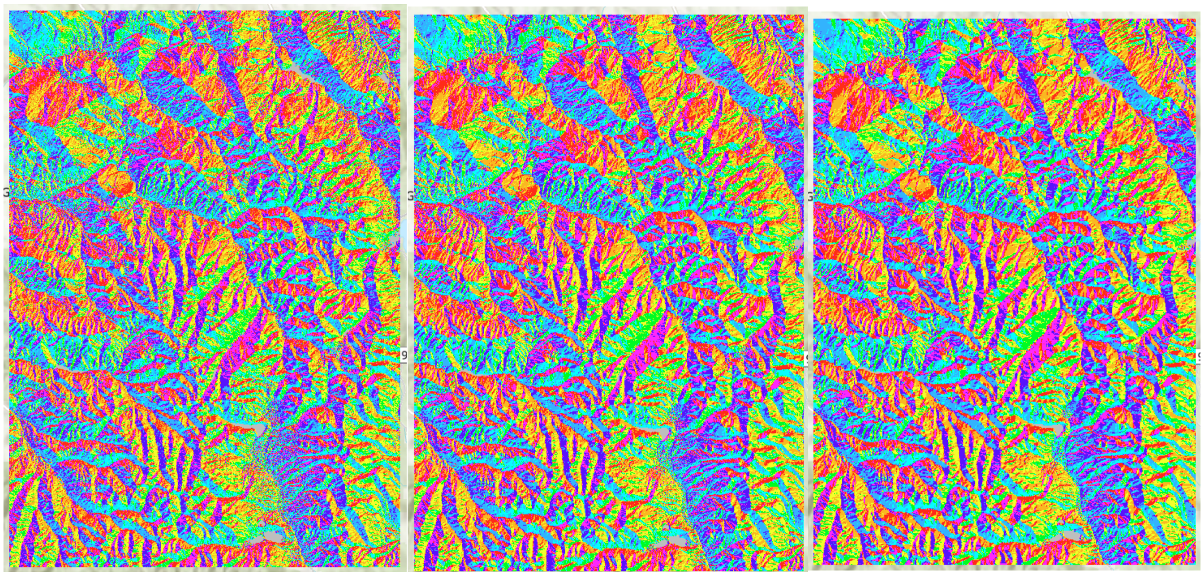
Is the information content in these maps similar or different? How do you know? Provide qualitative and quantitative evidence for your interpretation.

Qualitatively, the relief and standard deviation maps appear relatively similar. This is because as the topographic complexity increases, standard deviation values increase. A sharp change in standard deviation values could be cause by a sudden increase in elevation (relief) values. In addition, the range of standard deviations (0 - 110) is a little less than half the relief range value (0 – 280). This adds to the visual similarity since the relief map values are basically just scaled up versions of the standard deviation, and would rise and fall similarly to standard deviation in areas of changing relief.

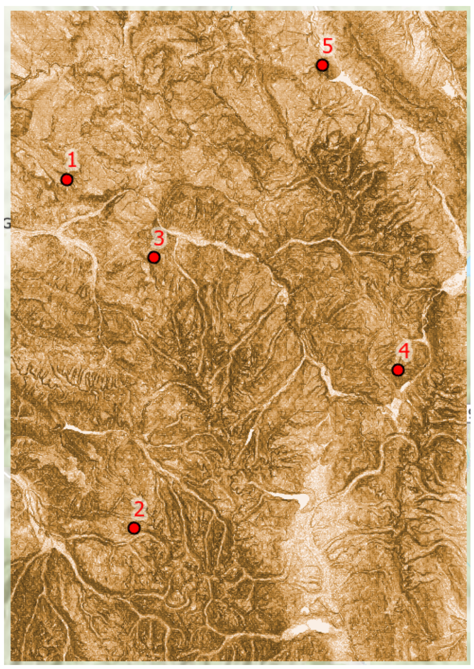
First-Order Derivatives



Left to Right: *Slope 30m, Slope 60m, Slope 90m*



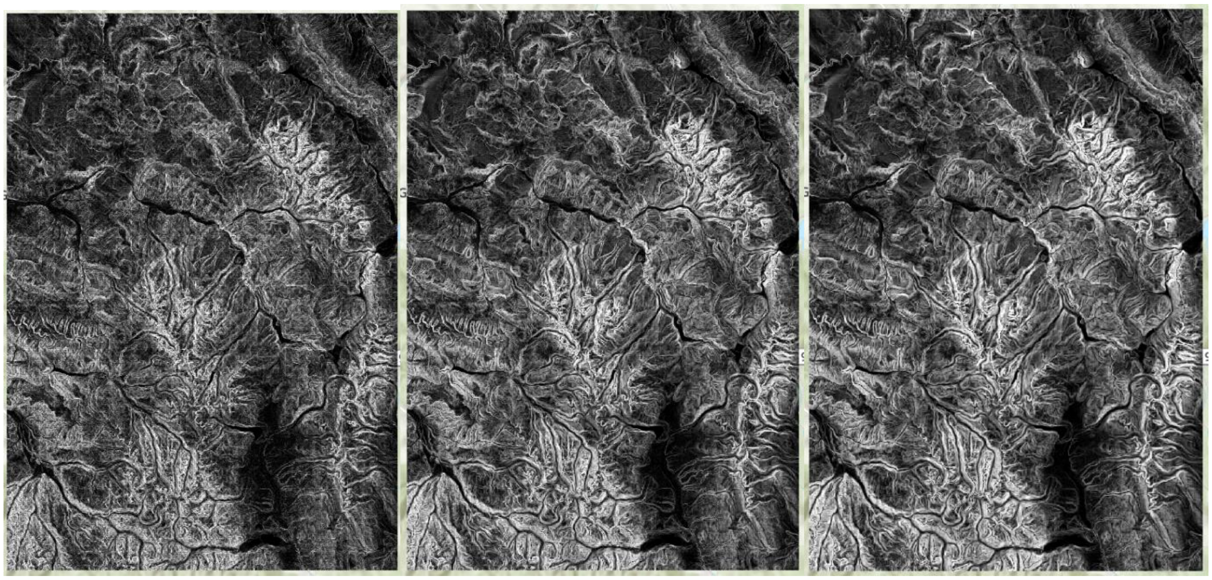
Left to right: *Aspect 30m, Aspect 60m, Aspect 90m*



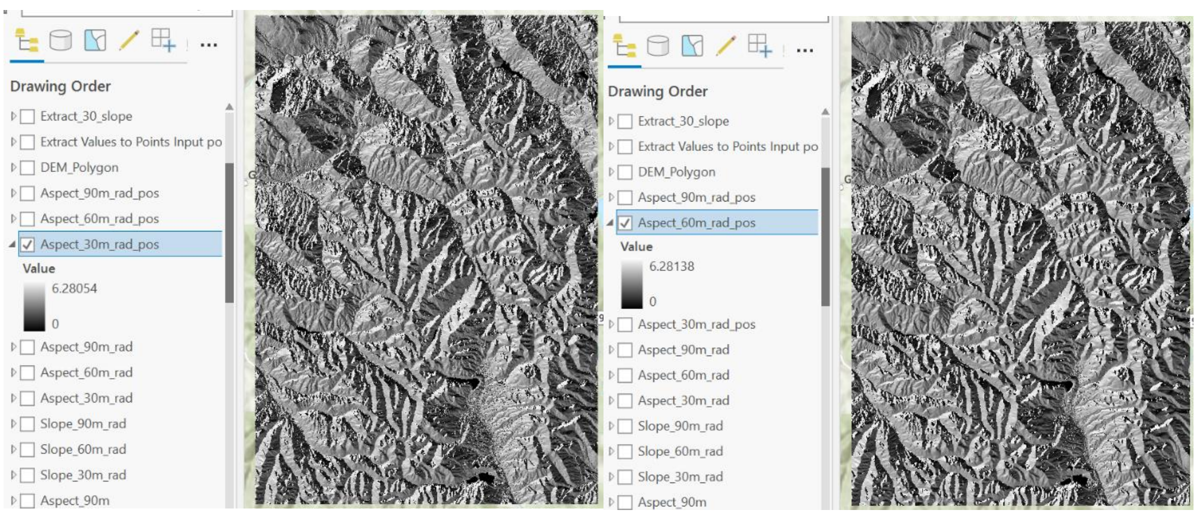
Random Point Locations Numbered 1 – 5, against backdrop of Slope 30m Raster for reference.

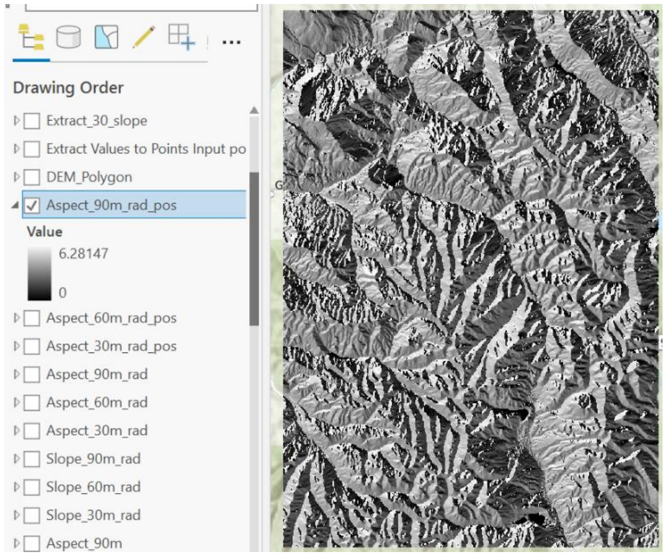
Point	Slope30mVal	Slope60mVal	Slope90mVal	Aspect30mVal	Aspect60mVal	Aspect90mVal
1	28.26449013	24.01726913	21.91627121	197.5924225	196.5709534	198.9353333
2	18.24570084	17.95980072	19.97092056	253.8556671	226.041626	224.3806152
3	20.95764732	15.95659161	16.52130699	22.38013458	46.77146912	8.888941765
4	22.11128807	25.47336769	10.85399723	115.5138702	129.6772461	97.07353973
5	31.89744949	33.49523163	30.14551735	296.2219543	298.1785889	289.5616455

Extract Values to Points table, with random points 1 – 5.



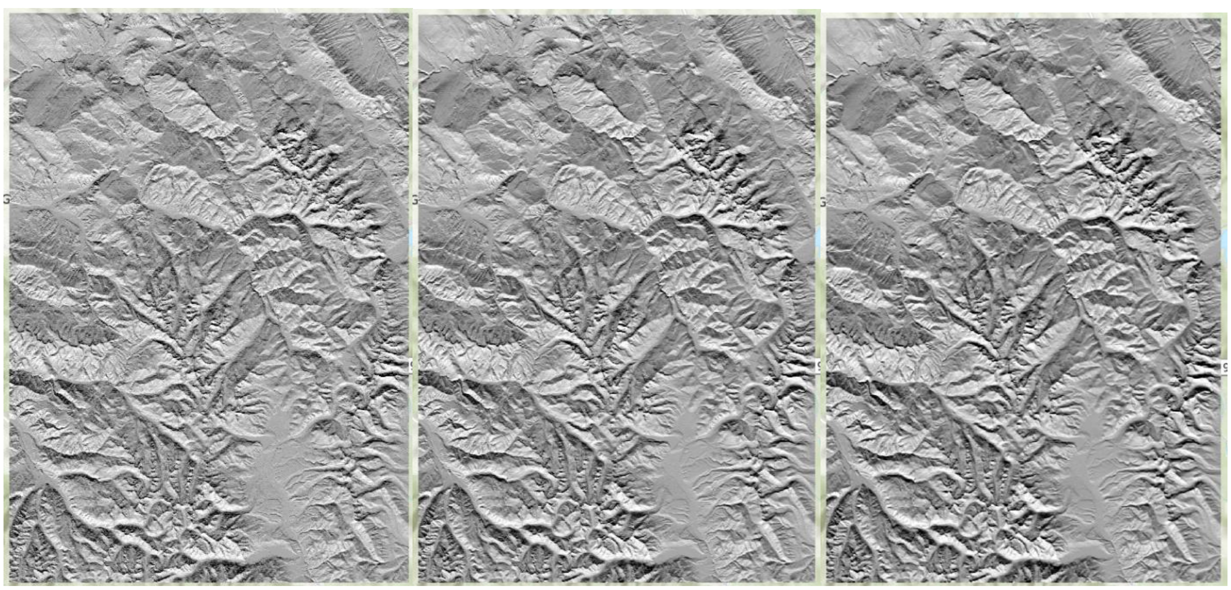
Left to Right: *Slope 30m calculated in radians, Slope 60m calculated in radians, and Slope 90m calculated in radians.*



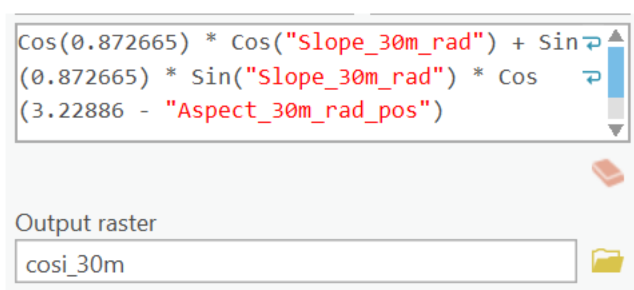


Top Left to Right: *Aspect 30m converted to positive radians, and Aspect 60m converted to positive radians.*

Bottom: *Aspect 90m converted to positive radians.*



Left to right: *30m Cosi, 60m Cosi, and 90m Cosi.*



Cosi equation for the 30m DEM.

Solar Zenith: *50 degrees → 0.872665 radians.*

Azimuth: *185 degrees → 3.22886 radians.*

Examine the spatial distribution of slope and slope-azimuth angles over the study area. Can you see much difference in spatial patterns given the measurement scale of the DEM?

Given the measurement scale of the DEM, it is hard to distinguish between each individual resampling. The only real visible difference is when the 30m and 90m slope rasters are compared side by side since the geographic areas with the highest slope values appear more exaggerated in the 90m raster. This could be a generalization of that topographic area.

Compare and contrast the magnitude of slope angle and slope-azimuth values in your table as a function of grid cell size. Do the values exhibit magnitude differences? Do you see any trends? Provide examples and explain the reasons for your results.

The slope angle and slope-azimuth exhibit magnitude differences, since the slope-azimuth is about 7, 8, and 9 times the slope angle (30m, 60m, and 90m, respectively). This illustrates a trend: as the resolution lowers, the magnitude difference between slope and slope-azimuth increases. For example, the Aspect 30m value for point 1 (197.5924225) divided by the Slope 30m value for point 1 (28.26449013) is 6.9908. The Aspect 60m value for point 1 (196.570953) divided by the Slope 60m value for point 1 (24.01726913) is 8.1846.

Compare the information content in the slope map with that of the relief, standard deviation and surface area map. Can you detect any information redundancy associated with these map products. Provide qualitative and quantitative evidence to validate your answer.

Between these maps, the content tends to be redundant. Since slope high values correlate with changes in relief, the two tend to mirror each other in trend. Consequently, this change in relief and slope causes high standard deviation values, making the information redundant. Because of this redundancy, the spatial distribution of high and low values is hard to differentiate.

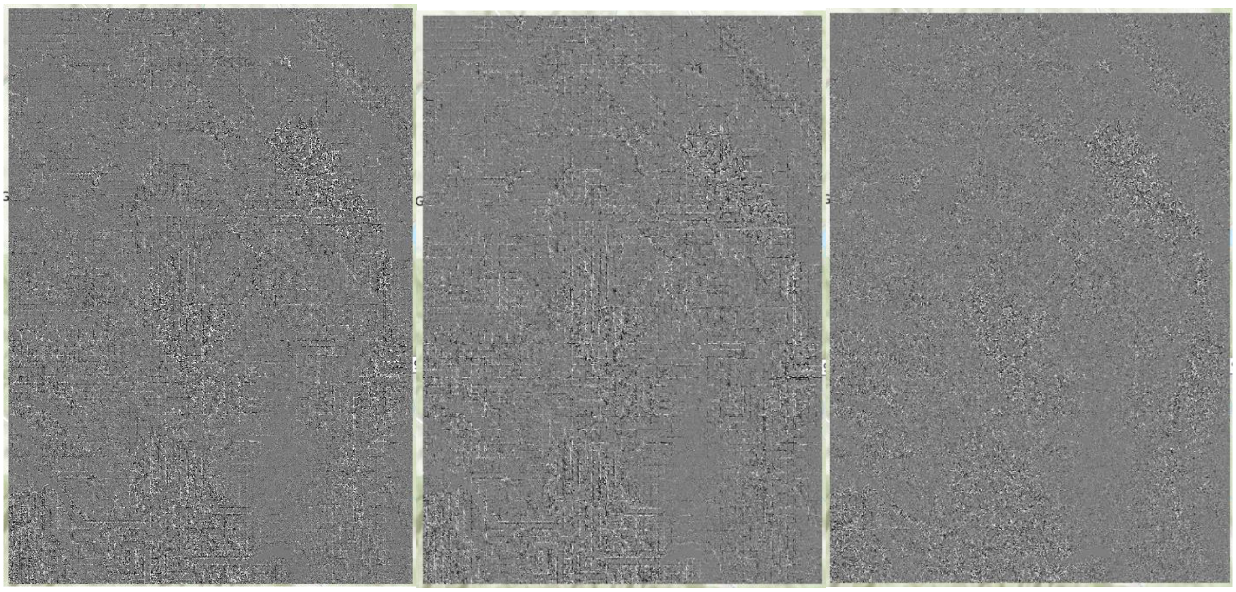
Does your shaded-relief map contain the same information as the previous maps that you have generated? How do you know? Provide qualitative and quantitative evidence.

The shaded-relief map contains the same information as the previous maps generated, just combined into one, since it used both the slope and slope-aspect rasters in the raster calculation. The combination accounts for both parameters, which characterizes the complexity of the topography better. The ridges and depressions in the shaded-relief map are like the slope-aspect map, along with similar patterns of highs and lows that the slope map characterized.

Which geomorphometric parameter (given the parameters that you have generated) would you tell someone else to use if they wanted to effectively visualize the spatial structure of the topography? Provide comparative image/map evidence to support your conclusion.

To effectively visualize the spatial structure of the topography, the Cosi parameter should be calculated. This parameter combines most of the other parameters in its calculation, including an added parameter of solar zenith and azimuth angles that are dependent on the geographic location of the area, which adds to the effective characterization of the topography. With the Cosi parameter, on the map you can see how the shadows manifests on the landscape, unlike just the slope or slope-aspect, which adds realism to the characterization of the landscape.

Second-Order Derivatives



Left to Right: *30m Curvature, 30m Profile Curvature, and 30m Tangential (Planform) Curvature*

What features or terrain characteristics are highlighted using profile curvature (highlighted could mean extremely high or low values on the landscape)?

Since profile curvature (vertical curvature) is defined by the slope azimuth angle, it mirrors the direction of the topography. High values represent high values on the landscape where acceleration of the flow of materials would be very high, in contrast to dark values which represent areas of deceleration of materials on the landscape.

What features or terrain characteristics are highlighted using tangential curvature (highlighted could mean extremely high or low values on the landscape)?

With tangential curvature (horizontal curvature) the values represent convergence or divergence calculated orthogonal to the vertical plane. This means high values represent convergence, such as mountains or ridges in the landscape, and low values approach divergence like faults or cracks.

Do curvature maps produce unique information about the landscape compared to the other metrics that you have generated? Provide qualitative and quantitative evidence for this.

Curvature maps are good for representing complex patterns in the landscape not calculated by univariate and first order statistics alone. It accounts of the possibility of processes, like landslides are depositional events. Other statistics would not provide enough information to suggest convex or concave areas are present, nor convergence or divergence in an area with any level of certainty.