Copernicus Master in Digital Earth

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Methods in Spatial Analysis

Assignment 2: Watershed Analysis.

Objectives

The objective of the study is to use spatial techniques to elaborate an analysis of a watershed located in Austria. All the methods are developed with the Arcgis Pro and its raster, terrain and hydrology methods.

Area of Interest:

For the watershed of interest, I decided to choose a watershed that pass through Zederhaus community. Surrounded by the mountains and the peak of Hochfeind. A localization map is represented on the figure 1:

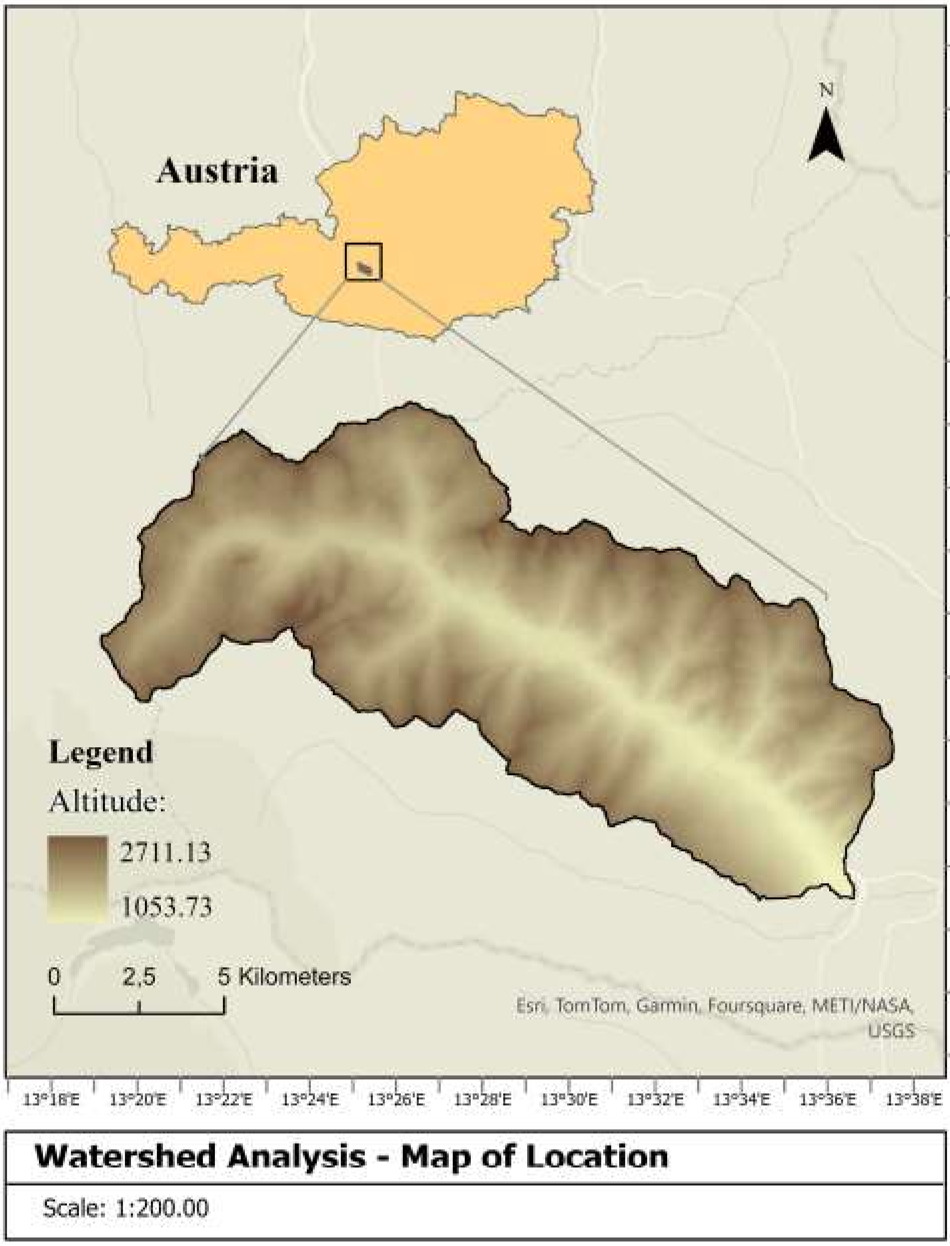


Figure 1 - Map of location.

The watershed choose has an area of 162 km², with 74 sub-watersheds. The average of all sub-watersheds is 2.19, with a standard deviation of 1.78. The figure below shows the statistic of the distribution from Arcgis properties.

	Dataset
Mean	2,1935014384
Median	2,00137385
Std. Dev.	1,7759305276
Rows	74
Count	74
Nulls	0
Min	0,00622139
Max	11,90248342
Sum	162,31910644
Skewness	2,6695336106
Kurtosis	14,3805420143

Figure 2 - Stats regarding the area of each watershed.

A hillshade map of the watershed is exhibited on the figure 3:

Figure 3 - Hillshade map.

Task 2:

To understand better how the watershed behaver when it comes to terrain and morphology, a study is contemplated by creating slope, aspect and subsequently analysis.

The Slope is show up on the figure 5:

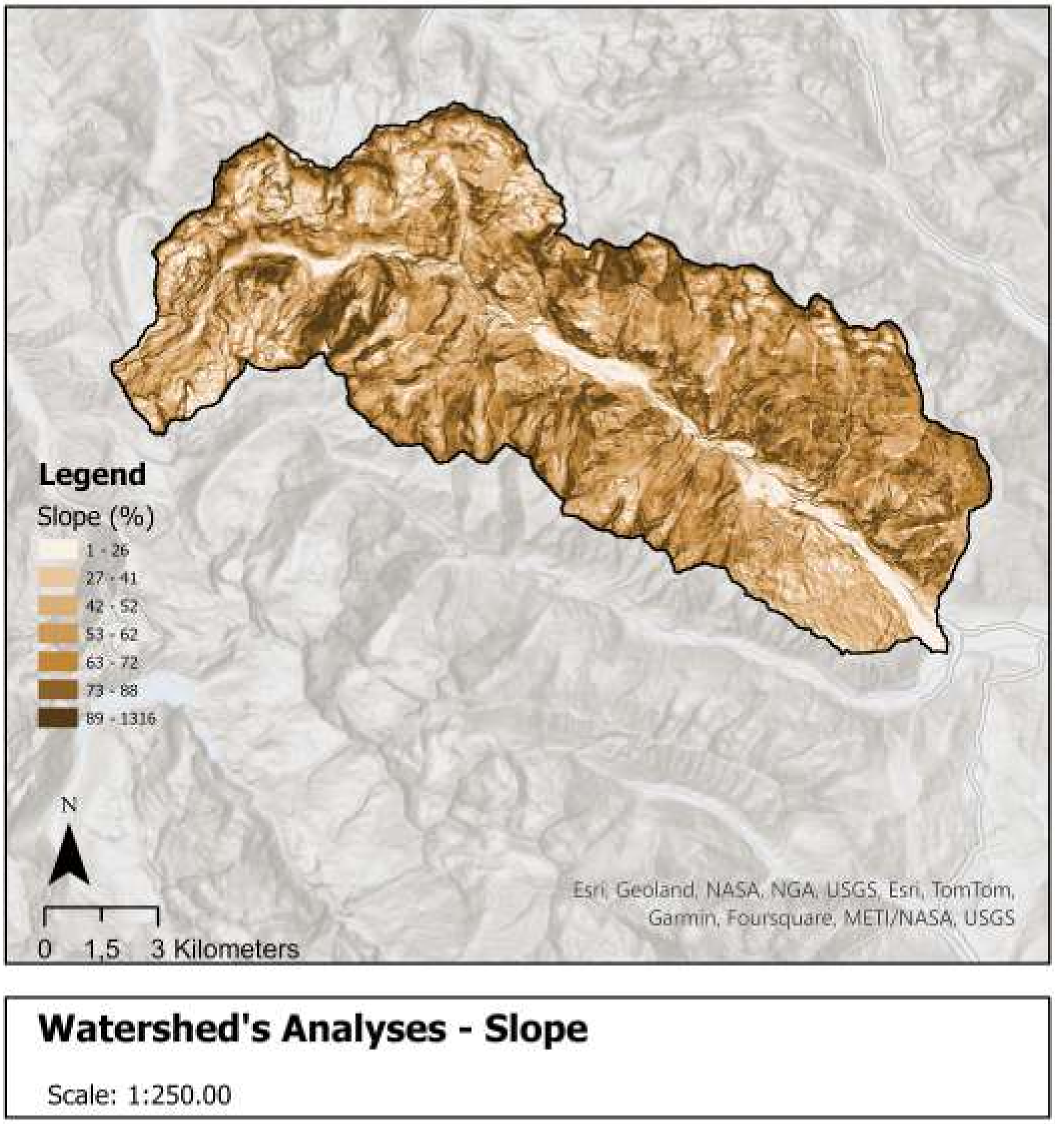


Figure 4 - Watershed's Slope

The aspect map can be visualized on the figure 5:

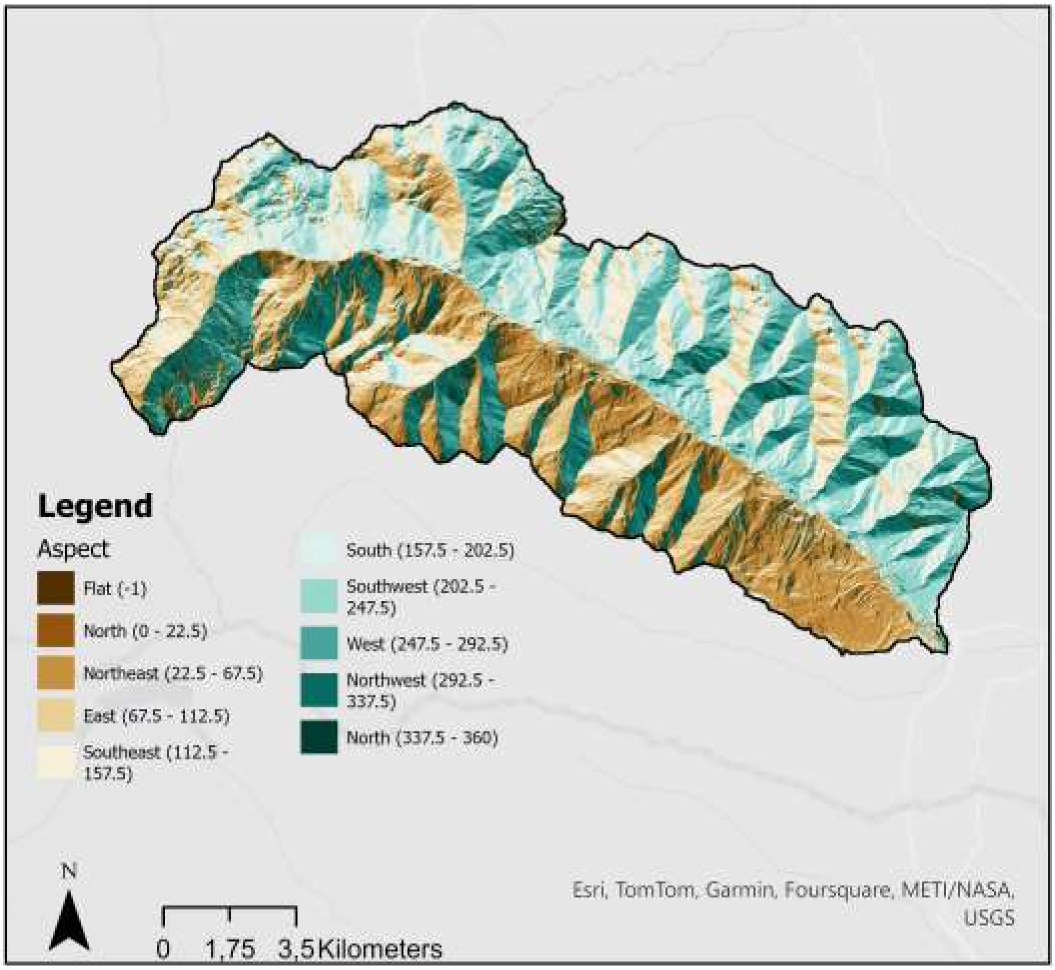


Figure 5 - Aspect of the watershed.

It is important to understand the distribution of the slope on the watershed, because it will bring a better overview of slopes, which influences directly on water flow and channels network. The histogram of the slope can be visualized on the figure 6:

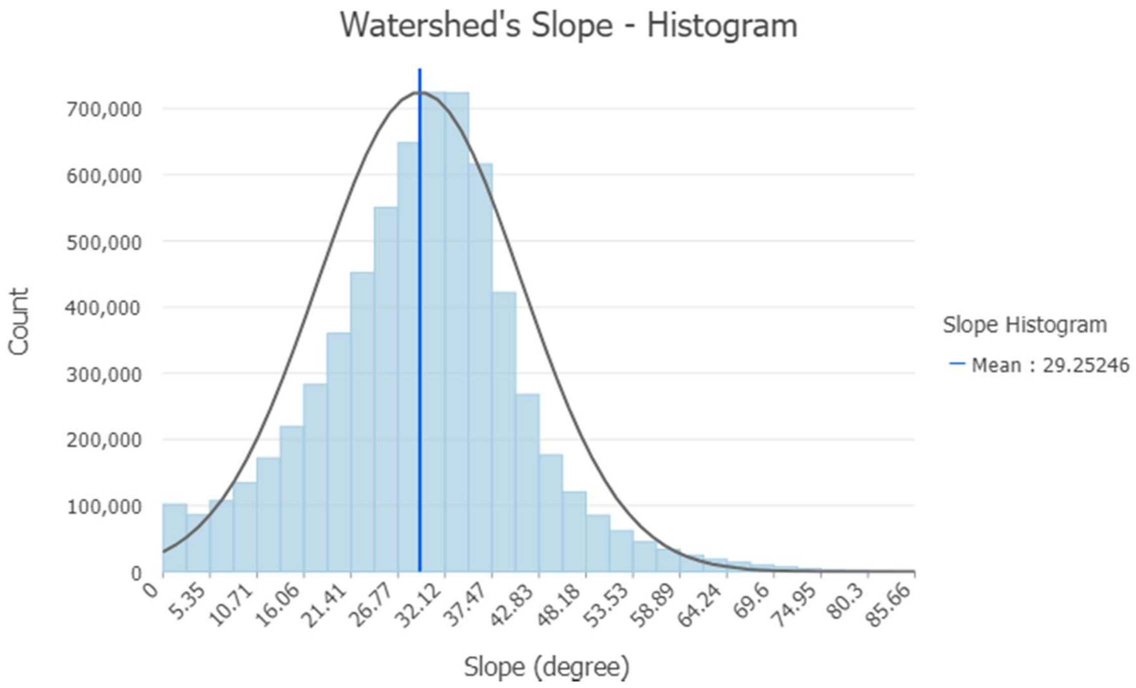


Figure 6 - Histogram Slope

The histogram shows an average of 29.25 degrees of slope in the watershed. The distribution has a briefly skewness towards left (positive) and at least 90 % of the values are lesser than 80 degree. In comparison with the normal distribution, the histogram is not fitting a normal distribution of values. There is a slightly bias towards the right side of the distribution.

Task 3

On the task three, it is investigate a zone altitude, looking at the contour lines and connecting with slope.

The map of elevation zones is shown in the figure 7.

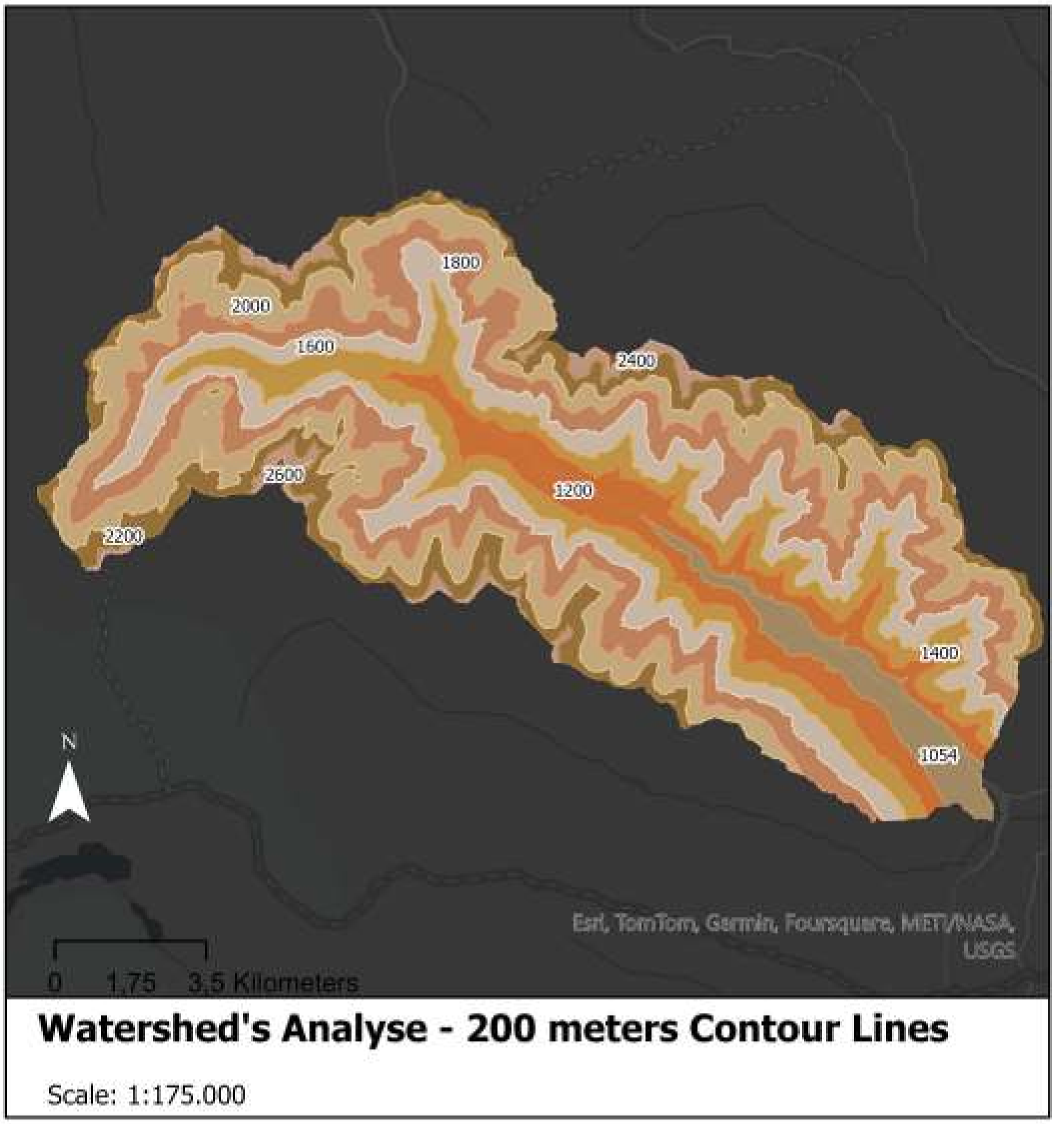


Figure 7 - Watershed's 200 meters contour lines.

The mean slope (degree) per each contour line can be visualized on the figure 8:

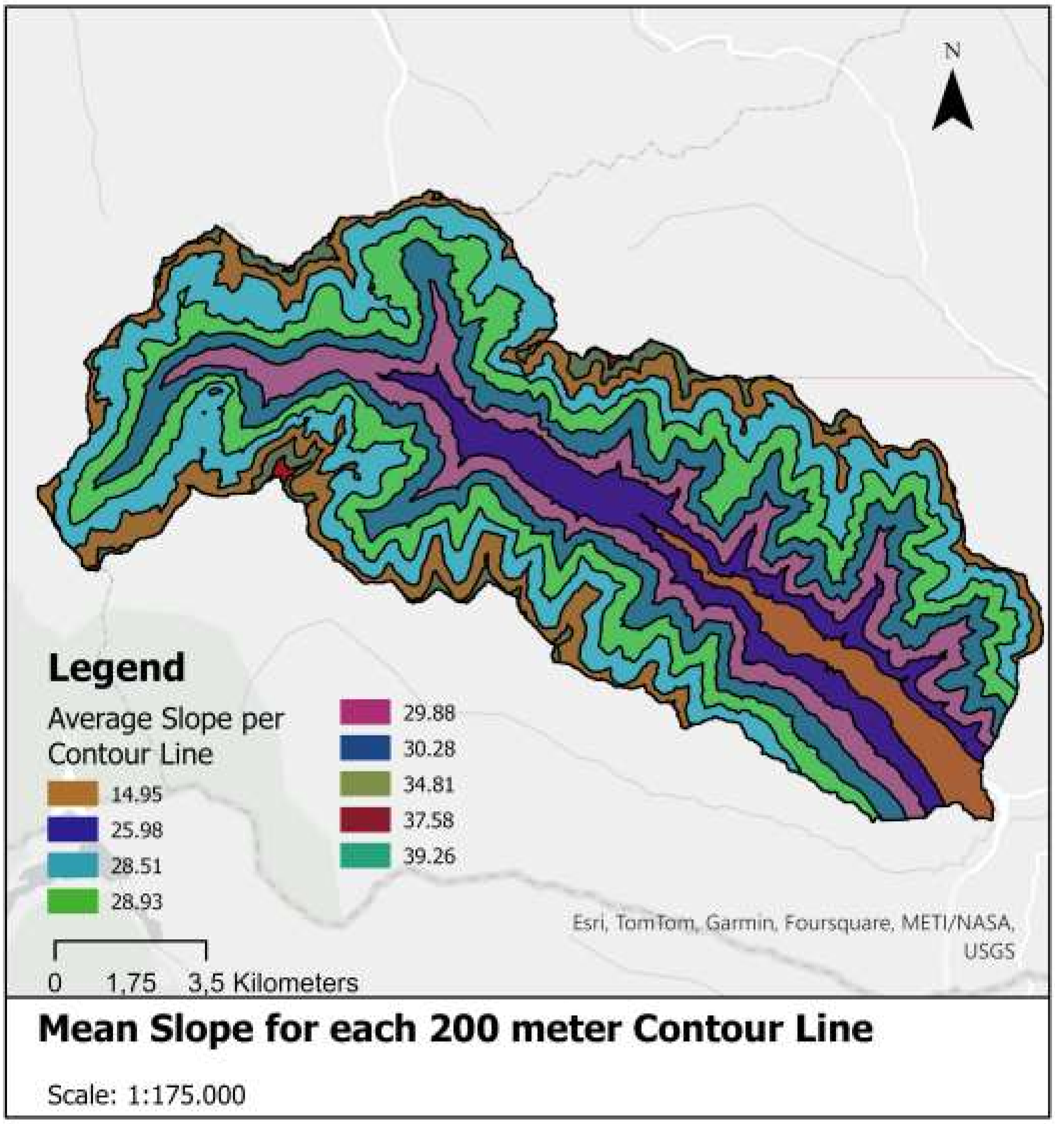


Figure 8- Mean slope per contour line

The figure 8, points out that as the altitude increases, the average slope also increase, which means that for higher altitudes results on higher slope for the watershed analysed. The mean slope close to 1200 is only 14 degree, but as the altitude goes close to 2400 meters, the slope degree average is almost 40 degree, showing a shape very sharps and bumpy for higher zones.

To create the histogram, I used the *tool Zonal Histogram*, to create the histogram for each elevation zone. Then, to optimize my plot, I exported the table as a .csv file and plot it using python and the seaborn library.

The histogram for each zone level is point out on the figure 9:

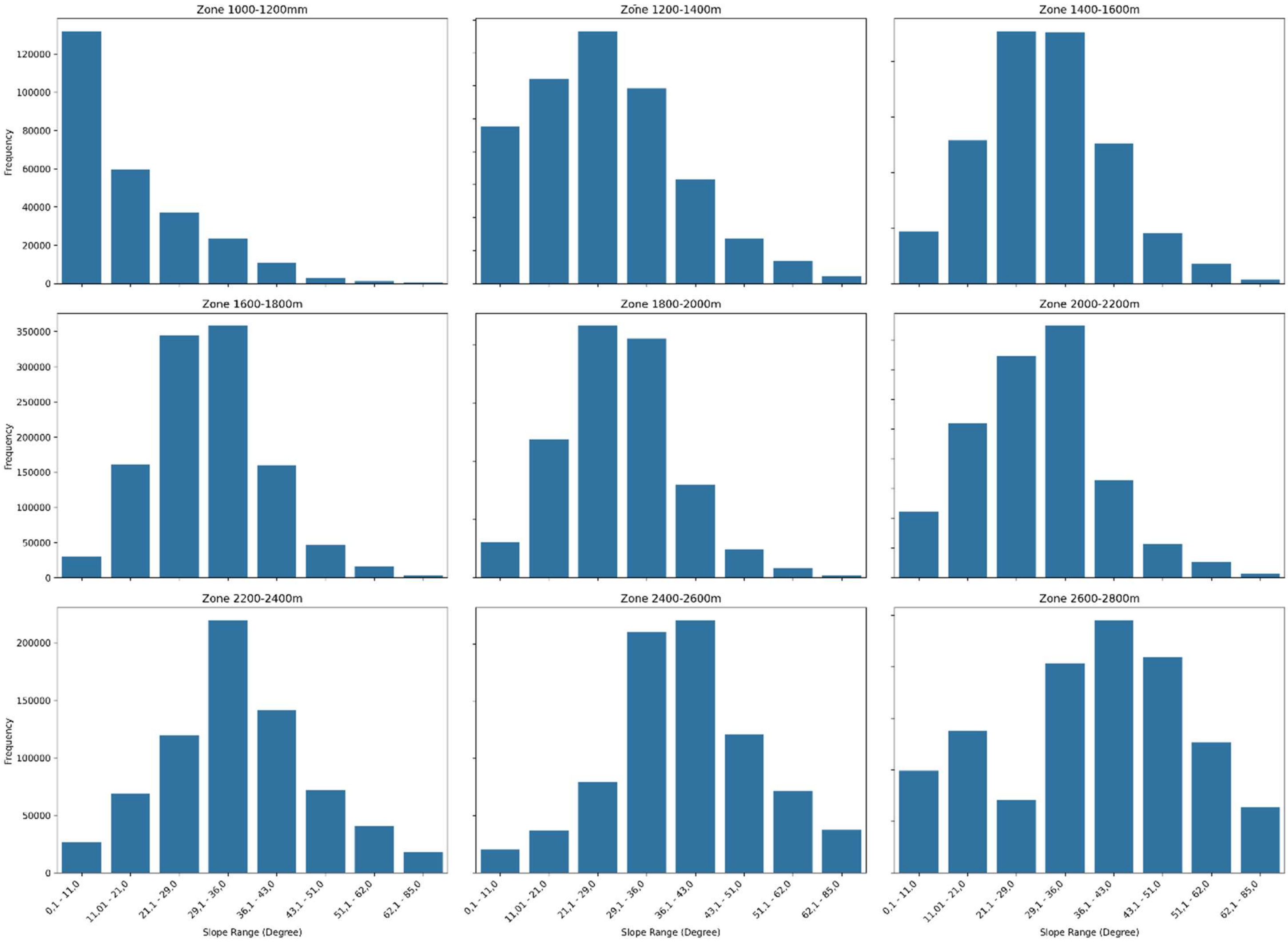


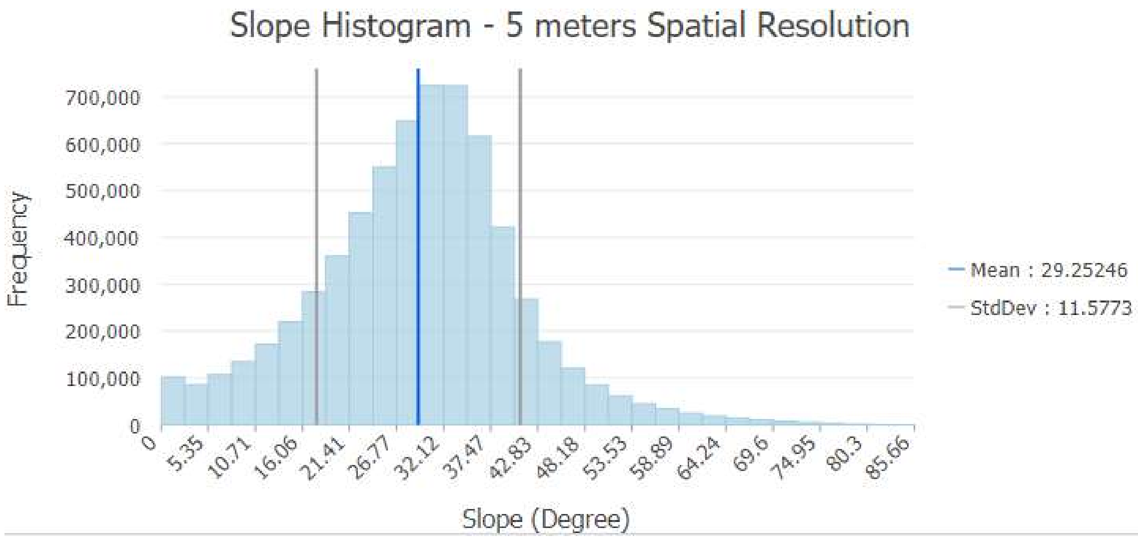
Figure 9 -Slope Histogram for each elevation zone.

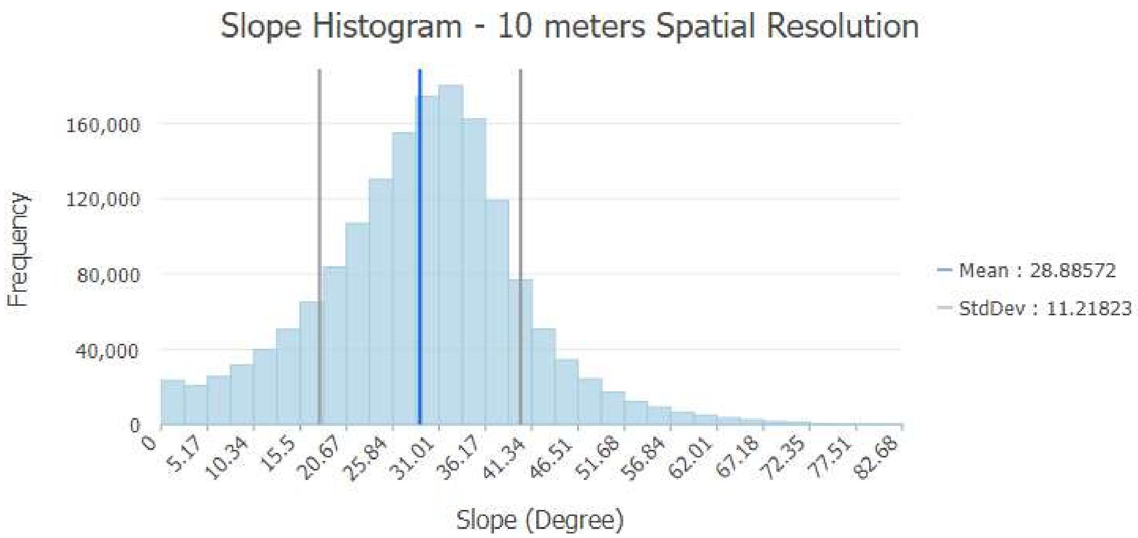
Figure 9 illustrates the differences in slope distribution across elevation zones. In the watershed's lowest elevation zone, the slope histogram shows an abundance of values in the first bin, representing slopes less than 11 degrees. This indicates that the lowest elevation zone predominantly consists of gentle slopes. Similarly, in the second and third elevation zones, with altitudes below 1,600 meters, the slope histogram distribution is skewed toward the left (positive skewness), indicating that these lower elevations also comprise relatively gentle slopes.

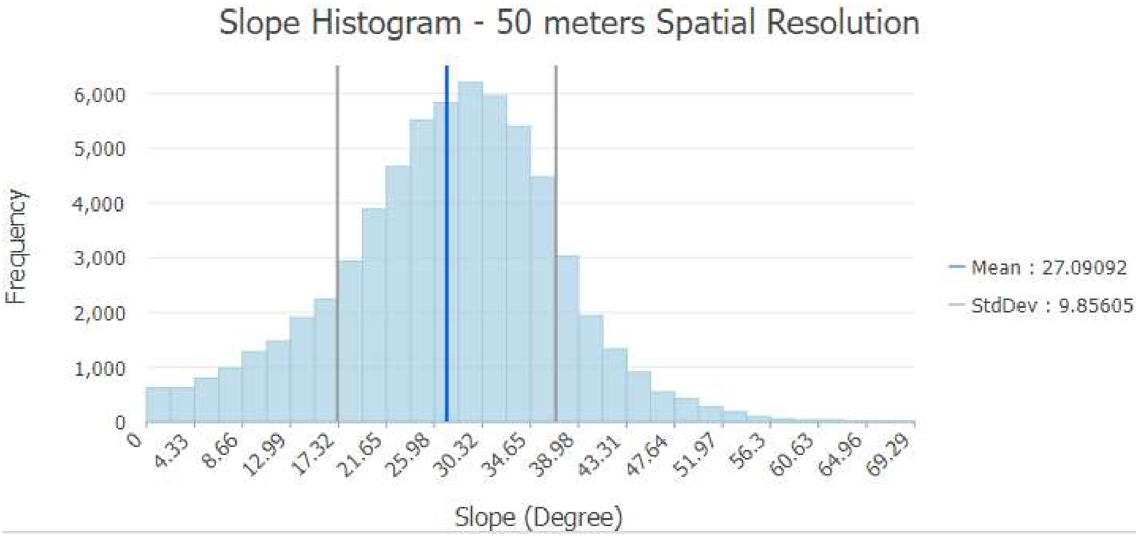
The histogram for the middle elevation zone of the watershed exhibits a distribution closer to normal, with only slight positive skewness. However, in elevation zones above 2,000 meters, the histogram distribution shows negative skewness, indicating the presence of steeper slopes. As elevation increases, so does the frequency of higher slope degrees, demonstrating that steeper terrain characterizes the peak areas.

TASK 4:

To create reduce the raster resolution, it was used the *tool resampling*. The raster was resampled to have two new spatial resolutions: 10 and 50 meters. The strategy used to resample was nearest neighbour. Then, a map and histogram were created for both resolution, being able to analysed on the figure







Based on Figure 10, it is possible to observe from the histogram that as the resolution becomes coarser, it affects the mean, reducing it. The standard deviation also decreases with coarser spatial resolution. The resampling strategy decreases the variability of the data, which in turn affects the statistics. A spatial resolution between 5 meters and 10 meters does not significantly affect the results, which demonstrates suitability for a watershed analysis at a resolution of 10 meters. However, a 50-meter resolution shows a different histogram shape, with a skewness towards right-skew. A significant reduction in standard deviation is also notable at the 50-meter resolution, indicating that the dataset becomes more concise due to the reduction in variability.

The table 1, highlights the difference between each spatial resolution when it comes to mean slope for each elevation zone.

Spatial Resolution		5 meters	10 meters	50 meters
ContourMin	ContourMax	Mean Slope	Mean Slope	Mean Slope
1053	1200	14.95	14.62	13.44
1200	1400	25.97	25.63	23.52
1400	1600	28.51	29.56	27.67
1600	1800	28.93	29.96	28.38
1800	2000	29.88	28.56	27.13
2000	2200	30.28	28.10	26.44
2200	2400	34.81	34.44	32.33
2400	2600	37.58	38.93	36.28
2600	2711	39.27	36.83	30.49

The differences between the mean slopes for each spatial resolution are notable. The 5-meter resolution again shows a loss of information, especially for higher altitudes, where the mean slope is 39 degrees in a 5-meter raster and only 30 degrees in a 50-meter raster. This implies that coarser resolutions cannot capture significant slope variations throughout space. In general terms, the 50-meter resolution shows a lower mean when compared with other resolutions. The 10-meter and 5-meter resolutions are similar in terms of slope averages for each zone, demonstrating the suitability of using a 10-meter resolution for watershed analysis.

The figure 12 shows on a map mean slopes on different zones for each spatial resolution.

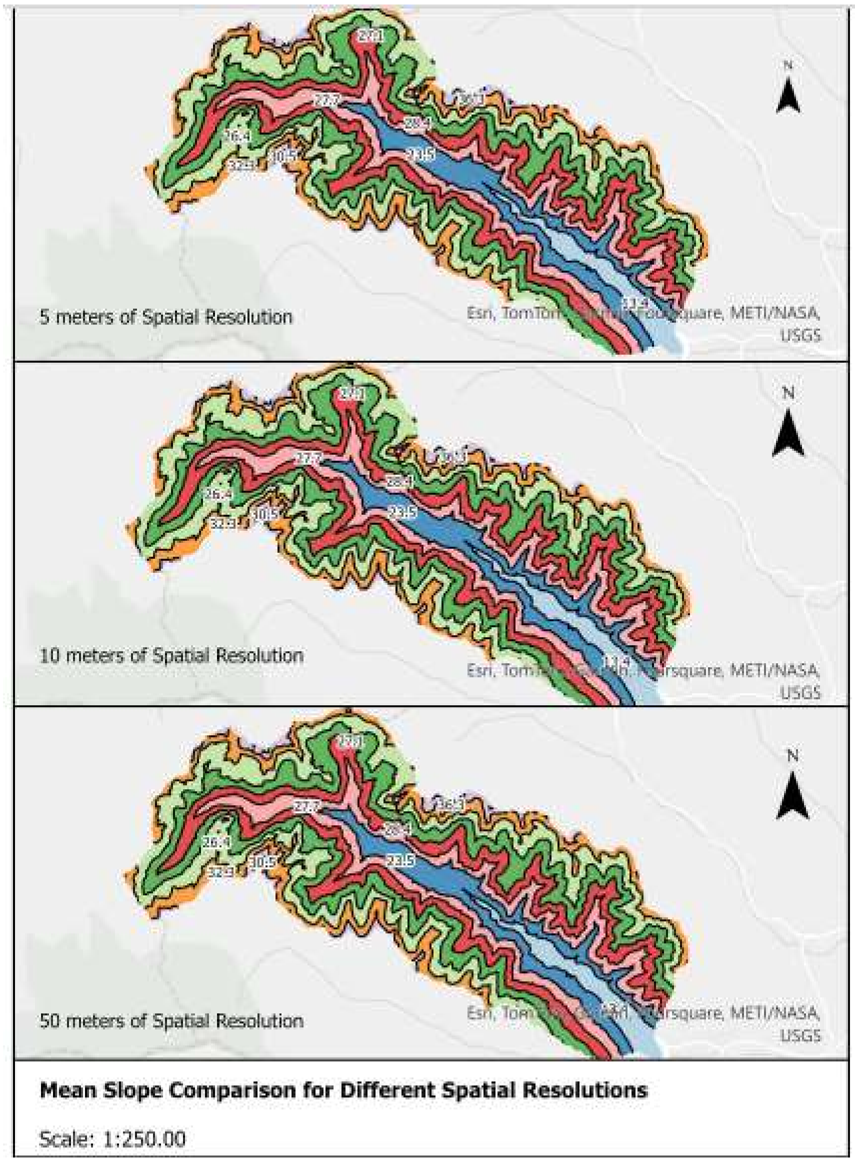


Figure 10 - Comparing different spatial resolution.