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Pellissier Ranch Remote Sensing Investigation

Abstract

Pellissier Ranch in Riverside, CA is a potential resting place of artifacts from the Inland Empire's first settlement, La Placita de Los Trujillos. The Great Flood of the Santa Ana River in 1862 washed away the entire settlement in a single night. Geophysical surveys are being employed at the site to non-invasively search the subsurface for buried artifacts. As Pellissier Ranch covers an immense area, remote sensing will be employed to narrow the search area to locations that would be likely deposit locations from the overwhelmed river. Digital Elevation Models were acquired from the USGS and used to derive raster datasets of slope, contour lines, flow direction, and flow accumulation. From the combined analysis of the three datasets, it is likely that the northeast portion of the site experienced the least force from the overwhelmed Santa Ana River and is best to prioritize in the search for buried artifacts.

Introduction

Pellissier Ranch is currently a vacant lot covered in tall grasses year-round. The northern half is in San Bernardino County, and the southern half in Riverside County. The most recent owner had been Antoine Pellissier, who purchased the land in 1905 and developed it as a vineyard. Shortly after, the dry laws came into effect and it ruined Pellissier's business, forcing him to abandon the land as it has remained until present day. Before it came into his possession, it belonged to the Inland Empire's first settlers and was known as La Placita de Los Trujillos (La Placita).

Lorenzo Trujillo was the leader of this settlement. A wealthy rancher in the area had given the land conditionally to Trujillo and the group of settlers he traveled with under the condition that they would protect the land and property of the rancher from hostile Native American raids. From 1843 to 1862, the settlement flourished. La Placita rested along the Santa Ana River and its soil was very fertile. The inhabitants were hard-working, community-oriented people. However, in 1862, January experienced two weeks of unceasing rain, leading to the complete overwhelming of the Santa Ana River. "What had been the largest settlement between New Mexico and Los Angeles in the mid-1800s was washed away in a single night" (Vickery, 1977). All the structures were adobe and stood no chance against the fury of the river.

While the structures themselves, excluding the possible existence of foundations, were entirely washed away, all that had filled the structures should have persisted. "Metal cookware, utensils, farming equipment, and wooden objects" (Brumgardt and Putney, 1977) that would have filled these homes and structures of La Placita would not have dissolved as adobe would have in water. Therefore, it is likely that many of the artifacts from this ancient settlement still exist in the subsurface somewhere. Seeing as Pellissier Ranch was ground zero for La Placita, it is likely that many of the artifacts are in the subsurface there.

At approximately 1,000 acres, Pellissier Ranch requires a vast amount of time to survey in it's entirety. With development plans approaching, it is important that artifacts be located as quickly as possible to preserve the history potentially buried there. To accomplish this, ArcMap 10.5 (ERSI, 2017) was utilized to remotely determine most likely locations of deposited artifacts. The archaeological geophysics survey to follow this study will be the first at this site, and the remote imaging done in this study is the first attempt at determining likely artifact deposit locations.

Methods

This study gathered digital elevation model (DEM) data from the United States Geological Survey (USGS) of Pellissier Ranch (area shown in Figure 1). Their "The National Map" GIS resource for topographic information was able to provide the DEM raster datasets used in this study. The format they were given in was ".xml", which is not directly usable with ArcMap. 7-Zip 18.05 and uGet 2.2.1 had to first be downloaded and used jointly to convert the files into usable image format from their original ".xml" format. Once they were usable disc images, all 23 DEM files, which had cell sizes of 3' x 3' and followed the North America Datum 83 coordinate system were added to the map. Each contained 1000 rows and 1000 columns, with a band number of 1, a source type Generic, and a pixel type and depth of floating point and 32 Bit respectively. Angular units were given in degrees and linear units in feet. A total area of approximately 5.6 km in a north-south direction and 8.8 km in an east-west direction, was able to be analyzed with the DEM data.

Figure 1 *Area of Pellissier Ranch in Riverside, CA outlined in light blue. Coordinates: 34.027524, -117.353731. River an obvious, light brown/beige feature snaking across the area.*

Initially, all the DEM datasets had scales that were independent of each other. One dataset's scale would color an area white (low elevation) where another dataset would show the same elevation as gray (intermediate elevation). To solve this issue, a uniform dataset had to be created by combining all 23 datasets into a single dataset. ArcMap's Mosaic to New Raster tool was employed to complete this task. This was possible as the number of bands (1) and pixel depth (32 Bit) matched for all DEM datasets. All 23 DEM files were input into the tool and the single output dataset was named "Combined_Elevation_Raster." This successfully was able to combine all 23 datasets into one with a single scale.

With the one dataset, it was possible to use ArcMap's Spatial Analyst tools to investigate the site for various features. First analyzed was the change in slope across the DEM with the Slope tool. The single dataset was set as the input and the output was named "combined_slope", with a value of degree and a Z factor of 1. As the change in slope across the river and the area of Pellissier Ranch was minimal, a large class value of 20 was chosen to show the minimal changes and the color ramp was set to purple and

blue hues (with green to yellow to red reflecting greater slopes respectively, seen mostly in the Loma Hills to the north of the ranch).

Next, ArcMap's Spatial Analyst tool, Contour, was employed to further delineate boundaries of the potential river flow during the Santa Ana River Great Flood event. The single output dataset was set as the input and "converted to vector representations using conventional image processing techniques" (Greenlee, 1987). This output was named "Contour (asl) in 10' increments". As the change in elevation across the river and area of Pellissier Ranch is minimal, a contour interval of 10' was chosen. The contour line color was set to fire red and labels set to peach to easily see them overlain on the dark-colored DEM map.

ArcMap's Spatial Analyst tool was then used to derive a Flow Direction raster dataset. This raster's use was in immediately deriving a Flow Accumulation raster dataset, called "Flow_Accumulation" in which each "grid cell is treated as a point on a continuous surface on which a unit of flow package is generated and flows to the next downhill point(s)" (Zhou et al., 2011). This method has been found to be successful in the past, as "digital comparisons of the Big Tujunga Reservoir watershed and a digitized version of the manually delineated watershed indicated 98 percent agreement" (Jenson and Domingue, 1988).

The Flow Accumulation raster's symbology was adjusted to pronounce changes in the map as much as possible. Even after adjustments were made, it was difficult to see the accumulations. To fix this, the Spatial Analyst tool, Focal Statistics, was used to derive another Flow Accumulation dataset, "Flow_Accumulation_2," which was able to enhance the flows visualized on the map.

A workflow of all inputs and outputs for this project is shown in Figure 2 below.

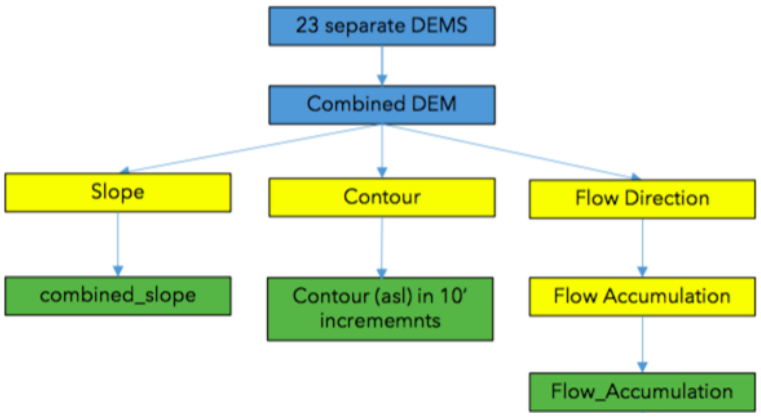

Figure 2 *Showing the workflow for this study. Blue = input raster datasets; Yellow = Spatial Analyst tools; Green = output raster datasets.*

Results

The combined DEM dataset created from 23 DEM datasets able to give us a quick visual overview of where there were respectively low vs. high locations at Pellissier Ranch and nearby areas (Figure 3). It is observed that the river is the darkest feature (lowest elevation) when compared to its surroundings and it travels in a southwest direction until it reaches the ranch. Here, the low elevation of the river (darkest color) matches the equally low elevation of Pellissier Ranch (darkest color). It is easy to see how a flooding situation is possible here. Resolution for this DEM is 1-meter.

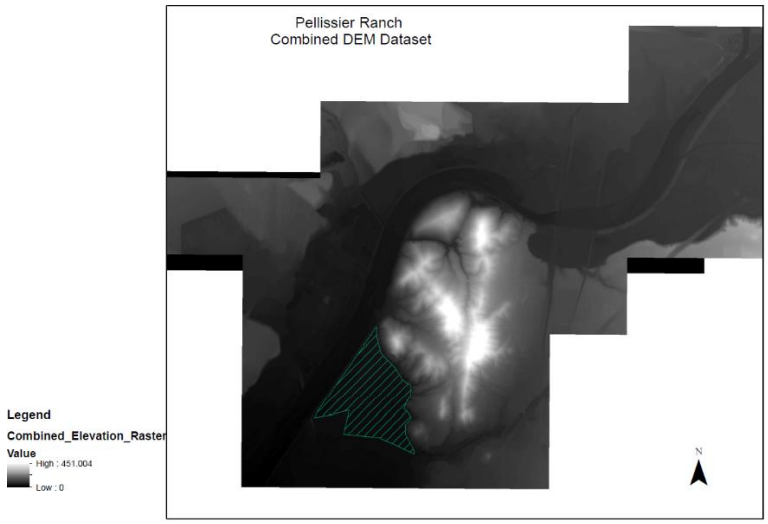

Figure 3 *Showing the combined DEM raster dataset created from the 23 individual DEM raster datasets*

The Slope tool, set with 20 classes of slope values, was able to show very small (1-3°) changes in slope across the entire area (Figure 4). Slopes across Pellissier Ranch are very low, mostly in the 0-1° range. The highest value seen in the area occurs sporadically and at approximately 6°. Looking at the southwest corner of the map, there is a definite sloping (~5°) towards the southwest, causing a quicker drop in elevation in this area of the river than the northeast area.

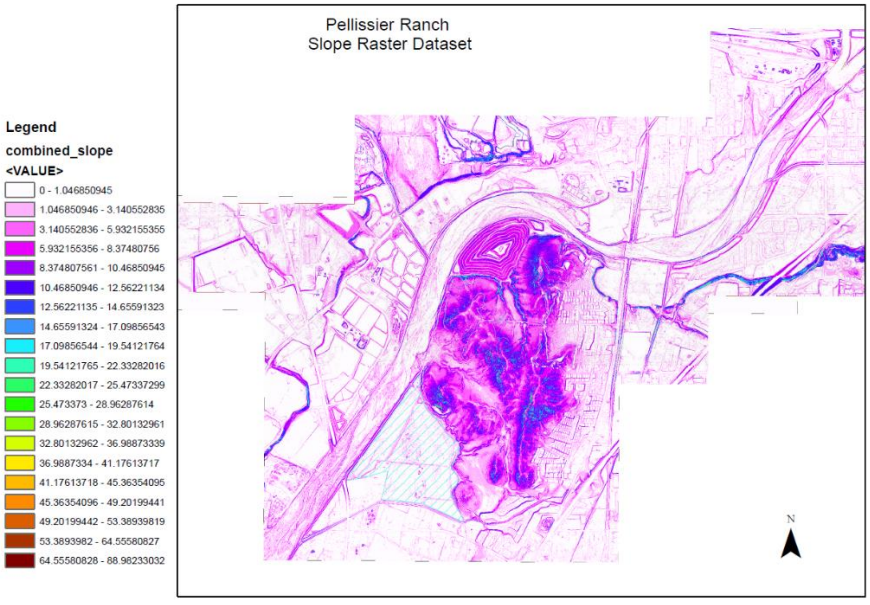

Figure 4 *Showing the slope raster dataset derived from the DEM raster dataset.*

The Contour tool, set at an interval of 10', was able to delineate the lowest elevations in the area (Figure 5). A decreasing slope is observed from the northeast corner of the map down to the southwest corner. The lowest elevation (in the river) is present in the southwest corner at 250', while the highest is in the northeast at 290'. The decrease of 40' in elevation occurs in this shown area (~10 km). In the middle of the map, it is seen that the river flows through a relatively narrow portion were its maximum width is

limited to 500 meters. Areas of the river directly above and below this point are almost three times the width at around 1300 meters.

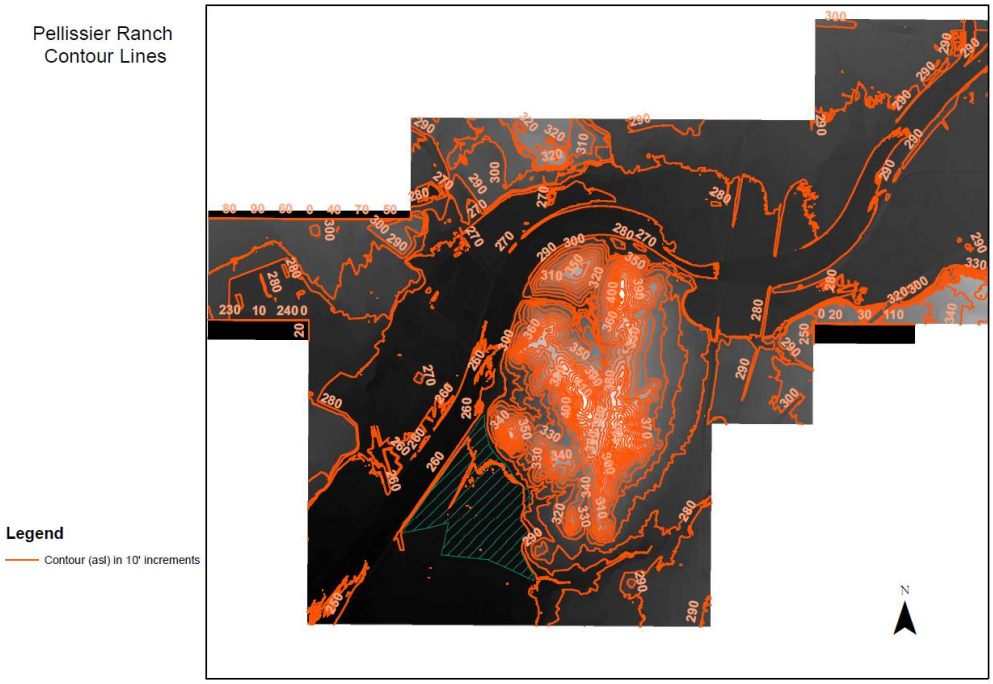

Figure 5 *Showing the contour raster dataset derived from the DEM raster dataset. Increments of contour lines = 10'.*

The Flow Accumulation tool, with the Focal Statistics tool applied in order to show more pronounced maximum values of accumulation, was only useful for showing how water flowed on La Loma Hills to he north of the site (Figure 6). The minor changes across the site were too small for the 1-meter DEM to have been able to derive useful information from.

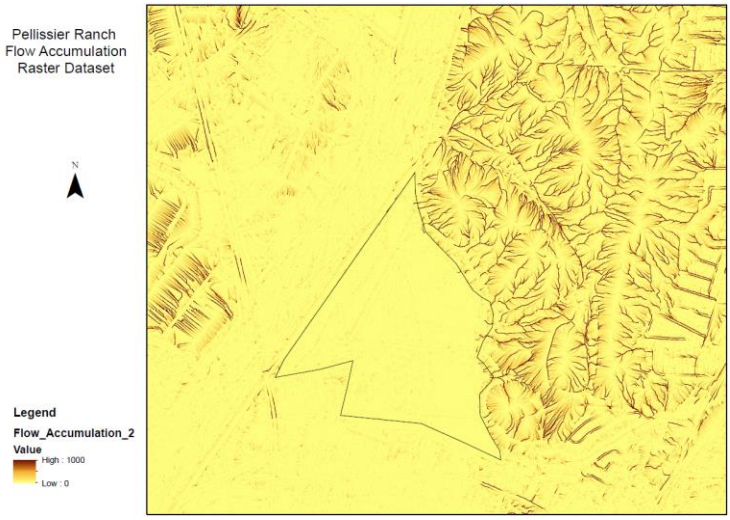

Figure 6 *Showing Flow Accumulation inside and nearby Pellissier Ranch. Brown-red lines = flow lines.*

Discussion

When looking at both the slope raster and the contour raster, a path for an overwhelmed Santa Ana River can be hypothesized. The northeast portion of the map has a wide area which would have allowed the Santa Ana River to spill into as it travels along its path. As it reaches the middle portion of the map, topographic highs on either side of the river force it through a relatively narrow width.

During an overwhelming of the river, it would cause a heavy build up and strong flow through this portion as it forces itself through. Once making it through this narrow portion, it would have spilled over in great force, with its flow towards the lowest elevation (the 250' elevation contour in the southwest corner). The greater width past the narrow portion would be filled, this includes Pellissier Ranch.

A limitation in this study was not being able to access Riverside County DEM datasets. San Bernardino County, which contains the northern half of Pellissier Ranch and all areas north of it, provided free and easily accessible datasets. Riverside County, which contains the southern half of Pellissier Ranch, did not have DEM datasets easily accessible to the public. While San Bernardino's datasets included enough of the northern border of Riverside County to show the entire Pellissier Ranch and a little south of it, a more conclusive study would have included areas further south.

This would have better shown how far south artifacts might have been taken before being deposited. Based on the two derived raster datasets in this study, it's possible to hypothesize that the Santa Ana River did indeed inundate the entire extent of Pellissier Ranch, which was once La Placita. The strongest force would have been experienced in areas in the southwest portion of the ranch due to the elevation and slope gradient seen in the river. An improved resolution for this survey could be accomplished with a drone, which would provide more minute changes in elevation to derive Flow Accumulation raster datasets of Pellissier Ranch from.

References

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