

Floodplain and Alluvial Terrace Mapping & Interpretation of Down Cutting Events on El Rito
De Tierra Amarilla

This thesis is submitted to the faculty of the Geology Department of Hanover College in partial
fulfillment of the requirements for the Bachelor of Arts Degree

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Geo 471

Winter 2018

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Abstract: Floodplain and alluvial terrace mapping can provide information into tectonic and environmental change in energy fluctuations, climate change, and deposition of alluvial sediments as floodplain and terrace surfaces. The interpolation of both topographic map and Digital Elevation Models and field data may be combined to provide an analytical map of floodplain and terrace surfaces along the El Rito De Tierra Amarilla. These techniques as well as my interpretation of the surfaces conducted during my Richter Grant provide crucial information into the history of the development of Rito De Tierra Amarilla. The correct interpretation of the local floodplain and terraces formed by the active stream can provide a history of thresholds that control deposition of these surfaces. With the development of alluvial geomorphology and associated surfaces, one can quantify geomorphic threshold events, or down cutting events, by quantifying the number of distinct terrace and floodplain surfaces in a basin.

Introduction

The location of my study area is in town of Tierra Amarilla, specifically focusing on the El Rito De Tierra Amarilla River floodplain and adjacent alluvial terraces. The surficial geology of this region is dominated by the Mancos Shale Formation of the Late Cretaceous Epoch. The sequence of down cutting on a river is subject to thresholds that control significant developmental features. These changes occur systematically as the input fluctuates in a system. The flow, sediment input and particle size are relative to the intensity of a threshold that induces

geomorphological change of a river system.¹ ArcGIS can be used with spatial interpolation methods to quantify the number of threshold events, or down cutting events on the river. The first map incorporates multiple uses of spatial interpolation to identify slope and terrace surfaces surrounding Rio De Tierra Amarilla, while the second map is a more detailed interpretation by method of topographic map and field research to identify the active stream, floodplain and adjacent terraces. Refer to Figure 1 for a visual representation of geomorphologic surfaces of a river system.

Methods

Map 1 incorporates the use of two spatial analysis tools. The slope tool identifies slope (gradient or steepness) from each cell of a raster.² Another beneficial tool is the hill shade tool. This tool obtains the hypothetical illumination of a surface by determining illumination values for each cell in a raster.³ . The spatial analysis surface toolset identifies specific patterns that you can

1) ¹ Church, Michael. "Geomorphic Thresholds in Riverine Landscapes." *Freshwater Biology*, vol. 47, no. 4, 2002, pp. 541–557., doi:10.1046/j.1365-2427.2002.00919.x.

2) ArcGIS Pro." *Mosaic-Data Management Toolbox / ArcGIS Desktop*, pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/slope.htm.

3) "ArcGIS Pro." *Mosaic-Data Management Toolbox / ArcGIS Desktop*, pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/how-hillshade-works.htm.

quantify and visualize by a digital 3D surface or elevation model. Both these tools together can enhance the 3D presentation of the raster dataset providing an appealing relief map. Visually, the map is easier to recognize gradient change and terrace levels, but struggles to identify separate or paired terrace levels. Tierra Amarilla 10M DEM file is projected in NAD 1983 UTM Zone 13 as raster base layer in ArcGIS. The base layer was first cropped to a smaller area of focus.

Projection of the DEM raster was initially very pixelated with incorrect output values. Using the bilinear interpolation, calculating a weighted average dependent on the four nearest cell creates a smooth display between elevation surface points.⁴ Bilinear interpolation became a useful tool for creating smooth transitions for both surface features. Introduction of the Rito De Tierra Amarilla shapefile shows the location of the river in the DEM file to help understand where the terrace surfaces are located along the channel sides. The green color on the map represents areas of less than 10% gradient, while the yellow represents between 10-50% gradient, leaving 50% and over with the color red. While less than 10% gradient cannot confirm a terrace level it gives a positive indication that there is one or multiple terraces within this percentage.

The process of identifying alluvial terraces on a topographical map can be done by locating elongated formations along the lateral edges of current streams. These elongated formations can be identified as “benches”, a mass of soil and rock that has been moved parallel to the stream due to deposition of rocks that flow down it. As the amount of water that is input into a river increases, more erosion, transport and deposition will occur within a system. The alluvial terraces are remnants of the most lateral point of erosion where these benches are incised

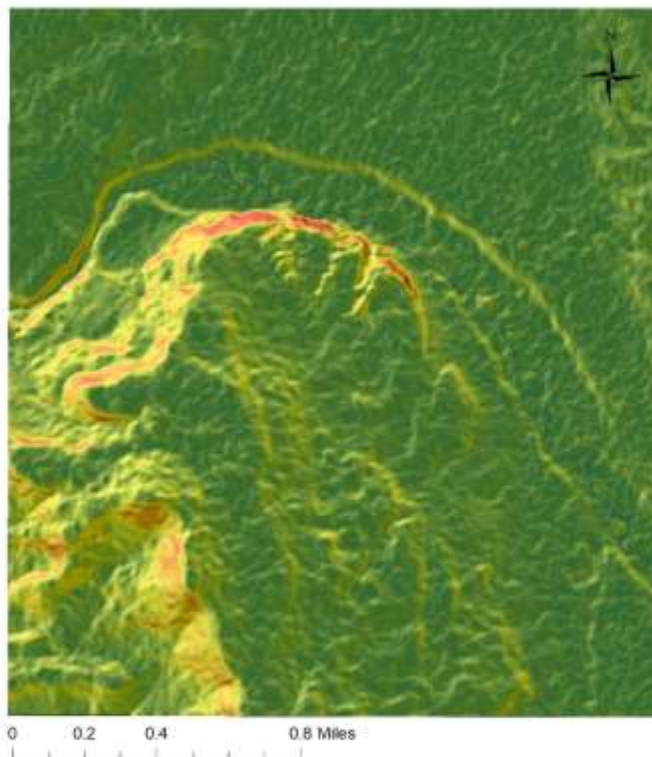
⁴ “FAQ: How Is Bilinear Interpolation Calculated?” *Digital Image / Definition - Esri Support GIS Dictionary*, support.esri.com/en/technical-article/000008915.

into the Mancos shale of this region. These “bench” terraces can form along one side or both sides of the stream forming paired terraces. The second map was constructed from identifying topographic “benches” and research I conducted last semester. The map is divided into 5 surfaces: Rito De Tierra Amarilla, active floodplain, terrace level 1, terrace level 2, terrace level 3, and terrace level 4. Each surface was drawn with the editor tool, creating polygon and poly line data. The area of each surface is bound by both topographic boundary and visual interpretation from field research. As you can see the stream flows southwest through the town of Tierra Amarilla crossing under the bridge of highway 64. Elevation of the stream is 7,480 feet above sea level in the east and 7,430 in the west. Tierra Amarilla sits on the highest terrace level adjacent to the stream at an elevation of roughly 7,525 feet above sea level. It is unaffected by flooding due to the low input into the system as well as distance and elevation from the stream. Terrace level 2 is between 7,480 and 7,460 feet from east to west. This is remnant of the largest down cutting event, introducing the highest input of water into the system, washing out other remnants of terrace level 1 throughout the central portion of the map. It is also a “paired” terrace, forming remnants on both the north and south side of the channel. Terrace level 1 is the most eroded of the 3 terraces due to how close in elevation it is to the active channel. As water input increases, previous terraces are eroded away, sometimes removing any evidence of their formation. The active floodplain of the river is relatively small, only widening in the central portion of the map. Water supply into the stream has been relatively low, forming a distinct channel, with a relatively thin floodplain throughout.

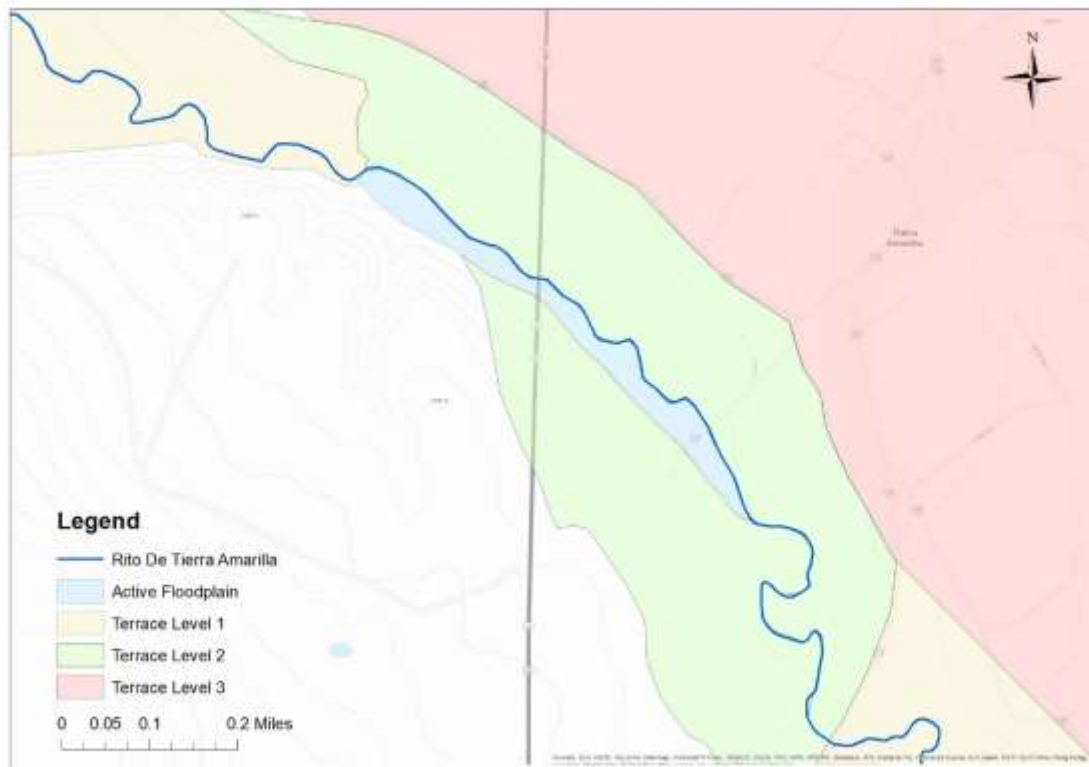
Conclusion

Each method proposed in this paper can be beneficial for interpreting down cutting events in a stream or river. While the interpolation of DEM file data can be used to identify slope gradient and terrace surfaces, Topographic “benches” and field research incorporated with the first method can help achieve a correct interpretation of down cutting events that occur on a stream. Rito De Tierra Amarilla has had 4 large geomorphological down cutting events that are identified as: 2 adjacent terrace levels, the active floodplain, and the active channel’s current location.

Slope & Hillshade of Rito De Tierra Amarilla

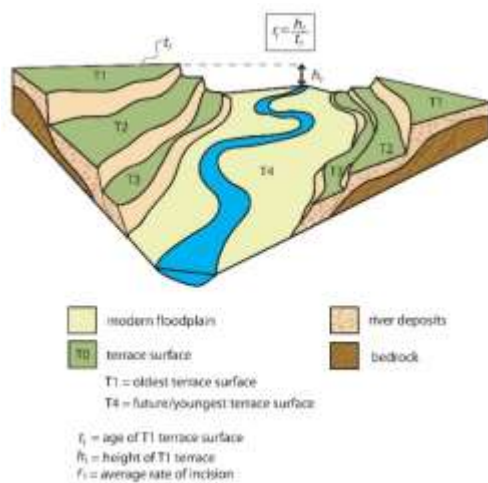


Map 1



Map 2

Figure 1:



Primary & Secondary Sources:

- 1) Church, Michael. "Geomorphic Thresholds in Riverine Landscapes." *Freshwater Biology*, vol. 47, no. 4, 2002, pp. 541–557., doi:10.1046/j.1365-2427.2002.00919.x.
- 2) "ArcGIS Pro." *Mosaic-Data Management Toolbox / ArcGIS Desktop*, pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/slope.htm.
- 3) "ArcGIS Pro." *Mosaic-Data Management Toolbox / ArcGIS Desktop*, pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/how-hillshade-works.htm.
- 4) "FAQ: How Is Bilinear Interpolation Calculated?" *Digital Image / Definition - Esri Support GIS Dictionary*, support.esri.com/en/technical-article/000008915.
- 5) commons.wikimedia.org/wiki/File:A_series_of_paired_river_terraces.jpg.
- 6) "Help." *Understanding Network Attributes-Help / ArcGIS Desktop*, desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/an-overview-of-the-spatial-analyst-toolbox.htm.