Michael Brehm Geo 4/593 Fall 2016 Final Project Abstract

Analyzing Terrain for High-Speed Train Route Suitability

<u>Abstract</u>

Finding a suitable route for a high-speed rail line considers several factors to determine the most economically feasible, efficient, and environmentally sensitive course possible. Not the least of these is the area of terrain analysis to ascertain slope characteristics of possible route locations. Because of the number of potential routes, the varying terrain profiles, and the distances involved, it is necessary to establish a process using a computerized digital terrain analysis format, such as GIS, to identify prospective problems areas quickly and efficiently, as well as to recommend the most appropriate solutions to these problems.

Using a prospective DEM quadrangle, a possible route was created between two destinations. After establishing a vertical profile of the route to help identify problems areas and splitting the route into smaller sections to aid in the analysis, surface information was added to the sections to provide distance, elevation, and slope data. A spatial join was then employed to determine the slope relationship between each section and its neighbors based on a variety of different search radii. Summary statistics was used to tabulate these results and joined to each route segment to provide an assessment of their overall slope characteristics.

The result of the analysis was only a partial step towards the ultimate goal of comprehensive terrain analysis. The issue of determining the slope characteristics of each segment and how this relates to its neighbors to ascertain the most appropriate course of action was left unfulfilled, and would require further analysis. Most likely, a new tool would have to be created, in which the script would be to take into account the slope characteristics of each segment, those of the two neighboring segments, and place said segment into a category based upon all of the possible slope permutations.

Key words: High-speed rail, route, slope, GIS, DEM, spatial join

Analyzing Terrain for High-Speed Train Route Suitability

Michael Brehm Portland State University Geography 493 (Digital Terrain Analysis) December 5, 2016

Project Goal

Use the various tools of digital terrain analysis in GIS to examine a proposed direct high-speed train route from Portland to Bend, based upon slope gradient specifications. Gradient specifications used are from the Engineering Criteria prepared for the California High-Speed Rail Authority. The ultimate objective is to develop a process for dividing route segments into potential terrain modification categories (Excavation, Bridge, Tunnel, or Re-Route).

Summary of Engineering Design Parameters

Parameter	Very High-Speed					
Double Track	Full					
Power Source	Electric					
Grade Separations	Full					
Potential for Shared Use	Yes					
Corridor Width Desirable Minimum	100 ft (30.4 m) 50 ft (15.2 m)					
Top Speed	220 mph (350 km/h)					
Average Speed	125-155 mph (200-250 km/h)					
Acceleration	0.4-1.3 mph/s ³ (0.6-2.1 km/h/s ⁴)					
Deceleration	1.2 mph/s (1.9 km/h/s)					
Minimum Horizontal Radius	500-650 ft (150-200 m)					
Minimum Horizontal Radius (At top speed)	15,600 ft @ 220 mph (4,750 m @ 350 km/h)					
Superelevation Actual (Ea) Unbalanced (Eu)	7 in (180 mm) 5 in (125 mm)					
Grades Desirable Maximum (sustained grade) Absolute Maximum (limited length)	3.5% 5.0%					
Minimum Vertical Radius	157,50 0 mph					
Crest Curve (at top speed)	(48,000 m @ 350 km/h)					
Minimum Vertical Radius Sag Curve (at top speed)	105,000 ft @ 220 mph (32,000 m @ 350 km/h)					
Horizontal Clearance	10 ft 4 in @ 220 mph					
Vertical Clearance (Top of rail to face of fixed object)	21 ft (6.4 m)					
Track Centerline Spacing	15 ft 8 in @ 220 mph (4.7 m @ 350 km/h)					

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Spatial Join:

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Segments with 2500m search radius





Examples of Possible Combinations

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	4	Point M	1052.536574	1397.700981	1200.390315	881.022984	4.687489	83.601454	44.84242	1	1
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	6	Point M	984.023507	1227.241278	1097.914341	836.391102	13.544402	62.251526	30.898553	1	1
	7	Point M	825.238326	991.8739	939.383443	840.705818	0.421423	74.262758	28.953989	1	1
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Conclusions:

While the steps taken aided in the creation of a process for identifying the terrain characteristics of route segments and the most appropriate terrain/route modifications for those areas, further analysis needs to be performed in order to accurately categorize the specific characteristics and the best course of action. A newly created tool, with a script specifically written to utilize the spatial information obtained thus far based upon the parameters of the intended project, is the next logical step to simplify and automate the route terrain analysis process.



References:

--Parsons, Brinckerhoff, Quade & Douglas, Inc. *"Program Environmental Impact Report/Environmental Impact Statement: Engineering Criteria"*. January, 2004. www.hsr.ca.gov/docs/programs/eireis/statewide_techrptEngineer_rpt.pdf

-- ESRI Resources, Help. *"Create Route", "Editor, Split", "Add Surface Information", "Spatial Join", "Summary Statistics"*