A Cost-Analysis of a Potential High-Speed Rail Network in Guangxi Province

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Introduction

China has the world's longest high-speed rail network as well as the world's longest high-speed rail line. Since the first line opened in 2007, tens of thousands of kilometers of railway tracks have been laid over the country and China's rail network is expected to be at least 18, 000km long by 2015. A 2010 World Bank report describes the positive benefits of high-speed rail to include significant time savings, the freeing up of capacity on existing modes of transport, and the consequent downward pressures on price on these existing modes. Additionally, a high-speed rail network can also drive economic growth by making urban centers more accessible and by opening up new markets.

However, high-sped rails are extremely expensive to build, and therefore represent a risky investment for the Chinese government. The same World Bank report claims that the "demographic and economic conditions that can support the financial and economic viability of high-speed rail are limited". In other words, only in sufficiently dense and wealthy urban corridors will high-speed rails be economically viable. Moreover, state institutions need the necessary political will to see through a project of such scale. At the moment, China's high-speed rails have largely been concentrated in the more populous and wealthier Eastern provinces, connecting major urban areas to each other through railway corridors that pass through all the major cities.

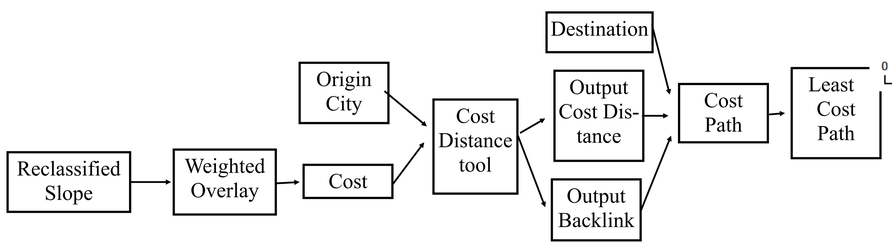
High-speed rail therefore has the potential to transform a region if implemented and managed well, yet is also a huge investment risk because of the extremely high fixed costs. The objectives of this project and therefore guided by this need to balance the extension of the rail network with financial concerns. The specific objectives include:

- Finding a suitable province where the construction of a high-speed railway network might be financially viable that does not have an existing rail network running through it
- To search for a route or routes within this province that minimizes costs and is able to serve the largest potential consumer pool

Methodology

The first objective of locating a suitable province for the construction of a high-speed rail network was first done by selecting the provinces that currently do not have an existing line running through it. Following that, the remaining provinces were categorized by their population densities and 2010 GDP figures. I then ran attribute queries to locate provinces that had a population density of above 180 persons per square kilometer, and had a GDP of above 5000. These were the two criteria that was used to determine the suitability of a high-speed rail network in the province.

The second objective of the project was to plan a new route within this province that minimizes costs and is able to serve the largest potential consumer pool by passing through the major urban centers of the province, determined by the population of the cities. In this project, cost will be a function of slope. The DEM of Guangxi province was first converted into a slope, before being reclassified from 1 to 10, with 1 corresponding to a lower slope and hence lower costs. In addition, I will locate the nearest existing high-speed rail station that this new route may potentially link up with. The least-cost path between any two cities was found by using the following set of tools:



Results and Findings

Part 1
Selection by Attributes queries were ran to locate provinces that population density of above 180 persons/ km^2 and had GDP of above 5000. These were set as the two necessary criteria for a new high-speed rail. An intersection of the two queries highlighted Guangxi Province in Southern China, as shown in the map below. It has a 2010 GDP of 9502.39 and a population density of 194 persons/ km^2.

Fig 1: Location of Guangxi Province

Part 2
The objectives of Part 2 of the project was to plot a route that passes through the major urban centers of Guangxi Province, and to locate the nearest existing high-speed rail station that this new route may potentially connect to. The spatial distribution of the cities, however, meant that two lines made more logical sense than one line that passes through most of the cities. One line was plotted from East to West, passing through Wenzhou, Liuzhou, Hechi and Bose cities, while another line with plotted from North to South, passing through Guilin, Liuzhou, Nanning and Guizhou.

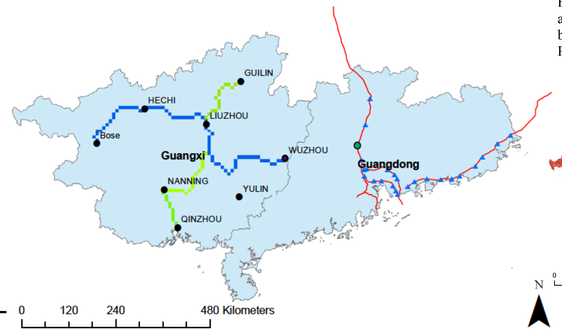


Fig 5: Proposed High-Speed Rail Network in Guangxi Province

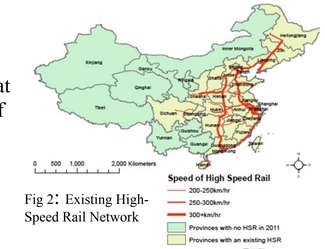


Fig 2: Existing High-Speed Rail Network

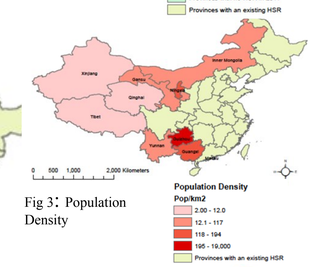


Fig 3: Population Density

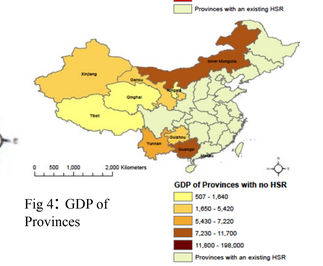


Fig 4: GDP of Provinces

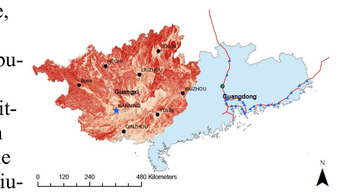


Fig 6: Reclassified Slope and location of major urban centers in Guangxi Province

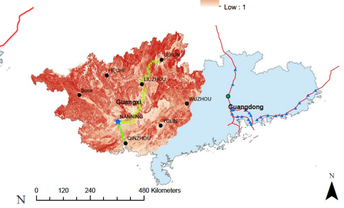


Fig 7: Proposed North-South Line

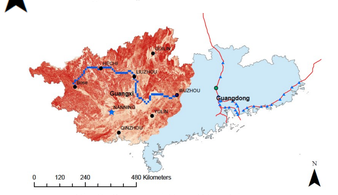


Fig 8: Proposed East-West Line

Limitations

In this analysis, the least cost path was a function of only the slope of the land, whereby a lower slope would correspond to a lower cost. The could be augmented with additional costs in future analysis to present a more accurate cost-analysis. Other factors that could increase costs include passing through nature reserves and major bodies of water, whereas factors that would decrease the costs include passing through agricultural areas that might benefit from increased connectivity to urban areas, or passing through rural tourist sights.

The accuracy of this project is also limited by the inability to locate more current data sources. The data on the existing train network was published in 2011, and changes have taken place in the last three years. Similarly, the population and GDP data is from 2010, and would likewise have changed in the last 4 years. However, it would be reasonable to expect limited changes in the Digital Elevation Model of the province.

City	Population
Nanning (Provincial Capital)	2, 660, 833
Liuzhou	963, 629
Guilin	1, 410, 712
Qinzhou	489, 139
Hechi	197, 528
Wenzhou	424, 734
Yilin	547, 924
Bose	185, 497

Data Sources:

ChinaMap , supported by the Harvard Weatherhead Center for International Affairs and the Harvard Fairbank Center for Chinese Studies, www..worldmap.harvard.edu/chinamap

Greater Mekong Subregion Core Development Program, www.gms-eoc.org

City Population, www.citypopulation.de

References:

Amos, Paul, Dick Bullock and Jitendra Sondhi. "High Speed Rail: The Fast Track to Economic Development?." Published by *The World Bank*. 2011.

Coordinate System: Hanoi_1972_GK_106_NE