Safia Khan
Melissa Kooiman
Matt Burch-Forgie

USING GIS TO IDENTIFY THE OPTIMAL SITE FOR PHASE 2 OF THE PROPOSED HIGH-SPEED RAIL IN THE TORONTO-WINDSOR CORRIDOR

INTRODUCTION

High-speed rail (HSR) operates at a faster speed than conventional rail traffic and is exclusive to passenger transport. In 2016, the Ministry of Transportation of Ontario (MTO) released a Special Advisory Report outlining two phases for an HSR project in Ontario's Toronto Windsor Corridor (TWC). Phase 1 between Toronto and London would be completed by 2025 while Phase 2, a proposed new-build track extending from London, through Chatham, to Windsor, would be completed by 2031.[1] Ontario's HSR project is anticipated to contribute to the province's goal of transitioning to a low-carbon economy by 2041 and reduce congestion on major roadways in the Greater Toronto and Hamilton Area. In 2019, the proposed project was halted with a government change, raising concerns over the future of Canadian inter-regional travel. Phase 2, the new-build line, requires additional socioeconomic and environmental analysis to identify the most suitable route with limited impacts from construction and operation. This research analyzes Phase 2 using GIS-based tools and a multi-criteria evaluation (MCE). Key socioeconomic and environmental factors are expressed as constraints and criteria and evaluated using a pairwise comparison and weighted analysis. A suitability analysis is conceptualized using MCE in **Figure 6** to show the most suitable areas for the Phase 2 new-build track construction in the TWC.

PROBLEM CONTEXT

- Canada remains the only G7 country without HSR
- Population in the Greater Toronto & Hamilton Area (GTHA) is expected to grow by 46% by 2041[2]
- Pressure on the provincial government to develop sustainable and economical inter-regional travel resulting from this growth
- Plans for retro-fitting exisiting lines and developing new HSR lines puts pressure on the socio-economic and natural environments
- These potential impacts from new-build development must be studied and evaluated using GIS-based applications to address these challenges

RESEARCH OBJECTIVES

1. Identify the socioeconomic and environmental variables that influence the development of an optimal HSR route.

2. Design a GIS analysis model using the MCE method by preparing the constraints, criteria, and assigning criteria weights to aggregated data.

3. Apply the MCE model to determine the optimal route for an HSR system.

4. Evaluate the strengths and limitations of the MCE model and suggest recommendations for future HSR transportation planning.

PURPOSE OF RESEARCH

The purpose of this research is to identify the optimal location for Phase 2 of the HSR in the London-Windsor region of the TWC, using an MCE to ensure minimal socio-economic and environmental impacts of the new rail line.

CONCEPTUAL MODEL

This conceptual map (mind -map) demonstrates the steps we to determine the suitability of a High-Speed-Rail in Southern Ontario.

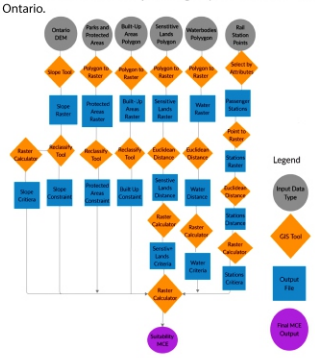
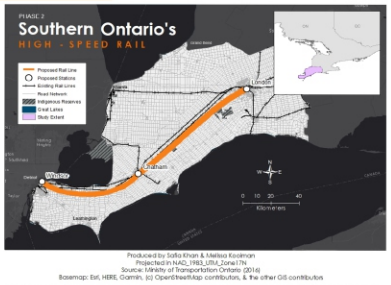


Figure 3. Conceptual model of data pre-processing and MCE

STUDY AREA



Produced by Safia Khan & Melissa Kooiman
Projected in NAD_1983_UTM_Zone17N
Source: Ministry of Transportation Ontario (2016)
Basemap: Esri, HERE, Garmin, (c) OpenStreetMap contributors, & the other GIS contributors

Figure 1. Map of the selected study area found in Phase 2 of the TWC

RESEARCH APPROACH

The socioeconomic and environmental variables that influence HSR planning were identified and classified as constraints and criteria (**Figure 2**).

Constraints and criteria layers were then prepared, assigned weights, and incorporated into the raster calculator to design an MCE model (**Figure 3**).

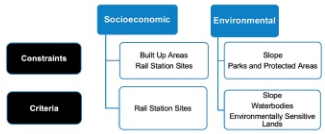


Figure 2. Model of the socio-economic and environmental constraints and criteria

RESULTS

CONSTRAINTS

- Constraints show areas with zero suitability (orange) and areas with high suitability (grey)

CRITERIA

- Higher ranked areas have high suitability development (grey)
- Lower ranked areas have zero suitability for development (orange)

FINAL OUTPUT

- Areas with higher rank (purple) are deemed as most suitable for development

CONSTRAINTS

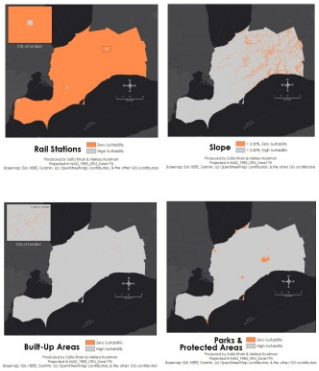


Figure 4. Constraint rasters of existing rail stations, slope, built-up areas and parks and protected areas.

CRITERIA

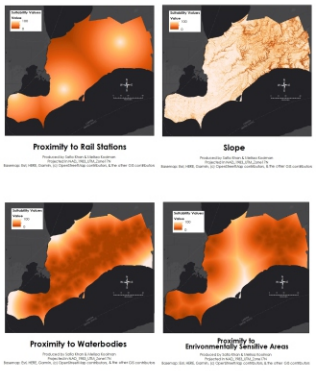
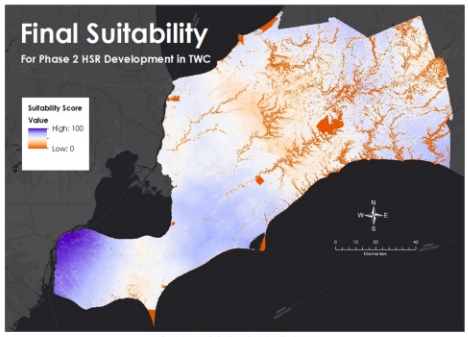


Figure 5. Criteria rasters of existing rail stations, slope, proximity to waterbodies, and environmentally sensitive areas.

FINAL OUTPUT



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Projected in NAD_1983_UTM_Zone17N
Basemap: Esri, HERE, Garmin, (c) OpenStreetMap contributors, & other the GIS contributors

Figure 6. Map of the final suitability output from the MCE

RESEARCH FINDINGS

The research findings show that the areas highlighted in purple are the optimal areas for HSR development.

Figure 6 illustrates the final suitability map of the modelling process that was applied using ArcGIS analysis tools. The final output map aids in the decision-making process for identifying the optimal route for development of Phase 2 of the proposed HSR in the TWC.

STRENGTHS/LIMITATIONS

STRENGTHS

- Ability to apply multiple economic, environmental and social factors into one suitability equation
- Benefical in identifying areas of interest for decision-making
- Allows public input in the decision-making process

LIMITATIONS

- Data for desired criteria is often limited and/or outdated
- Local or regional data may be missing from the analysis
- It may disregard other important, cultural factors that influence suitability

Figure 7. Table of the strengths/limitations of MCE

FUTURE WORK

For the future, it would be beneficial to add more data to the model including existing rail lines, built-up areas for noise, and utility infrastructure. This would have allowed for a more detailed, accurate and refined suitability score that would aid in the project moving forward. Further analysis is recommended.

CONCLUSION

Upon completing the suitability analysis, the most suitable areas have been identified in our research findings. The final suitability aids in determining where the new build track should be constructed for Phase 2 of the HSR in TWC, if the project were to be re-visited by the provincial government.

REFERENCES

[1] Ministry of Transportation (MTO). (2016). High speed rail in Ontario. Retrieved from: http://www.mto.gov.on.ca/english/publications/high-speed-rail-in-ontario-final-report/
[2] Ontario Land and Use Planning. (ND). The Greater Golden Horseshoe Region: An International Economic, Agricultural and Cultural Hub. Retrieved from: http://www.mah.gov.on.ca/AssetFactory.aspx?did=10852
Photo: Northern Ontario Business (2018)

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GEOG 4480 Applied Geomatics
Department of Geography, Environment and Geomatics
University of Guelph

Ontario Ministry of Transportation
University of Guelph
DEPARTMENT OF GEOGRAPHY, ENVIRONMENT AND GEOMATICS