ANALYTICAL RESULTS OF A ROAD CLEARING AND RELIEF SUPPLIES DISTRIBUTION MODEL FOR VANCOUVER ISLAND

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INTRODUCTION

Southwestern British Columbia is one of the most seismically active regions in Canada with Vancouver Island at risk of being cut off from mainland supplies in the event of a Cascadia or megathrust earthquake. Several studies have been done to improve the preparedness of the island in the event of such an earthquake.

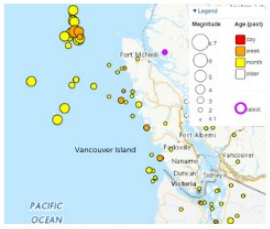

Figure 1. All earthquakes near Vancouver Island in the last 30 days [2]

This study focuses on analyzing the results of a road clearing and relief supplies distribution (RCRSD) model to point out critical regions on the island, as well as important parameters in the model. An initial demand is calculated for all the communities on Vancouver Island based on their populations. By also considering the resilience of the communities, a network optimization model that uses GRASP heuristics is then employed to calculate optimal road clearing and relief distribution routes [1].

OBJECTIVE

The aim of this study is to find patterns in the model results to identify critical regions, roads, and communities on Vancouver Island in the event of a Cascadia earthquake. A large number of inputs used in the model do not have a definite range. Therefore, this study is being done with the objective of reducing the scope of some inputs in the model, as well as determining the most critical regions on the island for emergency supplies planning.

RESEARCH QUESTIONS

1. Which input parameters need to be altered and which output parameters need to be observed for sensitivity analysis?
2. How can the outputs from the model be best represented to make them utilizable for this study?
3. In what ways can the 'critical' regions on Vancouver Island be identified in the event of a Cascadia earthquake?

METHODS

After classification, input parameters with significant effects on the results of the model were chosen for the initial analyses. These include the location of the road clearing teams' depot, damaged roads, and damaged ports. The time limit for road clearing and supplies distribution was set to 3 days. The observed outputs include the total number of food boxes supplied, supplied communities and isolated communities, and the number of roads cleared.

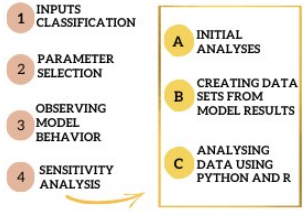

Figure 2. Communities and regional division of Vancouver Island used for the analyses (source : SIREN technical report)

The analysis of results from the model was done with respect to the regional divisions shown in Figure 2 to obtain a high-level understanding of the road clearing and supplies distribution activities in different parts of the island.

Figure 3. Sample input data of damaged (red) and undamaged (green) roads

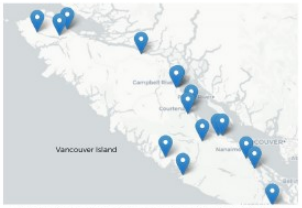

Figure 4. Depot location options of the road clearing teams for each run

The results of the model are stored in 16 different files (for each run) and some of the output files have over 300 elements that need to be studied. A major part of this study was to extract all the files from all the runs and condense them systematically into a few informative files that can then be further analyzed.

PRELIMINARY RESULTS

Figure 5. Communities on Vancouver Island that receive supplies for at least 80% of the runs

Figure 6. Repeated segments of roads that were cleared across model runs

Apart from the communities that are frequently supplied across multiple model runs as shown in Figure 5, a significant majority of the road-clearing activities also occur around the South and Central Island regions (Figure 6).

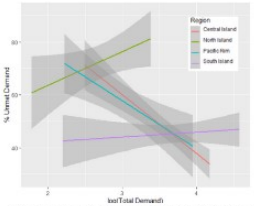

Figure 7. Relationship between the total demand and unmet demand(boxes) in each region

Figure 7 shows the relationship between community total demand and the percent of demand met across multiple runs, broken down by the five regions. The region with most of its demand not met is North Island. The demands of communities in South Island are met in a more consistent manner. For Central Island and Pacific Rim, communities with higher demands are serviced more than the ones with lower demands.

CONCLUSION

A total of 57 input parameters were classified and 6 were selected for the analyses. It is seen that a lot of the activity occurs in the South and Central parts of the island. Analyses are ongoing to determine the next set of activities once the repeatedly serviced roads and communities' needs are met.

REFERENCES

[1]Almeida. L. et. al, "A Greedy Randomized Adaptive Search Procedure (GRASP) for the multi-vehicle prize collecting arc routing for connectivity problem", Computers & operations research, 2022, Vol.143, p.105804

[2]Earthquakes Canada (nrcan.gc.ca)

ACKNOWLEDGEMENT

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