Spatial Correlation Analysis of Truck Traffic Patterns along Road Network Using Arc-GIS: *A Case Study of the Province of Saskatchewan*

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Introduction

Truck information is one of the important inputs for better pavement analysis, design, maintenance and management. While more efforts have been directed towards development of more accurate design methods, like Mechanistic-Empirical Pavement Design Guide (MEPDG), less have been done to enhance techniques for acquiring more accurate truck traffic information.

By the use of different spatial statistical and geo-statistical tools found in Arc-GIS software, this study used data from 12 WIM and 6 AVC stations to examine spatial truck traffic patterns along selected road sections in the Province of Saskatchewan.

Objective of the Study

This study used Arc-GIS spatial statistical and geo-statistical tools to analyse truck traffic patterns that can also be used to link vehicle classification with traffic loading patterns; and hence be used to extrapolate traffic loading distributions to other different road segments.

Methodology

- Moran Index (I) was used to test if truck traffic pattern along road network in Saskatchewan are clustered, randomly distributed or dispersed
- The Moran's I varies from -1 *(high negative spatial autocorrelation)* through 0 *(no spatial autocorrelation)* to 1(*high positive spatial autocorrelation*)
- The Moran's I was calculated as :

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(X_i - \bar{X})^2}$$

Where n is the number of observations (points or polygons), $\bar{X}$ is the mean of the variables, X_i is the variable value at a particular location, X_j is the variable value at another location & W_{ij} is a weight indexing location of i relative to j

- Kriging tool was used to quantify spatial structure of the data by fitting a spatial-dependent model to the data and produce a prediction surface for unknown values at several locations

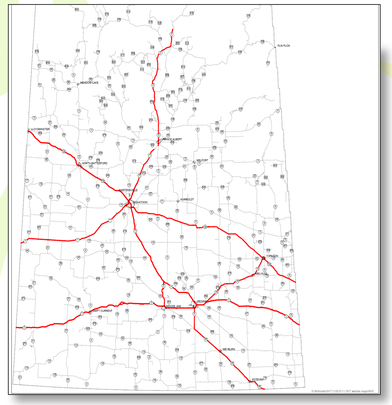

Figure 1: Highway network for the Province of Saskatchewan

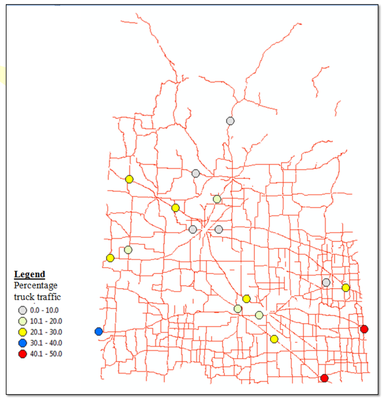

Figure 2: Truck traffic pattern along Saskatchewan road network

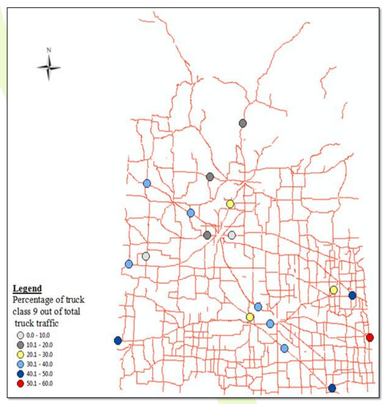

Figure 3: Truck class 9 pattern along Saskatchewan road network

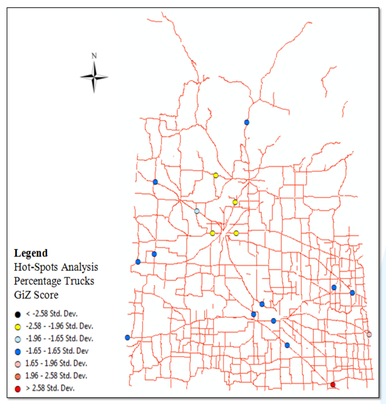

Figure 4: Hot-Spots analysis for percentage truck traffic

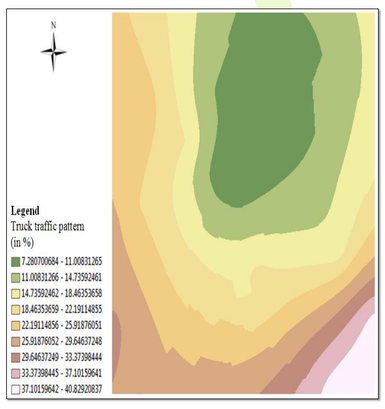

Figure 5: An interpolated surface presenting truck traffic patterns for Saskatchewan province using Kriging tool

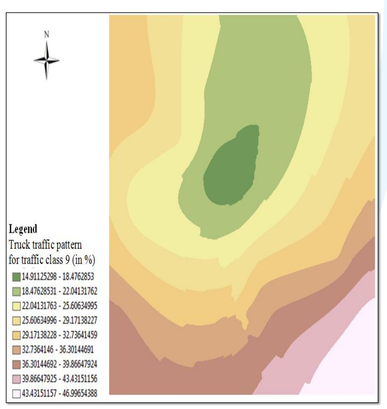

Figure 6: An interpolated surface presenting patterns of truck class 9 for Saskatchewan Province using Kriging tool

Observations

- The patterns analysis of truck traffic in the province of Saskatchewan showed random distribution with Moran's Index: 0.229, Z-score: 1.522 and p-value: 0.128.
- High percent (46%) of trucks was observed on Trans-Canada highway number 1 on the east of the province. The figure decreases as you move towards the central part of the province (around the city of Regina: 17%). The trend reverses as you move towards the western border where 33% was observed. The same scenario was observed on Trans-Canada highway numbers 16 and 39.
- Stations with high percent of trucks experienced high proportion of trucks class 9 as it can be seen on figures 3 & 6. Traffic class 9 was identified as the main contributor of trucks in the province of Saskatchewan.

Conclusions and Future Work

- The study results show that despite that the functional class does not change, the patterns of truck traffic along a highway may change significantly on several locations.
- The higher percent of trucks observed at borders with other provinces suggests that extrapolation of trucks information should base on commodity flows instead of highway classification.
- The higher percent values are seen at the borders and decrease as you move towards the central part of the province from south.
- In order to generalize the observed patterns, similar studies should be done in other provinces and be compared with the observed patterns in Saskatchewan.

Acknowledgements

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