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Examining the Relationship Between Spatial and Social Proximity in First Nation Food Sharing

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ABSTRACT

This study links social network analysis (SNA) with GIS in the examination of First Nation food sharing. Introducing spatial information into conventional SNA offers new perspectives and facilitates a better understanding of network data. Multiple GIS visualizations were used to complement the understanding of the network's multiple dimensions. Spatial statistics were carried out to test key hypotheses about the relationship between spatial proximity and social proximity in the food-sharing network. Results show both distance and kinship are important variables in explaining food sharing patterns.

1. Introduction

Within the social sciences literature, numerous studies examined the role spatial proximity plays on social tie formation. This research found that people are more likely to be friends if they are geographically close (Festinger et al., 1950; Feld and Carter, 1998; Mouw and Entwisle, 2006), whereas those who live further from a community "core" tend to be socially isolated (Festinger et al., 1950). The physical location of one's place of residence further increases the likelihood of strong social tie formation with others in close proximity (Coombs 1973) and diminishes as spatial distances increase (Hare, 1973; Latané et al., 1995).

Verdery et al. (2012) examined the relationship between kinship and spatial proximity. They used spatially referenced kinship networks and found a positive correlation between closeness of kin and households spatial proximity, attributed to close kin cohabitation.

Most studies use spatial proximity as the main factor contributing to tie formation. Verderey et al. (2012) draw attention to the fact that in the case of kinship networks, the closeness of relationships between family members also influences where members of these communities decide to live.

Social Network Analysis (SNA) is widely used to answer questions related to individuals' patterns of interaction, cohesion, social influence, and proximity. However, it is not spatially explicit. Mapping spatially referenced social interactions and activities allows us to uncover spatial patterns, associations, and ask new questions of network data (Logan, 2012). This motivated the current study. Specifically this study set out to examine the spatial parameters that influence food sharing between members of the Saulteau First Nations (SFN).

The SFN is located in northeast British Columbia. The population of SFN is 380, living in 125 on-reserve households (Statistics

Canada, 2016). SFN economy is a mixed economy, which includes wage earning and wildlife harvesting activities.

Within the SFN community, sharing harvested wild foods is prominent. Food sharing serves numerous functions, including the alleviation of household food insecurities, continuance of a cultural tradition, and social cohesion. In general, the SFN maintains strong family bonds. Kin continue to depend on each other for their social and economic wellbeing.

What requires more attention is the relationship between social ties and physical proximity. In this research, we measured physical proximity using the Euclidean distance, which was used to explore its relationship with social proximity (i.e. kin/non-kin, nuclear/distant kin) by answering the following:

1. Do kin live closer[1] to each other than non-kin?
2. Do nuclear family members live closer than extended kin does?
3. Within kin, is there an association between living close to one another and food sharing?
4. Are households located further from the community's core less engaged in food sharing?
5. Do households located further from the community's core receive less food?
6. Are households located closer to the community core[2] engaging in more food sharing?

The first part of our analysis involves visualizing the network data. This elucidated the spatial distribution of SFN's local and regional food sharing. In the second part of this paper, we focus on testing multiple hypotheses related to spatial and social proximity.

[1] In this study, the term "close(r)"means physical proximity

[2] Community "core" defined as the geographic center of the community.

2. Methods and Data

2.1 Data

Data used in this study comes from a larger research project focused on the *Assessment of First Nations Environmental Livelihoods in Northeast British Columbia (Lu et. al., 2019).*

Household surveys conducted in the SFN were used to assess how environmental change might affect their harvest and subsequent food sharing. The first part of the survey focused on wildlife harvesting and the second part of the questionnaire collected data on food sharing. Responses were compiled into several spreadsheets for analysis. Due to lack of spatial information for 13 households, 154 out of the 179 food exchange records were used in the final analysis.

A modified 10x10 km grid map of the T8TA territory was developed with GIS. This allows us to visualize the concentration of resource harvesting, in terms of household land use, food weight, by species, travel distance, and ecological values including land cover and habitat fragmentation.

Households' locations came in PDF format from Peace River Regional District (dated September 30th, 2014) showing land surface features as well as the location of 167 recognized households on Moberly Lake. Household locations were georeferenced and extracted. Certain households were not located because (1) the reference layer was outdated; or, (2) survey data collection errors.

Locations of regional communities were determined using Google's geolocator service followed by manual revisions for quality control. There were in total 77 households involved in the final analysis.

To ensure the integrity of the network dataset and account for unknown or missing the label "unknown location" was used. However, with missing data, there is less certainty over the reliability of findings, which is an important limitation to recognize. In the future development of this research we plan to incorporate various imputation techniques, already established in the SNA domain, to mitigate against missing data related errors.

2.2 Software

1. Python and R were used in this study to process the original data for the initial exploratory analysis and preparation for subsequent analysis.

2. UCINET was used for statistical testing and SNA descriptive statistics. Sociograms were created with NetDraw.

3. ArcGIS was used in this project to manage geodatabases as well as data manipulation, visualization and spatial analysis.

4. Interactive web-based SNA sociograms were programed as custom single page web applications. The backend was powered by Apache and PHP. HTML, JavaScript and CSS were used for the front-end development.

2.3 Methods

2.3.1 Overall methodology

The workflow started with social data collection through a structured survey (Figure 1). Surveys were cleaned and processed before analysis. Analysis was done in three steps.

1. Conventional SNA, which helped to explore the dataset through visualization and performing non-spatial statistics as well as hypotheses testing.

2. Visualization and spatial analysis using desktop GIS and WebGIS that facilitate exploratory analysis, interpretation and prepare distances for investigating of SFN's food sharing network.

3. Based on the spatial data and findings from the previous two steps, testing hypotheses on the interaction of spatial proximity and social proximity.

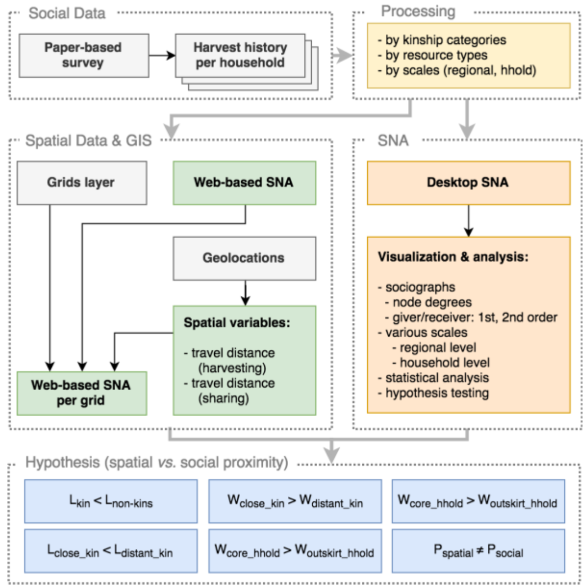


Figure 1. Overall methodology of this paper

2.3.2 Survey data reformatting

A structured survey was conducted. Original paper results were scanned into PDF format from correspondents in SFN; some responses were handwritten. A spreadsheet template was used to manually transcribe each survey, resulting in 150 individual spreadsheets for all households in SFN. Custom Python and R scripts were developed to reformat these spreadsheets into formats suitable for data visualization and analysis.

2.3.3 Data visualization

Several visualizations were used to explore the food sharing network dataset. A sociogram is an effective way of visualizing social network data. It depicts relationships among specific groups, with the aim of discovering underlying relationships (Figure 2).

A desktop SNA software and web-based solutions were used to prepare the sociograms[3]. The latter was specifically designed to streamline the procedure from raw data

[3] The term sociogram only partially depicts what these diagrams are. We are considering using an alternative term – sociomap, to better label these figures.

to final presentation and dissemination to stakeholders.

Conventional sociograms are not spatially explicit. Desktop GIS and WebGIS were used to process data for various geographic visualizations. However, visualizing social network data presents unique challenges, including multiple scales (e.g. regional and household), multiple dimensions (e.g. different food categories), directions of ties (e.g. giving and receiving in food sharing), multiple weights of nodes and ties, as well as overlapping ties that interfere with each other and impede visualization. A custom-built online solution was developed.

2.4 Data analysis

To determine the role of spatial proximity in SFN's food sharing network, student-t test was conducted to compare the food sharing (measured by food quantity, mean Euclidean distance) categorized by kinship type. Permutation based t-tests and other SNA descriptive statistics were conducted in UCINET.

To measure spatial autocorrelation we used both Moran's I and Geary's C. Moran's I ranges from +1 - strong positive spatial autocorrelation, to -1 - strong negative spatial autocorrelation, with 0 indicating a random pattern. For Geary's C, a value of 1 denotes no association, less than 1 a negative autocorrelation, whereas a value greater than 1 denotes positive autocorrelation.

Households' activity levels within the food-sharing network were measured using in-degree centrality scores in order to assess how much they received. Out-degree centrality scores were calculated to assess how much a household shared with others. The number of vertices[4] adjacent to a given vertex in a symmetric graph is the degree of that vertex, also referred to as Freeman degree centrality. In a directed or non-symmetrical graph, we further distinguish between in-degrees and out-degrees (Freeman, 1979).

3. Results

3.1 Integration of SNA and desktop GIS

The main objective of this study is to bridge SNA and GIS to reveal hidden patterns. Such link could be easily implemented through the loose coupling of SNA and GIS via a thematic map. Figure 2 shows how the sociogram was usually rendered inside SNA software. In this case, the food-sharing network inside SFN is visualized at the household level. At the regional level, with all communities' locations defined, a GIS can display a thematic map, or a geographic sociogram (Figure 3). Moreover, the previous household-scale sociogram is embedded to offer a complete view of the food-sharing network for SFN.

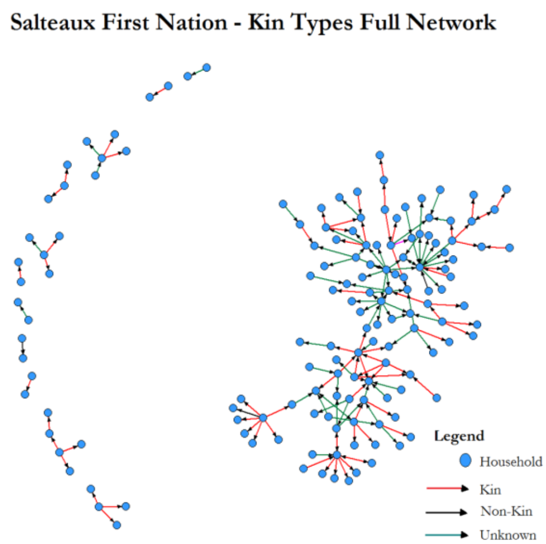
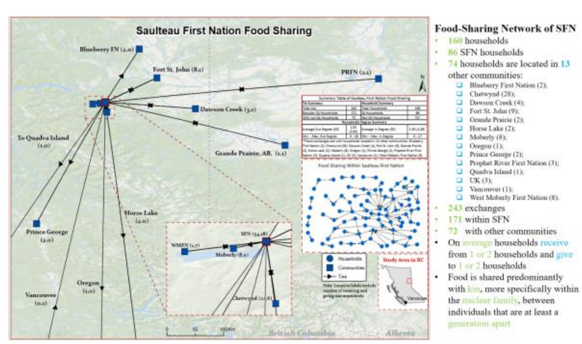


Figure 2. SFN Food Sharing Sociogram NetDraw



[4] Households are the graphs' vertices, and food-sharing interactions are ties.

Figure 3: SFN local and regional sociogram made as a thematic map using ArcGIS

3.2 Web-based geographic sociogram

Though sociograms could be made using desktop software, web-based visualizations were also investigated. Moreover, web-based visualizations offer interactive features that cannot be achieved through a loose coupling of desktop SNA and GIS.

Figure 4 and 5 show how the WebGIS can streamline and extend non-spatial methods.

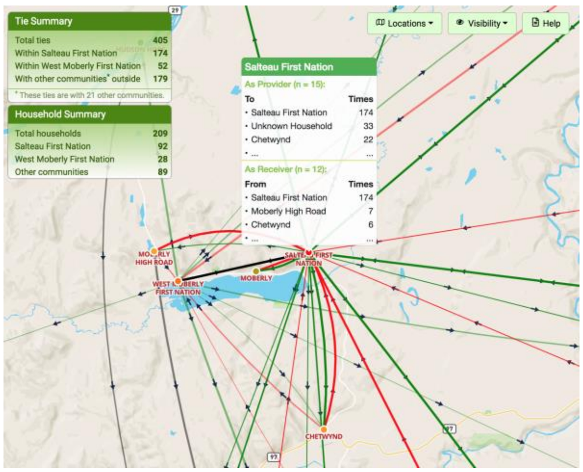


Figure 4: Regional food sharing network for SFN and another community. Arrows indicate food flow directions.

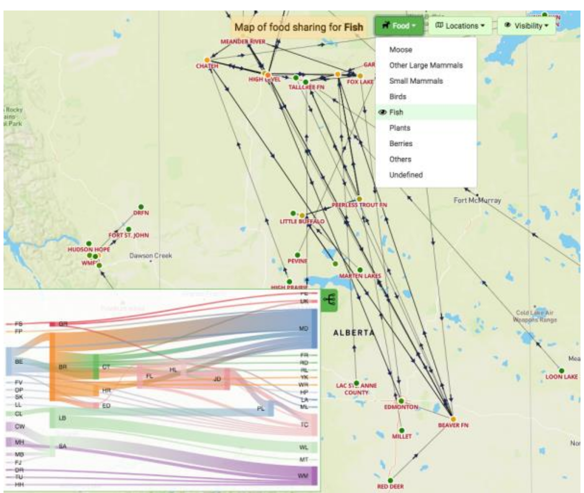


Figure 5: Regional food sharing network for SFN and another community. Resource types can be filtered by the dropdown list. The network is also visualized with a Sankey diagram to portray the volume of exchanges for selected food types.

To understand the pressure of harvesting activities on the landscape, a grid-based web sociogram was created (Figure 6 and 7). This web application offers a graph view and a map view. The graph view displays the food-sharing network for any chosen resource category. It also differentiates households by their selected roles. The map view links the social network to the landscape. As a result, the researcher can trace the food extracted within a 10x10km² grid and how it was shared within the social network.

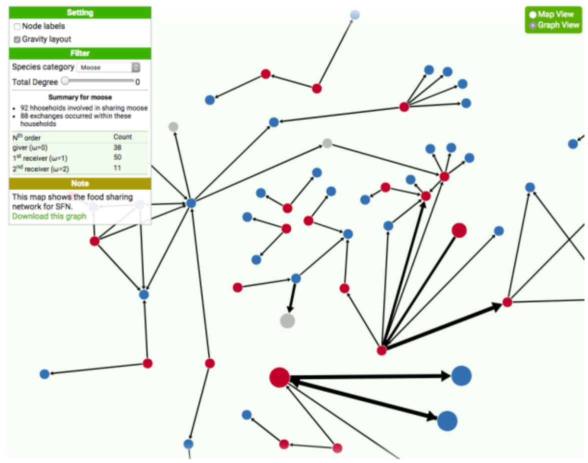


Figure 6: Grid-based online sociogram for the food-sharing network in SFN: the graph view.

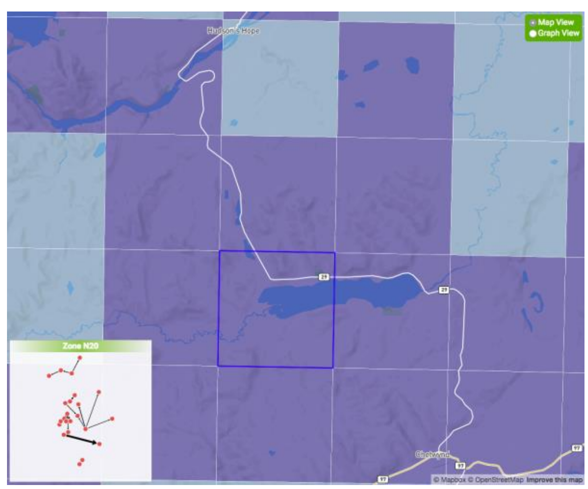


Figure 7: Grid-based online sociogram for the food-sharing network in SFN: the grid view. This view allows researchers to query resource categories harvested within a selected grid and displays its food-sharing network.

3.3 Statistical Analysis

3.3.1 Social Proximity vs. Spatial Proximity

One of the main objectives of this paper is to understand if there is a statistically significant difference attributable to physical distances between kin and non-kin households, and between nuclear and extended kin. Results show that within the SFN community, family members live closer to one another than non-kin. However, this difference is not statistically significant.

Table 1. Significance test of distances between kin and non-kin groups

	KIN	NON-KIN
Distance	1.68±1.3 km	2.02±0.89 km
Difference in Means	-0.35 km	p=0.40

When compared to members of the extended family, members of the nuclear family live closer together. This difference was not statistically significant either.

Table 2. Significance test of distances between nuclear and extended groups

	NUCLEAR	EXTENDED
Distance	1.54±1.23 km	1.80±1.18 km
Difference in Means	-0.25 km	p=0.51

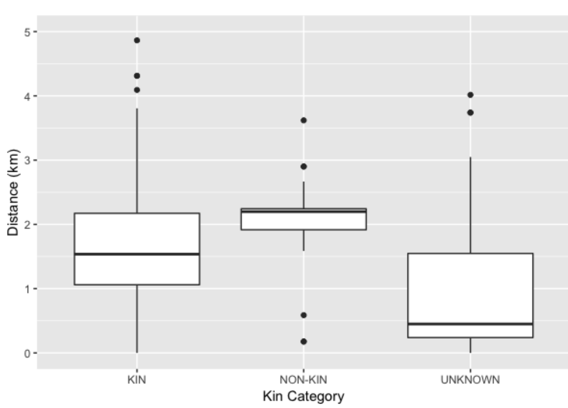


Figure 8: Distances by kin group

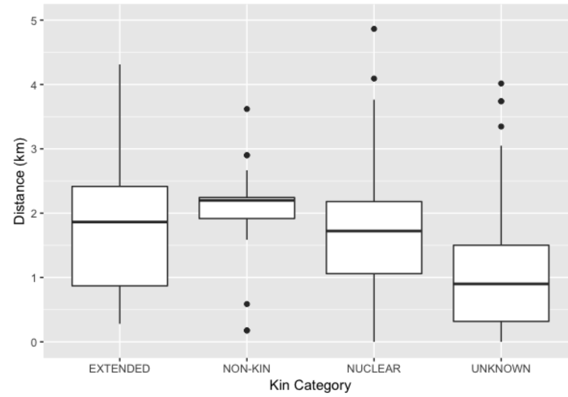


Figure 9: Distances by closeness of kin

We were interested in whether kin that live close to one another share more food. We calculated Geary and Moran's I statistics to answer the question. Results show a weak negative tendency between degree centrality and distance to kin (G=1.43, p=0.1; MI=-0.24, p=0.08), however this autocorrelation holds at p=0.1. In other words, there seems to be a tendency for kin who live close to one another to exchange more, if we accept a p-value of 0.1. Furthermore, given that this result was obtained using an incomplete kinship dataset, further research is required to consolidate this finding.

When we look at the entire dataset, irrespective of whether households exchanging food are related, households living close to each other tend to share more food (G=2.08, p=0.01). This should be interpreted with caution, since we restricted our food-sharing network to exchanges taking place only within the SFN community.

3.3.2 Social Engagement vs. Spatial Proximity

Similar analysis was performed to answer the remaining three questions. In the following section, distances represent the distance of households from the community's geographic center ('core').

Are households located further from the community's core less engaged in food sharing?

Levels of engagement in the food-sharing network were measured using Freeman's Degree Centrality scores. Households with at least four connections were considered highly engaged in the food-sharing network. Results show that less engaged households live, on average, closer to the community's geographic core. However, there was no statistical difference (p = 0.49). This result needs to be further refined – spatial clustering in the data means that there are multiple community foci.

Table 3. Significance test of distances between highly engaged and non-highly engaged groups

	Highly Engaged	Non-Highly Engaged
Distance from SFN core	1.62±0.81 km	1.43±0.88 km
Difference in Means	0.18 km	p=0.49

Do households located further from the community's core receive less food?

In-degree centrality scores quantify the total number of incoming ties for each household. In the SFN food-sharing network, this score represents the number of times a household received food. Based on these scores, we created a dummy variable for high receivers and low receivers (receiving food above or below three times). Results show that households receiving less food are located, on average, closer to the community's core when compared to high receivers. This difference was not statistically significant (p=0.79).

Table 4. Significance test of distances between high receivers and non-high receivers

	High Receivers	Non-High Receivers
Distance from SFN core	1.48±1.39 km	0.88±0.81 km

Do households located in the core of the community give more food?

Households located closer to the core of the community are not giving a lot of food to other community members. On the contrary, households giving more food were located slightly further from the core, when compared to non-high givers (out-degree centrality < 3). However, the difference in mean distance from the core between these two groups was not statistically significant (p = 0.97).

Table 5. Distances between high givers and non-high givers

	High Givers	Non-High Givers
Distance from SFN core	1.47±0.68 km	1.46±0.91 km

4. Conclusion

By incorporating spatial information into social network analysis, this study investigated visualization options and discussed the contribution of spatial variables within the social network.

Spatially explicit statistics were used to test key hypotheses about the role of spatial proximity and social proximity in the local food-sharing network. Both geographic distances and kinship are important variables in explaining food-sharing patterns.

Further research is essential, especially in the context of kinship networks where social proximity can reinforce spatial proximity and vice versa. Moreover, impacts of different measures of spatial distances need to be evaluated.

Furthermore, this line of inquiry needs further advancement, by building on anthropological and social studies realized within the context of Canadian indigenous communities.

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References

Coombs, G. (1973). Networks and exchange: The role of social relationships in a small voluntary association. Journal of Anthropological Research, 29(2), 96-112.

Feld, S. & Carter, W. (1998). When Desegregation Reduces Interracial Contact: A Class Size Paradox for Weak Ties. American Journal of Sociology - American Journal of Sociology. 103. 1165-1186. 10.1086/231350.

Festinger, L., Schachter, S. and Back, K. (1950) “Social pressures in informal group: a study of human factors in housing” Stanford University Press, Stanford, California.

Freeman, L. C. (1979). “Centrality in Social Networks: Conceptual clarification”, Social Networks 1, 215-239.

Hare, A. P. (1973). Theories of Group Development and Categories for Interaction Analysis. Small Group Research (Behavior). SAGE Publications.

Latané, Bibb, James H. Liu, Andrzej Nowak, Michael Bonevento, and Long Zheng. "Distance matters: Physical space and social impact." *Personality and Social Psychology Bulletin* 21, no. 8 (1995): 795-805. Logan, J. R. (2012). Making a place for space: Spatial thinking in social science. *Annual review of sociology*, *38*, 507-524.

Lu X., Natcher D., Rice A., Bodgan A., Zeng W., Ha T., Wang J., Azizi M., Abandankeshi F. Z., Doan T., Disano J., Bell S. (2019). Data collection and Spatial Analysis for Value Assessment of First Nations Environmental Livelihoods in Northeast British Columbia. Spatial Knowledge and Information Canada paper proceedings, 9. In Press.

Mouw, T. & Entwisle, B. (2006). Residential segregation and interracial friendship in schools. American Journal of Sociology, 112(2), 394-441. https://doi.org/10.1086/506415.

Statistics Canada. (2016). East Moberly Lake 169, Indian reserve [Census subdivision], British Columbia and Peace River, Regional district [Census division], British Columbia. Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=5955801&Geo2=CD&Code2=5955&Data=Count&SearchText=moberly%20lake&SearchType=Contains&SearchPR=01&B1=All&TABID=1.

Verdery, A. M., Entwisle, B., Faust, K., & Rindfuss, R. R. (2012). Social and spatial networks: Kinship distance and dwelling unit proximity in rural Thailand. Social networks, 34(1), 112-127.