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ASSESSING COMMUNITY COHESION IMPACT THROUGH NETWORK ANALYSIS

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ABSTRACT

Despite the importance of community cohesion to social impact assessment, evaluation remains problematic. This paper makes known a new descriptive method for assessing changes to community cohesion via network analysis. Selected results from a test application for the proposed Glengowan Dam and Reservoir indicated that community cohesion would be adversely affected.

An integral constituent of social impact assessment (SIA) is the notion of "community cohesion." In fact, Shields concludes that social impacts on community cohesion are the most crucial for they affect the entire range of structures and processes bearing on a community's identity and integrity [1]. Events illustrative of such disruptions are:

1. changes in transportation patterns (restructuring of local road networks);
2. displacement and relocation of local residents;
3. immigration of transitory and permanent workers with varying and often conflicting social and cultural values; and
4. destruction of social institutions (arena or general store).

Despite this pivital position within the SIA framework, evaluation of community cohesion impact remains problematic. Whether this condition will improve is largely dependent upon the development of new conceptualizations and attendant analytical notations. The aim of the present article is to offer a fresh view-point to grapple with identifying and interpreting change in

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community cohesion induced through some action.[1] The paper begins with an abbreviated discussion of network analysis, proceeds with an empirical application from a SIA and concludes with a few suggestions for future research.

NETWORK ANALYSIS

Movement of any form (people travelling, transportation of goods and services or ideas) takes place within a system of paths or routes linking origins and destinations, collectively known as a network. The study of networks has been related to an extensive array of subjects and to attempt a comprehensive explanation would be a travesty. Instead, only those issues most consistent with the theme of the paper are introduced.

The complexity of real world systems compels a certain degree of abstraction (simplification) in order to describe networks quantitatively and to compare exactly one network with another. To this end, networks have been approximated mathematically through graph theory, a branch of topology (qualitative geometry). As a result, when dealing with graph theory traditional Euclidean metrics such as straightness, absolute distance and direction are abandoned. What is important, however, is the overall connectiveness between places in the network; in other words, the presence or absence of links between pairs of places. Accordingly, a graph is nothing more than a simple pattern of points and lines, or in mathematical parlance, vertices and edges, respectively. This form of representation permits questions about the general structure of the pattern to be answered. One of the most fundamental and useful parameters of networks, in a topological sense, is the degree of connectivity, defined as the amount of direct movements vis-a-vis indirect movements. Expressed differently, given a certain number of vertices, the more edges there are the greater the connectivity of the network.

Several descriptive indices measuring connectivity are available, each possessing specific penalities and benefits. The details of each summary measure need not detain us here; in preference, only the two connectivity indices used in the SIA will be outlined:

1. the beta index,

$$\text{where } \beta = \frac{\text{vertices}}{\text{edges}} \tag{1}$$

This index has a range from 0.0 (indicating a network with no linkages) to a maximum value that can theoretically reach infinity. In reality, however, it seldom exceeds 3.0. A general interpretation of the parameter is that values greater than 0 but less than 1 signify a branch or tree network, whereas values

[1] An action is any policy, legislation or physical development with environmental implications.

equal to and greater than 1 reflect networks containing circuits (more connections between vertices).

2. the gamma index,

$$\text{where } \gamma = \frac{\text{vertices}}{3\ (\text{edges-2})} \tag{2}$$

The interpretation of the gamma index revolves around an assessment of the two extreme values (0 and 1). Low values indicate few edges (0 represents no edges) while high values represent a network containing many connections (1 denotes a totally connected network).

It should be noted at this point that the formulas for both the beta and gamma indices set down here relate to plannar graphs. A plannar graph is simply a two dimensional representation where the intersection of any edge is a vertice on the network. Conversely, three dimensional non-plannar graphs allow edges to cross without necessarily being connected (airline routes).

Having briefly treated selective aspects of network analysis, the next stage is to demonstrate how this method can contribute to the measurement of community cohesion impact.

RESULTS

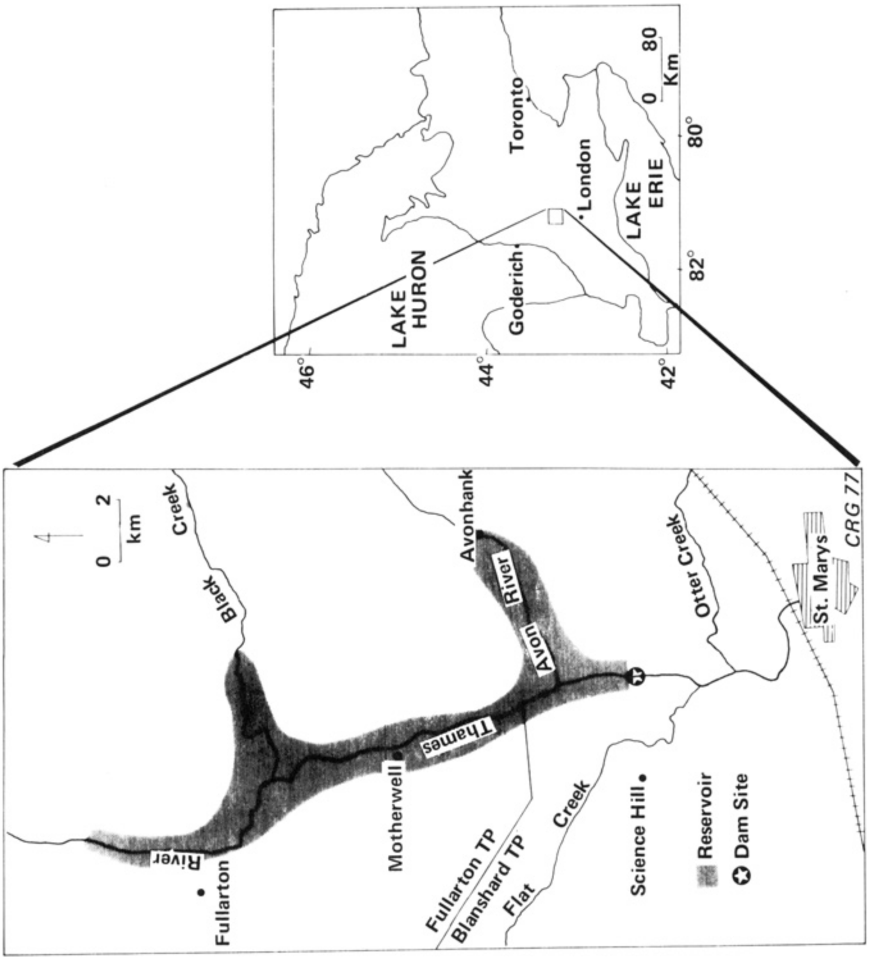
In 1976 a social impact assessment was performed on a proposed water management scheme in southwestern Ontario (Figure 1). The study exposed a number of potential social disruptions directly attributable to the project [2]. In what follows, however, only the likely impact to community cohesion owing to the restructuring of highway sections within the impact zone is discussed.

Four regions were delimited and analyzed in terms of pre- and post-project connectivity (Figure 2). Regions were circumscribed such that individuals travelling from point "A" to point "B" would cross through the region. The assumption, of course, is that individuals would take the path of least resistance to reach their destination.

The results are displayed in Table 1. Beginning with Region A, the direct impact zone, it was observed that without the project the road network had a beta value of exactly 1.0, describing a network with one circuit. By comparison, changes contingent upon construction of the dam and reservoir revealed a lower beta value (.93). Evidence which supports the argument that Region A would undergo a reduction in connectivity and, as a consequence, affect social patterns.

As expected both "with and without" project beta coefficients showed an increase in connectivity as the total area was enlarged but post project regions consistently yielded lower measures of connectivity.

Gamma values manifested a similar pattern. Region A experienced a 5.3 per cent diminuation in direct connection between all edges following dam



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River
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Blanshard TP
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Science Hill
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River
Otter Creek
St. Marys
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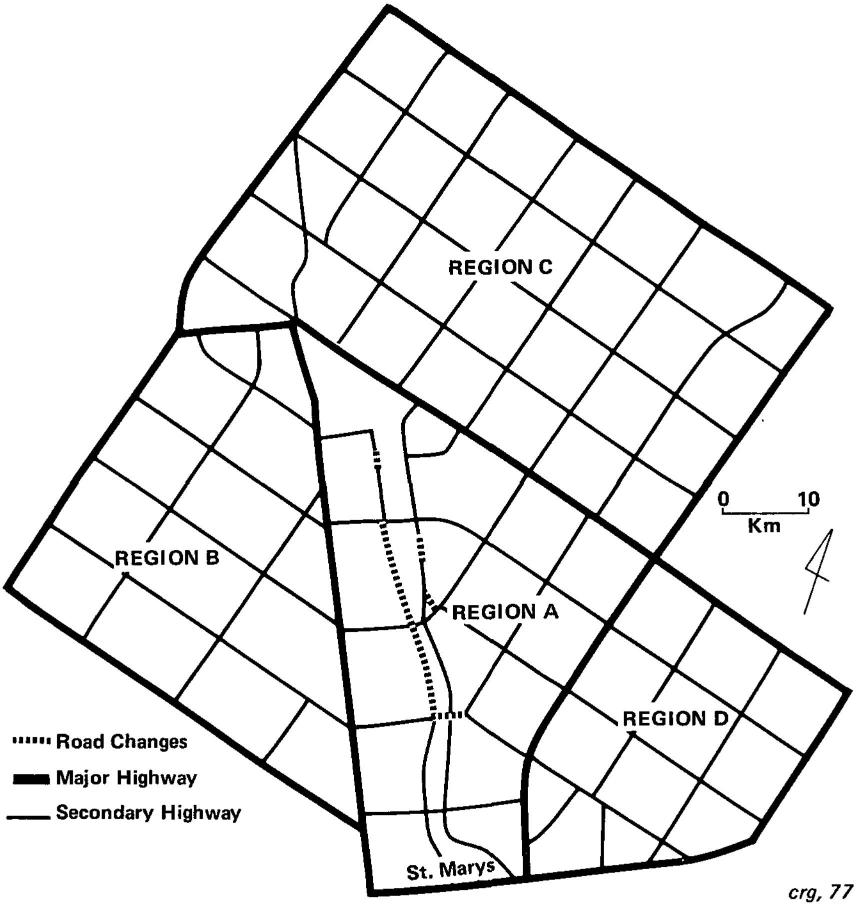

Figure 2. Network analysis regions.

Table 1. A Comparison of Connectivity Indices With and Without the Proposed Glengowan Dam and Reservoir

	Without		*With*	
Region	*Beta Index*	*Gamma Index*	*Beta Index*	*Gamma Index*
A	1.00	.384	.93	.333
B	1.18	.410	1.15	.376
C	1.31	.449	1.30	.445
D	1.31	.445	1.29	.438

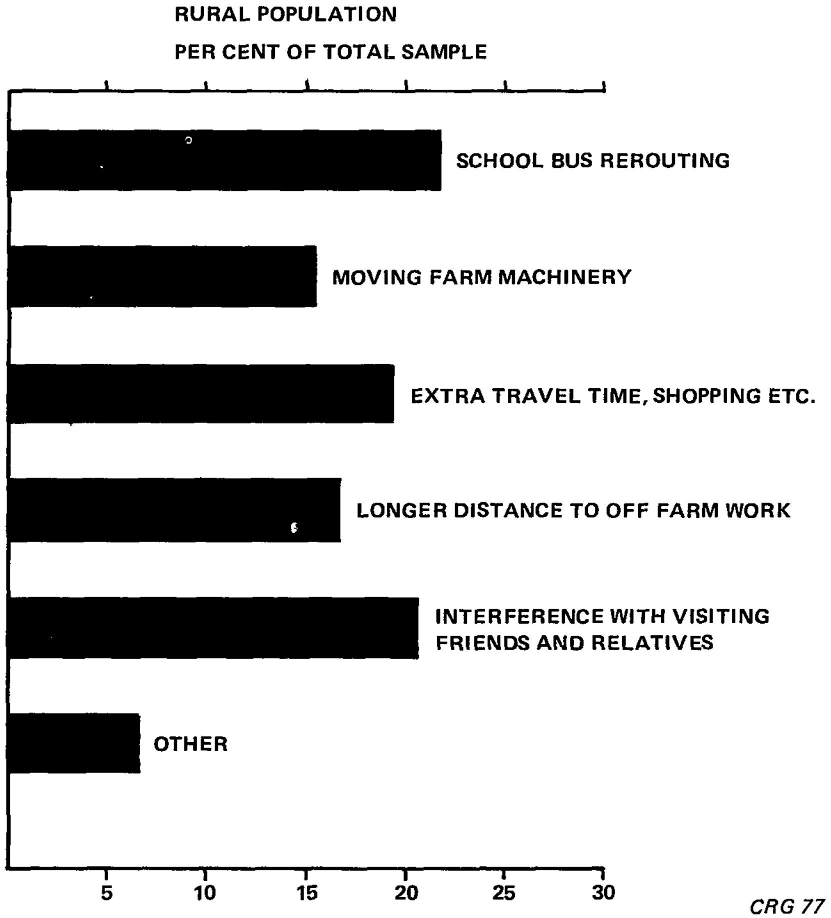

Figure 3. Perceived social inconveniences.

construction. In addition, the general behavior of the gamma values are worth mentioning. Intuitively, one would expect the gamma index to systematically increase as new regions were added. An inverse relationship often arises, however, because the index is relative to the number of vertices that exist at that point in time, rather than the total number of vertices brought into the system.

The two summary measures, in this instance, only communicate that a decrease in physical connectivity would occur assuming project implementation. To bring the implications of this finding into clearer focus residents within the impact zone were queried as to perceived social changes originating from the water development. As recorded in Figure 3, all of the specified changes dealt with some type of mobility interruption. The combined information, then, provides, to a certain degree, confirmation that constructing a dam and reservoir would adversely affect community cohesion.

CLOSING COMMENTS AND FUTURE DIRECTIONS

The paper has introduced a new descriptive approach in assessing changes to community cohesion via network analysis. The empirical exercise, albeit simple, did demonstrate the attractiveness of the technique. In the first place, it is project independent; that is, it can be applied to virtually all actions, proposed or real. Second, and perhaps most important, is the relative analytical simplicity of the method. Network analysis requires only nominally scaled data (presence or absence of events) to be functional. This condition is congruent with the existing state of the art for this impact variable. Moreover, it allows events to be "frozen" in a convenient form and subsequently interrogated from several angles (questionnaires and oral submissions). In the context of SIA, in general, and community cohesion in particular, the development of a network analytic orientation is inchoate. The ideas expressed in this paper should be used as a "springboard" for launching new and more sophisticated applications. Extensions might include estimating network volume (number of people using particular routes) together with exact distance changes from which total community time and monetary costs could be evaluated.

Another direction worth pursuing involves investigating non-physical networks. Social networks consisting of sets of relationships operating in social space rather than geographic space may yield substantive insights. Since these networks can be portrayed as topological structures they are equally amenable to a graph-theoretic format. From this point of view, connectivity is seen as a mathematical translation of some socio-psychological notion of group cohesiveness. Networks could be constructed through interviews and used in assessing the influence of new workers on established ties, for example.

In conclusion, several difficult problems of both description and interpretation are associated with evaluating change in community cohesion. And, as stated earlier, the state of the art can only progress by experimenting with fresh ideas and analytic techniques. In the early stages frustrations will be frequent but the ultimate pay-off in creating less socially disruptive actions is well worth the effort.

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