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LAND-USE CHANGE IN A SELECTED AREA OF THE NIAGARA FRUIT BELT

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IN A

SELECTED AREA OF THE NIAGARA FRUIT BELT

1954-1978

By

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ABSTRACT

The thesis examines land-use changes in a selected area of the Niagara Fruit Belt between 1954 and 1978. Part of the former township of Louth was chosen for investigation because it is located in the centre of the fruit belt, and is an area affected by several urban influences.

Two detailed land-use maps were produced from aerial photograph interpretation. These maps reveal the many exchanges among agricultural land uses and the actual loss to urban and urban-related uses which occurred during the time span investigated. They indicate the loss of fruit land to non-agricultural uses is less than was anticipated. Increases in grape acreages have been implemented relatively close to the City of St. Catharines and the lost peach acreage is not entirely due to urbanization.

A land-use change index was developed, based on total change per lot, for use in the quantitative analysis. The 1954 assessment roll provided the data on individual properties. Eight hypotheses were developed to account for the land-use changes. These were rejected, and it was suggested that the study area was undergoing a "normal" process of change, resulting from a combination of agricultural and urban forces. Further research is needed in order to understand more fully, the processes of land-use change in an area such as Louth.

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CHAPTER 1

INTRODUCTION

> Of all the factors that determine the quality of our environment, the most fundamental is the use we make of our land.
>
> Curtis, 1973, p. 2.

This statement is consistently true over a spectrum of land uses, from the large urban centres of our country where air and noise pollution plague us, through the rural-urban fringe, to the most remote rural and relatively untouched parts of the nation. Land constitutes the very essence of our natural resources. All living organisms are dependent upon it for food and shelter.

People are especially dependent on land as our economy is mainly based on the exploitation of natural resources by means of farming, mining, fishing, forestry and the production of energy. Ontario is not an exception. Its $80 billion per year economy is dependent to a great extent on its natural resources. Annual revenue from the farmlands, mines and forests amounts to $9 billion and billions more in related secondary and tertiary industries (Howard, 1980). This dependency demands that land be used efficiently. Thus, changes in land use should be monitored closely to determine trends and causes so that future trends may be predicted, and a rational balance of land uses may be established.

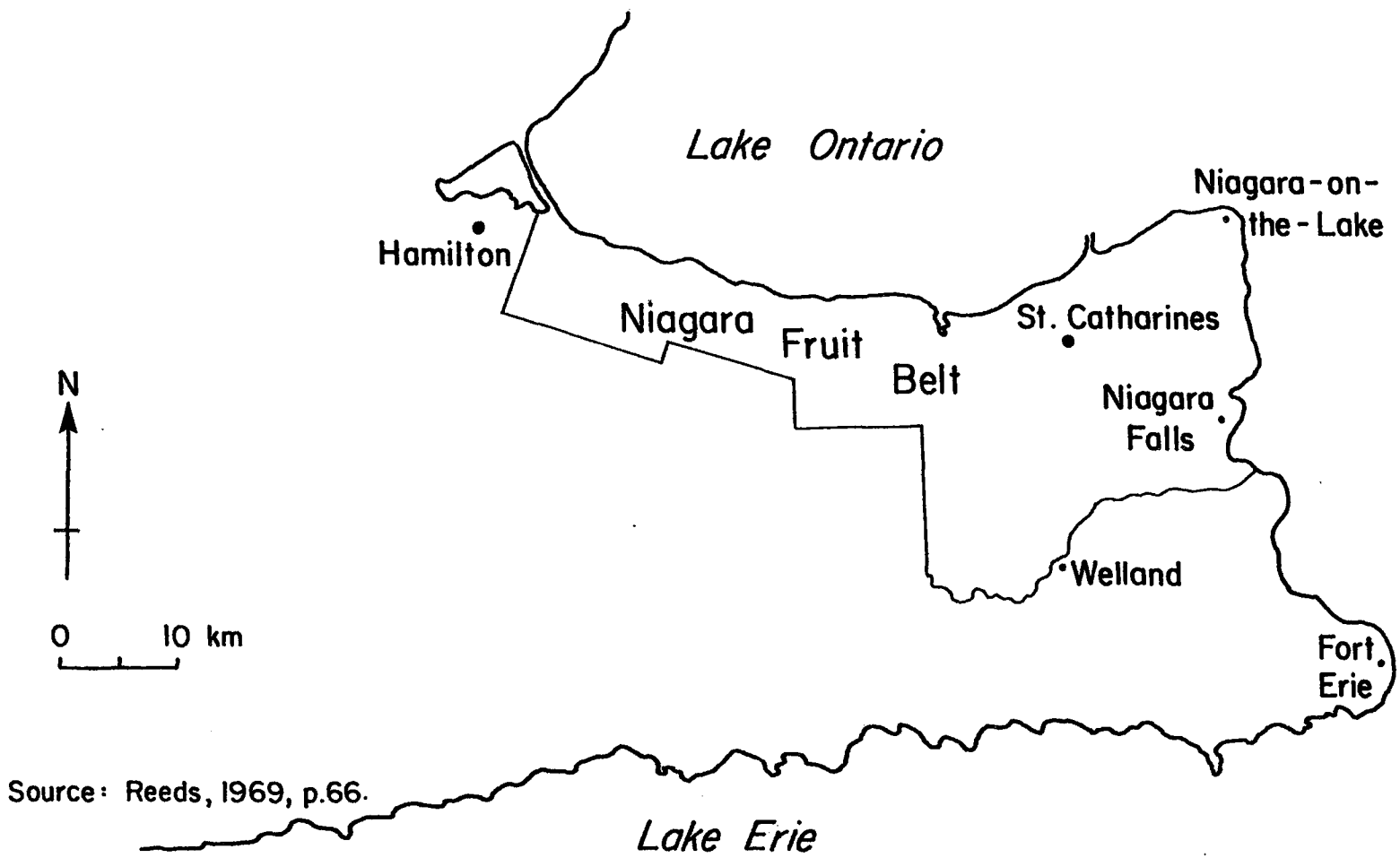
Today, conflicts of land use are causing an increasing amount of agricultural land to be converted to urban uses. The problem is particularly evident in Ontario which possesses 16 million (30%) of Canada's 55 million acres of prime farmland. In 1979 Ontario's $3.9 billion gross farm income accounted for one-third of Canada's gross agricultural sales (Howard, 1980; and O.M.A.F., 1980).

Prime agricultural land is not only good for farming but for many other uses as well. It can be converted into subdivisions or pasture, or it can be left unused. Urban centres such as Vancouver, Toronto, Hamilton and St. Catharines are expanding rapidly with detrimental effects on their agricultural hinterlands. All of these cities are located in areas of rich agricultural soils, and their growth oftentimes results in the conversion of prime agricultural land to urban or urban related uses.

Of primary concern, is the area along the southern shore of Lake Ontario, extending westward from the Niagara River to Hamilton, known as the Niagara Fruit Belt (see Figure 1). With its unique combination of physiography, soils and climate, the fruit belt is the best area in Canada for the production of tender fruit. This area however, is also ideally situated for urban and industrial development as it is located within one of the fastest growing population and market regions in Canada.

In the past two decades, the Niagara Peninsula has lost 15,000 acres of fruit land. Between 1976 and 1977 alone, Ontario's total commercial fruitland acreage declined by 5,000 acres. Although the rate of decline has diminished, the Ontario Institute of

Figure 1: Location of the Niagara Fruit Belt



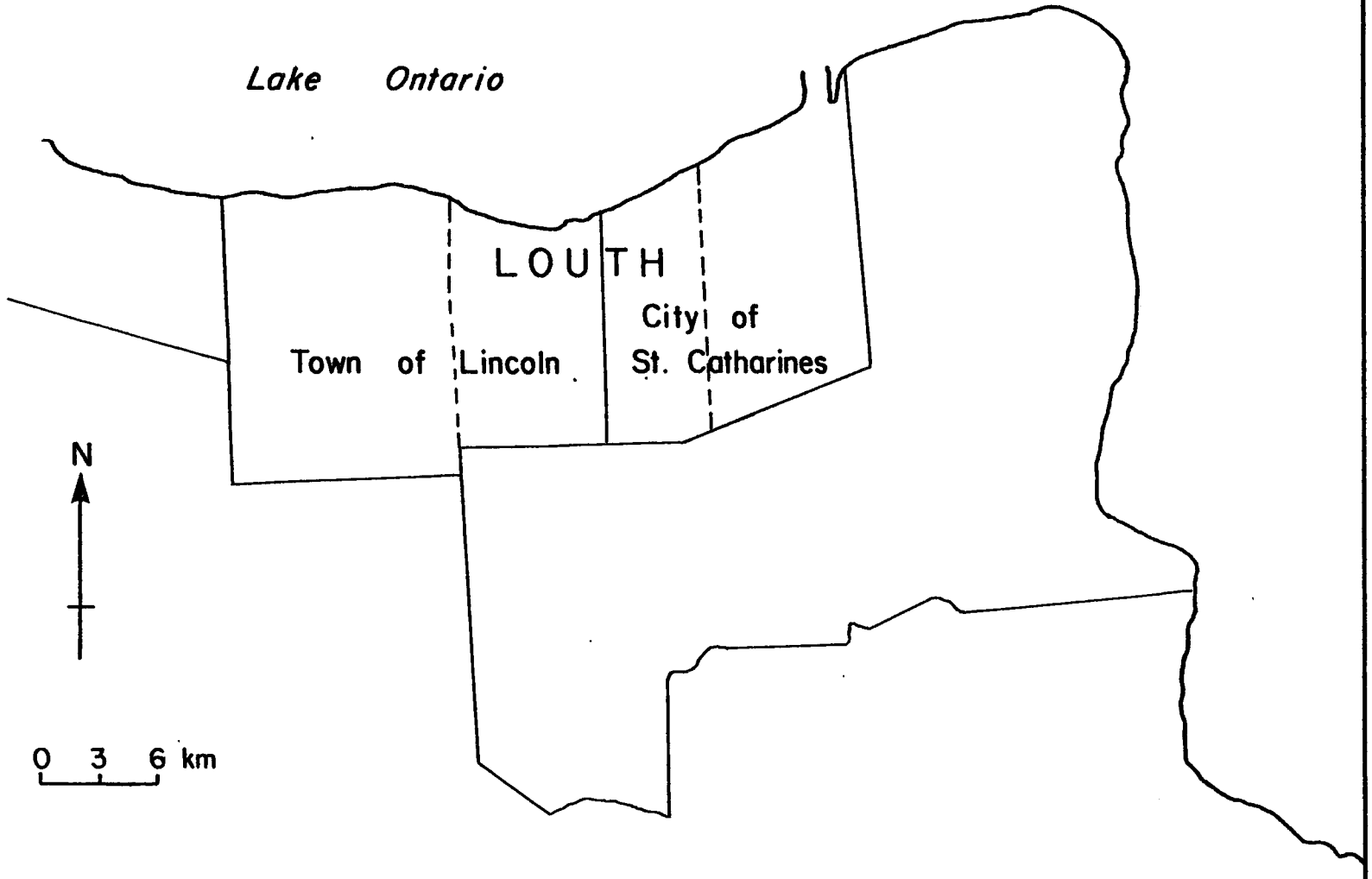
Source: Reeds, 1969, p.66.

Agronomists predicts by the year 2,000, Ontario will be 2 million acres short and very hard pressed to produce enough food for everyone (Frankena et al., 1980; and Howard, 1980). It is evident, there is a need for effective planning immediately. Before any plans can be formulated, the causes for land-use change peculiar to particular areas should be identified. It is the purpose of this study to investigate changing patterns of land use in a selected area of the Niagara Fruit Belt.

The section of the fruit belt chosen for this study is part of the former township of Louth[1] (see Figure 2). The area of the township north of the Niagara Escarpment will be examined to determine the extent, degree and type of land-use change that occurred in the period from 1954 to 1978. These changes will then be measured, described and explained.

Chapter 2 presents a description of the physical environment. In Chapter 3 the pertinent literature on land-use change is reviewed, and Chapter 4 describes the research design and methodology. In Chapters 5 and 6 the data set is described and the analysis is presented. Multiple regression is employed as an analytical technique to ascertain which variables are most significant in explaining land-use changes during the 24 year time interval. The study is summarized and conclusions are presented in Chapter 7.

[1]For the sake of simplicity, the study area, although not covering the entire township of Louth, will often be referred to throughout as Louth, or the township.



Source: Hubert, 1975, p.5.

Figure 2: Location of the Former Township of Louth

CHAPTER 2

THE PHYSICAL ENVIRONMENT

The former township of Louth occupies 8,021 hectares (18,230 acres) and is situated directly west of the City of St. Catharines, in the heart of the Niagara Fruit Belt. Two highways, the Queen Elizabeth Way and Niagara Regional Road 81 (formerly Highway 8), and the Canadian National Railway service the area. In 1954, the township had a population of 4,473 which had increased to 6,384 by 1978. There are four villages in the study area: (1) Vineland; (2) Vineland Station; (3) Jordan; and, (4) Jordan Station.

2:1 Bedrock geology

The entire Niagara Peninsula is underlain by sedimentary rocks of the Paleozoic Era. In the area of Louth, these consist of Ordovician and Silurian formations. The rock strata are horizontal beds dipping slightly toward the south and are made up of shales and limestones. Dolomitic limestones form the caprock of the Niagara Escarpment. Below the escarpment, the Queenston formation is often exposed. It is a red shale with a high silt content and it greatly influences the soils of the region. The upper level of the beds is slightly above that of Lake Ontario (Wicklund and Matthews, 1963).

2:2 Physiography

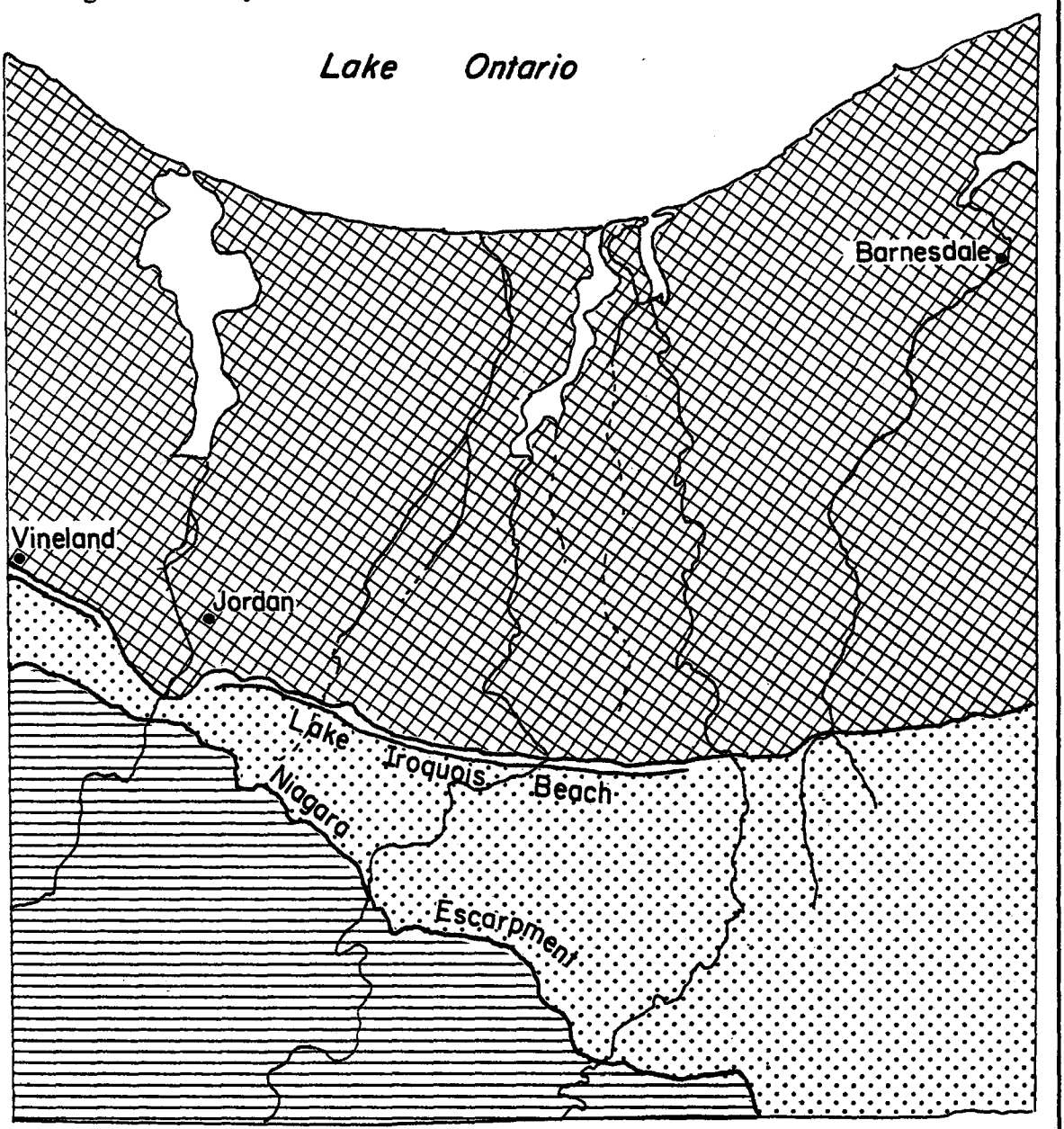
As a result of repeated glaciations in the area during the Pleistocene Epoch, the whole Niagara Region is covered with glacial drift. During this time, numerous glacial lakes, which partially account for the many clay deposits in the area, were formed. A glacio-lacustrine till was laid down during the many advances and retreats of the glacial ice. The entire region is underlain by these clay till deposits. They consist of red, yellow and olive clays, and include stones and pebbles of shale and sandstone with the same colour variation. Extending continuously from the lakeshore to the most southerly part of the region, these deposits are the parent material upon which most of the soils of the Niagara Region have developed (Wicklund and Matthews, 1963).

On the basis of its physiography, Louth can be divided into five distinct sections: (1) the Iroquois sand plain, (2) the Lake Iroquois shoreline, (3) the escarpment bench, (4) the Niagara Escarpment, and (5) the Louth till plain (see Figure 3). This study is concerned only with the sections north of the Niagara Escarpment (i.e. sections 1 - 3), as the escarpment provides a distinct break in the topography where land use changes from specialty fruit production to mixed farming and grapes. The southern boundary of the Iroquois sand plain marked by the Lake Iroquois beach is, in effect, the point of land-use change.

2:2:1 The Iroquois sand plain

The Iroquois sand plain borders the Lake Ontario shoreline

Figure 3: Physical Divisions of Louth Township

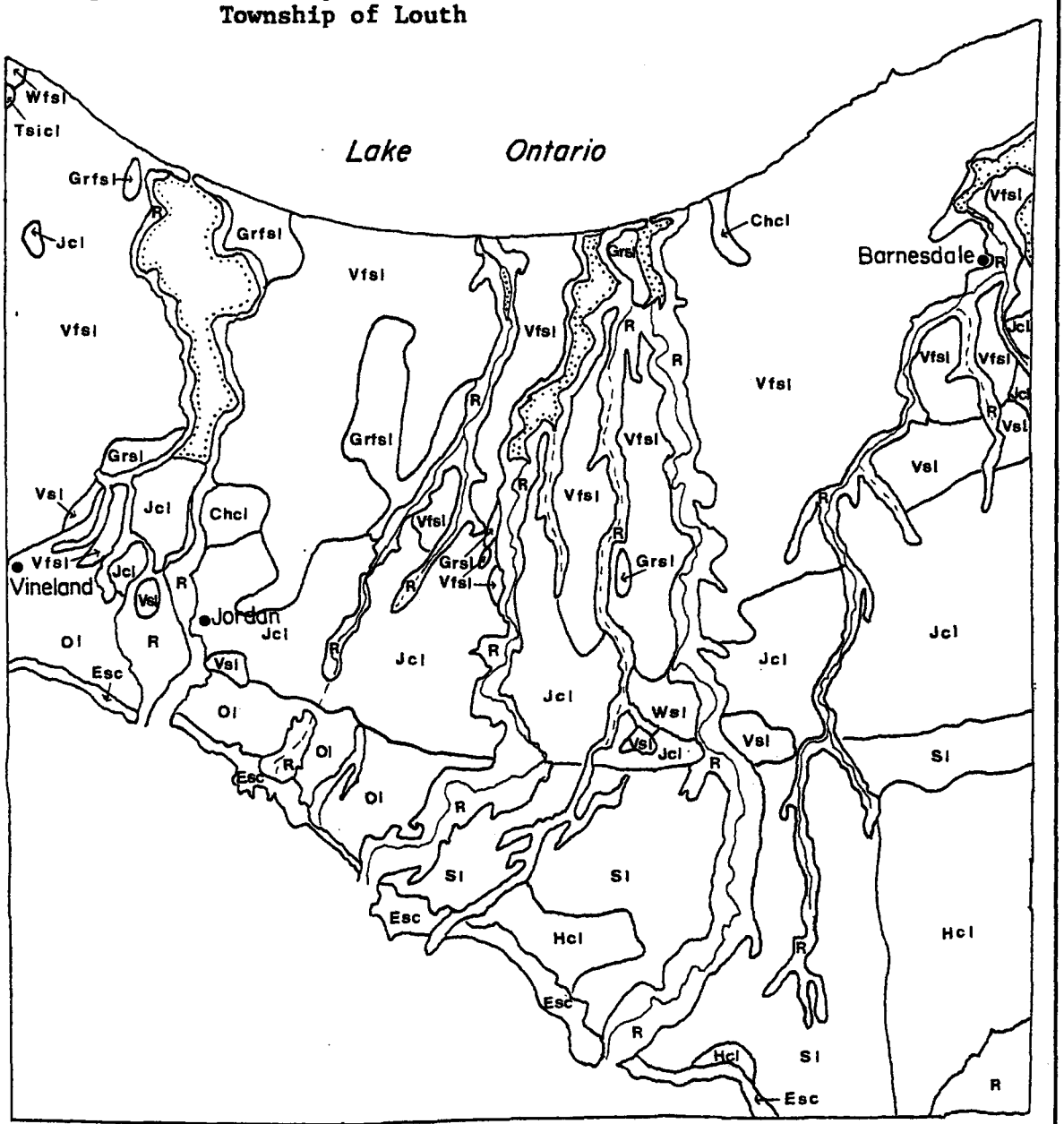


Source: O.M.A.F., 1957, p.20

and extends south to the Lake Iroquois shoreline (Regional Road 81). Having been formed by the waters of post-glacial Lake Iroquois, the plain is flat with mainly sandy surface sediments. It slopes gently north from Regional Road 81 to Lake Ontario, creating a moderate fifty-foot declivity over the plain. Slopes are usually less than two per cent except where streams have cut into the plain causing ravines and steeper slopes, sometimes exceeding 25%. The calcareous, medium and fine sands of the plain occur in a fairly continuous body along the shore of Lake Ontario, with a number of pockets located further south. They are underlain at various depths by the glacio-lacustrine clay till. The sand deposits are, in all probability, deltaic deposits, and are a unique reddish-brown colour being derived from the red sandstones of the Grimsby formation. The depth of sand varies from 0.6 m (2 ft) to 2.4 m (8 ft), becoming shallower along the Lakeshore (Ont. Dept. of Agr., 1957; and Wicklund and Matthews, 1963).

Extending from a point just east of Jordan to the eastern boundary of the township is a large wedge-shaped body of clay soil (see Figure 4). The flat topography of the area and the fineness of the covering material causes water movement through and off the soil to be extremely slow. It is not unusual to see large, deep drainage ditches. The thin sand formerly covering this area was removed by erosion leaving surface soils of silt loam or clay. This land is mainly used for grapes and general farm crops due to the poor and imperfect drainage conditions (Ont. Dept. of Agr., 1957).

Figure 4: Soil Map of Part of the Former Township of Louth



N

0 1 2
km

Source: Wicklund & Matthews, 1963

Chcl – Chinguacousy clay loam
Grsl – Grimsby sandy loam
Grfsl – Grimsby fine sandy loam
Hcl – Haldimand clay loam
Ol – Oneida loam
Jcl – Jeddo clay loam
Sl – Smithville loam
Tsicl – Trafalgar silty clay loam
Vsl – Vineland sandy loam
Vfsl – Vineland fine sandy loam
Wsl – Winona sandy loam
Wfsl – Winona fine sandy loam
R – Ravines
Esc – Escarpment

2:2:2 The Lake Iroquois shoreline

The 350 foot contour line on topographic maps of the region outlines the Lake Iroquois beach. The former shoreline coincides closely with Regional Road 81. Although the shoreline itself has no significant effect upon agriculture, as previously mentioned, it acts as the southern limit of the sand plain and denotes the place where land use generally changes from fruit cultivation to grapes and mixed farming. This is due to the change in surface soils from fine and medium textured sands to clays, sands and gravels (see Figure 4). Some fruit, such as peaches and cherries, may be grown on the small patches of sand and gravel (Ont. Dept. of Agr., 1957).

2:2:3 The Escarpment bench

The escarpment bench consists of the area lying between the Lake Iroquois shoreline and the Niagara Escarpment. The bench is triangular, with its apex at Vineland, becoming wider as the distance between the escarpment and the shorline becomes greater. At the eastern township line (1st St. Louth), it is about 3.2 km (2 mi) in width. The western part of the bench has a moderately undulating topography which changes to a more rolling landscape in the central and eastern sections where slopes greater than ten per cent can be found (Ont. Dept. of Agr., 1957).

In some areas, the escarpment bench is penetrated by eroded ravines and small streams running in the direction of the slope. The topography thus provides good surface water runoff and hence, good drainage, but soil erosion becomes a significant hazard due to the

steepness of some of the slopes (Wicklund and Matthews, 1963).

The soils of the bench have developed on the clay-textured glacio-lacustrine till and are slightly coarser in texture than the clays on the sand plain. Generally they are silt loams, sometimes having a clay loam subsoil. On the elevated areas of the bench, the soils are usually moderately well drained and the flatter parts have imperfect to poor soil drainage (Wicklund and Matthews, 1963).

2:3 Soils

Soils determine to a great extent the location of the prime fruit-growing areas. Evaluation of soils for the specialized crops of tree fruits and grapes produced in the Niagara Fruit Belt has not been included as part of Canada's major soil capability classification system (Environment Canada, 1972). It evaluates soils with respect to general field crops and thus is inadequate for the purposes of this study. A separate classification scheme must be developed which takes into account the soil factors that are critical for fruit production. These factors include: (1) soil texture, (2) depth to impermeable layers or bedrock, and (3) soil drainage. The most favourable conditions for tree fruits, as cited in present literature, are provided by deep, well drained, light textured soils. These are best because:

(i) sand soils provide a well aerated medium for root development;

(ii) absence of a water table or impermeable layers within the normal rooting zone allows for unrestricted root development;

> (iii) poor soil drainage or excess water promotes growth in the fall period, reducing the extent of plant hardening before winter which may result in increased winter injury and replacement costs.
>
> (Ecoplans Ltd., 1979, p. 30)

Peaches and sweet cherries are most demanding, and require the deep, well to imperfectly drained sands of the Iroquois plain. Other tree fruits such as plums, pears, apples and sour cherries, and also grapes will grow on the shallower more poorly drained depressions where the light textured soils of the plain are underlain by clay. Yields, however, are lower than on the deeper soils. Although grape varieties require varying soil conditions, the remaining well drained clay loam soils of the plain and the bench support the main North American (labrusca) type grapes. The less hardy, but more vigorous recently introduced European (vinifera) grape varieties, such as the French hybrids, prefer the sandy soils and for this reason are grown in the sandy areas of the plain (Ont. Dept. of Agr., 1957).

2:4 Climate

Not only are soils important in determining the best agricultural locations for fruit cultivation, but climate is a key factor as well. This is especially so in the Niagara Fruit Belt where the success of agriculture is due to a unique combination of physiography, soils and climate. A number of climatic requirements, together, create favourable conditions for fruit production in the fruit belt. Table 1 lists four major climatic attributes necessary for a fruit growing area and the corresponding conditions within the Niagara fruit

TABLE 1

MESOCLIMATIC REQUIREMENTS FOR FRUIT PRODUCTION
AND CORRESPONDING CONDITIONS IN
THE NIAGARA FRUIT BELT

Requirement	Condition Present
1. "Absence of extremely low temperatures (the critical temperatures for wood and bud damage vary with the different fruit crops)."	The moderating influence of local climatic conditions reduces the risk within the fruit belt of extreme low temperature injury. Table 2 shows that this area has the lowest probability of low temperature injury in Southern Ontario.
2. "Absence of killing frosts after blossom time."	Lake Ontario reduces air temperatures and retards blossoming for 1 or 2 weeks. This reduces the danger of frost for most fruit crops.
3. "Generally, fruit growing areas are best located close to the moderating effects of a large body of water."	The deep waters of Lake Ontario moderate the temperature within the Niagara Fruit Belt. In the spring, the cool lake water keeps air temperatures low, retarding blossoming so that the danger of frost for most fruit crops is greatly reduced. Similarly, in the fall, the warm lake waters moderate the air temperatures to delay frosts until mid-October, extending the growing and harvesting seasons.

TABLE 1 - Continued

	Requirement	Condition Present
4.	"Preferred sites within areas adjacent to the lakes, are those that allow good air drainage through local topographic variation."	The local topography plays an important role in terms of air drainage. Figure 5 illustrates the type of air flow pattern that develops over the northern part of the Niagara Region on a calm, clear night. As air over the land cools, offshore breezes begin. The cool air situated over the Escarpment slope flows downhill and slows as it crosses the level plain and mixes with warmer air as it approaches the lake. The air flowing down the Escarpment is replenished by warmer air from over the lake. Therefore, on a calm, clear, frost-free night in winter or spring, the warmest locations are closest to the lakeshore and also on the more steeply sloping portions of the Escarpment. Consequently, the slope from the Escarpment to the lake in the area below the Escarpment provides excellent air drainage that offers some protection from frost damage on cold nights. Micro-climatic variation within this meso-climatic air circulation will create air pockets with higher frost risk. These must be identified.

SOURCE: Ecoplans Ltd., 1979, pp. 40-45.

TABLE 2

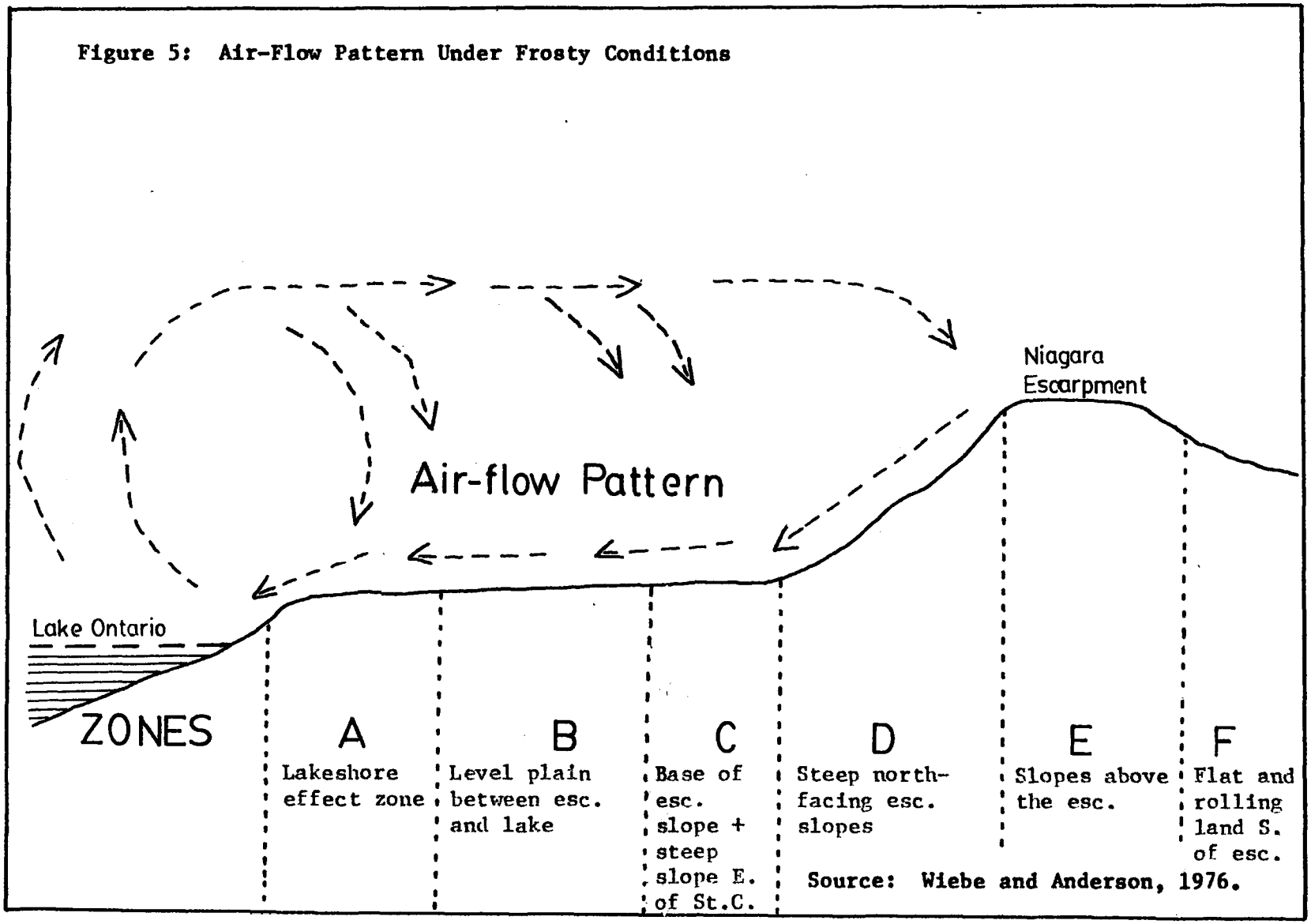
ESTIMATED YEARLY ODDS OF LOW TEMPERATURE INJURY TO PEACH TREES IN 30 YEARS (1925-54)*

	Tree Damage	Winter Bud Damage	Spring Bud Damage	Years in 30
	-28°C (-20°F)	-24°C (-12°F)	-5 - -4°C (23 - 26°F)	
Fruit Belt				
St. Catharines	-	2	0.2	2.2
Vineland	-	3	-	3.0
Other				
Harrow, Chatham, Leamington	-	4	1.2	5.0
Welland	1	6	-	6.0
Goderich	1	5	4.8	9.0
Port Dover	3	8	0.2	9.5
Forest	1	9	4.0	11.8
London	3	13	1.0	13.6
Simcoe	3	14	2.5	15.3

SOURCE: Ont. Min. of Agr. and Food, 1957, p. 11.

*Significant tree and branch damage occurred during an extreme cold period (Feb. 17-19, 1979) when temperatures fell to -28 to -29°C (St. Catharines Standard, May 26, 1979, p. 1). Previous low temperature episodes occurred in 1898-99 and 1903-04 in the Essex - Kent area of Ontario; Niagara was barely affected (Ecoplans Ltd., p. 41).

Figure 5: Air-Flow Pattern Under Frosty Conditions



Source: Wiebe and Anderson, 1976.

producing region.

Other conditions present in the Niagara Region, also favour fruit production. The region has sufficient winter chill to break the rest period, and the growing season is long enough to enable fruit to mature. The summers are relatively sunny, and are free from hail and heavy rainstorms when fruit is near, or at maturity. High velocity winds are absent throughout most of the year, and the annual precipitation of 762 mm to 864 mm is adequate for most fruit crops (Ecoplans Ltd., 1979).

The presence of these mesoclimatic features creates a favourable climate for a viable fruit production system, but the fact must not be overlooked that there may be microclimatic variation within the regional pattern causing some areas to be less suitable than others for the production of fruit. Krueger (1959a) states that the study area is a better climatic zone for tender fruit production than the western section of the fruit belt near Hamilton. Selected temperature records for Grimsby and Rock Chapel, illustrate that the Grimsby region has the probability of winter peach bud injury 4 years in 30 compared to 2 years in 30 for the St. Catharines region, (Ellis, 1968, cited in Ecoplans Ltd., 1979).

The combination of physiography, soils and climate distinguishes the Niagara Fruit Belt from any other area in Ontario. This unique association of variables constitutes a specialized agricultural production system. As previously mentioned however, the area is also ideally situated for urban and industrial development. If the exceptional circumstances present here are to be appreciated, priori-

ties must be set in the determination of the allocation of land. This is especially so in the study area as it presently is relatively unaffected by industrial and urban development.

CHAPTER 3

REVIEW OF LITERATURE

Social scientists have not developed adequate methods of describing and forecasting regional patterns of change in agriculture. While there are many theoretical and mathematical tools to choose from in describing and predicting the behaviour of economic systems generally, the analytical methods for examining land-use change are not as well developed. One of the few existing theories, hypothesizes that change is a function of previous states.

This theory, developed by Girt (1975), regards an agricultural enterprise as a system with a particular combination of inputs and outputs. A farmer's personal choice of combination will reflect his response to what he views as his conflicts and opportunities in the market, and in his own and his family's goals in life. Since response implies adaptation, any change that takes place in his enterprise is influenced by some previous state. In the farming enterprise, change involves the manipulation of existing conditions; thus, Girt hypothesizes that whatever change does occur is a function of previous states. Personal pressures for change will vary among farming enterprises within a particular area. Aggregation of farms, however, results in a filtering effect where many of the individual pressures are obscured and more consistent pressures affecting a large number of farmers are highlighted.

The lack of a diverse theoretical base has caused most researchers of land-use change to use Girt's theory implicitly or explicitly in their studies, and to take a more descriptive rather than an intensive analytical - hypothesis testing approach to the problem.

3:1 Background studies of land use in the Niagara Fruit Belt

The controversy over the Niagara fruitlands has carried on for several decades since the time university researchers and national forums, such as the 1961 Resources for Tomorrow Conference, identified the loss of farmland to be a critical problem. It was 1972 when the first public alarm was sounded for the loss of agricultural land in Southern Ontario. A joint federal-provincial study carried out by the University of Guelph (A.R.D.A., 1972) brought the farmland question to the forefront and made it a matter of widespread public debate and a prominent political issue. Over these years, there have been several reports describing the physical, economic and cultural conditions of the Niagara Region. One of the earliest of these reports was undertaken in 1955 as a "pilot" study to point the way for similar studies throughout the farmlands of Southern Ontario.

The "Louth Report" (Ont. Dept. of Agr., 1957) was initiated to gather information related to forces generating land transfers and to the productive value of the land. With this information collected, the Louth Township Land Use Committee hoped to determine the possibilities of saving the fruitland of the Niagara District from urban and industrial encroachment. The objective of the study

was to make a detailed survey of the township's soils, land use and socio-economic aspects. Researchers concluded that a close relationship existed between land use and land quality. It was also evident to investigators that land quality was of paramount importance in determining the type of crop, yields and income. The authors noted that the most important achievement of the survey was the development of a sound and flexible technique of studying and investigating the relationships of soils to land use and socio-economic parameters. This technique could be applied to any area in Ontario with minor variations to conform to local conditions.

In 1968, research was undertaken on a larger scale to investigate agricultural conditions in all of the fruit-growing areas of the Niagara Peninsula. Specifically it aimed to examine patterns of land use and to study socio-economic aspects of the fruit growing industry (Reeds, 1969). The conclusions and recommendations of the study indicated that it is unrealistic to attempt to preserve a maximum amount of fruit land, but there is a potential for preservation of certain core areas of first class tender fruit land which as yet are relatively unaffected by urban sprawl.

Other background studies include Krueger's 'The Geography of the Orchard Industry in Canada' (1972) and Ecoplans' 'Research Report on the Niagara Fruitland' (1979) which are comprehensive overviews of the region's agricultural industry. The Ecoplans report emphasizes environmental issues. It examines trends in the fruit-growing industry and explains the adjustments that have occurred as a result of urbanization, increasing land values and the cost-

price squeeze.

3:2 Studies of rural and agricultural land-use change

The lack of a sound theoretical base related to land-use change is one of the major reasons for the primitive state of research on this topic. Another problem with attempts to explain land-use change is that data on non-agricultural uses of land, land rents and land prices are inadequate. Thus, it is difficult to determine what has happened to the land that has gone out of agricultural production; and, it is even more difficult to account for these changes.

Several reasons for land-use change have been hypothesized by various researchers. Bryant (1976) suggests three processes of change resulting from the effects of a combination of agricultural and urban forces. The first of these is a "normal" process of change in land use and structure where the two sets of forces combine evenly. Under urban-fringe conditions, the second type of process is created by an overbalance of the urban forces. The third situation would be created by "responses to marginality" of farm structure in more remote rural areas. In these cases agriculture is not profitable because of isolation, low land capability or lack of specialization.

Bryant's subsequent analysis of change in 22 "urban centred regions" from 1961 - 1975 showed that in the Maritime, Northern Ontario and Northern Quebec regions, change involved tremendous removal of land and labour from agriculture: a response to "marginality of farm structure". Change in regions with high absolute levels of urbanization (e.g. Toronto and Vancouver) showed

smaller rates of removal of land and labour. The remaining regions were areas of more "normal" change as they were characterized by a prevalence of both urban- and farm-based influences.

On a smaller scale, Tōsine (1979) examined land-use trends in Ontario and Quebec over the period 1951 - 1976 using data collected from the Canada Census. Following general discussions of major non-farm land uses and agricultural land uses, the study focuses on the demand for rural land. Special emphasis is given to the competition among four particular uses of land: (1) urban development; (2) para-urban development; (3) the spread of recreational land uses; and, (4) the response to marginality. Tōsine concludes that the changes in agricultural patterns are not only the result of internal pressures peculiar to the agricultural industry, but they are also due to external demands on rural land.

Several other studies also stress that change in land use or, loss of farmland in some cases, is due to this combined effect. Van Vuuren (1972) identifies six existing and future societal forces exerting influence on land-use patterns. These are: (1) rapid population increase; (2) urbanization; (3) increase in per capita income; (4) increase in leisure time; (5) rapid technological advances in agriculture; and, (6) a changing attitude toward nature and the quality of life.

The joint federal-provincial study on planning for agriculture in Southern Ontario (A.R.D.A., 1972) recognizes both internal and external forces for change. Trends in the agricultural industry in the period 1951 - 1966 are examined. Changes relate to the cost-

price squeeze and technology, to the allocation of land between farm and non-farm uses, and to the response of individual farm operators to the pressures for change. As a result of detailed discussions of several aspects of each of the above categories, the report concludes that the same type of change does not occur in every part of Southern Ontario, nor is it occurring at the same rate. It happens as a result of a particular combination of forces.

Girt (1975) suggests that the A.R.D.A. report does not attempt to measure precisely the dynamics of the changes occurring, nor does it attempt to predict the future in light of the changes that occurred between 1951 and 1966. Girt's study endeavours to do this by describing the changes occurring in agriculture across Southern Ontario at the township level. He examines the forces which bring about change at the macro provincial level and those which relate to urban pressures locally. The study analyses patterns of change with respect to per cent of the assessed areas of townships in census farms, per cent of the census farm areas of townships in unimproved uses, per cent of the census farm areas of townships under crops and the mean size of census farms in townships. His analysis applies the theory of first order Markov chains.

The results of Girt's study provide confirmation that there are regional differences in agricultural change in Southern Ontario and that these reflect the fixed differences resulting from varying physical bases and different accessibilities to urban areas. It also lays a foundation for predicting that Southwestern Ontario will become increasingly different from the rest of Southern Ontario.

Rodd (1976) and the Bureau of Municipal Research (1977) have examined trends and conditions in Ontario agricultural land use to determine the scope or nature of the changes taking place, and to decide whether or not a crisis situation in loss of farmland has occurred. Both studies draw their data from the Census, various issues of Agricultural Statistics for Ontario, and the 1972 A.R.D.A. report. After discussing the reasons for farmland loss, they conclude the causes are many and complex.

All of the studies discussed have indicated that changing land-use patterns are a result of a combination of various types of societal and economic forces. The major causes that most researchers mention are: changes in the economics of farming, urban encroachment, rural non-farm uses, speculation, and rising land prices. There are some researchers who believe that change in land use or loss of agricultural land is chiefly due to one of these aspects, and other factors are relatively unimportant.

Urbanization is cited as the most common cause. Krueger has spent a great deal of time examining land-use changes in the Niagara Fruit Belt. His first article (1959b) was based on air photo interpretation, and measured the extent of the loss of fruit land between 1934 and 1954. He concluded that if the rate of loss were to continue, the fruit belt would disappear before the end of the century.

Krueger updated his review of the situation in the fruit belt in 1970 and revealed a further serious loss of tender fruitland. In 1978, he published a third article on the Niagara Fruit Belt.

This study looked at the changes in orchards, vineyards and urbanization as percentages of concession blocks, between the years 1934 and 1975. Air photos for the years 1934, 1954, 1965 and 1975 were used. The results of the study showed a decrease in orchards and increases in both vineyards and urban areas. Krueger attributed the decrease in orchards to urban encroachment. The increase in vineyards, he concluded, was due to the fact that any losses caused by urban expansion between 1954 and 1975 were more than compensated for by new plantings in areas farther removed from the cities, since grapes can be grown on a wider variety of soils than tender fruit.

Gierman's study (1977) examined loss of agricultural land in Canada in the period 1966 - 1971. Assuming that urbanization is a major cause of land-use change in the rural-urban fringe areas, Gierman focussed his study on rural lands located in the fringes of urban centres that had, in 1971, populations of 25,000 or more. His analysis was designed to determine the amount and quality of land that had been converted to urban uses in the period 1966 to 1971. The findings of the study illustrated that in the 24 urban areas, the average annual rate of rural-urban land conversion during the study period was 18,132 acres, of which 11,372 acres (63 percent) was formerly improved agricultural land and 14,301 acres (79 percent) was formerly prime (class 1 to 3) agricultural land.

Crerar (1970) undertook a study to relate the loss of farmland in the metropolitan regions of Canada to the increase in urban population. His results show that loss of farmland between 1951 and 1956 per 1,000 population increase in the seven major metropolitan

areas of Canada ranged from 192 acres around Windsor to 492 acres near London, and rises to 1,000 and 1,001 acres around Quebec and Ottawa respectively. The latter two areas appear to be very high, but they border the Laurentian Shield, so Crerar attributes much of the abandonment in these areas to sub-marginal land quality rather than to urban encroachment.

Milnes and Reeds (1978) in their study on changing land use in the Toronto Centred Region commutershed, confirm Crerar's results by proving, through correlation analysis, that farmland loss in the area around Toronto was related to urban population growth. They also found that farmland loss could not however, be related to variations in agricultural land capability or to rural non-farm population growth.

A similar study undertaken by Smollet (1976) analysed land-use patterns and changes around the major urban areas of the Niagara Fruit Belt between the years 1934 and 1973. Land use was assessed at only three points in time: 1934; 1960; and 1973. The rates of growth and the directions it took, for two time spans, 1934 - 1960 and 1960 - 1973, were determined and the results from the three major urban centres were compared. Although no quantitative analysis was undertaken the author suggested that the growth of the urban centres is creating a very uncertain future for the remaining fruit-growing areas.

Rural non-farm uses, another of the major aspects of agricultural change or farmland loss,has received much attention. McCrae (1980) reviews the relevant literature on the issue and finds that most authorities consider that direct losses of farmland to

non-farm uses are minimal. Some researchers however, suggest that this aspect deserves further investigation.

Changes in the economics of farming as they relate to farmland loss have also received considerable attention. Stutt (1970) examined changes in land use and farm organization in the Prairie area of Saskatchewan between 1951 and 1966 using Census data. Indicators of change dealt with land use, size of farms, number of farms, livestock numbers, types of farms, economic farm classes, land tenure, farm population, age of farm operators, farm operator residence and off-farm employment. The trends in these variables were observed for a selected group of rural municipalities representative of poor, medium and good grades of land in the Brown and Dark Brown soil zones of Saskatchewan.

The results of Stutt's study showed a tendency towards fewer but larger commercial farm units concentrating on specialization, economies of scale and increased volume of business. He discovered a trend toward a smaller proportion of improved land being used for field cash crops and a larger proportion being devoted to improved pasture and tame hay. A process of farm enlargement and several other operational changes were also occurring. Stutt concludes that these basic changes are a result of increasing adoption of new technology and mechanization, and a changing structure of the economics of farming.

Crewson and Reeds (1977) studied farmland loss in Central Ontario between 1951 and 1971. A model was generated to help explain the loss of farmland. Independent variables included were capital-

ization, farm-size, the per cent of part-time farms, length of shoreline, soil quality, and age of farmers. The model revealed that the proportion of part-time farms was the most important explanatory variable. That is, a high proportion of part-time farms was the best indicator that a phasing out of agriculture was taking place. Other characteristics identified in the study of farms involved in the loss of farmland process were low farm profits, a shortage of labour and uneconomic size of farms. These changes identified by Crewson and Reeds were also due to the changing structure of farm economics.

A totally different approach to the land-use change problem was taken by Smith (1971). He developed a method using simple mathematical models to predict trends in the use of rural land for forestry, agriculture, residential and recreational purposes. The trends predicted were based on economic rather than political, social, legal, aesthetic, ecological or other considerations. The main purpose of the study was to develop this technique to describe complex relationships existing among the forestry, agriculture and market values of land and their controlling factors. The majority of the report emphasizes the theoretical basis of the technique and the procedures followed in developing the method.

Another report on rural land-use changes, emphasizing the analytical techniques used rather than the causative factors of change, is Gierman's (1976) study of rural land-use changes in the Ottawa-Hull urban area between 1964 and 1973. He summarized the nature of the rural land-use changes that occurred during the selected

time period. His conclusions relate to the usefullness of on-line interactive graphics of the Canada Geographic Information System.

Martin (1975) studied land-use patterns and changes as one of four objectives in his study on land use dynamics in the Toronto urban fringe. Air photos were used to identify land-use patterns and land-use changes. These were mapped according to a classification system sensitive to the mix of urban, rural and transitional uses peculiar to the urban fringe. The study discovered that only one-third of the total area of change between 1961 and 1971 represented a net loss of specific uses. This emphasized that the land-use "exchange" rather than "change" phenomenon on the urban fringe appeared significant. However, there were still strong conversion pressures between 1961 and 1971 in the study area, and the permanence and irreversibility of conversion from non-urban to urban uses due to these pressures was recognized.

Although most of the studies discussed in the latter part of this section attribute land-use change to one major factor they do not discount the possible roles of other aspects of change. Thus, virtually all studies relating to changing land-use patterns confirm that the changes are due to a complex interaction of various socio-economic factors.

It is apparent from this review that considerable research has been carried out on agricultural land-use change. It is also evident that the theoretical framework is weak and that most studies have utilized macro-type data. It is the objective of this thesis to test some hypotheses that have not been tested previously, and to

use micro-type data collected at the individual farm level.

It would appear most appropriate in this study to follow Girt's theory as the main guideline. However, in the development of the several hypotheses, the knowledge gained from many researchers will be incorporated.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

The former township of Louth was chosen for this investigation for several reasons. It is one of the few areas in the Niagara Region least affected by urbanization, yet it is not far removed from urban influences. St. Catharines, a rapidly expanding city, is directly to the east. It now occupies approximately 2790 hectares (ha) (35%) of the former township's 8021 ha. The Queen Elizabeth Way (Q.E.W.) cuts across the northern half of the study area. Land was lost in the sixties due to the widening of this highway. It provides easy access to Hamilton and may even attract commuters to St. Catharines who will be employed in Hamilton or Toronto. Regional Road 81 (formerly Highway 8), which has been designated as a scenic drive, is a heavily travelled tourist route. Thus, the accessibility of the area puts heavy pressure on the agricultural use of the land.

The area enjoys the advantages of an unique environment which combines a favourable climate and good soils for tender tree fruits. However, in a region such as the Golden Horseshoe, where urbanization and industrialization are expanding, preservation of even the most stable part of the Niagara Fruit Belt is problematical. Agricultural uses of land do not generally compete favourably with other uses as the net returns per unit area are usually lower. Those who continue to farm in such situations may do so for other than economic reasons

or, they may be anticipating the benefits of future land value appreciation. Thus, the former township of Louth appeared to offer interesting prospects for a study of changing land-use patterns.

Incidental factors making the decision to investigate Louth more appealing were the existence of two studies of land use in the township in the mid-fifties (Ont. Dept. of Agr., 1957; and Wooley, 1956). These provided detailed basic land-use data for this period. The availability of 1978 aerial photography determined the choice of this year for comparison with 1954.

A 24 year interval was chosen for the study in order to observe change in light of long-term land-use decisions. Land-use changes in an orchard and vineyard area take place within a 15 to 20 year time period. This is because new plantings of vines and fruit trees require 3 to 5 years to become productive. Once the investment in a new crop has been made, another change is not made readily.

Aerial photographs provided the basis for the creation of the two land-use maps. The 1954 map is a modified version of a very detailed land-use map of Louth prepared by A. M. Wooley in 1956. His map was modified to correspond to the 18 land-use categories adopted for the 1978 map. Cherries, apples, pears, plums and mixed fruit were combined into one category labelled mixed fruit. Peaches and grapes were identified as two separate classes as it was important to distinguish between these two dominant crops. Since peaches cannot be grown in other areas of Canada as successfully as they are in the Niagara Peninsula, and because the consumption of North American wine is increasing, changes in these two categories deserved special

attention.

Small fruits and vegetables were combined as were woodlots and scrub land. Other combined categories included field crops, improved and unimproved pasture, and nurseries and garden centres. Cleared idle land, urban residential areas, rurban[2] areas, farm homesteads, greenhouses, recreation areas, the experimental farm near Vineland and a miscellaneous class including buildings and land areas belonging to churches, schools and governments made up the remaining classes. The new categories added were unproductive or abandoned land, commercial enterprises and industrial developments.

As with all forms of statistics and data, different results can be obtained from the same data if different classification schemes are used. The classification scheme selected is a rational one and serves the purpose for this study of land-use change.

Both land-use maps were drawn on a base map, produced in the early sixties by the Ontario Ministry of Natural Resources. The scale of the base map, the 1954 air photos and Wooley's land-use map is 1:15,840. Thus, Wooley's map was traced onto the base map and modifications were made during the tracing. The scale of the 1978 air photos however, is 1:10,000. To keep all maps at the same scale, a Bausch and Lomb Zoom Transfer Scope, model ZT4, was used to optically superimpose the 1978 air photos on the corresponding 1:15,840 base map. A lens with a 4x magnification was used to

[2]The term "rurban" is used to refer to small settlements in the study area having three or more residential units not located within an urban area.

increase the scale of the base map to 1:3960. Increasing the scale of the air photos by approximately 2.5 times to 1:3960 was within the capacity of the zoom transfer scope without any additional equipment.

The magnification of the air photos by the zoom transfer scope could reach seven times. This allowed for a closer look at particular land uses which were difficult to determine. If a land use could not be identified by this method or by looking at the location on stereo pairs through a mirror stereoscope, then the area was checked in the field. Before any extensive interpretation was done of the 1978 photographs, various grey tones and textures were selected from the air photos, interpreted, and field checked for ground truth accuracy. This process eliminated any unnecessary field work at a later date.

The numerous blocks on the maps are township concession lots usually bounded by roads. Although these lots are not all exactly the same area[3], they have been chosen as data collection units due to the ease of identifying them on air photos and in the field. Also, the municipal assessment data could be aggregated at the same level. The study area includes a total of 171 lots. The area of each land use

[3]Difference of means tests were performed on a number of sample lots to determine whether they were virtually the same size or significantly different. The latter was the case.

was measured from the maps using the squared paper method[4] and was computed as a percentage of the total area of the lot.[5] The smallest area measured was 0.31 ha.

Socio-economic data for 1954 and 1978 were available from municipal assessment rolls. Rather than selecting a sample of farmers to interview, data for the study area were collected from the rolls and subsequently aggregated by lots. Thus, most of the variables are averages. The distance variables were measured in kilometres from the centre of each lot to the edge of the road or boundary in question as it was in 1954.

Because the Canada Land Inventory Soil Capability Classification for Agriculture (1972) does not include capability of soils for trees, tree fruits and small fruits, soil ratings for tender tree fruits were developed using systems devised by Ecoplans Ltd. (1979) and by Reeds for Hubert's use (1975). Five quality classifications were used -- excellent, good, fair, poor and unsuitable. Each of the five classes was given an arbitrary numerical rating ranging from 1.00 to 0 as a means of quantification (see Table 3).

[4]Since the land uses tended to occupy rectangular parcels, squared paper was found, by experimentation, to be as equally accurate as a planimeter. As it was the easier method in this particular case, it was chosen.

[5]The total areas of the lots were measured as accurately as possible using the formulae for determining the areas of rectangles and triangles.

TABLE 3

SOIL CLASSIFICATION FOR TENDER TREE FRUITS

Excellent	1.00
Good	0.75
Fair	0.50
Poor	0.25
Unsuitable	0.00

All soil types in the study area were then assigned a capability rating (see Table 4). Following this, an enlarged acetate overlay of the mapped soils in Louth (Wicklund and Matthews, 1963) was placed over a base map with the lots marked. The percentage of each soil type in each lot was computed. This figure was multiplied by the soil's numerical capability rating and the sum of the individual ratings in each lot made up the overall soil capability rating for tender tree fruits.

Before any analysis was undertaken, an index of land-use change was computed for each lot. This was done by first calculating the percentage of change by lot in each of the land-use types. This was either a positive or a negative value, and the sum of these for each lot was zero. In order to measure total change, the absolute value of each land-use change was computed and the sum of all absolute changes in each lot became the index of land-use change. The values

TABLE 4

SOIL CAPABILITY RATINGS FOR
TENDER TREE FRUITS

Soil Type	Rating	
	Qualitative	Quantitative
Chinguacousy clay loam	poor	0.25
Grimsby sandy loam	excellent	1.00
Grimsby fine sandy loam	excellent	1.00
Haldimand clay loam	poor	0.25
Jeddo clay loam	poor	0.25
Oneida loam	poor	0.25
Smithville loam	poor	0.25
Trafalgar silty clay loam	poor	0.25
Vineland sandy loam	good	0.75
Vineland fine sandy loam	good	0.75
Winona sandy loam	fair	0.50
Winona fine sandy loam	fair	0.50
Ravines	unsuitable	0

SOURCE: adapted from Ecoplans Ltd., 1979, p. 58; and Hubert, 1975, p. 53 and 54.

of the index ranged from 0 to 200. This index is an important feature of the analysis as no other study has used such a measure of change as a dependent variable in an analysis of changing land use.

All statistical analyses were carried out using SPSS[6] on McMaster University Computer Centre's CDC 6400. The statistical procedure of multiple stepwise regression was chosen as the method of analysis since it appeared to be the best technique suited to the characteristics of the data. All variables were measured on an interval or ratio scale and the relationships among them were expected to be linear and additive.

Multiple regression is a statistical technique, derived from simple regression analysis, which analyzes the relationship between a dependent variable and a set of independent or predictor variables (Nie et al, 1975). In this study, the procedure is being used as a descriptive tool by which the linear dependence of land-use change on other variables will be summarized and decomposed. Other analytical techniques such as discriminant analysis and factor analysis were considered but rejected, as the data set was not in a suitable form to be analyzed by these methods.

[6]"SPSS (Statistical Package for the Social Sciences) is an integrated system of computer programs designed for the analysis of social science data" (Nie et al, 1975, p. 1).

CHAPTER 5

THE LAND-USE MAPS

The purpose of this chapter is to describe and compare the two land-use maps, and to discuss changes in land use that have occurred in the 1954 - 1978 time period. Visual observation of the two maps reveals certain spatial patterns of change. These will be noted generally and then described in detail. Following this, there will be a discussion of quantitative data derived from the maps and marketing boards, and from provincial and federal government sources. These will provide evidence regarding actual changes over the 24 years and fluctuations within this time span. The final section of the chapter will deal with the socio-economic data collected from municipal assessment rolls and the Census of Canada.

5:1 General discussion of land-use maps

In 1954 (see Map 1), land use in the northern part of the township consisted mainly of peaches and mixed fruit with scattered areas of small fruits and vegetables. Fruit production extended to the shoreline in many cases. Several nurseries were also located in this half of the study area. The major creeks and Jordan Harbour were all bounded by woods and scrub, and other areas of woodland were located as patches surrounded by various land uses.

Three small urban areas existing in this part of the township were Vineland Station, Jordan Station and Barnsdale (a suburb of St. Catharines). Both Vineland Station and Jordan Station were located in the western part of Louth along the Canadian National Railway line, and were very small villages. Barnsdale was in the north-east corner. At that time urban influences around Barnsdale had spread across the width of one lot and the length of half of the beach front concession.

Further south, towards Regional Road 81, an increasing amount of land was used for grape production. This is the area where the soils change from the light sandy soils of the Vineland series to the heavier clays of the Jeddo series (see Figure 4). The area of field crops in this section also seemed to increase. Some hardier tree fruits were still grown here, but peaches were seldom found. Woodlands still followed the paths of the creeks, and Vineland and Jordan, both on Regional Road 81, were the only urban centres in the central part of the township.

South of Regional Road 81, field crops and pasture were the dominant land uses. Grapes appear to have taken second place and very few tree fruits were in this area. The soils here are the loams and clay loams of the Oneida, Smithville and Haldimand series. The area of woodland was greater since the wooded edge of the Niagara is the southern boundary of the study area. No villages were located south of Regional Road 81.

Rurban settlement did appear in 1954 although its extent was quite limited. Overall, Louth Township, in 1954, appeared to be

substantially an agricultural region specializing in tree fruits and grapes.

In 1978 (see Map 2), the picture is somewhat different. Fruit production no longer extended as far north as the shoreline. The beach front was occupied by rurban settlements, recreational areas, some commercial and industrial activities and many abandoned orchards. One might speculate that these changes came about because of the widening of the Queen Elizabeth Way (Q.E.W.). Making it a limited access highway totally cut off some farmers' properties from their remaining holdings south of the Q.E.W. This inconvenience was sufficient to cause abandonment of fruit-growing in some cases or sale of the properties for non-farming purposes.

Further east along the beach front, St. Catharines had expanded as far as the second lot, to 3rd St. Louth. The other urban centres of Vineland Station, Jordan Station, Vineland and Jordan appear to have expanded as well. Many more rurban settlements were evident, especially in the north-east and along Regional Road 81.

The northern part of the study area was still mainly used for peaches and other tree fruits. More land appeared to be devoted to small fruits and vegetables than in 1954. Also, the number of vines in this area increased. This is possibly due to the introduction of the European or vinifera type grapes which prefer sandier soils similar to those in the northern section of the township.

Further south, approaching Regional Road 81, as in 1954, grapes were the dominant land use. Some abandoned orchards were located near the eastern and western boundaries of the study area,

close to St. Catharines and Vineland respectively. The area covered by field crops had decreased tremendously since 1954. Woodlands and scrub followed the creeks in this section of Louth as they did in both the northern and southern parts.

Between Regional Road 81 and the southern boundary of Louth, field crops and grapes were dominant. It is difficult to determine which land use covered more area. There was still a great deal of woodland, and hardy tree fruits were scattered in sparse fashion throughout this section. Rurban settlements had not infiltrated this part as much as they had the area north of, and along, Regional Road 81.

In retrospect, the 1978 land-use map shows apparent increases in the areas of land devoted to grapes, small fruits and vegetables, urban and rurban settlements and abandoned orchards. The amount of land used for field crops and pasture has declined. Thus, the general picture is still one of an area where fruit production continues to dominate the land-use pattern.

5:2 Detailed discussion of land-use maps

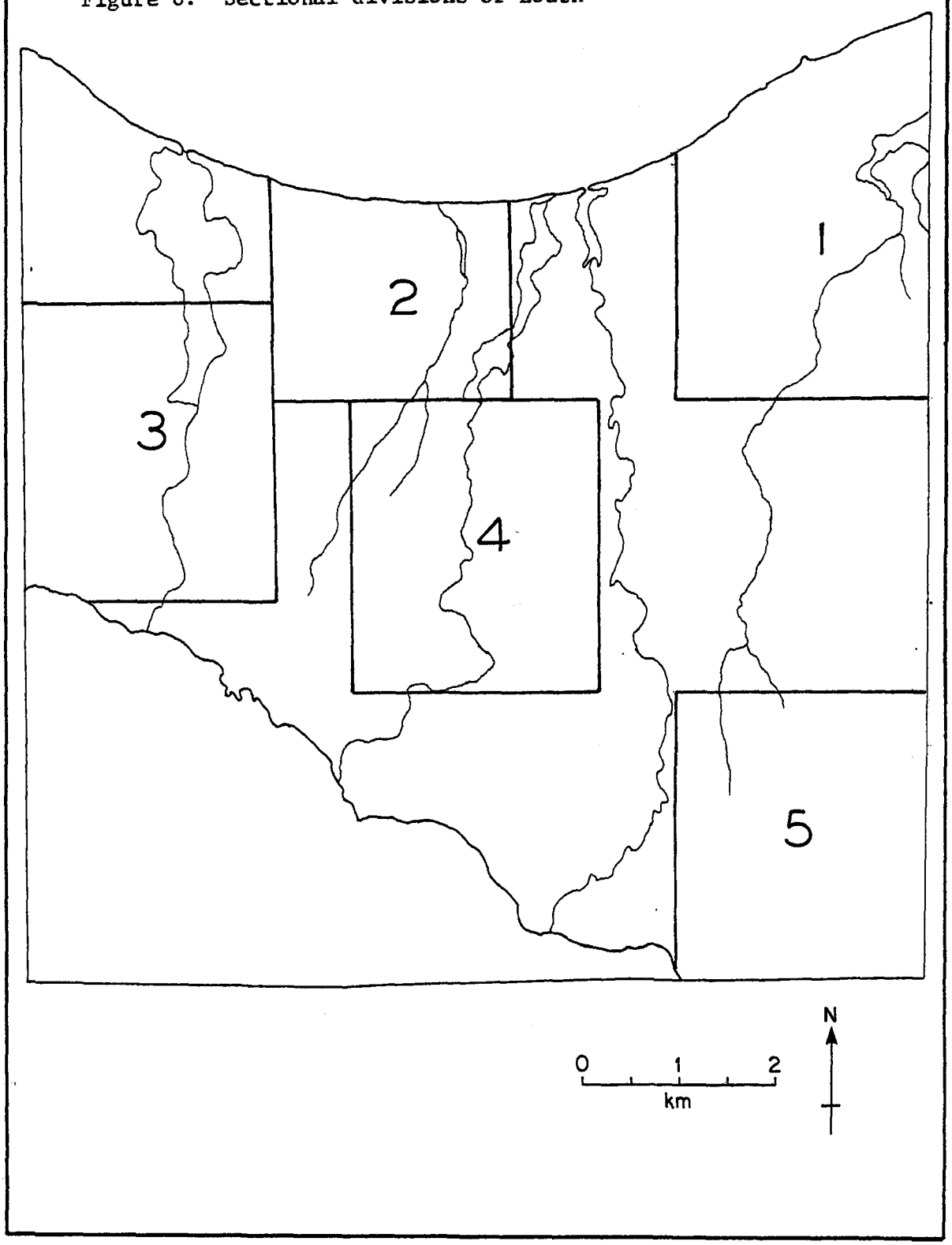
To illustrate the spatial patterns of change between 1954 and 1978 more fully, Map 2 was superimposed over Map 1, and specific land-use exchanges were noted for five sections of the study area. Each section was thought to be representative of the general area in which it is located, so that any particular causes of change in the vicinity would affect all, or part of, the section.

Section 1 is located close to St. Catharines and includes lots 1 - 6 of the beach front concession and concessions I and II. Section 2 is located in the north-central part of the study area, close to the Q.E.W. and includes lots 11 - 16 of the beach front concession and concessions I and II. The third section, including lots 17 - 23 of concessions II to IV is located near Vineland, on the western edge of the township. Section 4 is in the south-central portion of Louth, and includes lots 9 - 14 of concessions IV to VI. The fifth section is in the south-east corner of the study area and includes lots 1 - 6 of concessions VI to VIII. Figure 6 shows the relative locations of these sections.

5:2:1 Section 1

Because this section is close to St. Catharines, there are areas, used for agriculture in 1954, which have changed to non-agricultural uses. In lots 1 and 2 of the beach front concession, areas of mixed fruit and peaches have been converted to urban uses. In the same concession, but further west, in lots 3 - 6, several rurban areas have replaced peaches, mixed fruit, small fruits and vegetables and grapes. Some of this rurban development has replaced a recreation area in lots 4,5 and 6 along the beach. Several abandoned orchards have replaced productive peach orchards, small fruits and vegetable patches and vineyards, especially in concession I, lots 1,2 and 4. The expansion of the Q.E.W. took two areas out of mixed fruit production (con.I,lot 6). The number of farm residences appears to have increased, but the amount of woodland has remained relatively stable.

Figure 6: Sectional divisions of Louth



Exchanges among agricultural uses are evident in this section. Areas of intensive agriculture have replaced some mixed fruit orchards, as in lots 3 and 5 of the beach front concession. There was, however, a nursery which was replaced by grapes in lot 4 of concession II. Peaches have replaced grapes and mixed fruit in some cases (B.F. con., lot 3), but the general trend is for grapes to replace peaches and mixed fruit (B.F. con., lots 2 & 4; and con. II, lots 1 & 4). Some of the areas of grapes, peaches and mixed fruit in concession I, lots 1,3 and 4 have not changed noticeably. Patches of small fruits and vegetables have remained much the same in 1978 as in 1954.

5:2:2 Section 2

The urban influences of St. Catharines have not penetrated as far west as this section. However, the widening of the Q.E.W. here, has resulted in the loss of productive agricultural land to non-agricultural uses. Along the beach front, abandoned orchards, rurban settlements and a small amount of woodland have replaced all of the 1954 orchards. South of the Q.E.W., the only evidence of non-agricultural uses is in concession I, lot 15 where a small industrial plant and a rurban area have replaced peaches and grapes, and in concession II, lot 15 where another rurban settlement replaced peaches and a patch of small fruits and vegetables.

Exchanges among agricultural uses included the intensification of agriculture in greenhouses which replaced mixed fruit and peaches, in concession I, lots 11 and 15, and grapes, in concession II, lot 12. Peaches and mixed fruit dominated this section in 1954, and they

continued to do so in 1978. The area south of the Q.E.W. has remained basically stable with some exchanges between peaches and mixed fruit, and some minor intrusions of grapes in 1978, where peaches, mixed fruit and small fruits and vegetables were grown in 1954 (con. 1, lot 16).

5:2:3 Section 3

This section includes the villages of Vineland Station and Jordan Station, and the towns of Vineland and Jordan. The growth of these centres has caused urbanization to take some agricultural land out of production. Near Vineland Station, in concession II, lot 23, urban development has occurred where mixed fruit and peaches were,in 1954. At Vineland, in concession III, lot 23, the urban areas have replaced peaches, mixed fruit, grapes and a small amount of woodland.

In lots 17 and 18 of concessions II and III, the small amount of urban expansion near Jordan Station has occurred mainly on former peach land. At Jordan (con. IV, lots 18 & 19), the urban areas have expanded onto former woodland. A rurban settlement, in concession IV, lot 20, and a large urban development, in concession IV, lot 21, have also replaced areas that were wooded in 1954. A small portion of the latter development also replaced some grapes.

Other changes from agricultural to non-agricultural uses occurred in concession III, lots 18 and 20, and in concession IV, lots 22 and 23, where areas of peaches, grapes and mixed fruit had become unproductive. The area covered by woodlands in 1954 had expanded in 1978. In concessions III and IV, lots 19, 20 and 21, woodlots have replaced small areas of field crops and pasture, grapes and mixed fruit.

Peaches and mixed fruit dominated the landscape in 1954 in this section, as they did in section 2. However, areas of grapes, interspersed among the peaches and mixed fruit are more common. There seems to have been exchanges between the peaches and mixed fruit, as in concession III, lot 22, and grapes tended to remain where they were in 1954 (con.III, lot 18; and con. IV, lot 18), unless replaced by non-agricultural uses, as in concession IV, lots 18 and 20.

5:2:4 Section 4

Regional Road 81 transverses the fourth section. Most non-agricultural land uses, present along this road in 1978, were not there in 1954. The most common non-farm land use here is rurban settlement. Along, or near, the regional road, rurban areas have mainly replaced woodland or areas of field crops and pasture (con.V, lots 10 & 13; and con.VI, lots 12 & 13). A major change, from an agricultural to a non-agricultural use, occurred in concession V, lots 11 and 12, where a camping ground (recreation) replaced an area used for field crops in 1954.

This section mainly consists of agricultural land uses. Because of the clay soils in the area, the major land uses in 1954 were field crops and pasture, and grapes. In 1978, however, grapes dominated the landscape, as large vineyards replaced many areas of field crops and pasture (con.IV, lots 9 & 13; con.V, lot 10; and con.VI, lots 9,10 & 12). Grapes also replaced many of the few areas of peaches and mixed fruit that were present in concession IV, lots 10,12 and 13 in 1954.

5:2:5 Section 5

No urban, or urban-related uses existed in this section in either of the two study years, thus the presence of non-agricultural land uses was minimal. In concession VI, lots 1 and 2, and in concession VIII, lots 5 and 6, rurban settlements have mainly replaced areas of grapes. Some woodlots have replaced field crops, as is evident in concession VI, lots 1 and 6, and concession VIII, lot 1. Other woodlots have been replaced by field crops and pasture, resulting in a change from non-agricultural to agricultural uses (con.VI, lot 6; and con.VII, lot 6).

The most prominent exchange among agricultural uses, in this section, was between field crops and pasture, and grapes. Many large areas of field crops and pasture were converted to grapes (con.VI, lots 2 - 5; con.VII, lots 1 - 3 & 6; and con.VIII, lots 2 & 3). There were very few areas where field crops replaced grapes, as in concession VI, lots 1 and 6.

5:2:6 Summary

It is evident, that throughout the study area, many changes and exchanges of land use have occurred. In sections 1,2 and 3, those closest to St. Catharines, the Queen Elizabeth Way and Vineland respectively, there were many changes of land use from agricultural to non-agricultural uses. In these sections, there were also, however, exchanges among agricultural land uses, especially among peaches, mixed fruit and grapes. The descriptions of the last two sections of the study area, revealed exchanges between the agricultural uses of grapes

and field crops.

In generalizing these observations, it can be stated that more changes from farm to non-farm uses have occurred in the northern part of the study area while exchanges among peaches, mixed fruit and grapes occurred simultaneously in the same area. The central and southern portions of the study area were mainly characterized by exchanges of field crops for grapes.

It is recognized that these observations are qualitative and that a more precise description, using quantitative data is desirable. In the following section, measurement of the changes will be presented, and in Chapter 6, they will be analyzed.

5:3 Descriptive statistics of land-use changes

Land uses were measured by lots in 1954 and 1978. The average area per lot is 39 ha, but sizes range from 3 ha to 83 ha due to the irregularity of the shoreline in the beach front (B.F.) concession. Because of this vast range in area, and the necessity to make valid comparisons, land-use changes were computed as percentages of the lots. The total area of the study region is 6745 ha.

Referring to Table 5, it can be seen that in 1954 the greatest area of Louth was occupied by field crops and pasture (1298 ha or 19%) followed closely by grapes and woodlands covering 1207 ha (18%) and 1205 ha (18%) respectively. Mixed tree fruits covered 15% (1012 ha) of the study area and peaches occupied an additional 14% (964 ha). The remaining land uses covered areas ranging from 0 to 2%. Miscellaneous land uses, falling under the classification of "other",

TABLE 5

AREAS OF LAND USES

Variable	Year	Total Area (ha)	Total Area as a % of Study Area	Change in Area between 1954 and 1978 (ha)	Change in Area as a % of Study Area
Peaches	1954	963.94	14.29	. . .	. . .
	1978	734.20	10.89	-229.74	- 3.41
Mixed tree fruits . . .	1954	1,012.01	15.00	. . .	. . .
	1978	639.81	9.49	-372.20	- 5.52
Vegetables and Small fruits . . .	1954	110.71	1.64	. . .	. . .
	1978	131.69	1.95	20.98	+ 0.31
Grapes . . .	1954	1,207.06	17.89	. . .	. . .
	1978	1,959.34	29.04	752.28	+11.15
Field crops and Pasture . . .	1954	1,297.57	19.24	. . .	. . .
	1978	605.11	8.97	-692.46	-10.27
Woodland and Scrub . . .	1954	1,204.53	17.86	. . .	. . .
	1978	1,270.43	18.84	65.90	+ 1.00
Greenhouses . .	1954	1.25	0.02	. . .	. . .
	1978	32.92	0.48	31.67	+ 0.47
Nurseries and Garden Centres	1954	31.05	0.46	. . .	. . .
	1978	47.68	0.71	16.63	+ 0.25

TABLE 5 - Continued

Variable	Year	Total Area (ha)	Total Area as a % of Study Area	Change in Area between 1954 and 1978 (ha)	Change in Area as a % of Study Area
Abandoned or Unproductive	1954	0	0	. . .	. . .
	1978	105.69	1.57	105.69	+ 1.57
Idle	1954	153.47	2.27	. . .	. . .
	1978	20.08	0.30	-133.39	- 1.97
Urban	1954	104.42	1.54	. . .	. . .
	1978	166.20	2.46	61.78	+ 0.92
Rurban	1954	21.32	0.31	. . .	. . .
	1978	160.25	2.38	138.93	+ 2.07
Homesteads . .	1954	16.11	0.23	. . .	. . .
	1978	223.81	3.32	207.70	+ 3.09
Recreation . .	1954	21.63	0.31	. . .	. . .
	1978	32.92	0.48	11.29	+ 0.17
Commercial . .	1954	0	0	. . .	. . .
	1978	22.89	0.33	22.89	+ 0.33
Industrial . .	1954	0	0	. . .	. . .
	1978	5.84	0.09	5.84	+ 0.09
Other	1954	562.45	8.34	. . .	. . .
	1978	537.90	7.97	- 24.55	- 0.37
Experimental farm	1954	40.63	0.60	. . .	. . .
	1978	42.96	0.63	2.33	+ 0.03

In 1978, only three land uses occupied more than 10% each of the total area compared to five in 1954. Grapes ranked number one and covered 29% (1959 ha) of the study area. Woodland was second and covered 19% (1270 ha) of the region and 11% (734 ha) was taken up by peaches. The classes of mixed tree fruits and field crops each occupied 9% of the total area, while the remaining land uses covered from zero to three per cent of the area.

In both years, the three largest uses of land together covered more than half of the study area. In 1954, they were field crops, woodland and grapes; whereas in 1978, they were grapes, woodland and peaches. The most important shift is that of grapes from third rank to first. The area of woodland increased by 66 ha. Decreases were experienced by peaches and field crops. The former lost 230 ha and the latter declined in area by 693 ha -- a change of 10%.

Other relatively large changes were in mixed tree fruits, which decreased by 372 ha, and in homesteads and rurban settlements which increased by 208 ha and 139 ha respectively. Abandoned land increased 106 ha (almost 2% of the total study area), while idle land declined by 133 ha. The remaining land-use changes were each less than 1%. The highest of these was an increase in urban uses by 62 ha (019% of the study area), and the lowest was an increase of 2 ha in the area covered by the Vineland experimental farm.

Table 6 shows the average per cent change per lot of each land use. It also shows the largest per cent decrease and the largest per cent increase. As expected, the average change in grapes is the highest at 10% followed closely by a 9% average change in field crops. It is interesting to note the great range in changes occurring in most of the variables even though some land uses changed little overall. For instance, vegetables, woodland, nurseries and recreational uses remained relatively stable.

The above changes noted from the land-use maps coincide with the more general statistics that are available from other sources. From 1951 to 1978, the area in Ontario occupied by peaches has steadily decreased. In 1978 the area of peaches was 54% of that in 1954. This is a greater decrease than in the study area, where the area occupied by peaches in 1978 was 76% of the area covered in 1954. The number of vines in Ontario has increased since 1951 as has the total production of grapes. From 1954 to 1978 the increase in grapes in the province was less than that in the study area. In Ontario, the area covered by vines in 1978 was 121% of that in 1954, and in the study area, this figure is 162%. A more detailed description of these statistics, obtained from marketing boards and the provincial and federal governments, can be found in Appendix A.

5:4 Discussion of socio-economic data

Socio-economic data from the municipal assessment rolls of the Town of Lincoln and the City of St. Catharines were collected and aggregated by concession lots. The information found in Table 7 is a

TABLE 6

CHANGES IN LAND USES

Variable	Average Change per lot (%)	Largest Decrease (%)	Largest Increase (%)
Peaches	- 4.62	-55.29	48.90
Mixed tree fruits	- 6.19	-44.72	32.10
Vegetables and small fruits	+ 0.33	-11.90	23.44
Grapes	+10.02	-26.55	75.77
Field crops and Pasture	- 9.41	-77.20	42.93
Woodland and Scrub	+ 1.03	-45.56	53.99
Greenhouses	+ 0.45	0	16.04
Nurseries and Garden Centres	+ 0.31	-22.90	27.07
Abandoned or Unproductive	+ 2.53	0	63.62
Idle	- 2.28	-40.45	5.41
Urban	+ 0.78	0	31.55
Rurban	+ 2.44	-11.23	31.59
Homesteads	+ 3.03	- 8.62	44.48
Recreation	+ 0.59	-11.74	57.47
Commercial	+ 0.37	0	20.58
Industrial	+ 0.16	0	20.77
Other	+ 0.31	-25.74	47.92
Experimental farm	+ 0.02	- 7.16	8.02

TABLE 7

SUMMARY OF ASSESSMENT DATA
(AVERAGED BY LOT)

Variable	Year	Average per lot	Range		Total for the study area
			Minimum	Maximum	
No. of properties assessed . . .	1954	6.67	0	70	1,259
	1978	12.54	0	182	2,150
Mean property size (ha) . . .	1954	11.70	0.32	80.13	
	1978	6.02	0.22	40.47	
Owners (%) . . .	1954	90.86	0	100	
	1978	97.34	50	100	
Tenants (%) . . .	1954	9.14	0	100	
	1978	2.66	0	50	
Mean age (yrs) .	1954	52.15	23	87	
	1978	51.88	29	76	
Full-time farmers (%) . .	1954	55.31	0	100	
	1978	43.69	0	100	
Non-farm workers (%)	1954	44.77	0	100	
	1978	56.31	0	100	
Total lot assessment ($)	1954	15,188	100	102,350	2,715,673
	1978	67,383	770	878,955	11,320,000
Mean property assessment ($)	1954	2,929	100	23,313	
	1978	5,376	385	50,812	

summary of these data. The total number of persons assessed in 1954 was 1259 and in 1978 it was 2150. The average number of holdings per lot in 1954 was 6 to 7 and in 1978 it was 12 to 13. In 1954 the largest number of properties in one lot was 70 and in 1978 this figure had risen to 182. The increase in the average number of properties per lot might be due to decreased farm size, increased urbanization, or both. In 1978, the average mean size of holding per lot was six hectares, compared with 12 ha in 1954.

The average percentage of owners per lot in 1954 was 91 and the remaining 9% were tenants. By 1978, the average percentage of owners per lot had increased to 97 with 3% being tenants. The mean average age per lot changed little over the study period. In 1954, it was 52.15 years and by 1978 it had slightly decreased to 51.88 years. The range in average age however, declined by 1978. The average percentage of full-time farmers per lot was 55 in 1954. This figure had decreased to 44% in 1978.

Total assessment for the study area increased from $2.7 million to slightly over $11 million. The mean average property assessment per lot in 1954 was close to $3,000, whereas it had increased over the study period to more than $5,000 in 1978. One must keep in mind that assessment values do not represent real market values which have increased by a greater amount due to inflation and increased demand for agricultural land.

Table 8 shows the variables of the assessment data averaged

over the entire study area before they were aggregated by lots. A comparison of this table with Table 7 indicates that aggregation did little to distort the data. In cases of more noticeable differences between averages, the trends remain the same.

Population data for Louth[7] from Census Canada, the Town of Lincoln and the City of St. Catharines confirms the trend found in the assessment data towards an increased population in the study area[8] from 1954 - 1978 (see Table 9).

5:5 Summary

The data presented in this chapter have identified the land-use changes which occurred between 1954 and 1978. Socio-economic characteristics of the study area were also discussed. In particular, increases in land covered by grapes, rurban settlements, homesteads and abandoned orchards have been identified. Notable decreases occurred in peaches, mixed fruits, field crops and idle land.

Ontario production statistics for peaches and grapes indicated a decreased peach acreage while the area of grapes in Ontario increased significantly from 1951 to 1978.

Other changes which occurred were increases in population and the number of property owners. There was a decrease in the average

[7]In this instance the reference to Louth Township implies the entire township rather than the study area. Due to the definition of Census districts it was impossible to separate the population of the study area from that of the whole township.

[8]Since the study area covers slightly over 80% of the former township of Louth, it is assumed that trends in the population statistics for Louth are representative of trends in the population of the study area.

TABLE 8

SUMMARY OF ASSESSMENT DATA
(AVERAGED OVER THE STUDY AREA)

Variable	Year	Average
Property size (ha)	1954	6.23
	1978	2.85
Owners (%)	1954	92.9
	1978	97.3
Tenants (%)	1954	7.1
	1978	2.7
Age (years)	1954	50.58
	1978	50.86
Full-time farmers (%)	1954	43.1
	1978	28.3
Non-farm workers (%)	1954	56.9
	1978	71.7
Property assessment ($) . . .	1954	2,180
	1978	5,266

TABLE 9

POPULATION IN LOUTH TOWNSHIP
1951 - 1978

1951	4,473
1956	5,183
1961	5,086
1966	5,677
1971	n.a.
1976	n.a.
1978	6,384

SOURCE: Census of Canada, Town of Lincoln and City of St. Catharines.

n.a. - not available.

size of holding and in the number of full-time farmers. The average property assessment had also risen considerably.

These statistics show that the study area is undergoing considerable change. It remains essentially one of the prime fruit-growing areas, but pressures are evident and further erosion of agricultural land can be expected.

A quantitative analysis was undertaken in order to ascertain whether or not a more precise explanation of the land-use changes might be discovered. The chapter which follows presents the findings of this undertaking.

CHAPTER 6

ANALYSIS OF DATA

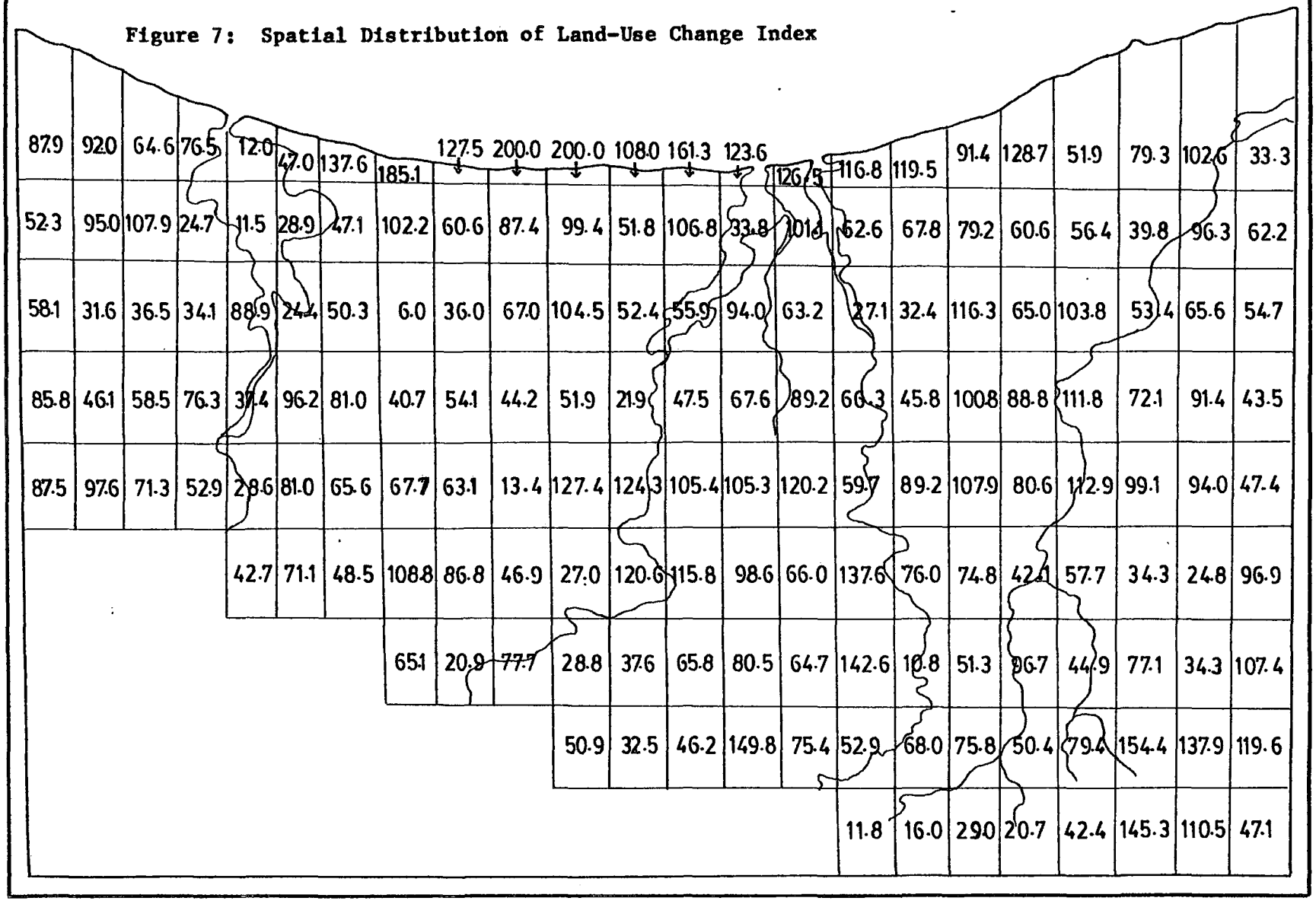
Considerable quantitative data were available from the assessment rolls. From knowledge available on the reasons for land-use changes, a number of a priori hypotheses were developed. Since change is the variable to be explained, the index of land-use change, distributed as shown in Figure 7, was the dependent variable in the major set of hypotheses. Multiple stepwise regression analysis was used to test the relationship of selected independent variables to the land-use change index. A correlation matrix of the major land-use variables was examined to help explain exchanges within the township. Various other hypotheses were formulated to explain additional changes and exchanges of land use, but when tested yielded no significant results.

The hypotheses will be outlined and reasons for their selection will be given. The results of the regression analysis will then be presented and interpreted, and the relationships noted from the correlation matrix will be summarized.

6:1 Outline of hypotheses

It is anticipated that a number of variables will have influenced land-use change in the study area. Based on conditions in 1954, these are age of the operator, whether or not the operator was a full-time farmer, tenancy, size of the property, assessed value

Figure 7: Spatial Distribution of Land-Use Change Index



of the property, land capability for tender fruit production, and the distances of the lot from the Q.E.W., Regional Road 81 and St. Catharines.[9] Because the index of land-use change was determined by lots, the assessment data were aggregated by lots. Thus, most of the variables are lot averages.

It was hypothesized that there would be greater change in a lot where the average age of occupants in 1954 was low. Crewson and Reeds (1977) showed there was a very weak positive correlation between the proportion of farmers over 60 years and farmland loss. Their study, however, was undertaken to document farmland loss in an area specializing in mixed farming with large average farm sizes. Because the characteristics of this study area are different, and because change in all land uses rather than in one particular use is being studied, it was hypothesized that the relationship between age of the occupant in 1954 and land-use change would be negative. Younger farmers would be more willing to keep their land and undertake a long-term change in land use than would older ones nearing retirement.

A second hypothesis formulated was that the land-use change index would be high where there was a large percentage of full-time farmers. Crewson and Reeds (1977) found that part-time farming explained almost 72% of the farmland lost in Central Ontario in the period 1951 - 1971. In this case it is hypothesized that full-time farmers would be more willing to make long-term changes in land use. Thus, the change index would increase with an increasing percentage

[9]The order in which these variables have been listed and will be discussed is of no particular significance.

of full-time farmers. For much the same reason, i.e. that owners would be more likely to undertake long-term changes than would tenants, it was hypothesized that a higher percentage of owners would result in a greater amount of land-use change.

As the amount of farmland in Canada has been decreasing, there has been a general trend toward increasing farm sizes (Stutt, 1972; and Milnes and Reeds, 1978). Larger farms can more easily absorb inflationary increases in costs associated with farming, and can benefit from economies of scale. In a sense, they are more stable. For this reason, they are more likely to risk making long-term land-use changes. Thus, another hypothesis formulated was that lots with larger average property sizes in 1954 would undergo more change.

The soil quality of a lot was also thought to have some bearing on the amount of change that might occur. Both Crewson and Reeds (1977), and Milnes and Reeds (1978) found weak negative relationships between farmland loss and land capability. Also, previous studies, Crerar (1970) and others, have noted that low quality soils offer little resistance to urban penetration and create conditions conducive to farm abandonment. It is hypothesized in this instance that more change would occur in lots with higher quality tender fruit soils.

All previous studies of this nature have referred to the Canada Land Inventory Soil Capability Classification for Agriculture when discussing soil quality. Thus, when reference is made to a high quality soil, it is a soil that is good for general field crops. The soil rating developed in this study refers to the capability of soils

for tender fruit production. Shallow, poorly drained or stoney soils are poor in both systems, and are difficult and expensive to manage. Since better quality soils, either for tender fruit or for field crops, are also more adaptable to other farm or non-farm uses, the suggestion is made that more change would take place in lots with higher soil capability for tender fruit production.

Because of the increasing demand for farmland for non-farm uses over the past few decades, it is hypothesized that more change would occur in lots having higher average assessment values, assuming these are the lots where land is in greater demand. Higher value land requires the operator to choose the most productive uses.

A great number of researchers have verified that loss of farmland is due in part to urbanization (Crerar, 1970; Gierman, 1977; and Krueger 1978). For that reason, and because Louth is an area subject to pressures of urbanization, it was essential to attempt to identify the forces at work. There are three major urban related entities in the study area. These are the City of St. Catharines, the Q.E.W. and Regional Road 81. Since influence can be felt more readily when one object is close to another, it was hypothesized that greater change would occur in lots closest to St. Catharines, to the Q.E.W. and to Regional Road 81. These nine hypotheses are summarized in Table 10.

TABLE 10

SUMMARY OF MAJOR HYPOTHESES

Dependent variable - index of land use change

Independent Variables	Hypotheses
Age in 1954	- the lower the average age of occupants, the greater the change.
Proportion of full-time farmers in 1954	- the greater the percentage of full-time farmers, the greater the change.
Proportion of owners in 1954	- the greater the percentage of owners, the greater the change.
Property size in 1954	- the larger the average property size, the greater the change.
Tender-fruit soil rating	- the higher the soil rating for tender fruit, the greater the change.
Average assessment in 1954	- the higher the average assessment, the greater the change.
Distance to St. Catharines in 1954	- the shorter the distance to St. Catharines, the greater the change.
Distance to the Q.E.W. in 1954	- the shorter the distance to the Q.E.W., the greater the change.
Distance to Regional Road 81 in 1954	- the shorter the distance to Regional Road 81, the greater the change.

6:2 Analysis and Results

The REGRESSION subprogram of SPSS provides for forward (stepwise) inclusion of variables in multiple regression analysis. Independent variables are entered into the regression equation one by one, provided they meet certain pre-established criteria. Variables are included in the order in which they contribute to the explained variance. The three statistical criteria by which variables were to be included are: (1) the maximum number of predictors that may be entered in stepwise mode (n), (2) the minimum F value acceptable for variables that were included (F), and (3) the proportion of the variance of that variable not explained by the independent variables already in the regression equation (T). Because there were no pre-conceived ideas as to the level of explanation the independent variables would attain, these three statistical criteria were set so that little restriction would be placed on the regression. Thus, n was set at 10, F was given the value of 0.01, and T was set at 0.001.

The correlation matrix of the nine independent variables showed a strong negative correlation between the distance to the Q.E.W. and the distance to Regional Road 81. The Pearson product-moment correlation coefficient was -0.71. To avoid problems of multicol-linearity in the regression, the distance to Regional Road 81 variable was removed from all facets of the analysis. This was not thought to be too severe a step, since the increase in non-farm uses along this road did not appear to be as high as that along the Q.E.W.

The regression, testing the hypotheses developed to explain land-use change, was thus carried out with eight independent variables instead of nine. Together, they explained 6.2% of the variation in the land-use change index. The low value of the R^2 indicates that there was only a very slight relationship between the independent variables and the land-use change index. None of the regression coefficients was significant, but the directions of the simple relationships of seven of the eight independent variables to the dependent variable support their respective a priori hypotheses (see Table 11).

The small value of the R^2 indicates that this model has failed to explain the land-use changes which occurred in the study area. One possible reason for this, is that Louth is characteristic of an area where Bryant's (1976) "normal" process of change, in land use and structure, is occurring. This is when agricultural and urban forces combine evenly to produce change. In the study area, urban forces around St. Catharines, Vineland and the Q.E.W. may be causing agricultural land to go out of production and to be used for non-agricultural purposes. In the central part of the township, agricultural forces may be causing the occurrence of various exchanges among agricultural uses. The separate influences of the independent variables may thus be acting in opposite directions causing the explained variance in the regression model to be low.

To test this assumption, the 18 classes of land use were divided into two groups -- agricultural (group one) and non-agricultural (group two) uses. The first group included peaches, mixed fruit, small fruits and vegetables, grapes, field crops, greenhouses, nurseries and the

TABLE 11

SUMMARY TABLE OF REGRESSION ON THE VARIABLE: CHANGE INDEX

Step	Variable Entered	B	F to Enter	Significance	Multiple R	R Square
1	TFSRATG	22.425155	3.53105	.062	.15367	.02361
2	MEANA54	-1.002787	2.76521	.098	.20466	.04189
3	DISTSTCA	-1.517832	1.97364	.162	.23418	.05484
4	DISTQEW	-1.361615	.49692	.482	.24107	.05811
5	MEANAG54	.189134	.42053	.518	.24677	.06089
6	MEANH54	.183990	.11842	.731	.24836	.06168
7	FTFARM54	.020184	.04665	.829	.24899	.06199
8	OWN54	- .015906	.01069	.918	.24913	.06207

TABLE 11-Continued

Step	Variable Entered	R Square Change	Simple R	Overall F	Significance	Standard Error B
1	TFSRATG	.02361	.15367	3.53105	.062	11.933931
2	MEANA54	.01827	.14221	3.16948	.045	.001676
3	DISTSTCA	.01295	-.10305	2.78505	.043	1.080413
4	DISTQEW	.00327	-.14266	2.20572	.071	1.931579
5	MEANAG54	.00278	.05464	1.84153	.108	.291655
6	MEANH54	.00079	.02727	1.54482	.168	.534666
7	FTFARM54	.00031	.08121	1.32184	.244	.093446
8	OWN54	.00007	.01578	1.14978	.334	.153813

Legend:

Variable Acronym	Variable Name
TFSRATG	Soil rating for tender tree fruits.
MEANA54	Average property assessment in 1954.
DISTSTCA	Distance from St. Catharines in 1954.
DISTQEW	Distance from the Q.E.W. in 1954.
MEANAG54	Average age of operator in 1954.
MEANH54	Average property size in 1954.
FTFARM54	Percentage of full-time farmers in 1954.
OWN54	Percentage of property owners in 1954.

experimental farm. The second group included all other classes of land use, except for the miscellaneous category of "other" which was not included in either of the groups. The totals of the percentage change per lot for each group were then used as the dependent variables in two stepwise multiple regression analyses with the eight independent variables used in the first regression. This would determine the types of influences acting on the two land-use groups.

The results of the regression, where group one -- agricultural changes -- was the dependent variable, showed that exchanges among agricultural uses occurred more often when the distance to the Q.E.W. and average property size were large, and when average age of the operator was low (see Table 12). These three variables explained 12% of the variation in agricultural exchanges. The remaining five independent variables of soil rating, assessment, occupational status, ownership and distance to St. Catharines made no significant contribution to the proportion of variance explained.

Changes from agricultural to non-agricultural uses occurred closest to the Q.E.W. where average property size was low and where average age and tender fruit soil rating were high. The regression with group two -- non-agricultural uses -- as the dependent variable, showed that the above four variables accounted for 9% of the variation in increases in non-agricultural uses (see Table 13). No significant contribution to the level of explained variance was made by the remaining four independent variables of assessment, occupational status, ownership and distance to St. Catharines.

It is therefore evident, that in the study area, distance from

TABLE 12

SUMMARY TABLE OF REGRESSION ON THE VARIABLE: AGRICULTURAL CHANGES

Step	Variable Entered	B	Multiple R	R^2
1	DISTQEW	2.504*	.318	.101***
2	MEANAG54	- .170	.335	.112***
3	MEANH54	.187	.348	.121***

* Regression coefficient significant at $\alpha = 0.01$

*** Equation significant at $\alpha = 0.01$

TABLE 13

SUMMARY TABLE OF REGRESSION ON THE VARIABLE: NON-AGRICULTURAL CHANGES

Step	Variable Entered	B	Multiple R	R^2
1	DISTQEW	-1.841*	.251	.063***
2	MEANH54	- .244**	.284	.081***
3	MEANAG54	.127	.296	.088***
4	TFSRATG	-6.872	.307	.094***

* Regression coefficient significant at $\alpha = 0.01$

** Regression coefficient significant at $\alpha = 0.10$

*** Equation significant at $\alpha = 0.01$

Legend for Tables 12 & 13

Variable Acronym	Variable Name
DISTQEW	Distance from the Q.E.W. in 1954.
MEANAG54	Average age of operator in 1954.
MEANH54	Average property size in 1954.
TFSRATG	Soil rating for tender tree fruits.

the Q.E.W., property size and age of the operator affect both agricultural and non-agricultural changes in two different ways. The former, increase as distance to the Q.E.W. and property size increase, and as age decreases, and the latter increase as distance to the Q.E.W. and property size decrease, and as age increases. Although in the last two regressions, the separate and combined effects of the remaining independent variables are not significant, their simple relationships with each of the dependent variables behave in the same way as those of distance to the Q.E.W., average property size and average age. That is, they are opposite (see Table 14). This is true for all but the variable related to assessment. Therefore, because these variables are affecting two different types of change in two different ways, the explained variance in the first regression, where the change index was the dependent variable, was very low.

Another contributing factor to the low value of the R^2 in the first regression may have been due to the aggregation of the assessment data. The effects of this procedure, however, were not believed to be as significant as the effects of the opposing influences of the independent variables. The high level of detail at which the data were collected implies that the data set was representative and therefore contributed minimally to error size.

In conclusion, it is suggested that the study area is undergoing what Bryant (1976) terms as a "normal" process of change, where agricultural and urban-related forces combine evenly to create change. Therefore, other variables, peculiar to the agricultural industry and urban processes, and not included in this analysis, must be important in explaining the land-use changes in Louth.

TABLE 14

SIMPLE CORRELATIONS BETWEEN THE EIGHT INDEPENDENT VARIABLES AND CHANGES IN AGRICULTURAL AND NON-AGRICULTURAL USES

Independent Variable	Simple Correlation with Agricultural Changes	Simple Correlation with Non-agricultural Changes
DISTQEW	.318	-.251
MEANH54	.234	-.245
MEANAG54	-.088	.051
TFSRATG	-.160	.122
MEANA54	-.013	-.047
FTFARM54	.060	-.016
OWN54	-.114	.108
DISTSTCA	-.066	.039

Legend

Variable Acronym	
DISTQEW	Distance from the Q.E.W. in 1954.
MEANH54	Average property size in 1954.
MEANAG54	Average age of operator in 1954.
TFSRATG	Soil rating for tender tree fruits.
MEANA54	Average property assessment in 1954.
FTFARM54	Percentage of full-time farmers in 1954.
OWN54	Percentage of property owners in 1954.
DISTSTCA	Distance from St. Catharines in 1954.

6:3 Summary of land-use exchanges

An increase in grapes and decreases in peaches and field crops were noted in Chapter 5. The correlation matrix in Table 15 shows a weak negative relationship between change in grapes and change in peaches. There is, however, a very strong negative correlation between change in grapes and change in field crops which is statistically significant at $\alpha=0.01$. The direction and magnitude of this relationship indicates that close to 61% of the increase in grapes was explained by a decrease in field crops.

One of the most important issues in the Niagara Region is the loss of tender fruit soil to non-agricultural uses. The negative correlations between change in peaches and change in abandoned land, and between change in peaches and change in rurban areas indicates that there is some loss of prime fruit land to non-farm uses (see Table 15). Separately, the increases in abandoned land and rurban areas accounted for 15% and 7% respectively, of the decrease in peaches. Other relationships among the major land-use variables are fairly weak, accounting for 6% or less of the variation in the changes in each other.

TABLE 15

CORRELATION MATRIX OF MAJOR LAND-USE VARIABLES

MXD	-.22						
VEG	-.05	-.11					
GRPS	-.09	.05	-.07				
FLD	-.04	-.17	-.04	-.78			
ABN	-.39	-.22	-.01	-.20	.16		
URB	-.03	-.20	.16	-.15	.15	.04	
RURB	-.27	-.25	.08	-.14	.14	.20	-.07
	PCHS	MXD	VEG	GRPS	FLD	ABN	URB

Legend

Variable Acronym	Variable Name
PCHS	Change in peaches.
MXD	Change in mixed fruits.
VEG	Change in small fruits and vegetables.
GRPS	Change in grapes.
FLD	Change in field crops.
ABN	Change in abandoned land.
URB	Change in urban area.
RURB	Change in rurban areas.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7:1 Summary

As one of the few areas in the Niagara Region least affected by urbanization, the former township of Louth appeared to offer interesting prospects for a study of land-use change. The physical aspects of the township were examined and the pertinent literature regarding land-use change was reviewed. The time period chosen for the study was 1954 - 1978. The choice of this time period was due to the availability of a detailed land-use map for 1954 and aerial photographs for 1978.

Socio-economic data for 1954 and 1978, related to the study area, were collected from the municipal assessment rolls of the Town of Lincoln and the City of St. Catharines. Two detailed maps, showing 18 different classifications of land use, were drawn. The 1954 map was modified from a more detailed land-use map drafted in the late 1950's from 1954 black and white aerial photographs. The 1978 map was drawn from 1978 aerial photographs.

The study area was divided into 171 lots bounded by the township's concession roads and lot boundaries. These were chosen as data collection units due to the relative ease of identifying them on the air photos and in the field. The assessment data could

also be aggregated at this level. The percentage of land occupied by each land-use type was then computed for each lot.

A soil capability classification system was developed to rate the soils of the study area according to their capability for tender tree fruit production. Each soil was assigned to one of five categories: (1) 1.00 -- excellent, (2) 0.75 -- good, (3) 0.50 -- fair, (4) 0.25 -- poor, or (5) 0 -- unsuitable. The capability rating for each lot was then computed according to the relative percentages of the various soil types within the lot.

Trends in land-use change, evident from the maps and from data collected from these and other sources, were discussed. An index of land-use change was computed for each lot and used as the dependent variable in a stepwise multiple regression model. Hypotheses to explain changes in land use manifested in the change index were developed and tested with the regression model. Other exchanges within the township were speculated upon and also tested using multiple regression analysis.

Two important aspects of the study were the development of the soil rating system for tender tree fruits and the land-use change index. Although the soil rating system designed is an arbitrary assignment of numbers to discrete levels of capability, it provided a means of quantifying qualitative ratings so they could be used in a quantitative analytical framework. All other studies of this nature have used the Canada Land Inventory system of soil capability for agriculture which is inadequate when judging the capability of soils for the production of special crops.

Hopefully, the system designed for this study can be made more accurate in the future by studying the yields of different fruits on different soils. The concept of the land-use change index is one that has never been employed by other researchers.

7:2 Conclusions

This study was undertaken to map, measure and explain the land-use changes which occurred in a selected area of the Niagara Fruit Belt in the 1954 - 1978 time period. It was discovered that none of the eight variables selected for the analysis explained a significant proportion of the variance in the land-use change index. Soil capability for tender tree fruits, explaining 2.4% of the variance, accounted for the largest proportion of change. The remaining seven variables of property assessment, proximity to St. Catharines and to the Queen Elizabeth Way, age of the operator, property size, occupational status of the operator and ownership, contributed little to the level of explanation, raising it to 6.2%. Thus, all of the major hypotheses have been rejected.

When the 18 classes of land use were divided into two groups of agricultural and non-agricultural uses, the subsequent regression analyses, where the sums of the changes in each group were the dependent variables, showed interesting trends. More exchanges among agricultural uses were occurring in the central and south-eastern parts of the township where the distance to the Q.E.W. and farm size was large and where farm operators were young. Actual changes from

agricultural to non-agricultural uses took place closest to the Q.E.W. where property size was small and where age and soil rating were high.

The majority of exchanges were among agricultural uses, such as the large decrease in field crops and the equally large increase in grapes. A very small proportion of the decreases in the major agricultural land uses was attributed to increases in non-farm uses. The largest area of agricultural land lost to non-farm uses was from peaches. Fifteen per cent of the decrease in peaches was due to an increase in abandoned land, and 7% was due to an increase in rurban land. Six per cent of the increase in abandoned land occurred close to the Queen Elizabeth Way and St. Catharines where most of the tender fruit soil is located. Thus, there has been some loss of tender fruit soil to non-farm uses.

The study area has a high proportion of uniformly good quality land for fruit production. Thus, land capability is not a significant factor in accounting for land-use changes. Other farm characteristics such as age of operator, ownership, areal size of enterprise and location, which have proven to be important factors in accounting for land-use changes in other areas, do not appear to be significant in this case.

It is thus evident that the study area is undergoing what Bryant (1976) refers to as a "normal" process of change where agricultural and urban-related forces combine evenly to produce change. One must conclude that variables peculiar to the agricultural industry and to the process of urbanization are more important in accounting for the land-use changes in Louth.

The investigation has shown that the actual loss of fruit land to non-agricultural uses is less than was anticipated. It appears that many of the exchanges among agricultural uses relate to intensification. It has also been discovered, contrary to the findings of other researchers (Krueger, 1978) that the loss of peach acreage is not entirely due to urbanization, and that increases in grape acreages have been implemented in areas relatively close to the city of St. Catharines.

In this regard, several developments have occurred which have influenced decision making. These include the improved demand and prices for grapes for wine production, the higher net economic return per unit area from vinifera type grapes than from peaches, the decline in peach processing, the increases in land value and the consequent need to increase dollar output per acre.

Future research should examine these economic variables in depth in order that the reasons for land-use changes may be understood more fully.

APPENDIX A

MARKETING BOARD AND PROVINCIAL AND FEDERAL GOVERNMENT STATISTICS

Most of the statistics collected by the Ontario Tender Fruit Producers' Marketing Board and the Ontario Grape Growers' Marketing Board are at the provincial level. Data obtained from the provincial and federal governments are at the county or regional level and the provincial level. For the purposes of this study, it was assumed that Louth Township was and is representative of Lincoln County and the Niagara Region as a fruit producing area. Thus, the trends shown by the statistics representing Lincoln County and the Niagara Region also reflect the trends occurring in the study area.

Of general interest is the fact that, in 1976, the district of Niagara[1] had 69% of Ontario's peach farms and 77% of the province's peach trees. Ninety-nine per cent of the grapes in Ontario were also found in the Niagara (O.M.A.F., 1976a and 1976b). Table A1 shows that almost half of the peach trees in the Niagara were between 4 and 9 years old, and over a quarter were 1 to 3 years old, and not bearing fruit yet. This table also shows that 14% of the vines in the Niagara

[1]The district of Niagara, as defined in the 1976 Fruit Tree Census carried out by the Ontario Ministry of Agriculture and Food, consisted of the Regional Municipalities of Niagara, Hamilton-Wentworth (south of Hwy. 99) and old Haldimand County.

TABLE A1

AGE GROUP CLASSIFICATION OF PEACHES AND GRAPES IN THE NIAGARA DISTRICT

Peaches

1-3 yrs.	4-9 yrs.	10 or more yrs.
	% of trees	
26.98	41.32	31.70

Grapes

1-3 yrs.	4-8 yrs.	9-24 yrs.	24 or more yrs.
		% of vines	
13.74	21.07	36.05	29.14

SOURCE: O.M.A.F., 1976a and 1976b.

were in the immature 1 to 3 year age group in 1976. These new plantings are an indication that the production of peaches and grapes may still be profitable in parts of the Niagara Region. Trends in area, production and farm value of peaches in Ontario are shown in Table A2. Production has fluctuated over the years from a low of 27,295 tonnes in 1967, due to a heavy infestation of peach canker, to a record high of 85,567 tonnes just seven years earlier in 1960 (Ont. Tender Fruit Producers' Mktg. Brd., 1968 and 1961). The average production between

TABLE A2

AREA, PRODUCTION AND FARM VALUE OF PEACHES
FOR ONTARIO: 1951-1978

Year	Area ha	Total Production tonnes	Farm Value		
			Total $.000	per ha $	per kg ¢
1951	6,582	30,574	2,869	436	9.4
1952	6,496	53,822	4,384	675	8.1
1953	6,415	53,286	4,565	712	8.6
1954	6,433	48,846	4,654	723	9.5
1955	6,542	53,761	5,235	800	9.7
1956	6,659	31,010	3,726	560	12.0
1957	5,884	51,381	5,289	899	10.3
1958	5,876	58,690	4,886	832	8.3
1959	5,607	48,610	4,455	795	9.2
1960	5,611	85,567	4,994	890	5.8
1961	5,589	57,931	5,563	995	9.6
1962	4,870	37,029	4,570	938	12.3
1963	4,494	44,018	5,844	1,300	13.3
1964	4,484	48,638	6,743	1,504	13.9
1965	4,479	36,415	5,531	1,235	16.0
1966	4,479	39,091	6,179	1,380	17.0
1967	4,101	27,295 *	5,717	1,394	22.1

TABLE A2-Continued

Year	Area ha	Total Production tonnes	Farm Value		
			Total $.000	per ha $	per kg ¢
1968	4,107	36,255	7,325	1,784	20.7
1969	4,121	38,551	8,935	2,168	23.7
1970	4,115	40,939	7,968	1,936	19.6
1971	4,115	47,546	8,940	2,173	19.5
1972	4,010	29,572**	7,593	1,894	26.5
1973	4,014	33,076	8,198	2,042	25.5
1974	4,040	39,061	10,820	2,678	28.4
1975	4,040	48,994	11,066	2,739	24.8
1976	4,038	35,011	11,725	2,904	33.6
1977	3,748	32,720	9,690	2,585	33.2
1978	3,487	29,489	11,985	3,437	42.0

SOURCE: O.M.A.F., 1979b.

*1967 - heavy summer pruning made necessary by one of the heaviest canker infestations in history along with poor fruit set drastically reduced the estimated crop.

**1972 - almost total loss in Kent-Essex due to lack of adequate cold storage facilities and a light crop in Niagara reduced the estimated crop.

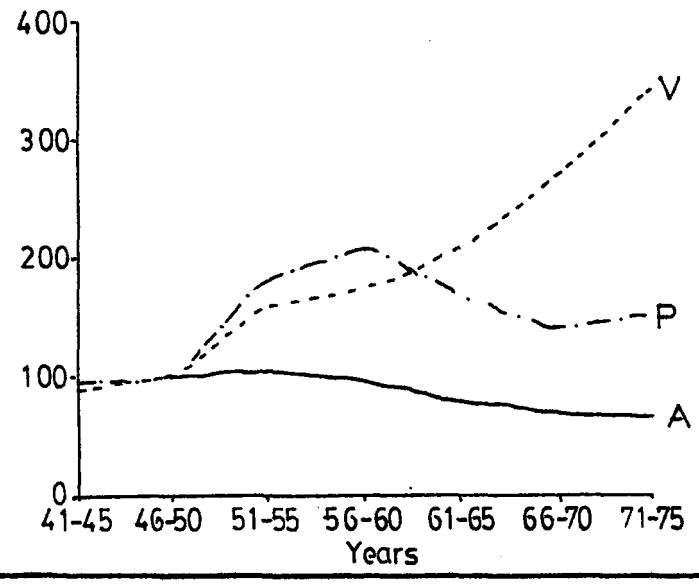
1951 and 1978 was 43,471 tonnes. The total value of the peach crop had risen over the years, even though total production was so erratic, because of the steady increases in production value per hectare and value per kilogram. Figure A1 shows this data graphically using five-year averages.

Similar statistics for grape production are found in Table A3. Fluctuations in production are evident as in 1957 when the crop was reduced due to poor weather, or in 1971 when the crop was the largest in history (Ont. Grape Growers' Mktg. Brd., 1958 and 1972). The total value of the crop increased as well, especially in the 1969-1978 period when values per hectare and values per kilogram increased dramatically. Figure A2 shows these trends graphically.

Statistics from Census Canada, supplemented by data from the provincial government, although missing certain values for some years, show the same general trends in area occupied by peaches and grapes for Lincoln County (before 1970) and the Regional Municipality of Niagara (after 1970)[2] (see Table A4). Data for only two years, 1971 and 1978, were available for the area of peaches in the region. They indicate a marked decline in peach acreage. The census data also show a decrease in the number of peach trees in the county. Another point to consider is the fact that the total area covered by all tree fruits in the county had declined. Grapes show a definite increase in area.

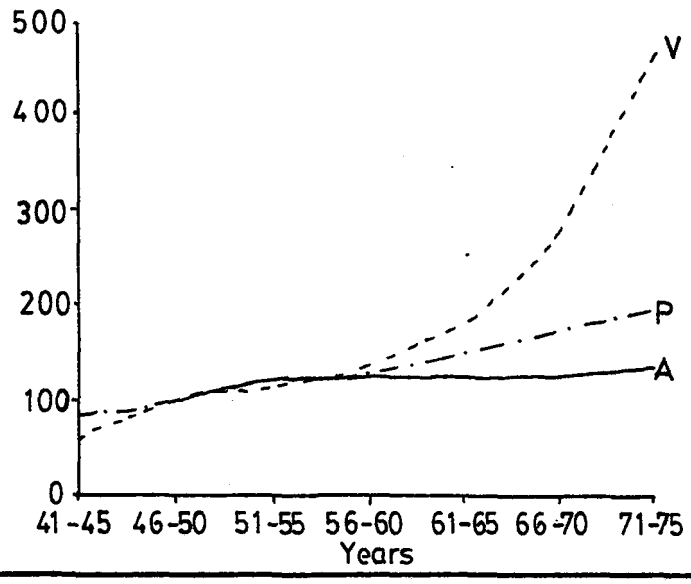
[2]Because of the larger area covered by the Regional Municipality of Niagara, there may be a sudden change in the trends of the data in 1971.

Figure A1: Area (A), Production (P), and Total Value (V) of Peaches Five year averages (1946-50=100)



Source: O.M.A.F., 1979b, p. 37.

Figure A2: Area (A), Production (P), and Total Value (V) of Grapes Five year averages (1946-50=100)



Source: O.M.A.F., 1979b, p. 37.

TABLE A3

AREA, PRODUCTION AND FARM VALUE OF GRAPES
FOR ONTARIO: 1951-1978

Year	Area ha	Total Production tonnes	Farm Value		
			Total $.000	per ha $	per kg ¢
1951	8,599	39,330	2,709	315	6.9
1952	8,559	38,054	2,914	340	7.7
1953	8,548	35,502	3,347	392	9.4
1954	8,537	39,509	3,812	447	9.6
1955	8,625	42,075	3,496	405	8.3
1956	8,670	36,203	3,257	376	9.0
1957	8,330	30,436*	2,684	322	8.8
1958	8,323	47,116	4,698	564	10.0
1959	8,275	37,104	3,871	468	10.4
1960	8,451	50,729	4,815	570	9.5
1961	8,451	37,029	4,060	480	11.0
1962	8,392	40,376	4,494	536	11.1
1963	8,419	46,529	5,482	651	11.8
1964	8,419	51,625	5,639	670	10.9
1965	8,419	56,987	5,411	643	10.3
1966	8,825	52,844	5,933	672	11.3
1967	9,061	59,271	6,666	736	11.6

TABLE A3-Continued

Year	Area ha	Total Production tonnes	Farm Value		
			Total $.000	per ha $	per kg ¢
1968	9,057	49,623	6,743	745	13.6
1969	9,050	55,734	8,970	991	16.4
1970	9,052	57,362	9,479	1,047	16.5
1971	9,052	76,362**	12,465	1,377	17.6
1972	9,104	47,347	8,928	981	18.9
1973	9,432	54,121	11,452	1,214	21.2
1974	9,441	62,776	15,180	1,608	24.7
1975	9,441	65,882	16,727	1,772	25.6
1976	9,441	72,793	16,642	1,763	24.1
1977	10,281	55,306	13,080	1,272	24.6
1978	10,287	67,721	18,013	1,751	26.7

SOURCE: O.M.A.F., 1979b.

*1957 - reduced crop due to poor weather.

** 1971 - largest crop in history.

TABLE A4

AREAS OF PEACHES AND GRAPES IN LINCOLN COUNTY
1951-1978

	1951	1956	1961	1966	1971*	1976	1978
Tree fruits							
Total area (ha)	9161	8823	8152	8010	8557	7245	5757
Peaches							
- area (ha)	4730				3690		2760
- number of trees	1,292,898	1,152,256	1,007,762		1,005,097		
Small fruits							
Total area (ha)	6777	6591	7497	7860	8457	9080	9650
Grapes							
- area (ha)	6317	6140	7063	7511	8060		9482

SOURCE: Census of Canada; and O.M.A.F., 1978.

*After 1970 these data refer to the Regional Municipality of Niagara.

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WITH

LAND USE IN PART OF THE FORMER TOWNSHIP OF LOUTH

1954

— MAP 1 —

LAKE ONTARIO

Jordan Harbour

QEW

Vineland Sta.

C.N.R.

Jordan Sta.

Mile Cr.

Vineland

Twenty

Jordan

P.M.P. Cr.

(81)

Mile

Sixteen

Fifteen Mile Cr.

Barnesdale

B.F.

I II III IV V VI VII VIII

P	Peaches
M	Mixed fruit
V	Small fruits and vegetables
G	Grapes
F	Field crops and pasture
W	Woodlots and scrub
L	Greenhouses
N	Nurseries and garden centres
X	Experimental farm
A	Abandoned or unproductive
I	Idle
U	Urban
B	Rurban
H	Homestead
R	Recreation
C	Commercial
D	Industrial
O	Other

N

0·25 0 0·25 0·50 0·75 1 mile

0·5 0 0·5 1 1·5 km.

23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

LAND USE IN PART OF
THE FORMER TOWNSHIP OF LOUTH
1978
— MAP 2 —

LAKE ONTARIO

Jordan Harbour

Q.E.W.

Barnesdale

Vineland Sta

C.N.R.

Jordan Sta

Mile Cr

Vineland

Jordan

Twenty

81

Mile

Sixteen Cr

Fifteen Mile

B.F.

B.F.

P	Peaches
M	Mixed fruit
V	Small fruits and vegetables
G	Grapes
F	Field crops and pasture
W	Woodlots and scrub
L	Greenhouses
N	Nurseries and garden centres
X	Experimental farm
A	Abandoned or unproductive
I	Idle
U	Urban
B	Rurban
H	Homestead
R	Recreation
C	Commercial
D	Industrial
O	Other

N

0·25 0 0·25 0·50 0·75 1 mile

0·5 0 0·5 1 1·5 km.

I II III IV V VI VII VIII

23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1