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THE UNIVERSITY OF OTTAWA
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LANDSCAPE TRANSFORMATION AND INDUSTRIAL DEVELOPMENT: ENVIRONMENT, ECONOMISM AND "SUSTAINABLE DEVELOPMENT" IN THE PULP AND PAPER INDUSTRY OF EASTERN MANITOBA

GRADUATE STUDIES, DEPARTMENT OF GEOGRAPHY

SEPTEMBER 15, 1995

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ISBN 0-612-04962-0

Canada

UNIVERSITÉ D'OTTAWA
UNIVERSITY OF OTTAWA

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Acknowledgements

I acknowledge with gratitude the assistance of the University of Ottawa for Graduate Scholarship assistance from 1989 to 1992, the Province of Ontario for Graduate Scholarship assistance from 1990 to 1992, and P.E.O. Manitoba Chapter N for scholarship assistance and moral support from 1992 to 1994.

Abitibi-Price and the Pine Falls Paper Company provided the use of digitizing equipment as well as access to their large and eclectic collection of topographic and land use maps. The aerial photographs on page 77, c 1924 and c 1962 Her Magesty the Queen in Right of Canada, are reproduced from the collection of the National Air Photo Library with permission of Natural Resources Canada. The aerial photograph on page 78, c 1983 is reproduced from the collection of the Manitoba Air Photo Library with permission of Province of Manitoba Natural Resources.

I deeply appreciate the guidance of my supervisor, Dr. Michel Phipps of the Department of Geography at the University of Ottawa, as well as that of Dr. Anne Buttimer of University College, Dublin in the earlier stages of this work. Thanks are also extended to Dr. William Norton of the Geography Department, University of Manitoba, who read an earlier draft of this thesis and made valuable suggestions.

Many thanks are due to friends and family in Ottawa, Winnipeg and Pine Falls for generous gifts of time with my child. They enabled me to attend conferences, do field work and undertake the many other tasks associated with this type of endeavour. And special thanks to Claire, for making it all worthwhile and necessary.

ABSTRACT

This thesis studies change during the twentieth century at the lower reaches of the Winnipeg River in eastern Manitoba Canada. The pulp and paper industry there is part of a global network of economic exchange. "Sustainable development" is popular in the industry and is promoted as economic development which does not impair the abilities of future generations of people to meet their needs.

The first section explores discourse about "environment" and its relationship with value and utilization. Technological innovation and cultural development have helped create a wide gulf between human experience and the natural world. Geography as a discipline has been for both good and ill a mirror to that process.

The section on landscape develops the idea that the built environment emerges or is imposed as a consequence of purposeful human activity and natural evolution. Information Theory, in particular Boltzmann's concept of spatial entropy, is used to evaluate the combination of stability, resiliency and structure of the landscape system in response to environmental and economic factors. PEGASE (Partition d'un Ensemble Géographique pour l'Analyse Spatiale Ecologique) derives a hierarchical arrangement of landscape units based on combinations of constraining factors.

Three land use regimes were evaluated in terms of changing landscape organization. On

the Sagkeeng First Nation Reserve landscape reorganization from 1941 to 1991 was due to maturation of succession from muskeg and willow to forest. The settlement pattern was closely connected to environmental factorss. Vegetation location was less ordered. The Forest Management Licence Area, part of an industrial forestry concern, comprises 885,705 hectares. Maturation of succession was a major factor, as in the control area on the Reserve. Timber berths were carefully chosen for economic productivity, so one would expect uniformity. Clear evidence of the impact of cutting practices on forest organization was not found, due to unavailability of environmental information for the entire Forest Management Licence area. There was substantial alteration of landscape structure in the agricultural lands, particularly where drainage ditches and roads were constructed. This regime reflected the situation where many individuals made land use decisions on small plots of land

The third, contextual, portion of the thesis focused on distinct phases in the development and growth of industrial forestry. Three main threads run through the entire period: wood supply, energy to drive the process, and international competition. In each period those themes were embedded within broader societal events.

In the 1920s uncertainty over wood supply led to delays in construction. The company wanted to secure a wood supply in a marginally productive area and to block competing interests. Meanwhile the western provinces were attempting to gain control over natural resources while the Dominion Ministry of the Interior was in charge of allocating those resources to various interests.

After the Second World War, the widespread attempt to move the economy to consumer-oriented industry and the drive to electrify rural areas played an integral role in the paper industry

of eastern Manitoba. Later came a period when expansion, mergers and takeovers were used to fight international competition.

In the 1980s and 1990s two important situations are juxtaposed: globalization of industry and finance, and widespread concern for the environment. Renewal of rights to exploit and manage the large timber limits now requires environmental impact studies and public hearings. Waste management, air and water pollution and recycling are regulated. The present economic climate of global competition and freer trade has made older smaller mills non-competitive. Within that climate, a group of investors and the labour unions negotiated a buyout of the operation from the parent corporation (Abitibi-Price).

"Sustainable development" has been a cure-all. Its meaning is so nebulous that it invites a definition tailored to any situation. The new paper company, like corporations and government bodies around the world, can use concern for the environment and the ambiguity of the concept not only to survive but to garner funding to modernize and upgrade the facility. Due to the competitive nature of the industry, the end result will likely be the sale, in several years, of the publicly-funded refurbished operation to a large corporation.

RÉSUMÉ

Cette thèse étudie les changements qui ont eu lieu pendant le vingtième siècle dans la région inférieure de la rivière Winnipeg dans l'est de la Province du Manitoba, Canada. L'industrie de la pâte à papier fait partie du réseau global d'échanges économiques. Le « développement durable » est populaire dans cette industrie et est avancé comme mode de développement qui ne diminue pas la capacité des générations futures à satisfaire leurs besoins.

La première partie explore le discours sur l'environnemenrt et son rapport avec la valeur et l'utilisation. L'innovation technologique et le développement culturel ont contribué à créer une profonde séparation entre l'expérience humaine et le monde naturel. Le domaine académique de la géographie a reflété tant bien que mal cette séparation.

La partie consacrée au paysage développe l'idée que l'environnement bâti émerge ou est sur-imposé par conjonction de l'activité humaine et de l'évolution naturelle. La théorie de l'information, spécifiquement le concept d'entropie de Boltzmann, permet de définir une entropie spatiale et est utilisée pour examiner la combinaison de facteurs sous-jacents à la structure d'un système paysagique formées en réponse aux facteurs environnementaux et économiques. PEGASE (Partition d'un ensemble géographique pour l'analyse spatiale écologique) révèle un arrangement hiérarchique d'unités paysagiques selon des combinaisons de facteurs contraignants.

Trois régimes d'utilisation du sol ont été examinés par rapport aux changements de

l'organisation du paysage. La réorganisation du paysage de la réserve Sagkeeng First Nation entre 1941 et 1991 fut causé par la maturation de la succession des saulaies marécageuses à la forêt. Le mode d'établissement humain est étroitement lié aux facteurs envionnementaux. La végétation est moins ordonnée. Le territoire soumis au régime de « Forest Management Licence Area » qui fait partie des possessions de l'industrie forestière comprend 885 705 hectares. La maturation de la succession secondaire fut, là aussi, un facteur de changement majeur. Ces territoires ont été choisis en raison de leur productivité et on s'attend donc à une certaine uniformité. Une évidence claire de l'incidence des pratiques de coupe n'a pas été établie puisque l'information environnementale pour la région entière n'était pas disponible. La structure du paysage du territoire agricole a subi un changement significatif surtout là où des fossés d'écoulement et des chemins ont été faits. Ce régime refléte le fait que des décisions concernant l'utilisation du sol ont été prises par un grand nombre de personnes relativement à des surfaces minimes.

La troisième partie, contextuelle, de la thèse concerne les grandes étapes du développement de l'industrie papetière. En général, trois thèmes se retrouvent tout au long de cette période historique : L'approvisionnement en bois, les sources d'énergie industrielle et la compétition internationale. À chaque étape, ces thèmes sont considérés en fonction d'évènements sociétaux plus généraux.

Pendant les années 1920, l'incertitude à propos de l'approvionnement en bois entraînait des délais de la construction de l'usine. La compagnie voulait s'assurer d'une quantitté de bois suffisante dans une région de production marginale, tout en voulant aussi se prémunir contre la compétition. À cette époque les provinces de l'ouest du Canada tentaient de prendre le contrôle de leur ressources naturelles alors que le Ministère de l'Intérieur fédéral avait la responsabilité

de l'allocation de ces ressources. Durant la période qui suit la deuxième guerre mondiale, le développement d'une économie de consommation et l'électrification des zones rurales ont influencé l'industrie forestière dans l'est du Manitoba. Plus tard, l'expansion de l'entreprise, des fusions et l'absorption d'autres compagnies ont permis de lutter contre la compétition internationale.

Pendant les décennies 1980 et 1990, deux éléments importants concourent à créer une nouvelle situation : la globalisation de l'industrie et des institutions financières ainsi que l'émergence de préoccupations environnementales dans les enquêtes publiques. Le contrôle des rejets de déchets, de la pollution de l'air et de l'eau ainsi que les pratiques de recyclage sont réglementés. Le climat actuel de compétition mondiale et de libre échange ont rendu les petites usines désuètes et non compétitives. Dans ce contexte, un groupe d'investisseurs et les syndicats ouvriers ont négocié l'achat de la compagnie Abitibi-Price.

Le développement durable est apparu comme une véritable panacée. Le sens de ce terme est si nébuleux qu'il permet une définition cas par cas. La nouvelle compagnie, comme, le font beaucoup d'autres corporations et gouvernements du monde, utilise l'environnement et le développement durable, non seulement pour la survie de l'usine mais également afin d'attirer le financement nécessaire à sa modernisation et son expansion. Grâce à la nature compétitive de l'industrie, nous assisterons presque certainement à la vente de cette compagnie dans quelques années alors qu'elle aura été réaménagée.

Chapter One

Cogito, ergo mundus talis est

(I think, therefore the world is as it is)

Carter, Cited in Couclelis, 1983, p.

Introduction

Globalization is a catchword heard with increasing frequency as we approach the twenty-first century. It describes a progressive interconnection of communities, places, economic activity, culture and information exchange at all scales and types of human activity. Very few places in the world today remain disconnected from actions and consequences of actions taken far away.

"Sustainable development" is another catchword enjoying rampant appeal. While a variety of definitions are used, it tends to be promoted as sustainable economic development which does not impair the abilities of future generations of people to meet their needs. It achieved widespread acceptance with the publication of the report Our Common Future (1987), popularly known as the Brundtland Report. Governments, institutions, industrial and business corporations, service clubs and academic bodies have enjoyed a surge of activity, attempting to define a scientific and/or ecologic basis for what is fundamentally a political motherhood statement. It

implies a fairly direct interaction between human activity and the natural environment which supports it.

The concept of "sustainable development" is associated now with a variety of industries which depend on natural resources. Exploitation of non-renewable and renewable resources is mainly carried out in rural and isolated places by individuals and communities of people. Those people have a commitment to their area and can clearly see the changes to their environment and community, but they have limited control over externally-driven economic activities. The financial benefit of their activity is appropriated by global interests which are extremely powerful but which may be unaware and largely unconcerned about the local effects of their activity. The process tends to be mediated by remote authoritative bodies whose interests represent regional or national levels of concern and are themselves limited by political and jurisdictional boundaries.

This thesis is a study of landscape change during the twentieth century within an area of 250 km^2 at the lower reaches of the Winnipeg River in eastern Manitoba, Canada, centred on the town of Pine Falls (Figures 1.1 and 1.2). Activities undertaken there include industrial forestry for a pulp and paper company, hydro-electricity generation, agriculture and recreation.

Until very recently, the land based resource extraction industry carried out in eastern Manitoba was controlled by and financially benefited a corporate entity based in an urban setting far from the community. While a group of investors and the trade unions collectively bought out the local company from Abitibi-Price, it still suffers from the lows and thrills with the highs of economic factors out of its control. Pine Falls is but one of a large number of single enterprise communities in Canada which are products of twentieth century technology-driven resource exploiting industries (Lucas, 1971; Govt of Canada, 1987; Can Assoc. of Single Industry

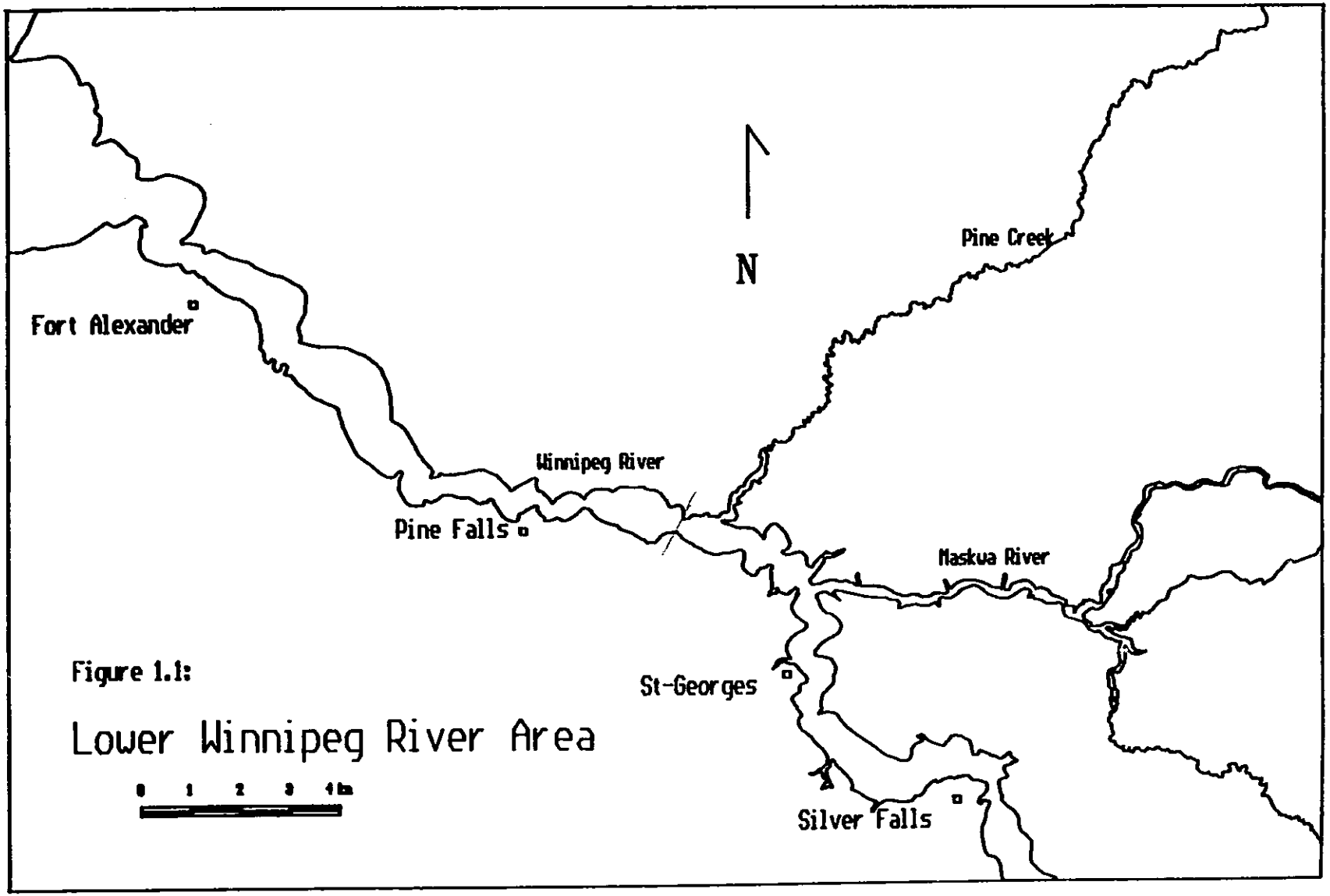


Figure 1.1:

Lower Winnipeg River Area

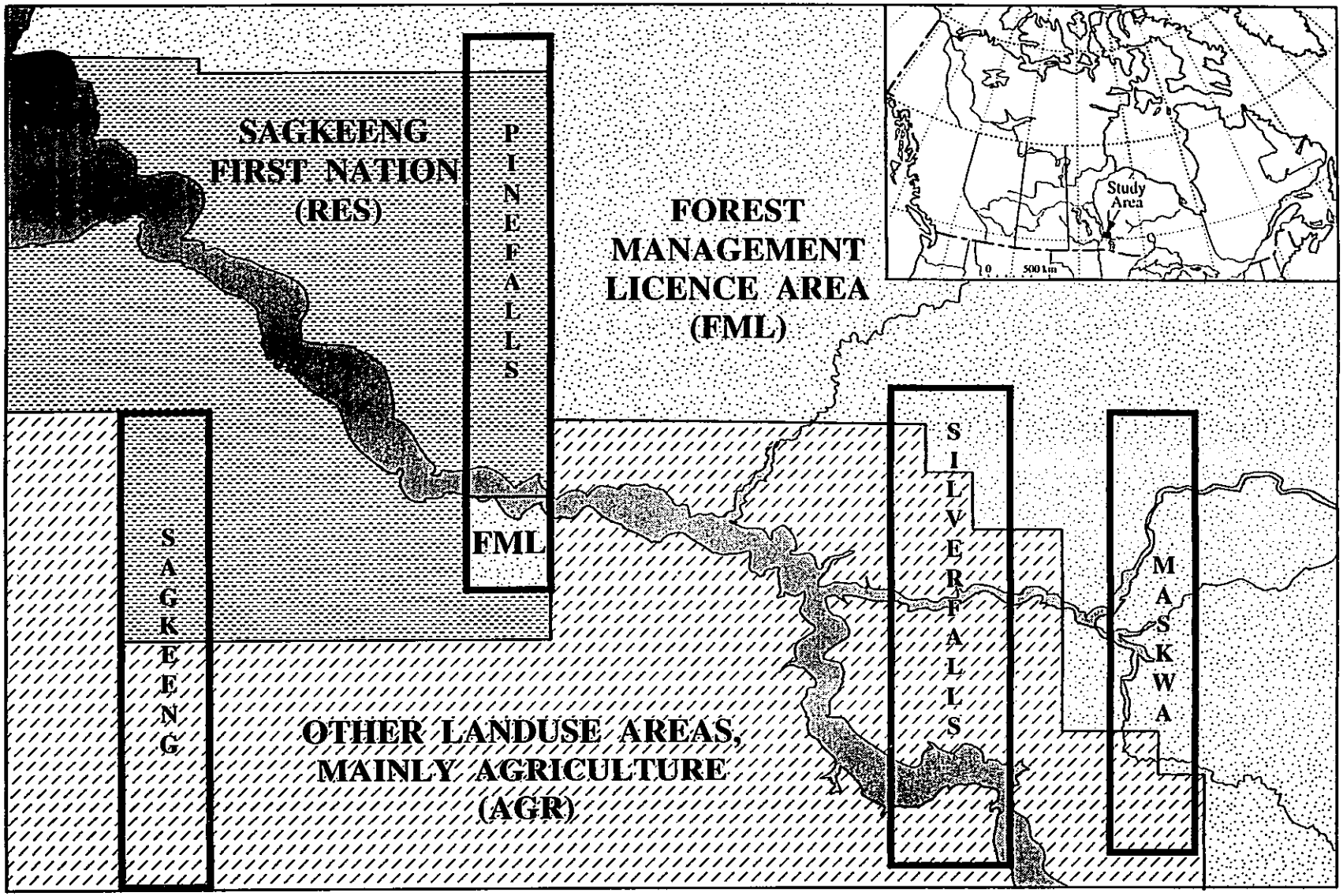


Figure 1.2: Outline of Land Use Regimes.

Communities).

As such, this microregion provides in microcosm a good example of the tensions between local and global issues, of environment and economy, of internal and external decision-making, of biophysical activity and economic control.

The Study Area

An important aspect of this study will be the investigation of the effects on a small area of decisions and events in an increasingly globalized system of human interaction with the environment. These operate at vastly different scales; however, if there is self-similarity between scales, it should be possible to compare the interactions. The organization of landscapes characteristic of industrial forestry, agriculture and aboriginal Reserve will be used to compare differences among these very different human land use regimes. Their change in time, either as a result of the activities in the community or instigated by external decisions or events, will be interwoven with a contextual study of the events and alliances which set the activity in place and which continue to play a significant role. The following is a brief introduction to the three land use regimes used in the thesis.

Sagkeeng First Nation Lands (RES): For millennia the Winnipeg River was a major transportation route of aboriginal peoples in their annual cycles of migration for hunting, fishing, harvesting, trading and appropriate shelter through the cycle of the seasons (see Historical Atlas of Canada, 1987). The lands and waterways of Canada have also served transnational corporate

interests since 1670, when a charter to operate in North America was granted to a group of speculators in England. Later, in 1734, a rival group headed by La Verendrye established the first of a series of forts installed on the shores of the Winnipeg River, dating up to the 1880s.

The forts were located near the mouth of the Winnipeg River as far upstream as the first set of rapids. They were used as provisioning posts for the fur brigades on way to and from the interior" (Ross, 1980:67; see also Lalor, 1988; Winnipeg River-Lake Winnipeg Heritage Project (WRHP), 1988). It was a natural point of contact between the supply areas in the prairies and the fur trade houses further north. Thus it was the most cost-effective location for provisioning.

There was some agricultural activity at the forts. Barley, peas, oats and potatoes were grown, according to eye-witness accounts in 1814 (WRHP, *op cit.*). The Church of England established a mission there in 1856 and a Roman Catholic Mission sent its first resident (rather than itinerant) priest in 1860.

The Hudson Bay Company had transferred some land from its charter to Lord Selkirk in 1811, with the proviso that he settle 1000 families. The first wave of homesteaders was soon followed by others, so that in 1870 the aboriginal peoples of the area requested treaty negotiations in order to protect their territories from further encroachment (Morris, 1880). The Dominion government proposed to extinguish aboriginal title to lands in Manitoba "but also to so much of the timber grounds east and north of the Province as were required for immediate entry and use" (Morris, *op cit.*:26).

The built structures at Fort Alexander, originally located for the convenience of the fur brigades, imposed spatial inertia on the settlement pattern. It was chosen as the site of the reserve. By 1874 the land around Fort Alexander had been surveyed and partitioned into lots.

"An extent of one hundred and sixty acres for each family of five, or in that proportion, [was allowed] that they might have their land where they chose, not interfering with existing occupants" (letter written by Adams G. Archibald, The Honourable Secretary of State for the Provinces in Morris, *op cit.*:34).

Air photographs of 1927 show the landscape of the reserve to have had very few anthropogenic features. This land use regime is used as a "control site", as there has been no activity in the Reserve, apart from some recent tree-planting, to alter the natural environmental dynamics.

Corporate Forest Management Licence Area (FML): The Manitoba Pulp and Paper Company Limited was originally chartered in 1916 to exploit extensive areas of timber in northeastern Manitoba. The pulp and paper industry in Canada was in its infancy. The company was formed by J.D. McArthur, a contractor based in Winnipeg, who had built up a wealth of expertise in railway construction through muskeg, rock and marsh during the construction of the transcontinental rail line and rail lines in northern Alberta. He had several forestry concerns, including a sawmill further up the Winnipeg River.

Timber berths for wood supply were leased or purchased between 1921 and 1927, based on timber cruises carried out jointly by McArthur and the Dominion Government. A railway line was constructed to the chosen site on the Winnipeg River. A mill and planned model townsite were carved out of the bush and muskeg in a matter of months. It was a major industrial project for the province and was covered with considerable excitement by the press (Appendix 2.c).

Pulpwood supply berths were selected on the basis of the expected cordage (volume

measure) of pulp-quality wood and on the ease of transport to the mill at Pine Falls. The land chosen was optimal for forest productivity and access. The terms of the agreement guaranteed a sufficient quantity of wood to ensure production for a set number of years. Natural regeneration would replace the forests; even at the present time, natural regeneration is practised on two/thirds of the FML (Peacock, Environmental Hearings, Oct. 16, 1991).

Homesteads and Agricultural Settlements (AGR): For the purpose of this analysis, what is called the agricultural regime is actually all the lands which are not Forest or Reserve. Notwithstanding the small-scale farming carried out in connection with the fur trade provisioning depots and the farming practised and taught at the Roman Catholic and Church of England missions, agricultural settlement in the area began in 1882. Two Oblate priests at the Fort Alexander Roman Catholic Mission persuaded members of their families in Québec to come to the area and to establish a settlement on the Winnipeg River. The site chosen, present day St-Georges, was typical of eastern French Canadian Roman Catholic villages, with the spires of the church reaching even higher from its position at the highest elevation of the surrounding area.

Five families initially came to homestead along the shores of the Winnipeg River. In the early years, they supported themselves with a combination of farming, hunting and fishing. St-Georges officially became a parish in 1905 and soon had a school, church, co-operative *fromagerie* and numerous other enterprises(J. Dupont, pers.comm. 1992).

Further agricultural settlement came from two sources. Beginning in about 1905, Swedish immigrants homesteaded what became known as the Broadlands. More families arrived during the Great Economic Depression, as part of the back-to-the-land movement. Unemployed workers

were provided with temporary relief and homesteads (WRHP, *op cit.*; G. & W. Jansson, pers. comm. 1992).

The extent of utilized lands increased substantially after 1951, when a vehicular traffic bridge was constructed on the new hydro-electric dam, connecting both sides of the river. Previously the far shore had been served by a ferry. In recent years, this section has experienced a type of gentrification, with houses built along river frontage by people whose livelihood is practised elsewhere.

The Interaction of Human Activity and the Natural Environment

Specific questions to be addressed in this study are:

1. How has the physical landscape changed since the 1920s?
2. How has the landscape been affected by the activities of the human inhabitants of the area? In what ways has landscape change been a consequence of natural landscape self-organization?

Those questions will be addressed from the perspective of ecological landscape analysis, using the concept of spatial entropy (described in detail in Chapter Four). PEGASE (Partition d'un Ensemble Géographique pour l'Analyse Spatiale Ecologique (Phipps, 1981a) offers a technique for evaluating landscape organization in relation to ecologic and economic factors.

Using landscape as a focus allows the observer to recognize the interrelatedness of human

activity and the physical and biological environment. It can be used to contrast the evolution of landscape organization by natural and by human action and to evaluate the role of technology and capital.

3. How has land use been patterned by internal (cultural, landbased) activities and how has activity been imposed by external factors - economics, industry, world events. How much control have local residents had?

This will be addressed in an exploration of the context within which economic development progressed during the period of study. It will incorporate government documents and legislation, historical accounts and press reports and analysis. It will link the local activity with that of national and international events. The influence of individuals as well as large corporate entities for which the microregion is but a node of a much wider web of enterprise will be explored.

4. What constraints have past land use choices and community function imposed on activity which developed later? What opportunities have been made available that would otherwise have not been possible? Can knowledge of their past activity and of their response to change be used to suggest alternatives for the future?

This question is related to the issue of globalization and of "sustainable development" in connection to the life of the microregion. It sees the cultural or humanized landscape in a way

opposite to that described by Wagner. That is, the significance of landscape is not that it displays the history of past land use activity. Rather, it is important because it imposes a constraint on the future action and land use choices.

Organization of the Thesis

Chapter Two contains the description and explanation of the conceptual framework of the stesis. It introduces disciplinary and theoretical ideas and attitudes which permeate geographical study and are essential to the present study. Chapter Three is concerned with landscape, the observable formal surface which results from natural processes and human activity.

Part II is devoted to the landscape analytical part of the thesis. Information theory and self-organization are a way to re-unite the physical and "cultural" elements of landscape. Chapter Four introduces a discussion of Information Theory and self-organization as a method of landscape study which can deal with discrete, continuous and nominal data. It is well-suited to evaluating ecologic and economic organization. It provides detail about the mathematical properties of information theory and spatial entropy. Then there is an outline of PEGASE and discussion of applications.

Chapter Five comprises the results and discussion of the PEGASE analysis. It includes a comparison of the three regimes regarding general ecological landscape forms: forest, cleared/agricultural, residences, willow/alder bush and muskeg/marsh. The importance of specific soil, moisture, topographic, spatial and management factors of landscape organization are discussed. Finally, factorial correspondence analysis is used to highlight landscape organizational

features.

Part Three begins with Chapter Six. It addresses the question 3. above, regarding the tensions between internal and external factors and the role of significant individuals in land based activities. There is a concentration on three time periods focusing mainly on the paper company. Three major themes are threaded through the entire period. They are 1) wood supply; 2) international competitiveness; and 3) energy. The first period, Power and Finance in Eastern Manitoba, details the initial establishment and expansion of the paper company, from 1916 to 1932. Post-War Expansion follows the expansion of the capacity of the mill in the 1940s and 1950s to meet demands of the new consumer economy. The Corporate Shuffle focuses on the mergers, takeovers and expansion which characterized the 1960s and 1970s.

Finally, Chapter Seven is about the present: Economic Development or Environmental Sustainability. It investigates the process of the buyout of the operation from the parent company from the perspective of the three themes of wood supply, international competition and energy.

Chapter Eight is the Conclusion, in which there is a summation of the thesis. It draws together the purpose, problems and results. It includes speculation on future developments within the study area in the context of the future of the major industry, the pulp and paper mill. It does not propose a solution, as such, if indeed there is a way out of the problem of sustaining human occupance on the finite resource base on which we live. However, it does propose a way that knowledge such as that gained in this study may be used to evaluate or suggest alternatives for future planning. As well, there is discussion of interesting future directions in research which relate to the Lower Winnipeg River Area. It ends with a summing up of "sustainable development" and its relationship to geography.

Chapter Two

Theoretical Underpinnings and Conceptual Framework

The broad scope of the research problem raises the necessity to involve both local and global scales of action, as well as the interrelation of social, political and cultural aspects of the study area. Furthermore the changing morphology and ecological ortanization of the landscape in response to economic or social initiatives requires an analysis more frequently associated with what is called "physical geography".

This is problematic because there tends to be a dichotomy inherent in research between that termed scientific and that termed humanist. Indeed, geography as a discipline has been characterized by progressive compartmentalization. It is part of dichotomy in scientific discourse in general, and shall be addressed here as introductory justification for the conceptual framework to be used.

Growth of Technics: Uncoupling of Economic, Ecologic and Cultural Linkages of Activity

"Technics and civilisation as a whole are the result of human choices and aptitudes and strivings, deliberate as well as unconscious, often irrational when apparently they

> are most objective and scientific; but even when they are uncontrollable they are not external. Choice manifests itself in society in small increments and moment-to-moment decisions as well as in loud dramatic struggles; and he who does not see choice in the development of the machine merely betrays his incapacity to observe cumulative effects until they are bunched together so closely that they seem completely external and impersonal."
>
> Lewis Mumford, Technics and Civilisation, 1934.

Events and transformations far in the past have contributed to the modes of thought and behaviour which are dominant today. Mastery of technology in order to do work and to fabricate materials and products has led not to closer ties but to increased distance and alienation of humanity from the land. Dehumanization of the value assigned to work, land, material, skill and knowledge led to a culture mediated through negotiable exchange value.

Mumford's germinal work, Technics and Civilisation, sought to explain the growth in prominence of the machine in Western society. The development of technics had far more significant and far-reaching consequences than merely the invention of amazing machines and the furtherance of scientific knowledge. Of course, mechanization and automation purported to free workers from drudgery and to make products accessible for the betterment of the masses (Giedion, 1948). Technics developed, mainly in the west, as a process of stripping the layers of social, spiritual and cultural meaning away from economic activity (Mumford, *op.cit.*).

In Europe, the process began in the feudal period. Property rights and land management

had been connected to the social and ecological base within a mutually understood framework (Cosgrove, 1984). Gradually, symbolic customary rights based on mutual trust were invalidated in favour of written proofs and documentation. Once separated from the land, control over production was also lost.

The concentration of property led to enclosure of lands and the beginning of creation of surplus, which could be sold. Barter of goods and services was replaced by use of money as an exchange medium. Money separates value and cost: a quantity of real product or time or skill was exchanged for coin which had symbolic rather than real value. As money became the accepted medium of exchange, the value of money and goods and services became negotiable in a way not possible when real entities were bartered. Money became a higher level of abstraction where various commodities and skills could be quantified uniformly (Schumacher, 1973).

> "Since money does not disclose what has been transformed into it, everything, whether a commodity or not, is convertible into gold. Everything becomes saleable and purchaseable. Circulation is the great social retort into which everything is thrown and out of which everything is recovered as crystallized money. Not even the bones of the saints are able to withstand this alchemy; and still less able to withstand it are more delicate things, sacrosanct things which are outside the commercial traffic of [humanity]. Just as all qualitative differences between commodities are effaced in money, so money, a radical leveller, effaces all distinctions. But money itself is a commodity, an external object, capable of becoming the private property of an individual. Thus social power

becomes private power in the hands of a private person'."

Karl Marx, cited in Mumford (*op.cit.*), p.24

As scientific understanding grew, it increased the separation between humanity and the world around us. During the seventeenth century an orderly world emerged, as science became capable of articulating knowledge-based explanations for the workings of Nature, which had previously been attributed to an external conscious design. Innovations of technology, such as the telescope, microscope, navigation instruments, clockwork and the like, enabled scientific knowledge to expand. Newton, Galileo and others, articulated a methodical world. But along with the growth of knowledge and technics came the scientific paradigm which defined the way research was carried out.

Kuhn (1970) suggests that scientific research paradigms, while purporting to maintain scientific rigour, can become rigid mechanisms to maintain the status quo against innovation. Normal science is described as "*a strenuous and devoted attempt to force nature into the conceptual boxes supplied by professional education... it is predicated on the assumption that the scientific community knows what the world is like*" (Kuhn, *op.cit.*). Principles on which the mechanical study of physical sciences depends contributed to the process of separating knowledge and activity from its cultural and geographical groundedness.

Latour (cited in Haraway, 1993) rejected any notion of epistemological realism in scientific practice, stating rather that scientific practice is "negotiation, strategic moves, inscription, translation". Hayles (1990) is more generous and gives an example of interpretation of reality which meet the cultural and social needs of people while providing an adequate

interpretation of experience. In Newtonian times when there was belief in an understandable clockwork universe, gravity was described as the attraction between masses of different size. Later, using Einstein's theories of relativity, it was interpreted as a consequence of the curvature of space. In a totally different interpretation, there was an aboriginal belief that gravity was the Great Earth Mother calling her creatures to her. Those interpretations are very different, but would provide adequate explanation of the consequences for a person who stepped off the edge of a tall building.

The principle of *ceteris paribus*, "all other things being equal", is necessary in order to create a controlled situation in which to study a phenomenon. Standardization of laboratory or experimental conditions and allowance for variations in conditions is necessary in order to differentiate that which is studied from other phenomena or confounding mechanisms.

So, in scientific knowledge and in industrial activity, a process has been underway for centuries to place human activity and knowledge apart from nature. The fruits of the increasing distance between humanity and the physical and biological environment is the gulf between human economic activity and the control over that activity.

Whittlesey (1945) saw power concentrated in nation states. Now, power is increasingly held in globalized transnational corporations and institutions which move from country to country. They exist no where as much as they exist within computers and telecommunications networks (Henderson, 1987; Rifkin, 1991). They are not spatially grounded, but temporally grounded. Ultimately, the materials of exchange come from real places and are extracted or processed by people who have negligible control over their production and consumption.

Globalization is concerned with abstract, temporally efficient sectors of finance,

telecommunications, computerization, transportation and militarization which create or produce nothing: they facilitate exchange. Technological innovation benefits from scientific discoveries but serves economic rather than intellectual goals. These innovations increase the speed and efficiency of production, processing and distribution of real objects and materials. As well, the phenomenon "recognizes no self-limiting principle - in terms, for instance, of size, speed, or violence" (Schumacher, *op.cit.*:122).

That marks a long path along a continuum from local, placedness of people with their means of living and their integrated culture, to a situation where all forms of economic, cultural, industrial activity and knowledge have been uncoupled from one another and are considered as separate, productive or consumptive aspects of exchange. Underneath the superstructure of commodification and global networks there remains the activity which takes place on the ground and ultimately retains a connection with natural balances and laws.

The environment also has been reduced to the status of a consumer item, maintained, utilized or destroyed on the basis of economic advantage. The antinomies of environment and economy, of place and space, of local and global control over resources, as well as the movement of materials, energy and information are fundamental aspects of human-land activity. Geography, a field of enquiry admirably suited to the study of human-land relationships, should be leading the way in dealing with this. Unfortunately, geography tends to be a mirror of society in this regard. Geography as a discipline has tended to follow the split of humanist and scientific discourse. As well, major themes of geographic discourse have tended to reflect broader trends in western social and economic spheres. Not all geographic study sought to embrace model-building and strict hypothesis-testing. Running through the discipline have been other streams

of endeavour.

World Views and Conceptual Frameworks: How Can We Lose?

> "We dissect nature along lines laid down by our native languages . . . We cut nature up, organize it into concepts, and ascribe significance as we do, largely because we are parties to an agreement to organize it in this way - an agreement that holds throughout our speech community."
>
> Benjamin Lee Whorf. Science and Linguistics
>
> quoted in Lowenthal, 1968

Ability to symbolize, the capability of language to express mental constructs and the ability to alter the physical environment enable us to impose patterns on the land to suit our needs and desires (Tuan, 1971). Language is a product of cultural evolution and is composed of constructs and codes which reflect and reinforce the culture and society from which it springs (Eco, 1989; Berdoulay, 1989). Thus, our culture is reflected in the ideas, frameworks and methodologies which we use to express our environmental attitudes and activities.

Of course, all frameworks and geographic themes by their very nature are necessarily anthropocentric. There is no cultural geography from the point of view of dogs, lodgepole pines or Atlantic cod. Reflection on ideas, sharing or hoarding of knowledge, deliberate transformation of the natural landscape and accumulation of property and materials are activities carried out by human beings alone.

Derwent Whittlesey's presidential address to the Association of American Geographers near the end of World War II, "The Horizon of Geography" (1945) is only one example of this. It demonstrates clearly not only the anthropogenic but also the 'Western' stance of the world view.

Whittlesey used the term Horizon, to mean "the combined space occupied and otherwise used at any stage of human evolution [and] constitutes the realm which encompasses [humanity]'s geographic outlook at the time" (Whittlesey, 1945). He scrutinised space horizons from the most "primitive" hunter gatherers to that of mid-twentieth century concepts of space, using the context of modern technological and socio-political norms. The spatial horizon of so-called primitives was a uniform, "narrowly-restricted" environment, essentially a two-dimensional world (a timeless plane). A later period of enhanced exploration, trade and communication was said to have diversity of landscapes and repetition of forms, creating patchiness in a total environment, which he still considered to be two-dimensional.

He next identified a "Worldwide" sense of space enabled by voyages of discovery and trade which identified the unified world ocean linking continents. It was a time when "worldwide imperialism, although dividing the lands among several sovereignties, was a standing proof of the indivisibility of the ocean routes and the interdependence of all parts of the earth" (p. 11). Human settlement exhibited a stretching of horizons and vastly increased area, along with innovations of technology and methods of warfare. Braudel (1982, cited in Cosgrove, 1985) argued for this period as the defining era in the establishment of European capitalism and the growth of cities in which were concentrated financial, social and political power paid for by profits from metals, spices and luxury goods from the expanded globe. It also led to "rapid

changes in fashions of diet, innovation, change, circulation and accumulation" (Cosgrove, *op.cit*), those attributes now positively associated with progressiveness and forward-thinking.

Whittlesey then introduced a vertical dimension, empowered by technological innovation, extending below the surface and up into the atmosphere. He added the dimension of time, indicating that the concept of time was needed to illustrate the "shrinking world" as more of it became accessible. The time dimension had three parts: velocity, relating to speed (of travel, of communications), pace, "average tempo of trajections" in different areas and timing, related to synchrony of events.

Similarly, Gutkind (1956) used a series of aerial photographs to show artefactual expression of the changing interaction of humans to the environment and human landscapes, from an I-Thou to an I-It relationship. To Gutkind, shelters and structures were artifacts of a progression of human emotions and behaviour motivated initially by fear and defence. Much later behaviour was motivated by confidence and aggressiveness and human interaction with the physical and biological environment became more evident in the built environment. The diffusion of styles and technological innovation over the surface of the earth showed the increased domination over space and scale of human activity, also empowered by technology, compared to the smaller scale, inward-oriented, structures of those without advanced technology.

Turner (1980) emphasized the importance of walls as well as artificial light and heat, in the growth of cultures which were increasingly divorced from nature. The farther the built environment became divorced from the natural world, the further the ambient culture and thought paths diverged as well.

Conceptual and operational frameworks to understand the human-land relationship reflect

the culture from which they were created. Pepper's Theory of World Hypotheses (1942) presented a group of "Root Metaphors" of thought styles which he said describe peoples' understanding of the world. He suggested four root metaphors relating to the world views of so-called advanced peoples, along with two based on magical thinking. Animism, where all beings and objects are considered to be sentient and Mysticism, where there is hidden and unknowable meaning behind all activity, were considered primitive. An organicist world view presents the world as a unified, intimately interconnected whole. The formist world view sees a mosaic of varied but repeating patterns. The mechanistic world view is precise and analytical, where processes are ultimately interrelated, but can be understood and studied each in their own right. The world view of contextualism conceives of each incident, process or community within its own unique but integrated reality (see also Buttimer, 1993, for comprehensive discussion of world views and geographic thought).

Pepper's world hypotheses of so-called primitive peoples failed to acknowledge the deeply rooted empirical knowledge and appropriate cultural milieu which connected tribal peoples to their world. The constructs were based on literate, scientifically competent peoples' understanding of scientific discourse.

A framework developed by Buttimer (1993) to explore environmental experience as it relates to human thought and emotion includes categories which comprise Environmental Milieu. These were adapted to use for exploring environmental experience of officials, academics and folk in the "Human Use of Woodlands" project (Buttimer, 1992). This framework provides a means by which to explore environmental experience on cognitive, behavioural and biophysical levels. Identity relates to the "cognitive-symbolic level of human experience with the

environment; that is, self-identification and perceived relationship with the surroundings." Order addresses "the behavioural-social level, including the management aspects of life - spatial, temporal and societal". Niche represents "the bio-physical level, including the resources for economic life and defining territory and extent of movement". Expression of Identity, Order and Niche is integrated within Horizon, which connects place of rest and movement, territory and range, security and adventure, and places with spatio-temporal organization (Buttimer, 1978). It provides a more unified expression of the *genre de vie.*

This framework is quite useful in exploring the environmental experience of post-industrial, mainly urban peoples, whose thought and experiences can be compartmentalized. Environmental Milieu has varying success in comparing vastly different technology-using peoples. For "traditional" peoples, position in the natural environment and adaptation of lifestyle and resource use to available energy and material were shown to be integrated and comprehensive. The meaning of territoriality and of dwelling were synthesized into a cohesive picture. It was difficult to tease out aspects of life that could be related to cultural identity, or to social behaviour, or to patterns of interaction with bio-physical resources; biophysical activity was intimately connected with cultural identity and was maintained through social organization (Halpin, 1992).

It is difficult in geographic discourse to get away from technology-referenced concepts of culture. As well, it is difficult to conceive of "innovation" as a less than ideal attribute of humanity. This becomes critical as we enter the realm of the global environmental and economic crisis.

Rediscovery of the Environment: Sustaining Development or Developing Sustainability?

A new shift has occurred in geographic interest, again reflecting a shift in society in general. It represents interest in broader issues of humanity and the environment. Previously the increasing importance of money as the fundamental unit of exchange and value was discussed in relation to the dehumanization of work. The interest in the tensions between the environment and the economy appears also to be embedded within the economic interpretation of Darwin's "Survival of the Fittest". To some, the environment has become a new marketing tool. To others it represents an additional cost parameter for negotiation within the broader context of industry.

Fairly stark analyses have been presented about human use of resources. Hardin's article in Science in 1968 focused on the issues of population growth and scarce resources. He popularized the concept of the "Tragedy of the Commons", the basis of much resource management today. White's (1967) similar paper on ecology sounded the alarm in a broader way, calling attention to the rights, so to speak, of other species and the interrelationship of ecosystem health and our own. Carson's treatise on chemical poisoning of the world in Silent Spring (1962) survived the outrage and dismissals of conventional scientists to convince people of the dangers of technological short-sightedness in its dire consequences to the environment (Graham, 1967; Greenberg, 1963; Rudd, 1964). Schumacher's Small is Beautiful: Economics as if People Mattered (1973), George's A Fate worse than Debt (1988) and Ill Fares the Land (1985) and Henderson's The Politics of the Solar Age: Alternatives to Economics (1981) are but a few works which have addressed the crisis from the perspective of economics. They proposed that modern economic models do not operate on negative feedback stability mechanisms

but are inherently positive feedback systems leading to disequilibrium and instability.

All stated clearly that these were problems for which there is **no technical solution.** Unfortunately, business, industry and many governments have decided that there is a **management solution**. The result has been emphasis on co-management of resources, consumer oriented solutions to ecologic overconsumption problems and jurisdictional squabbles over resources.

A special issue of Scientific American in 1989 was entitled "Managing Planet Earth". The keynote paper in the special issue was also entitled "Managing Planet Earth". In that article the word "manage" (including managing, management, managers) was used twenty-six times. For example:

> "Efforts to manage the sustainable development of the earth must therefore have three specific objectives. One is to disseminate the knowledge and the means necessary to control human population growth. The second is to facilitate sufficiently vigorous economic growth and equitable distribution of its benefits to meet the basic needs of the human population in this and subsequent generations. The third is to structure the growth in ways that keep its enormous potential for environmental transformation within safe limits - limits that are yet to be determined." (Clark, 1989:48-49).

The first objective begs the question that the lion's share of resources is being consumed at an alarming rate by the industrialized nations, which already have extremely low birth rate. The second objective is simply a restating of Keynes' 1930s pronouncement that economic growth

will lead to a trickle down effect until everyone's needs will have been met. The third recognizes that its assumptions are based on knowledge and wisdom that humanity does not have, but hangs that telling phrase at the end of a long sentence about "structuring growth".

"Sustainable development" is a term which inspires hope. It meets public approval partly because it is so nebulous a term that it can mean virtually whatever is expedient or acceptable at the time. It is ultimately up to government employees or elected officials or voters to decide just what constitutes "unacceptable impairment" of biodiversity, productivity or viability.

The economy of Canada depends heavily upon the exploitation of biological and mineral materials for export. It is readily understandable that Canada would have an interest in "sustainable development". The forest sector is a good example. Canadian government publications clearly indicate that the goal of sustainable development is to sustain development within manageable limits to environmental destruction (Maini, 1988, 1994; Science Council of Canada, 1987). Forestry Canada (1990) interpreted the meaning of "sustainable development" as it applied to Canadian forest policy:

> "Sustainable development of the forests and their multiple environmental values involve fostering without unacceptable impairment the productivity, renewal capacity, and species diversity of forest ecosystems." (p. vii)

Furthermore, the "mission" of Forestry Canada included the concept:

> "To promote the sustainable development and competitiveness of the Canadian forest

sector for the well-being of present and future generations of Canadians." (p. vii)

That becomes even more necessary if one uses a definition such as that suggested by Poore (1994, p.64):

> Sustainable development of forests is the "consistent, deliberate, and sustained, yet flexible, action to maintain in a balanced manner the goods and services of the forest and to use these to increase the contribution of the forest to socio-economic and environmental well-being."

A group of experts recently convened in Canada to discuss the need to develop "scientifically based and internationally accepted criteria for sustainable forestry" (Natural Resources Canada, 1994:1). In setting out general principles for forestry, the workshop stated that these lands and forests "should be sustainably managed to meet the social, economic, ecological, cultural and spiritual human needs of present and future generations" (p.15). Of those needs, only those deemed ecological are related to the natural world, the others being human attributes and criteria. The workshop defined "sustainable management" as

> "the stewardship and use of forests and forest land in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, and vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems." (p.5)

At issue is not whether we should concern ourselves with the consequences of human industrial, economic and domestic action. Of course we must. Nor is it a question of whether we should attempt to develop scientifically based understanding of these processes. At issue is the arrogant naïveté of those who believe that there is a way to scientifically determine (and then regulate) the limits and tolerances of human activity. Furthermore, event if that were possible, it is highly unlikely that all that all the criteria and principles developed regarding "sustainable development" can adequately deal with the unpredictability and chaos of nature, let alone that of human economic activity.

Perhaps the most telling statement uttered at the seminar of experts in regard to "sustainable development" was that by D. Poore of the International Institute for Environment and Development: "... It will be surprising if there are not groups or individuals who use the argument of sustainability to further their own interests" (Poore, 1994:76).

The power and influence necessary to exert decision-making is dependent upon financial power. That power is increasingly controlled by global economic bodies. Goals of personal satisfaction and environmental integrity take a secondary importance to monetary reward in employment and economic activity in order to maintain position and "competitive advantage". In a society based on individualism and rational decision-making, internal ethical motivations for acting collectively for the common good are lacking (Hirsch, 1976), or are repressed and marginalized (Kropótkin, 1914).

> "Resourcism is a kind of modern religion which casts all of creation in categories of utility. By treating everything as homogeneous matter in search of a use it devalues all.

> Yet its most dangerous aspect is its apparent good intention. By describing something as a resource we seem to have cause to protect it. But all we really have is a licence to exploit it."
>
> N. Evernden, 1985
>
> The Natural Alien, p. 23

This position is shared by Evernden's colleague Livingston (1994). The use of what are termed "resources" and indeed the entire concept of sustainability and conservation are brought into question. Livingston also critizes the Darwinian perspective on competition and survival which is so convenient to the "Western" world view. He goes on to say that the challenge to humanity must be addressed from a metaphysical and cosmological perspective, not in terms of management and technology. This will probably not happen.

Environmental impact, social impact and resource jurisdictional frameworks reflect the current holistic view of human-land activity. They tend to be governmental and judicial responses to concerns over the non-economic issues related to "resource exploitation". They illustrate the duality and paradoxical nature of institutions and serve to highlight the dilemma facing governments in particular. They are responsible for both the exploitation and protection of material and cultural resources. While useful for problem structuring, contextual frameworks of this genre tend to begin from the basic premise of "users" of "resources".

More recently, issues are addressed more from the position of the resource as the central focus. Factors for and against activity which may destroy, degrade, or disrupt social and

environmental conditions are considered in terms of impact (Forestry Canada, 1990; Howitt, 1992). These include whether they are reversible, whether the perceived benefit of the activity is worth the adverse effects, how many people are considered to be positively or negatively affected (i.e. for the common good) and how to settle compensation for adverse consequences.

Some frameworks work from the basis of land ownership and jurisdiction. Berkes classified "administrative and governance regimes according to dominant norms with respect to ownership and access to natural phenomena (Berkes, 1989). He created an organizational table to determine control over renewable resources and natural environments. Land is privately, communally, state owned, or ownerless, over which there might be varying degrees of access. The organizational framework helps to understand the types of social mechanisms used in decision-making over resource use, such as free market, community self-regulation, administrative regulation, or legal action. Similarly, Cox derived a typological table of common-property resources, with which to structure problem-solving (1989). The framework creates hierarchies of user pool and classes of property right and nature of the resource. Cox's framework can provide a means by which the resource and users are subject to control and jurisdictions at several levels, to elucidate push and pull factors, vested interests, power nodes and long-term consequences of the decision. While such approaches are invaluable in framing the issues, we are left with the often untenable dilemma of how to resolve the problem in a way that does not rest upon economic tradeoffs.

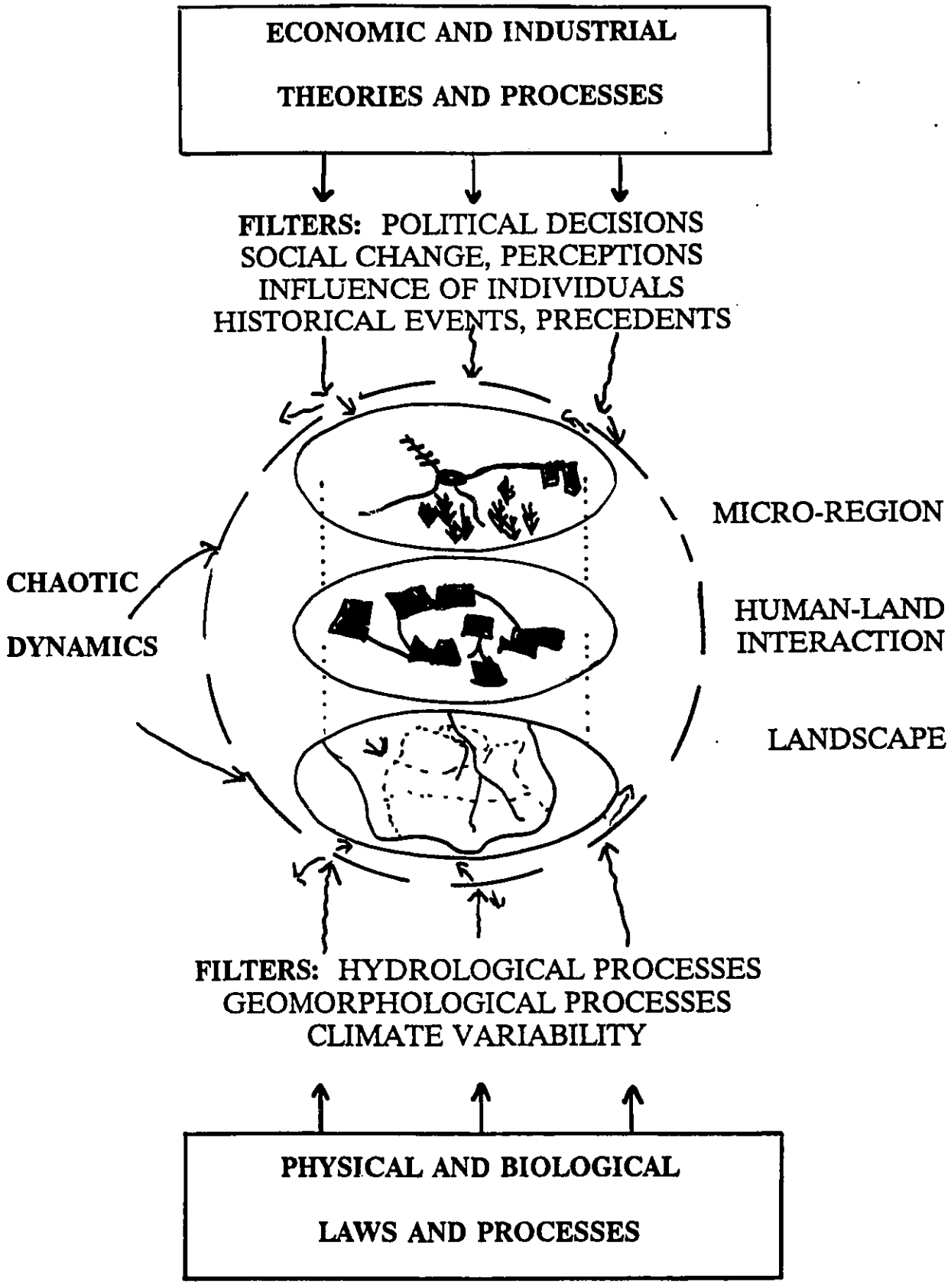
Conceptual Framework for the Winnipeg River Study

One of the stated goals of this present study is to find a way to integrate both physical/biological processes and the economic processes which drive our exploitation of materials and transformation of landscapes. Figure 1.2 provides a schematic representation of the conceptual framework of the study. It can be described easily in very general terms, although justification for using it along with theoretical background will follow.

On one hand, the physical and biological processes are at work shaping and ordering the earth. Tectonic activity over millions of hears created the landforms and relief as well the variations of materials. At the same time land has been sculpted by water, ice and wind. Materials have been weathered, eroded, transported and deposited. Life has developed in association with the energy and materials and climatic conditions. Variations result from processes which can be known, studied and understood, but which are subject to fluctuations, cycles, catastrophic upheavals, and so on. Those variations impart uncertainty to the form and structure of the earth. That is the natural world.

On the other hand economic, industrial and other processes take place, and there are models and theories which purport to know where they take place and how they should be interconnected. However, these principles may be in practice changed, deflected and reinterpreted due to other social, economic, political reasons. In the case of both physical/biological and economic/industrial theories, the arrows become weaker and less straight to represent the attentuation of the strict principle theorized, as it passes through filters of local experience or situations.

Figure 2.1: Conceptual Framework



Finally, notwithstanding the fact that one can write an equation or formulate a model to represent a process or structure, and even when the workings of a process are well understood, there remains the true uncertainty of elements working at different time scales, "unforeseen" events, technological breakthroughs, population disruption, and myriad other individually unpredictable but quite plausible events. One could imagine those two elements of figure 2.2 as the opposing parts of a vise grip exerting pressure on the entity enclosed in the vise. On the one side are the workings of the natural world, the environment, which provides the materials of existence. On the other side pressure is exerted by the mechanism of human action and control.

In the middle of the model is the earth. It is shown here as three disks representing geographic themes which are of interest in this study. The micro-region, so-called because it is a very small area in geographic terms, can be used to show overall the interdependence and meaning of the processes underway. Human-land interaction is the biophysical aspect of human activity on the land: the extraction of materials, the harvest of crops and animals, and so forth. It is subject to the requirements of the enterprise. It is also responsive to the natural dynamics of the living world, the cycles, variability and events of which are not of clockwork regularity.

The landscape is the outward observable form which shows the imprint of geomorphological, biological, climatic, engineering, undustrial and social processes. One would expect to see evidence of all sorts of activity in the form and structure of the landscape.

From the diagram of the conceptual framework and the explanation of its elements, it is evident that a variety of geographic themes and concepts are being used. As well, an attempt is being made to put together ideas from what are called "human" and "physical" geography. Following is a brief discussion of the justification for the elements being used.

The Region: The concept of region has come in and out of favour in geographical study, in large part due to the problem of defining just what a region is. A geographic region is an intellectual construct which serves to differentiate areas based upon homogeneity of certain elements of interest. There are climatic regions, industrial regions, ethnic, linguistic and cultural regions and so on. The bad reputation of the concept has arisen partly from the sometimes arbitrary or narrow choice of criteria, and from a purely descriptive approach which is often used. It may mask or marginalize critical aspects of internal diversity in favour of the central concept.

Smith (1984) said that region could "reveal the mutual interdependence of social structure and spatial form". He went on to suggest that case studies of regional issues were a means to explore a model or framework while at the same time they could be "a reassertion of the importance of that place-specific uniqueness which has always been a more sensitive reflection of actual human life on earth than the empirical regularities . . . of statistical analysis and mathematical models" (Smith, *op cit.*, p 4). The case study has suffered in popularity because of a tendency to emphasize the unique in an era when the discipline of geography has attempted to find generalizing models and to focus on spatial analysis rather than to explore the idea of place.

Nir offered a definition of region which is amenable to the present study: "the region is connected by interrelationships of social-economic-political groups in the area as well as a relationship with the attribute of the area itself" (Nir, 1990). He emphasized that regional geography is concerned with the impact of culture on landscape, and that analysis of landscape can contribute significantly to the understanding of a region. Others go even further. As the

interface between human activity and the biophysical environment, "the principal content of cultural geography becomes . . . the impact of culture on landscapes" (Norton, 1984).

Landscape Organization: Broek's Santa Clara Valley (1932) is regarded as a classic study of cultural landscape as the areal expression of human activity. Broek defined landscape (after Hellpach) as "the pure sensory impression received by observing a section of the earth's surface and the sky above it" (p. 8). The physical environment contained potential energies and material which were utilized according to the cultural stage of the human inhabitants. Broek sought to describe and "explain" the development of the area using the characteristic landscapes of a series of human settlement periods. Landscape as a symbolic, cultural and ecological entity is developed in greater detail in Chapter Three.

A natural union exists between a regional study encompassing Nir's definition of region, and one which uses landscape as a focus. Furthermore, the transformation of landscape as a result of economic and cultural activity using the resources of the area invites an approach which can explore the relevance of both biophysical and cultural influences. At the Institute for Landscape Care and Nature Protection in Germany, landscape was defined as "the total living space as a multi-layered interacting system of both the geosphere and the biosphere" and it was suggested that landscape study had "the important task of helping to overcome the tensions between modern society and its landscapes resulting from the increasing demands of industrial society and natural land potentials" (Naveh & Lieberman, 1994:7).

The tension between activity on the living, ecological level and control at an abstract, economic level is an essential component of a Marxist interpretation of geographical processes.

The increasing separation of action from control has been associated with the historical trend of capitalism "in progressively creating the world market, in continuously enlarging the perimeter of circulation, undermining the isolation of the old modes of production based in use values and revolutionizing the means of transport and communication" (Quaini, 1982, p.123).

That process is not confined to creation of the sphere of influence and network of economic activity. Reinforcement of the infrastructure, social climate and personal networks maintain and perpetuate the system (Wolch and Dear, 1989). Consequently, the research considers not only the issues of economy, culture and ecological relationships. The interconnection between institutional actors and the pressure brought to bear to maintain the land use system are important.

It is common to rest the transformation of landscape and the development of a regional dynamic on the readily identified geographic foundations: location, access to transportation technology and networks, government policy regarding economic development, along with general economic conditions (Artibise, 1984). Certainly they are of critical importance in the Pine Falls study. One could explain the presence of a pulp and paper mill near the mouth of the Winnipeg River as a locational coincidence of hydro-electric power, good water supply, secured wood supply, coupled with an exploding demand for newsprint in the early years of the twentieth century. However, those factors alone were not sufficient to get the process of economic development underway. Indeed, it will be shown that any perceived advantages of the site were certainly not enough to ensure the venture.

However, the establishment and expansion of activity is not solely dependent on what can be seen to be "impersonal and mechanistic forces" (Artibise, *op cit.*, p.209). The role of

significant individuals can be pivotal in determining whether or not activity will go ahead, or setting up all the networks and contacts to set the process in motion (Meredith. 1985). The dynamics of the paper industry in general (and the Pine Falls situation in particular) include the role of significant individuals in the transformation of landscape (Samuels, 1979). The actions of those individuals and their connection to institutions or industrial groups of power can fundamentally impose structure and direction on the continuing land use on into the future (Meredith, *op cit.*).

Spatial Entropy: A 'natural' landscape develops over time and represents an optimization of the environmental transformation of the visible forms, elements and energy flows. Slope, aspect, soil parent material, seasonal change, moisture dynamics and fire are but a few of the myriad factors which interact to create an ever-evolving natural landscape. A 'cultural' landscape develops as a result of economic, social, industrial influences. The organization of networks, the built structures, the arrangement of fields and corridors may be an enhancement of the natural attributes. Alternatively, built structures may destroy or alter, or ignore the natural dynamics.

"Environment at any instant is participation in a multitude of histories' (Wagner, 1972). One can look to the transformation of the visible landscape for an indication of the action of natural dynamics or the forces of technology, industry and human ingenuity to alter the form of landscape. The history of a landscape can be traced using old photographs, paintings, maps and by charting the position of building foundations, relict vegetation and soils, old roadbeds and stream beds, etc.

Another alternative is to use a quantitative measure of association between natural

environmental factors, built structures and energy flows and the landscape form and organization. By comparing the effect of a range of human interventions on landscape at different time periods, an interpretable measure of the degree of intervention may emerge.

Spatial entropy is a statistical measure of the association (or order) between the visible landscape and the environment of its creation. A multivariate statistical technique can be used to evaluate the degree of association between the visible landscape and the environmental factors. It can indicate the degree to which the general landscape form is organized, how closely or fleetingly specific landscape features are influenced by environmental factors, and which environmental factors are particularly important in the way the landscape is organized.

Region, landscape, spatial interaction and so on are geographic constructs, intellectual ideas on which to elucidate meaning in the world and humanity's relationship with it. One could choose from a broad range of geographical approaches and methodologies to study a spatial, locational, dwelling place issue. All could legitimately reflect what Dansereau (1975) called the essentially cybernetic interaction between the natural world and humanity.

Part III of this thesis, Chapters Six and Seven, deal with this aspect of the problem. The contextual analysis looks at the external economic, political and social situation. It attempts to understand the relationship between landscape factors and human action and the constraints which have bound them together while keeping them separate.

Prior to that, however, we turn to the changing landscape itself to learn more about the effect of human occupance. Chapter Three presents this construct which is so well suited to geographical analysis: landscape. Landscape is visible. It contains elements of climatic action,

physical and biological structures, as well as cultural, social and economic meaning, all available from the same 'scene' (Meinig, 1976).

A central value of landscape in geography, as in art, is that it displays the evidence of human activity. Built structures, networks, paths connecting other places, organization of material and energy flows and vegetation are interpretable sign posts to what is happening. They have meaning just as landforms, soils and vegetation successions express the impact of natural phenomena.

Chapter Three

LANDSCAPE

"Landscape denotes the external world mediated through subjective human experience in a way that neither region or area immediately suggest. Landscape is not merely the world we see, it is a construction, a composition of that world. Landscape is a way of seeing the world."

Cosgrove, Social Formation and Symbolic Landscapes,

1984, p. 13

In ecological terms, a landscape is "a heterogeneous land area composed of clusters of interacting ecosystems that is in similar form throughout" (Forman & Godron, 1986). Landscape ecology is a research field which seeks to elucidate the ecological structures and processes occurring at a microregional level of organization. The fundamental components include: 1) structure, the landforms, topography, climatic regimes which form the substrate for living organisms; 2) function, the interactions between organism, communities and the substrate; and 3) change through time, the dynamic aspects of the landscape, including disturbances, colonizations, resulting from slow or catastrophic changes.

The surface of the earth is the interface between human activity and the physical and biological environment. The landscape includes both natural and artificial elements. There are virtually no places in the world which do not contain direct or indirect influences of human intervention, or at least are the object of human regard. A landscape is composed of physical space, the area of interest, conceptual space, relating the use to which it is put and spiritual space, related to the mystical expression of attitude to the land (Naveh & Lieberman, 1984).

Human beings have transformed their landscapes in a conscious, meaningful way. Man's [sic] Role in Changing the Face of the Earth (1956) dealt with human occupance of land as a history of transformation using whatever tools were available and reflecting cultural, social and economic interests. Therefore, the study of changing landscape organization is a good way to have a visible, observable focus for understanding the effect of human land use.

A Landscape is Made

New landscape configurations continually emerge from a transformation of the earth's surface by natural forces and of human inhabitants. Landscape can be a dominating influence on land use, a matrix for economic activity, a setting for events, a valuable property, or may contain a host of other attributes (Meinig, *op.cit.*). A pattern or arrangement of natural and built forms could be imposed to reflect ideas or could simply be a byproduct of land use (Entrikin, 1989; Hardison, 1989; Osborne, 1988; Sörlin,1989). The dualities of emergence and imposition of landscape forms and structure speaks to Cosgrove's assertion of "landscape's dual ambiguity as the subject and object of human activity" (Cosgrove, *op.cit.*).

By natural or human agency, major discontinuities can occur where the natural regime gradually accommodates to the new situation or adapts to changes of a catastrophic scale, reaching a new equilibrium. A catastrophic natural event such as an earthquake or flood or a substantial climatic change sets in motion a transformation of vegetation, soil, atmospheric circulation regimes, etc. The environment adjusts to or recovers from the discontinuity and the landscape presents an evolving integrated image of the new regime.

Early immigrants to Canada imposed a quasi-European landscape on southern Canada (Osborne, 1988), to create an image of "a landscape of productivity". It contrasted to the natural forested landscape of much of Canada, which was perceived by European immigrants as not only untamed, but underutilized.

"Landscape constitutes a significant level of analysis, since it is embedded in a physical geographic logic which intersects traditional specialties (geomorphology, climatology and biogeography) which have their own ends and techniques" (Berdoulay, 1989). Further, landscape is charged with meaning, is a living thing. It exhibits links between the materials and the structures which give it meaning (Berdoulay et Phipps, 1985).

The most irreversible, most dominating human transformation of landscape have occurred under the influence of western industrialized countries which embraced wholeheartedly the principles of materialism and technological magic. Structures and networks are imposed not only to carry out purposeful activity, but to impose visible symbols of the "vision" and sensitivities of the people (Sörlin, *op.cit.*). Technology-assisted human transformation of landscape can be sudden and massive and tends to be ongoing once set in motion.

According to Hardison (1989) and to Guha (1989), landscape has become a consumer

item, defined by the culture of the observer. History and geography have essentially "disappeared", leaving a post-modern landscape defined in terms of technology and art. Hardison articulates the landscape in reference to human artistic sensibility:

> "The dual-land highways of the American interstate system can be recognized as the most majestic linear sculptures created in human history, far surpassing in size, conception, and engineering the Great Wall of China. Seen from the air they create grand reticulations, making the flat places of the earth look like huge Mondrian paintings. Seen from the ground they segment and order the landscape. Perhaps they should be understood as picture frames because they make pictures out of what would otherwise be disordered and undefined. . . . the gentle grades, sweeping curves, and graceful bridges of the Interstate assert the triumph of man over nature."
>
> (Hardison:137).

There is no clearer example than this of the extent to which 'landscape' has become an external element, subject to the ideas and planning process of humanity.

While landscape seems to have become a cultural symbol, it continues to resonate to biophysical, functional and economic values. The changing landscape retains clues to the ambient conditions of its formation and evolution. The changes tell the tale of all the contributing features of its existence. They should be seen as much for their projection of future dynamics as for the historical or contemporary meaning.

Human land use, particularly where the land has been altered significantly, has a powerful

affect on landscape transformation. Physical changes are traditionally within the realm of physical geography, community life is cultural geography, while *genre de vie* may be resource management, regional science, or economic geography, depending on training or disciplinary grounds. But they must all be intertwined to provide a composite picture of what is happening at the microregional level of enquiry. It is at the level of landscape organization that one can evaluate the effect of economic control on ecologic vitality.

Sequent occupance was a geographical model which arose in the 1930s, reached its peak in the 1940s and disappeared as a conceptual methodological tool by the mid 1950s (Mikesell, 1976). A central theme was regional/landscape transformation through internal evolution or through specific stages in a process, which were "imposed" on the basis of transportation networks, agricultural practice, communication, etc. Broek's Santa Clara Valley study certainly falls within this purview. The Santa Clara Valley study of 1932 looked at patterns resulting from the interaction of physical nature of the land and the character of the people, catalysed by external influences.

Broek related a contemporary school of thought which considered landscape or environment to be analogous to an organism, where the biological meaning of organism is "a well-defined unit". He rejected that analogy as inappropriate for land use systems in the Santa Clara Valley. It would not work in the social sciences where the subject is not a well-defined entity. That is, the landscape is always a construction of the research problem and every change results from external influences. He cited his own study where outside factors, including the succession of various peoples, the discovery of gold and the building of the trans-continental railroad were all external, not related to inherent development.

Broek elucidated landscape change by explaining the succession of cultural groups in the valley. Human settlement patterns and land use regimes were seen to be primarily manifestations of cultural advancement or succeeding occupants and external events. They were explainable only by interpretation of underlying causes.

He was searching for an objective methodology to associate the areal forms which develop as a result of human activity. Physiography dealt with natural forms and could provide rigorous scientific explanations about landforms, areal arrangement of land and water, and successions in vegetational and animal communities. Human geography, however, in searching for causal relationships between human activity and the environment, could not avail itself of objective, scientific methodologies. An explanation of landscape forms could arise from understanding why the landscape transformations occurred as they did, even though the explanation might consist of further descriptions of underlying causal factors.

The form of the analysis related human modification of landscape to technological, economic and cultural advancement, which he called "the character of the people". The stages of landscape development were a) primitive, as the "white man" found it; b) a Spanish-American period of missions and *encomiendas*; c) an Early American period, of conflicts between ranchers and grain farmers and the introduction of horticulture; and d) the early twentieth century, where irrigation and water management were important controlling factors. The Santa Clara Valley study used the landscape forms as visible manifestations of progressive stages of human cultural, economic, technological and social development. These were interpreted as representative stages or endpoints of an evolutionary process.

That reflected the three fundamental cornerstones of the formation of cultural landscape:

1) the physical environment; 2) the character of the people (which Sauer called "racial stock" but which I take to mean the value system, world view, environmental and economic practice); and 3) time.

The physical environment was considered to be of fundamental importance for "it supplies the materials out of which the cultural landscape is formed" (Sauer, 1924). That may have been the case in 1924 for some cultural milieux. It certainly is not the case now and it was not case in industrial landscapes even 1925. Long distance transport of materials and energy was a fact of life. The concept of "emergence" of landscape, the "coming up into view, especially when formerly concealed" may have semantic meaning, but as a practical concept it is not at all accurate in reference to twentieth century North American landscape.

The other aspect of the cornerstone of the cultural landscape school which needs interpretation is that of time. It is a necessary component of a process. In historical geography, landscape is a palimpsest. Layers of meaning may be stripped off to show past land use. A regional study in geography incorporates time to understand and interpret the changes in the regional as its character develops.

However, structures are not left behind: they are placed in front of us, in our path. They impose structure on the future. Landscape forms are beginning points as much as they are end points. The structures and network nodes constrain the functions of the place, imposing constraints on the future. The present study sees the landscape forms not as endpoints in cultural states, but as initialized forms of constraints on future activity in the area.

Landscape as a System of Interacting Elements and Energies

One way of incorporating various diverse elements which encompass a landscape is to think of it as a system. Advances in particle physics, a scientific discipline which is concerned with extremely small scales of matter and energy, led to the realization that at every level of observation it is not matter but organization which is the important factor (Morin, 1977; Prigogine & Stengers, 1984; von Bertalanffy, 1968). Both non-living and living systems are open systems which continually exchange matter, energy and information with the surroundings. There is organized complexity at all levels of the hierarchical structure of the universe.

Classical physics is concerned with matter, and with linear causality, stability and permanence. A small number of generalizing laws and principles "explained" a vast range of astronomical, terrestrial, biological phenomena within a world view of clockwork determinism. Quantum mechanics and relativity introduced stochasticity and time to account for the variability observed in real-life situations (and even controlled laboratory conditions).

Biological, behavioural and social relationships cannot be reduced to the lowest level of the constructs and laws of physics. von Bertalanffy (1968), a pioneer of general systems theory, attempted to reunify scientifically the study of quantifiable phenomena with qualitative analysis. While disciplinary fields and research methodologies impose restrictions on the level of enquiry, the unifying principle of organization exists at all levels. A general theory of systems would integrate the natural and social sciences. It could facilitate development of theoretical rigour in the inexact sciences.

Scientists' conception of what an environmental system is strongly influences the way

they perceive that system. For convenience of analysis, one assumes that the dominant elements of the system operation have been identified, isolated and measured. Fluctuations caused by external influences and factors not included in the model are treated as "error terms". Those include experimental error, observation error, random fluctuations and all factors of the larger system of which the element of interest is a part.

There is a tendency to erect complicated mathematical and statistical models to explain the workings of systems. Couclelis (1988) suggested that complexity of interrelationships is mistaken for complication. She presented a simple experiment to demonstrate that complex behaviour can result when quite simple models or constructs are used. The program modelled the dynamic way in which rodent populations formed patchy distributions within a small area, all depending on the initial conditions. Holling identified similar distribution patterns regarding resilience and stability in ecosystems (1976, cited in Naveh & Lieberman, *op cit.*). The patchiness of distribution was attributed to the interplay between stability in the face of minor perturbations and resilience, to maintain functioning in far-from-equilibrium conditions.

The same response was found in animal populations, where wild fluctuations in populations were related not necessarily to sampling error or environmental unpredictability, but to the broad range of solutions to a simple, rigidly deterministic chaotic process (May, 1976). It is in essentially healthy organisms and systems that unpredictability and irregularity occur. Alternatively, more regular and accentuated periodicities are indicative of disease and aging (Goldberg *et al.*, 1990; Atlan, 1974).

A formal definition of organization was developed by Atlan. Optimum organization is a compromise between maximum information content, seen in variety of structure and maximum

redundancy, in order to maintain or re-establish function during times of instability (Atlan, *op.cit.*). Organization was defined by three parameters: information content, which has structural meaning; functional reliability, enabling the system to resist noise producing factors; and redundancy, which has structural and functional characteristics, because structural redundancy helps to ensure reliability. The accumulation of "errors" in a system could lead to either greater autonomy or to destruction or little overall change.

A family of theories based on self-organization address the process of reorganization and change of complexity initiated during far-from-equilibrium conditions. Adaptability Theory says that dynamic living systems are multi-functional (Conrad, 1986). What is selected as a viable adaptation changes during the course of evolution. An innovation which succeeds in one circumstance initiates a structural evolution of that function. Selection is based on random fluctuation and chaotic behaviour, not a deterministic pathway of natural selection. Catastrophe Theory (Thom, cited in Naveh & Lieberman) describes processes which are stable up until thresholds are reached, beyond which behaviour becomes unpredictable.

A self-organizing system appears to be adapting to its environment, but only because the innovations which are coincidentally appropriate to the current environment are successful (Atlan, 1974; Conrad, 1986). Later, the same random noise-producing effects are responsible for the aging and death of the system, once its redundancy has been exhausted.

Differences Between Natural and Artificial Systems

System transformation due to random fluctuations and interactions may be extremely stable and regularly structured, or they may be ephemeral and related to continued energy input (Atlan, 1979; Nicolis & Prigogine, *op.cit.*). Similarly, simple deterministic causes may lead to stable, unstable, periodic or wobbly results in system organizations, including landscape systems (May, 1976; Couclelis, 1989; Stewart, 1989; Henderson, 1987; Phipps, 1989).

The capacity of humanity to intervene in many ecosystems has the potential for significant impact. Intervention in natural systems imposes constraints on the ecosystem and, significantly, imposes constraints on the human system itself. The created structures tend to limit opportunities for further reorganization and require continual maintenance at simple levels of complexity.

A thermodynamic model of an industrial or economic system could be described in terms of sequences of steady state conditions, continually increasing productivity (Bennett & Chorley, 1978). Far-from-equilibrium conditions in all facets not included in the model must be perpetuated in order to be maintained (Nicolis & Prigogine, 1984). A similar view was voiced by Kuhn (1974, cited in Bennett & Chorley:533):

> "Human effect on the environment has been to produce a highly constrained uncontrolled system rather than a controlled one. [Humanity] has an important and dominant conscious effect on the whole system, but this is quite different from controlling the system."

The terms order and organization are often used interchangeably. However, in

comparing natural and artificial systems, one can make a distinction that is not semantically trivial between complexity and order of natural versus anthropogenic land systems. Table 3.1 highlights factors of system organization/complexity from the perspective of a natural process and an anthropogenic one. One can envision landscape mosaics which show these attributes.

Table 3.1: Contrast Between Self-Organization of Natural and Reordering of Artificial Landscape Systems (adapted from Atlan, 1974)

"Natural" System	"Artificial" System
Emergent Self-organization	Imposed Order
May appear rigidly structured, patchy or disorganised	Structured and controlled
Complex interrelationships	Simplified structure and function
Untightening constraints at one level creates functional complexity at a more integrated level	Untightening constraints and substitution of structural and functional order
Potential for greater diversity and resilience	More integrated, usually less complex
Creation of Meaning: System in equilibrium is logical and efficient	Creation of Structural and Functional Constraints
Subject to random fluctuations, dynamic interactions of myriad factors, "butterfly effect"	Maintenance of intervention through material, energy and information inputs to maintain system in response to random fluctuations, dynamic interactions and "butterfly effect"

A natural landscape system is self-organized by adapting or adjusting to random fluctuations. Untightening the structural constraints at one level may create functional complexity at another more integrated level. It tends toward greater diversity and low redundancy; elements migrate to evolve to fill up all available niches.

On the other hand, in a landscape system dominated by artificial elements, loosening constraints is followed by substitution of structural and functional order from outside the system. The system may become more integrated and hierarchical, where different levels of subsystems are connected to the regulating control of a higher level (François, 1983). There is a tendency toward low diversity and low natural resiliency.

Natural ecosystems are restricted to "capturing, mobilizing and controlling only a small and geographically restricted portion of the energy and matter with which [they] come into contact" (Bennett & Chorley, *op.cit.*). Alternatively, industrial and economic systems are perceived to be more robust, because technology is used to transport materials and energy on a large scale, in an ordered fashion. They are considered to be less restricted by limitations of available energy and matter.

Natural systems do tend to be dominated by stable negative feedback loops producing homeostasis. There is a tendency to self-maintenance, rather than to the continual growth expected by human intervenors. However, manipulation of anthropogenic systems, because of managed flows of energy and information, may lead to considerable consequences besides those consciously imposed in order to channel productivity. The constraints on the system to maintain uniform productivity (or, in industrial and economic systems, to continually increase productivity)

cause imbalance and perturbations down-stream. The disorganizing ambiguities can be serious. They tend to be of protracted duration and often involve structures and materials (chemical, biological) which are beyond the capacity of the natural system to adapt. Modern economic models do not operate on homeostasis. They are inherently positive feedback systems leading to disequilibrium and instability (Henderson, 1987; Schumacher, 1973).

It is the difference in complexity and order between natural and anthropogenic landscape systems which is of interest in this study. An increasingly destructive imbalance is fostered by building the exploitation of the environment on a foundation of competition. The emphasis on competition and growth are often in direct opposition to environmental system attributes of interaction and self-maintenance.

Landscapes resonate to natural and well as ordered influences. If land use activities do have an impact on the landscape, that impact should be apparent. One would expect that the natural ordering of a landscape would decrease in time. Management techniques and energy-subsidized activities impose a new order on dynamics which previously were consistent with available energy and which were subject to random variation.

It is here that the derivation of spatial entropy will be valuable in demonstrating the changing complexity and structure of the landscape in the study area. A sense of the organization of landscape under various land use regimes does not explain the structure. However, it can provide a base on which to interpret changes with respect to human interventions on land which was essentially homogeneous in organization at the beginning of the twentieth century.

The procedure is concerned with two spaces. One is the environmental or ambient space

of influencing, constraining or determining factors. the other space is that of the visible landscape; the vegetation communities or built structures which appear on the surface. Their location results from self-organization (expected on the Reserve lands) or as a result of conscious management (agricultural and forest management licence lands). These spaces do interact. . . "car ce sont ces deux espaces ensembles et leur relation qui definissent le paysage" (Phipps, 1993).

Chapter Four

Information Theory

"L'ordre était la notion qui, en écrassant toutes les autres, avait écrassé aussi l'idée d'organisation. Aprés les surgissements du désordre et les premiers reflux de l'ordre, nous avons vu enfin l'interaction devenir idée centrale dans la physique moderne."

(Morin, 1977, p. 94)

A means by which the organization of a system can be studied is Information Theory. Information theory is rooted within thermodynamics and statistical mechanics and the concepts of entropy and disorder (Kullback, 1959). In thermodynamics, entropy is a measure of the dissipation of energy no longer available for work. Boltzmann used the concept of entropy as a measure of probability of a molecular distribution (Lebowitz, 1993). These concepts are discussed below as an appropriate analogy to study the spatial entropy of a landscape system.

The beginnings of information theory in statistics can be traced to R.A. Fisher, who proposed a probability function to measure of the amount of information supplied by an unknown parameter. Here, entropy is not related to consumption or dissipation of energy, but is a neutral

statistical measure of the equiprobability of events and the tendency toward elemental disorder (Eco, 1989). It is used to measure order and disorder.

Information theory was refined by Shannon and Weaver and by Wiener to address structural aspects of information. Called communication theory, it was applied in engineering to transmission of unambiguous messages through a channel (Blahut, 1987). Communication theory provides many of the important mathematical functions used to identify order and disorder in a system. Structural order and redundancy are the important factors, where the goal is to reduce the ambiguity of a transmitted message. They provide a code of structural and grammatical rules which govern language and the organization of messages.

The rules of language reduce the ambiguity of the message transmitted, but also limit the amount of information transmitted (Eco, *op cit.*). The difference between "information" and "meaning" is that new "significant" information is created when a message violates the rules of the code and introduces elements of disorder and innovation. That leads to restructuring of the code and to creation of a new set of rules.

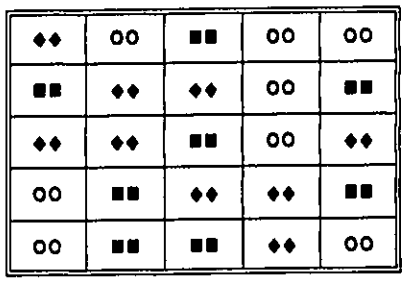
In life, a decrease of entropy against the gradient of maximum probability is a clue that an energetic process is at work. Most organic processes result in a decrease in entropy (an increase in organization). The significance of Boltzmann's "redefinition of entropy as a measure of the probability of a molecular distribution [is that] it implies that wherever we find an improbable molecular assembly it is probably life or one of its products . . a distribution which is sufficiently different from the background state to be recognizable as an entity" (Lovelock, 1979:34).

Furthermore, differences in the level of organization and the appearance of contradictory yet clearly ordered arrangements is evidence of human intervention in the system.

Mathematics of Information Theory

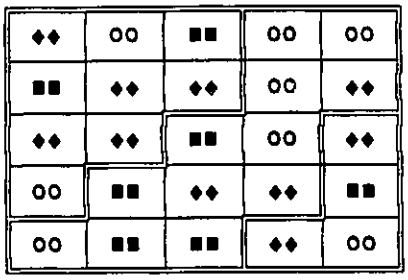
A and B are two areas each containing 25 cells, of three different states, as indicated. Those states might represent three different land use systems, such as cropland, hayland and pasture. However, Area B, with the same number of patches, has a constraint on the reorganization of states. Those constraints might be a variation in soil type or topography which makes the cell more appropriate for a particular kind of land use. The rearrangement of patches is constrained by the soil type or topography, increasing the degree to which the landscape is ordered.

A1



S_0 ♦♦ = 9
OO = 8
■■ = 8

B1



S1 ♦♦ = 7 S2 ♦♦ = 2
OO = 3 OO = 5
■■ = 3 ■■ = 5

Information theory offers a valuable mathematical and statistical framework with which to study the structure, form and development of geographical landscapes. Because it uses probability distributions or frequency counts, it is an appropriate way to deal with combinations of discrete, continuous and categorial variables. Phipps (1981, a&b) provides an introduction to the concepts and parameters of information theory, from the point of view of the statistical meaning as well as Boltzmann's formulations and their appropriateness to study of landscape organization.

Entropy

The probability of occurrence of an event or state can be estimated from its relative frequency after a series of trials:

$$p_j = \frac{f_j}{N} \tag{1}$$

The information quantity contributed by a trial, ε_k is equal to minus the natural logarithm of the probability of the outcome produced by the trial:

$$e_k = \ln \frac{1}{p_j} = -\ln p_j \tag{2}$$

The information value of events depends on the probability of the event. Rare events contribute a large quantity of information, due to low probability. Relatively common, expected results contribute very little information, but do contribute to the overall redundancy. Over a series of trials, the amount of information gained for each outcome is:

$$\lambda_j = -(f_j \cdot \ln\frac{1}{p_j}) \tag{3}$$

The occurrence of each outcome is determined according to the probability associated with that state. If there is no control apart from their individual probabilities, the freedom to take any state is called the entropy. Entropy is the statistical measure of the maximal equiprobability allowed by the system:

$$H(U) = -\sum_{j=1}^{m} p_j \ln p_j \quad (4)$$

Equation (4) is the *a priori* (initial) entropy of the system, the uncertainty based on the relative frequency of each state of the variable U in the system. Additional information, or factors which impose constraints on the system, limit the freedom to assume different states. Each piece of information in addition to U serves to refine further the constrained order of the system.

Additional information always decreases the average uncertainty.

$$H(U|A) \leq H(U) \quad (5)$$

where A is additional information which could influence the order of the system.

Mutual information:

Mutual Information is a measure of order. By subtracting the residual uncertainty H(U/E) from the initial uncertainty H(U), one arrives at the amount of information about the system:

$$I(U|A) = H(U) - H(U|A) \quad (6)$$

Mutual Information is symmetrical. In landscape organization, knowledge of the constraining factors can be used to predict the land use pattern. Knowledge of the land use pattern can be used to make predictions about the underlying physical constraints (Davis & Dozier, 1990). In land use analysis, Mutual Information is most useful in evaluation of ecological order of an environment.

Mutual information is evaluated by a cross-tabulation of the effects of channel subsets. The test of statistical significance of mutual information is a modification of the X^2-test, called Kullback's criterion, or the log likelihood ratio, where:

$$\xi = [2.N.I(U,A)] \sim X^2(with(n-1)(m-1)df) \tag{7}$$

Redundancy:

A related function is Redundancy. It is the ratio of mutual information, I(U/A), to the initial entropy, H(U).

$$R(U|A) = \frac{I(U|A)}{H(U)} = \frac{H(U) - H(U|A)}{H(U)} \tag{8}$$

In landscape analysis this measures topo-ecological order (Phipps *et al.*, 1986a). As constraining factors are introduced to the probability model of the system, the entropy decreases and redundancy increases.

However, there is a point beyond which more information does not significantly decrease the entropy of the system; that is, there is no further influence on the outcome. The entropy at that point is H(U/A), the *a posteriori* (final) entropy, the portion of uncertainty remaining after information due to other factors has been accounted for (Phipps, 1981a; Blahut, 1987).

$$H(U|A) = -\sum_{j=1}^{m} p_{j|k} \ln p_{j|k} \tag{9}$$

Spatial Entropy in Landscape Analysis

An alternative formulation which is well suited to landscape analysis is that derived by Boltzmann to model the movement of gas molecules in an enclosed space. While expressed in a different manner, it represents the same statistical relationships as the previous method. It makes use of frequency counts of outcomes rather than probability of outcomes. Boltzmann's thermodynamic equilibrium probability equation measures the ratio between the macroscopic state of the system and the microscopic configuration of the constituent molecules or elements. The freedom to rearrange into different configurations is a function of permutations:

$$W(U) = \frac{N!}{f_1 f_2 f_j \cdots f_k} \tag{10}$$

where N = total number of elements and

f_j,1,...k = the frequency of *j* outcomes in *N* elements

Entropy, **H**, or uncertainty, is proportional to ln**W**(**U**):

$$H(U) = k* \ lnW(U) \tag{11}$$

where k* = Boltzmann constant. In landscape analysis, it is the reciprocal of the number of elements, 1/N.

Where there are constraints, such as soil type, slope, elevation, etc., one first calculates the total possible number of arrangements within each group, **n**, using, for **i=1,n**:

$$W_i(A) = \frac{f_i!}{\prod_{j=1}^{m} f_{ij}!} \tag{12}$$

Then, for the total area A:

$$W_B(A) = \prod_{i=1}^{n} W_i(A) \tag{13}$$

and the entropy is

$$H_B(A) = \frac{1}{N} \ln W_B(A) \qquad (14)$$

This formulation is particularly appropriate for landscape analysis, where one is interested in spatial entropy and its relevance to ecological constraint (Phipps, 1981). Returning to the example introduced above, it is now possible to demonstrate the different situation if the land use is rearranged in the two areas A and B. In A_2, the crop, hay and pasture fields can be freely rearranged within the 25 possible sites. In B_2, however, the fields can be rearranged only within the areas of the two constraining landscape features.

A2

■■	♦♦	oo	♦♦	■■
oo	oo	■■	oo	♦♦
oo	♦♦	■■	oo	♦♦
■■	oo	■■	♦♦	■■
♦♦	oo	♦♦	■■	♦♦

B2

oo	■■	♦♦	■■	oo
♦♦	♦♦	oo	♦♦	oo
♦♦	■■	oo	■■	♦♦
■■	■■	oo	♦♦	■■
oo	■■	■■	oo	♦♦

Each set has 25 units. A S_0 ♦♦ (e.g. crop) = 9; ■■ (hay) = 8; oo (pasture) = 8.

The freedom of A, with the set of S_0 cells of 3 types, to rearrange, is found from the permutations, that is:

$$W(A_{S_0}) = \frac{25!}{9!\,8!\,8!} = 2.62931 \times 10^{10} \quad (15)$$

and the Entropy is

$$H(A) = \frac{1}{N} \ln W(A) = 0.959 \quad (16)$$

In B, there are also 25 cells and the same number of each of three categories. However, a constraint has been introduced so that the spatial pattern can only be rearranged within the boundaries of the two sets. That is S_1 has 13 cells, with ♦♦ = 7; ■■ = 3; ○○ = 3. Set S_2 has 12 cells, with ♦♦ = 2; ■■ = 5; ○○ = 5.

The total number of constraints for this arrangement is

$$W(B_{S_1}) = \frac{13!}{7!\,3!\,3!} = 34{,}320 \quad (17)$$

$$W(B_{S_2}) = \frac{12!}{2!\,5!\,5!} = 16{,}632 \quad (18)$$

The entropy of B is found from

$$H(B|S) = \frac{1}{N}\ln(W_{S1} \times W_{S2}) = 0.81 \quad (19)$$

Use of PEGASE Procedure

PEGASE (Partition d'un Ensemble Géographique pour l'Analyse Spatiale Ecologique) is a computer program which performs mutual information analysis (Phipps, 1981a). It creates a hierarchical, divisive arrangement of landscape units based on combinations of constraining factors and it models the observed landscape. The program follows a step-wise reduncancy-maximizing procedure in order to find in the matrix of ecological and economic factors, **E**, representing the environment, the best predictor of **U**, the pattern of land use categories.

In the first step, all independent characteristics are tested against the community types distribution. Mutual information and other statistics are calculated for each case. Following that, the initial set is divided into sub-sets depending on which characteristic provided the highest mutual information, i.e., the characteristic which most significantly influenced the distribution of the community types. At each succeeding step, the most significant characteristic identified determines the split of subsets at the next level.

The program continues until one of three stopping rules intervenes:

1. when the number of cells in the subsets is fewer than the minimum number required for statistical validity and is usually set at 30; or

2. when the entropy of a subset has reached a value where the community type is considered to be determined adequately; or

3. when subsequent processing does not significantly decrease entropy.

The procedure requires large data bases. This is to ensure a large enough number for the program to continue for a reasonable length of time before stopping rules intervene. As well, a large amount of information permits a clearer spatial division related to the distribution of community pattern elements.

Each factor contributes to the negentropy of the landscape. The data set is divided into subsets according to levels of the most significant factor. However, at succeeding divisions, other influences come into play. Interpretation of the way the environmental factors fit together leads to understanding of the integration of various attributes in creating a landscape unit. For example, in an application of PEGASE to study the ecological order of a forest in a hilly area, the dominant factor was elevation. At the higher elevations, the direction of slope was the next most critical factor, while at lower elevations, depth of overburden was dominant (Phipps, 1981a, 1981b).

Applications:

Landscape ecological research and the various methods and conceptual tools serve a variety of purposes. Many of the objectives of landscape analysis deal with "management", including land use capability, regional landscape classification, ecologically based land use and design (Naveh & Lieberman, 1984). Some analyses study the topo-ecological order of

landscapes. In the case of "natural landscapes" the goal is to elucidate the underlying physical and climatic factors which influence the organization of the vegetation community (Phipps, *op.cit.*). Davis & Dozier (1990) used Mutual Information Analysis to derive an ecological land classification of an area in California. Land classifications can be used to inventory lands for future "sampling", or for resource mapping, habitat assessment or impact analysis.

Mutual information analysis has been used to determine the topo-ecologic order of agricultural landscapes, incorporating physiographic factors, time and proximity of urban areas. Phipps *et al.* (1986a) studied the link between topo-ecologic order and economic performance of rural landscape under different land use regimes. A 27,000 ha. area near Ottawa was sampled from soil survey maps, soil capacity surveys and soil utilization maps. The analysis studied the use of land on till, post-glacial moraines, eskers and deltas. A related study (Phipps *et al.*, 1986b) used a diachronic approach to explore the change in agricultural land use due to proximity to urban area. The topo-ecologic order at three time periods was compared for one landscape subset (or landscape form) less than one kilometre from the urban area and one farther away. The statistics generated by the mutual information analysis were plotted graphically to show the relative change in the proximal and distal sites.

Dewez *et al.* (1984) used Mutual Information Analysis to study distributions and characteristics of White River Ash deposits in the Yukon. Mutual Information Analysis has also been applied to frozen ground phenomena, (palsas, etc.) in Northern Quebec (Lagarec *et al.*, 1984).

Intensity of agricultural land use and cropping in three areas of Canada were studied to determine the relationship between soil factors and land use (Dumanski *et al.*, 1987). They found

that in addition to the environmental influences on land use, economic factors are important. Depending on the intrinsic value of the soil association for intense land use, investment was an important method on enhancing the use of the land. In all cases, land use to take optimum advantage of the natural attributes of the soil.

Factorial Correspondence Analysis

Through successive iterations PEGASE develops a hierarchical division according to the active variables of the ecological environment and management regime which most reduce entropy. However, it is also important to understand the relationship between broad classes of active variables in their influence on overall landscape organization.

L'Analyse Factorielle des Correspondances (Factorial Correspondence Analysis), developed by Benzécri (1973) is a good method for this task. It is appropriate for use with qualitative variables and can show structures which are not necessarily linear (Benzécri, 1992; Sanders, 1989). The factorial correspondence procedure also creates a hierarchical organization of information from contingency tables (Legendre & Legendre, 1979).

This part of the analysis follows that of PEGASE which creates the hierarchical arrangement. Each of the terminal subsets produced by the iterative program consists of a group one or more of the categories of interest, in this case the land use forms. The procedure finds the best path through a scatter plot of the values in a contingency table, calculated not from least squares distance (quantitative data) but using Chi^2 distance (appropriate for non-quantitative indicators of classes of information). Using the scatter plot, the relative distance of points from

one another and from the landscape indicators shows the strength of their association. Close proximity indicates a strong correspondence.

In a genre of work subsumed under the term Numerical Ecology, correspondance analysis can be used to study clustering of species according to environmental factors (Gower, 1987). It was used to investigate differences in settlement characteristics of French and English in eastern Ontario and western Quebec (Langlois *et al.*, 1993).

The Winnipeg River Study

In the present study, PEGASE is used to evaluate the effect of natural (ecologic) and human (economic) factors in landscape change and organization. For the purpose of the empirical study three sub-regions, corresponding to three different land use regimes, have been chosen for the information analysis. As indicated in Chapter One, the land use regimes are: **RES**, the lands belonging to Sagkeeng First Nation, centred on Fort Alexander; **FML**, the Forest Management Licence area of the Abitibi-Price pulp and paper mill at Pine Falls (now called the Pine Falls Paper Company in its most recent form); and **AGR**, the other areas, mostly used for mixed agriculture.

Figure 4.1 is an air photograph taken in 1924 of a portion of the lower Winnipeg river centred on the present location of the Pine Falls Generating Station. There was little differentiation of land cover at that time. The built and ordered landscape was at that time confined to the small farms cleared along the river. Another artefact of industry cannot be seen but a small channel was opened at the edge of the falls in the 1870s. The channel was used to

reroute water to drive a sawmill. The enterprise failed due to inability to control the yearly cycle of discharge. Since then, profound changes to the visible landscape have occurred.

Figure 4.2 was taken in August of 1962 in the same area. It shows substantial change. Pine Creek has backed up. Large log booms enclose pulpwood destined for the paper mill. A network of roads and the hydro-electric dam are in place. They both reflected and encouraged settlement and industry on both sides of the river. While the areas at a distance from the river still are forested and appear unaltered by human activity, an enlarged agricultural area is evident.

Finally, a composite image from 1983 (Figure 4.3) clearly illustrates the humanized landscape of the area. Wood is no longer transported on or stored in booms in the river; the road network has taken over that function. Large sections of land have been cleared and are evident in the checkerboard appearance. Housing developments and the road network have been extended. the streams contiue to adjust to the higher water level imposed in 1951.

Changes can be seen in the visible landscape. Can these changes be explained more meaningfully? The use of Information Theory in this instance is twofold. It will be used to elucidate the extent of and differences in landscape organization under the three land use regimes, compared to the "natural" or "unmanaged" regime. It will seek to evaluate the extent of changes in this organization over a period of fifty years in the forest management lands and thirty-five years in the case of agricultural land. A variety of land management practices support the specific economic activity carried out on the Forestry land and on land used for agriculture. These include drainage of peatlands, using artificial drainage ditches; construction of roads and bridges to increase access for harvest and management; planting preferred species, both on the FML and on agricultural plots; settlement, in all three areas.

Figure 4.1: Air Photograph of falls on Winnipeg River, October, 1924. FA66 - 67, October 7, 1924. Used with permission of National Air Photo Library.

Figure 4.2: Air Photograph of former falls on Winnipeg River, August, 1962. A17626 - 5, August 25, 1962, used with permission of National Air Photo Library.

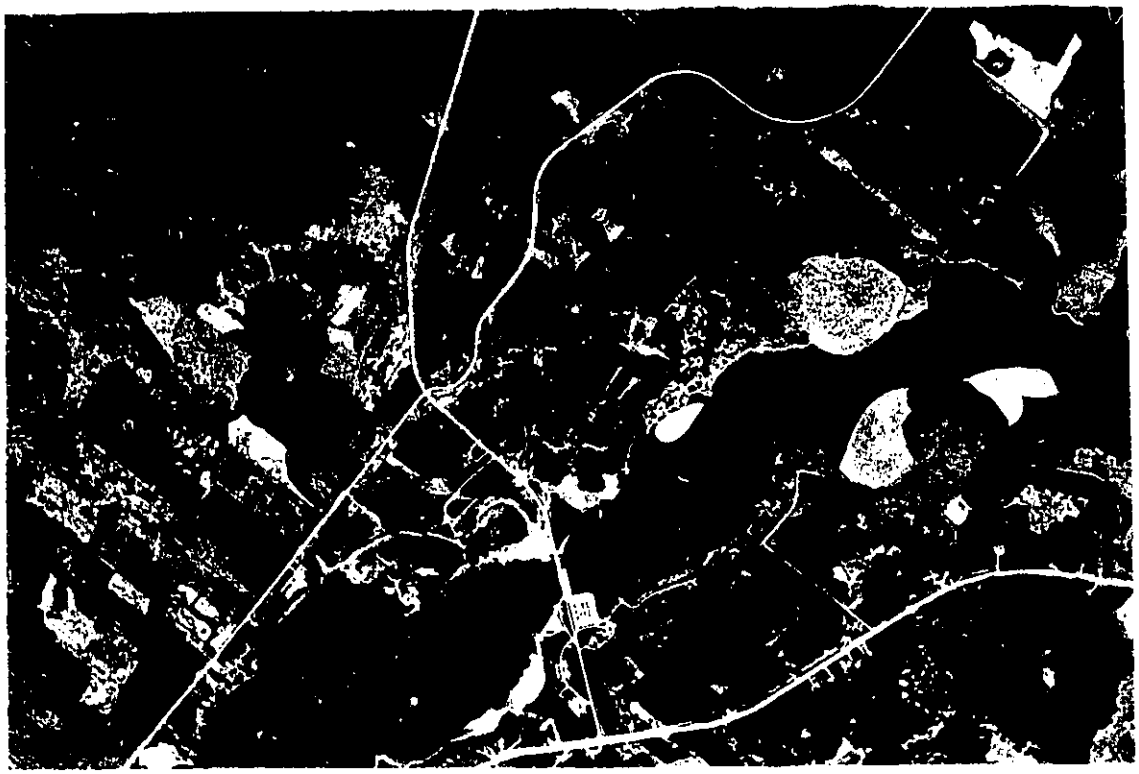
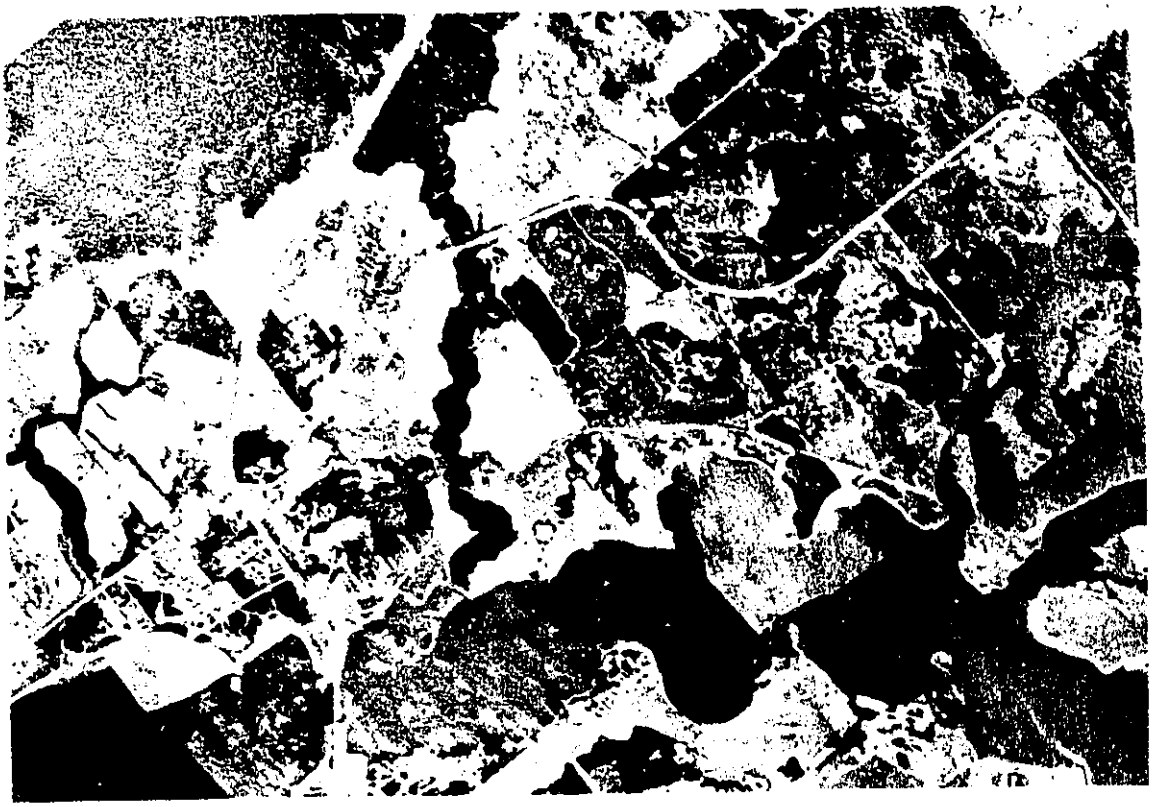


Figure 4.3: Pine Falls Generating Station portion of air photo mosaic of Township 18 Range 10E Forest Inventory for 1983, courtesy of the Manitoba Air Photo Library.



Chapter Five

LANDSCAPE ANALYSIS OF THE LOWER WINNIPEG RIVER

Study Area

A database suitable for the ecological landscape analysis was constructed from representative portions of the microgregion (Figure 5.1). Four strips were chosen, extending across the range of the study area. The strips were in grids of 150 m x 150 m square units. All of the strips are oriented in a North-South direction.

The sample units and strips are at the scale suggested by Miller (1978:67). Analysis at the scale of hectares can deal with ecosystems, while a landscape mosaic, a patchwork of connected or contrasting ecosystems, is seen at the scale of 10 km^2 to several thousand km^2. The sizes of strips are as follows:

Fort Alexander	16.09 km^2
Pine Falls	18.56 km^2
Silver Falls	21.94 km^2
Maskwa River	14.85 km^2

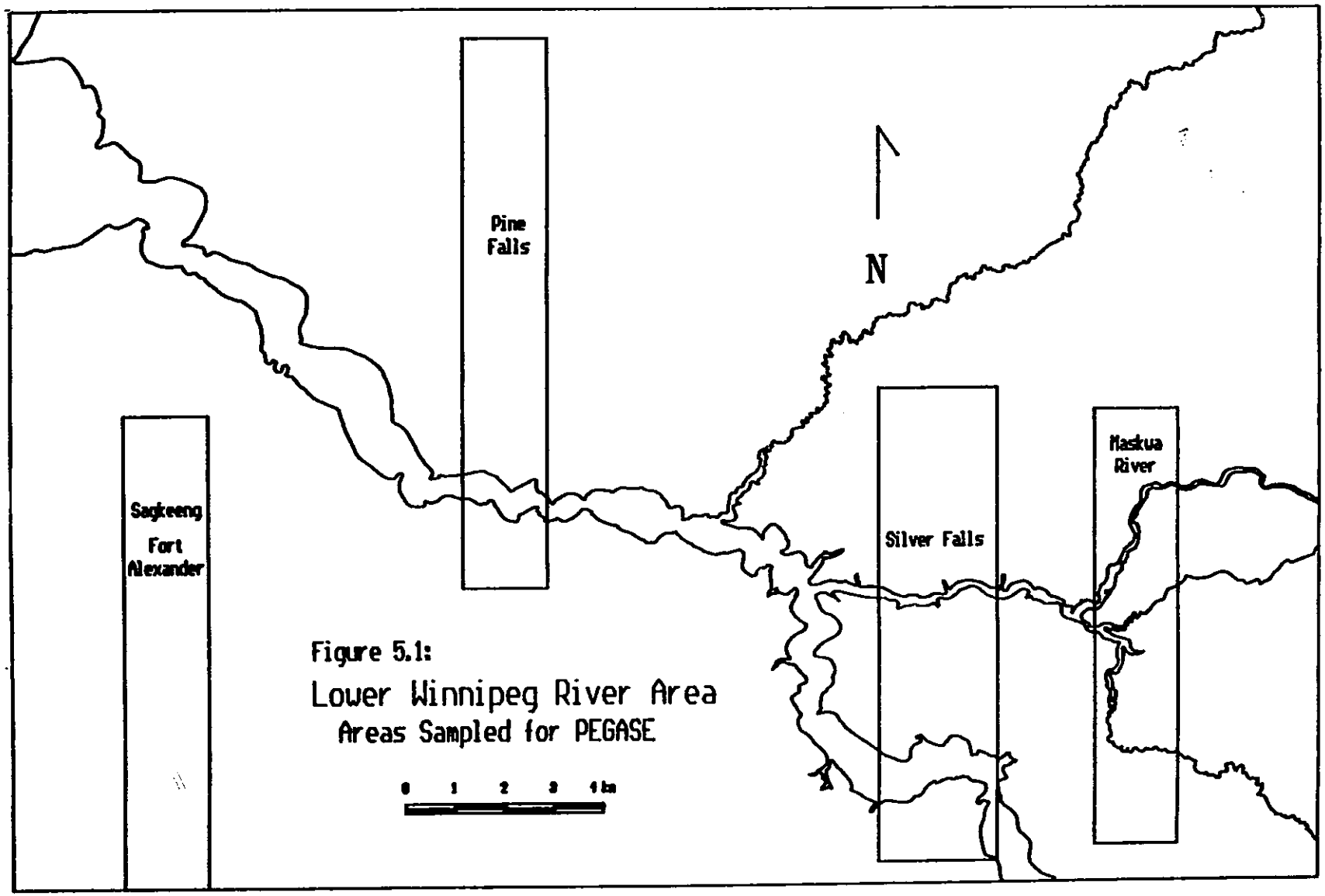


Figure 5.1:
Lower Winnipeg River Area
Areas Sampled for PEGASE

Sampled Areas

Each of the four strips crosses a boundary between land use regimes (Figures 5.1 and 1.2). Differences in land management practices can be seen from the plots of landscape forms.

1. Sagkeeng strip, totally south of the Winnipeg River, begins just beyond the townsite at Fort Alexander and extends south past the southern limit of the reserve into an area where ditches have been installed to drain the peatlands. A Canadian National railway line runs diagonally through the lower portion of the strip. The entire strip is of fairly uniform terrain, underlain mostly by deep peat deposits, with some zones of shallower organic soils.

2. The Pine Falls strip extends from the forested North Shore area of the Sagkeeng First Nation Reserve, across to the Pine Falls townsite and environs on the south shore of the river. The soils are lacustrine clays and some organic soils.

3. The Silver Falls strip extends from the southern portion of the Forest Management Licence area across the Maskwa River and into settled agricultural land on the east side of the Winnipeg River. It extends across to Silver Falls on the Southwest side of the Winnipeg River.

4. The Maskwa River strip is located entirely on the northeast side of the Winnipeg River. The upper (northern) portion is on FML land, then crosses the Maskwa River as well as Little

Bear Creek. There is agricultural land in the southern portion. It contains some of the Indian Bay Complex 'soils', which are characterized by pockets of varied soil types and rock outcrops.

Map Coverage

Table 5.1 lists the main sources used to construct the PEGASE database.

Table 5.1: Maps Used to Create Database of Topo-ecologic Variables and Land Use

Source	Scale	Information
Reconnaissance Survey of Lac du Bonnet Area, Soils Report No. 15,.R.E. Smith, W.A. Ehrlich, & S.C. Zoltai. Report published by the Manitoba Department of Agriculture, Map published by Canada Department of Agriculture., 1967	1:126,720	Soil Texture, Soil Profile, Parent Material, Natural Drainage, Dominant Natural Vegetation, Relief, Slope, Agricultural Capability, Forestry Capability, Limitations due to climate, wetness, vegetative competition
National Topographic Survey, Canada, Energy, Mines and Resources	1:50,000	Elevation, Rail Lines, Drainage Canals
Manitoba Paper Company, Abitibi-Price maps, 1950, 1966, 1991	various	Jurisdiction.
Forestry Branch, Aerial Survey. Pine Falls Area, Block 2, No. 3 and 6, Dominion Forestry Branch, 1941	1:31,000	Land Use, Vegetation, roads and Trails, 1941
Abitibi-Price, Pine Falls, Manitoba, Forest Inventory Map, 1966	1:15,540	Land Use, Vegetation, 1966
Canada. Energy, Mines and Natural Resources, Aerial Photographs of Winnipeg River and Environs, August 26, 1962.	1:26,000	Land Use, Vegetation, Roads and Trails, 1962
Abitibi-Price, Pine Falls Division Woodlands, Pine Falls Manitoba. Township/Mapsheet No. T17R09EP to T19RO11EP, December 18, 1991.	1:50,000	Land Use, Vegetation, Roads and Trails, Drainage Channels, 1991

The soil and land use variables were derived from the Manitoba Soil Survey literature and maps. The northeast portion of this study area had not been sampled for the soil survey, as it was considered to be too marginal for economic use to warrant the extensive field work necessary to map the sites. That limited the area which could be used for the analysis.

A large number of detailed and accurate maps of the area exist, dating from before 1900. However, it was difficult to find maps which covered the appropriate area and contained information which was consistent from map to map. In the early period, maps were prepared to inventory commercial forestry resources. Therefore they concentrated on forested areas. For example, on the 1941 inventory maps, agricultural areas were omitted or were classified only as "Cleared", with no detail as to the use being put to them. The southern portions including the peatlands of the Reserve were not surveyed.

A major forest inventory is done each decade. Even so, it is increasingly difficult to compare information from earlier decades with more recent data. Estimation techniques, boundaries, format and type of information collected changed with time. The 1941 maps classified stands as complexes of species, such as conifer, broadleaf and mixed stands and cutover status. The 1991 map used a detailed breakdown of species: black spruce, white spruce, jack pine, broadleaf and tamarack. Each stand was graded to age class and harvest status: not renewed, regenerated, saplings, immature, mature, overmature. Willow and alder bush and muskeg areas were easier to delineate and were fairly consistent between 1941 and 1991.

Air photographs were available for the agricultural areas on the Silver Falls and Maskwa River strip. The photography was carried out in 1962 as part of a survey of all rivers draining into Lake Winnipeg, preparatory to engineering work for the Winnipeg floodway project. The discrimination of ground cover was excellent as it was the end of the crop year. Different land covers could be accurately interpreted. Those areas had flourished following the construction of bridge and road access along with the hydro-electric dam (open in 1951). There had been a

significant amount of land clearing between then and 1962. The later period was used in the analysis because detailed information on agricultural land use was more readily available.

The agricultural database for 1962 was interpreted from air photography and compared with recent imagery and ground inspection. Interpretation of forested areas was checked against forest inventory maps dated 1966. Categories were consistent with those on the 1991 inventory map.

Land use on 1991 Abitibi-Price Maps, although updated regularly for cutting areas, chance (temporary) road construction and other industry-related features, was produced from 1983 and 1986 air photography. Similarly, the agricultural land use taken from 1962 air photos could be considered relatively consistent with the forest inventory maps dated 1966, as they would have been abstracted from air photography several years earlier.

Variables Used in the Analysis

The database consisted of a large number of topo-ecological variables which were expected to be important in determining landscape organization on the three land use regimes (Table 5.2). Many of the variables were mapped as part of a soil survey conducted by a joint committee of Canada Department of Agriculture, the Lands Branch of the Manitoba Department of Mines and Natural Resources and the Department of Soil Science at the University of Manitoba (Smith & Ehrlich, 1967). The soils information was classified according to the taxonomic system of the National Soil Survey Committee of Canada. The soils were grouped

in detailed series based on composition, texture, mode of deposition of parent material, as well as thickness and development of horizons (Smith et al. *op.cit.*)

The topographic variables should be important for localized variations in landscape organization. The area is quite flat, so minor variations in relief and elevation would be important. The soil types follow a locational pattern, with the clay and fine-textured sediment along the Winnipeg River and to the north and east. Extensive areas of peat are in the south west part of the study area as well as in deposits in the transition zone between the Manitoba Lowlands and Canadian Shield.

Drainage and soil moisture conditions are important aspects of the study area. They have been the object of active management to reduce the effect of excess moisture. With either fine-textured sediments or peat deposits, moisture would be expected to be a significant factor.

The indices for agricultural and forest productivity are standardized measures used across Canada (Smith, Erhlich (and Zoltai), 1967). The agricultural productivity classification indices used were based on the system developed by the Canada Land Inventory, ranging from classes capable of sustained production, those suitable for hay and pasture, to those unsuitable for agriculture.

The forest productivity index rated soils in increments ranging from 1(over 110 cu ft/acre) to 7 (less than 10 cu.ft./acre)(Smith et al. *op cit.*). Because the forest areas were of interest in this study, three indicators associated with forest productivity were included. Excess of soil moisture due to slow internal drainage related to fine texture or in some situations to high water table was considered important in this area. Soils which would support or encourage vegetation other than economically-desirable tree species, necessitating management practices to favour

useful species, were categorized as providing "vegetative competition". As well, the regional climate is characterized by coolness and short growing season. Soil conditions which would not ameliorate those limitations were differentiated.

The presence of roads, trails and drainage channels can be considered to be "economic" as much as "ecologic" landscape variables. They represent deliberate action to alter the physical environment for human activity.

Table 5.2 Topo-ecologic Variables

Topographic Factors:

ELEVATION
EL1 <240 M asl
EL2 240-250 m
EL3 250-260 m
EL4 260-270 m
EL5 >270 m

RELIEF/TOPOGRAPHY
RE1 Level
kE2 Level to Irregular
RE3 Depressional to Level

SLOPE
SL1 Level
SL2 Level to very gently sloping
SL3 Very gently sloping
SL4 Gently sloping
SL5 Steeply sloping

Soil Factors;

SOIL TEXTURE
TE1 Clay
TE2 Clay Loam
TE3 Indian Bay Complex - rock outcroppings, pockets of drift, peat
TE4 Shallow Peat
TE5 Deep Peat

SOIL PROFILE
PR1 Dark Grey
PR2 Dark Grey Wooded
PR3 Solonetzic Dark Grey
PR4 Solonetzic Grey Wooded
PR5 Orthic and Gleyed Grey Wooded, Podzolic, Organic
PR6 Organic
PR7 Rego Black
PR8 Peaty Carbonated Rego Humic Gleysol
PR9 Peaty Rego Humic Gleysol

PARENT MATERIAL
PM1 6" - 30" slightly calcareous clay over calcareous silty sediments
PM2 Slightly to moderately calcareous saline lacustrine clay
PM3 6" - 30" clay over strongly calcareous silty sediments
PM4 Weakly to moderately calcareous lacustrine clay
PM5 Moderately calcareous, moderately fine textured sediments
PM6 Strongly calcareous, moderately fine textured sediments
PM7 Granitoid rock with stratified drift and peat deposits
PM8 Peat 12"-36" thick over undifferentiated deposits
PM9 Peat deposits >1 metre thick, usually underlain by lacustrine clay

Soil Moisture Factors:

NATURAL DRAINAGE
ND1 Poor to very poor
ND3 Poor to imperfect
ND4 Imperfect
ND5 Imperfect to good
ND6 Good to Poor
ND7 Good

GLEYED HORIZONS
GL1 Present
GL2 Absent

PROXIMITY TO DRAINAGE DITCH (1991)
D80 >300 m.
D81 Adjacent to drainage ditch
D82 Less than 300 m.

Land Use Variables:

DOMINANT NATURAL VEGETATION
VE1 Aspen, Balsam Poplar, Broadleaf
VE2 Aspen, Balsam Poplar, Softwood
VE3 Aspen, Grass
VE4 Aspen, Balsam Poplar, Marsh species
VE5 Jackpine, Aspen, Birch
VE6 Black Spruce and related species
VE7 Meadow Grass, Sedge
VE8 Sedge, Marsh Species

CAPABILITY FOR AGRICULTURE
CA1 2W1, Drainage, high water table in spring
CA2 3W1, May be subject to waterlogging
CA3 3D, Poor structure, tillage problem
CA4 3DW, Subject to waterlogging, poor structure
CA5 3W2, Subject to waterlogging, flooding
CA6 3FW, High water table in spring, low organic content
CA7 7, Considered unsuitable for agriculture

FOREST CAPABILITY CLASS
CF3 Three - 71-90 ft^3/acre/year
CF4 Four - 51-70 ft^3/acre/year
CF5 Five - 31-50 ft^3/acre/year
CF6 Six - 11-30 ft^3/acre/year
CF7 Seven - <10 ft^3/acre/year

Forest Productivity Limitations:

LIMITATIONS DUE TO WETNESS (FOR)
WE1 Yes
WE0 No

LIMITATIONS CAUSED BY CLIMATIC FACTORS (FOR)
CP1 Yes
CP2 No

EXCESSIVE COMPETITION FROM OTHER VEGETATION (FOR)
VC1 Yes
VC2 No

Accessibility:

PROXIMITY TO ROADS AND TRAILS
R0 >300 m. from road
R1 Adjacent to road
R2 Less than 300 m. from road
R3 Adjacent to trail

PROXIMITY TO WATER BODY
W0 >300 m. from water body
W1 Adjacent to water body
W2 Less than 300 m. from water body

Information Analysis of Land Use Categories

Three types of land use regime were compared: **FOR**est (spruce, pine, tamarack, broadleaf species); **CLE**ared areas and agricultural lands (crop, hay, forage); Residential areas and **BUI**lt structures (barns, farm houses, commercial and industrial structures); **WIL**low and alder bush; and **MUS**keg (muskeg, swamp, wet meadow and beaver floods). The analysis compared landscape organization at different time periods. For the FML and RES lands, the years 1941 and 1991 were used. For AGR, 1962 and 1991 were compared.

Figures 5.2, 5.3 and 5.4 show the distribution of general land use categories for 1941, 1962 and 1991 respectively. Comparisons were made a) among land use categories within land use regimes; b) between land use categories across land use regimes; and about c) changes from one time period to the next.

Measures of Topo-ecological Order

As explained earlier, PEGASE progressively isolates landscape forms according to topo-ecologic factors. An endpoint is reached where land use categories are sufficiently defined, or where further division would not yield a clearer description, or where low numbers invoke a stopping rule. Dendrogrammes which show the division of the general land use categories according to environmental factors, along with spatial entropy associated with each level are in Appendix 1.a. Lists of terminal landscape forms (subsets) showing distribution of land use

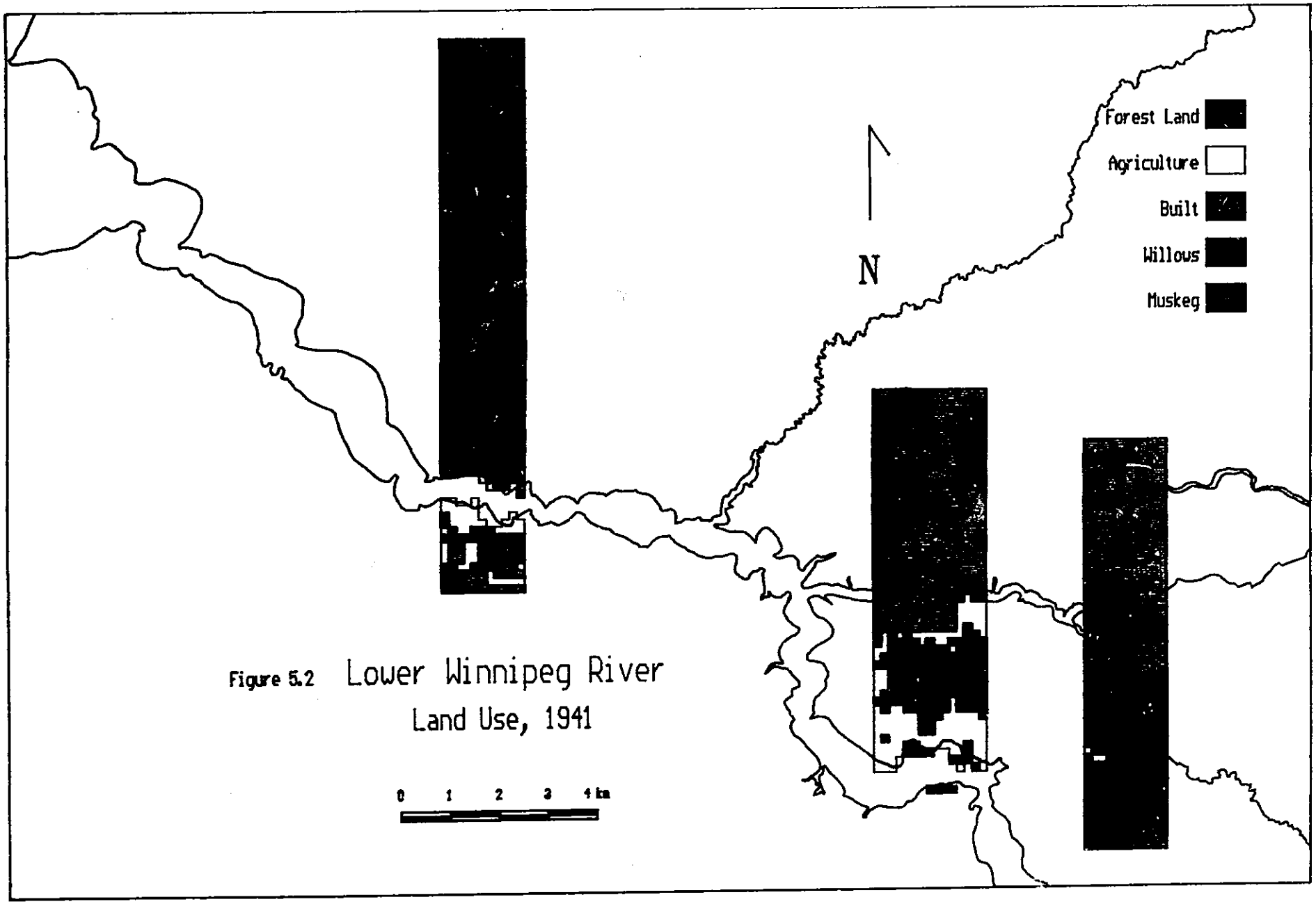


Figure 5.2 Lower Winnipeg River
Land Use, 1941

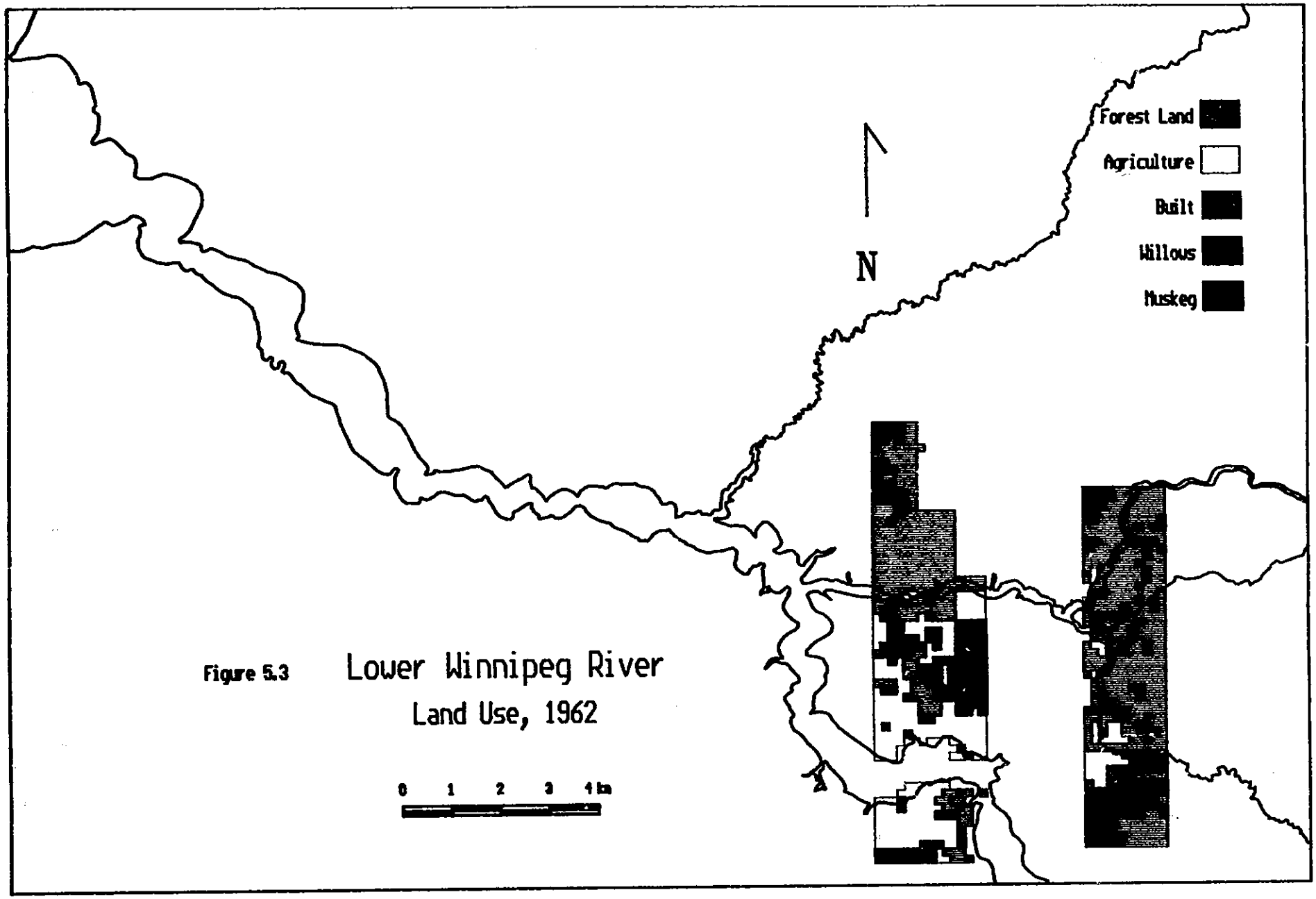


Figure 5.3 Lower Winnipeg River
Land Use, 1962

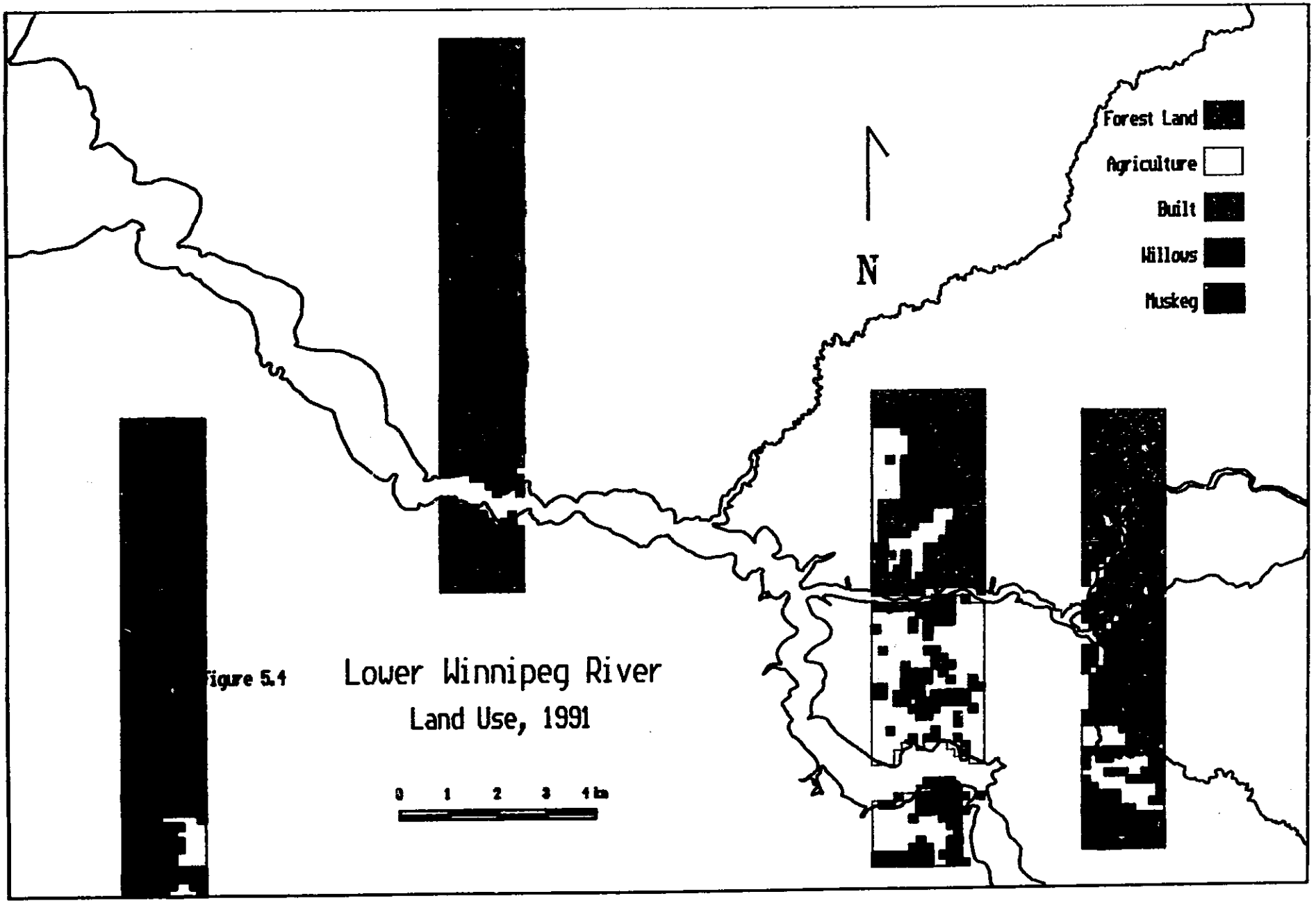


Figure 5.1 Lower Winnipeg River
Land Use, 1991

categories in each form are in Appendix 1.b.

The volume of information provided by PEGASE includes various measures of topo-ecological order related to the entire set of environmental and land use variables. These include initial and final entropy, redundancy and environmental entropy. Initial entropy is a measure of the randomness of the landscape mosaic forms which would result in the absence of any topo-ecologic relationship. The distribution of landscape forms would be based on the number of units of each category. Now, if topo-ecological factors do influence the organization of landscape, the mosaic will not be random. The final entropy is a measure of the remaining disorder of the pattern not accounted for by environmental (or economic) factors used in the analysis. The redundancy is the percentage of entropy which has been removed; i.e., it measures the level of order of the landscape system. Finally environmental entropy measures the "amount of environmental diversity needed to account for the land use diversity in the landscape" (Phipps, 1993).

Other measures of topo-ecological order attempt to quantify more specific aspects of landscape organization. The environmental specificity of land use measures the extent to which individual land use categories are constrained or influenced by the environmental factors. There is also a measure (expressed as a percentage) of the contribution of each topo-ecological element to redundancy. Finally, groups of environmental or economic determining factors create trends or clusters which reflect broad aspects of topo-ecological ordering principles.

The physical-biological environment does not completely determine the pattern of the surface. Random variation as well as periodic or episodic events change the configuration. More importantly, a vegetation community transforms its own environment. Roots stabilize the

substrate and assist in soil formation in the long term. Trees and shrubs use large amounts of water and lower the water table. Birch, aspen and pine, which are shade intolerant, themselves provide shade and shelter for other tree species, until these in turn become dominant. In the boreal forest, periodic fires pass over, destroying or damaging the trees. Depending on the time of year of the fire, the extent of damage and the ambient soil and moisture conditions, the area could be recolonized with pine or birch, or willows and alders (Pielou, 1988).

Prior to allocation of timber reserves in the early years of the twentieth century, the forest of eastern Manitoba regularly experienced severe burns, some of which were quite extensive (Abitibi-Price fire maps, in collection of Pine Falls Paper Company and Model Forest). Those fires contributed to the patchy arrangement of tree stands, a situation which is economically and operationally beneficial. Even-aged stands of same tree species are easy to harvest. The random, self-organizing factors which could contribute to a patchy landscape is replaced by constraining factors which discourage growth of competitive non-economic tree species. Techniques may include enhancing the environment by ground preparation after cutting (e.g. dragging a chain over the surface, cutting through runners of aspen) or planting and tending desired species where warranted by economic, aesthetic or locational consideration. Other changes undertaken as forest management include the cutting of extensive areas of timber, as well as fire and insect suppression. There is extensive fire history for the FML; however, the area mapped here is outside the portions which have burned during the period of record.

Those factors of landscape organization operate over extensive areas of forest land. Thus a large area under centralized control is required. Only a small part of that could be utilized for the study because the data requirements could not be met for most of the FML area (see above).

The results available are applicable to that part in proximity to the populated area, for which data about soils and water balance are available.

Changes to the landscape for agricultural purposes are quite significant, although they cover a more limited area and are the consequence of individuals' land use decisions. The first step is the removal of the vegetation on the site, followed by cultivation of the soil and introduction of [usually] completely new non-native species. The agricultural community has grown substantially. The presence of buildings not associated with any agricultural activity has also increased. Some of these are related to the aesthetic qualities of river frontage. Also important is the accessibility and convenience afforded by the hydro-electric dam and all-weather road system on the far side of the river.

On the Reserve lands, traditional land use practices did not and do not involve manipulation of the physical landscape. The Reserve was originally surveyed into lots for the purpose of agriculture, but more areas were not cleared other than for houses. It is expected that the visible landscape of the sampled areas represents the natural self-organization of landscape.

Sagkeeng First Nation (RES)

As noted above, the sites used for Sagkeeng First Nation were considered to be a "control" site. Apart from some recent, localized tree planting and some drainage of peat lands, the area used was not subject to human intervention.

The decrease of initial entropy from 1.17 in 1941 to 0.95 in 1991 (Table 5.3) is indicative of landscape transformation which took place over the intervening years. Large areas which

contained muskeg and willow in 1941 gave way to forest cover. This could be attributed both to maturation of succession as well as to some drainage as a by-product of road construction in the area. However, the overall redundancy was consistent from 1941 (28.8%) to 1991 (29.4%). The patchy arrangement of varied species in the South Shore appears on a fairly uniform underlying terrain. The environmental entropy, the amount of variation in the topo-ecological characteristics to account for landscape complexity is consistently low: 1.34 in 1941, 1.96 for the area in 1991.

The environmental specificity is an indication of the degree to which expression of individual landscape forms is constrained by the environmental factors. The clearest connection is that of the built environment, increasing from 0.57 in 1941 to 0.82 in 1991. This was due to the strengthening of the importance of the river to the activity of people on the Reserve. All the structures are built adjacent to the Winnipeg River, as were, historically, the mission and fur-trade buildings. As noted above, the forest has overtaken areas previously too wet to support vegetation other than muskeg and dwarf spruce. This indicates a spatial disorganization, where forest sites are less constrained by moisture-related difficulties than in the past.

The Reserve portion had a range of elevation of only 20 metres, from 240 metres to 260 metres asl, and no appreciable alteration of the landscape associated with traditional economic land use activity. The settlement pattern and moisture regime are the only factors which impose order on the landscape organization. Regarding the contribution of individual topo-ecologic factors to landscape organization, factors associated with water balance dominated the organization of landscape with the exception of placement of built structures. Excessive wetness and, in particular, the potential for waterlogged conditions at certain times of the year was

extremely important in 1941, accounting for a total of 67.1% of landscape redundancy. Other related factors were presence of gley horizons, 14.3% in 1941 and natural drainage, 7.2%. In 1991, the major factor was proximity to the river, related primarily to the settlement pattern. The non-human part of the landscape was influenced by soil related factors.

Table 5.3: Measures of Topo-ecological Order, Sagkeeng First Nation Regime (RES)

	FOR	CLE	BUI	WIL	MUS	TOTAL
1941	200	-	12	228	188	628
1991	415	-	27	55	131	628

LANDSCAPE ORGANIZATIONAL INDICATORS	1941		1991
Initial Entropy	1.17		0.95
Final Entropy	0.83	0.67	
No. of Landscape forms	6		15
Redundancy	28.8%	29.4%	
Environmental Entropy	1.34		1.96

ENVIRONMENTAL SPECIFICITY OF LANDUSE CATEGORIES		
Forest (Conifer and Broadleaf)	0.25	0.14
Cleared	-	-
Built	0.57	0.82
Willows/Alders	0.09	0.17
Muskeg (Dwarf Spruce, Marsh, Beaver Floods)	0.34	0.20

CONTRIBUTION OF ACTIVE LANDSCAPE VARIABLES TO REDUNDANCY (per cent)		
Soil Texture		17.3
Soil Profile		13.4
Gley Horizons	14.3	
Natural Drainage	7.2	
Slope	2.3	
Excessive Wetness	67.1	
Elevation	9.1	13.3
Proximity to Roads and Trails		9.8
Proximity to Water		46.2

The factorial correspondence analysis highlights those associations (figure 5.6, for 1991). Note the large distance of the built environment from the vegetation forms, and a trend, from forest to willows and alders to muskeg, suggesting a moisture gradient. However, apart from the clearly defined settlement pattern, the landscape is fairly chaotic, subject to wide local variation.

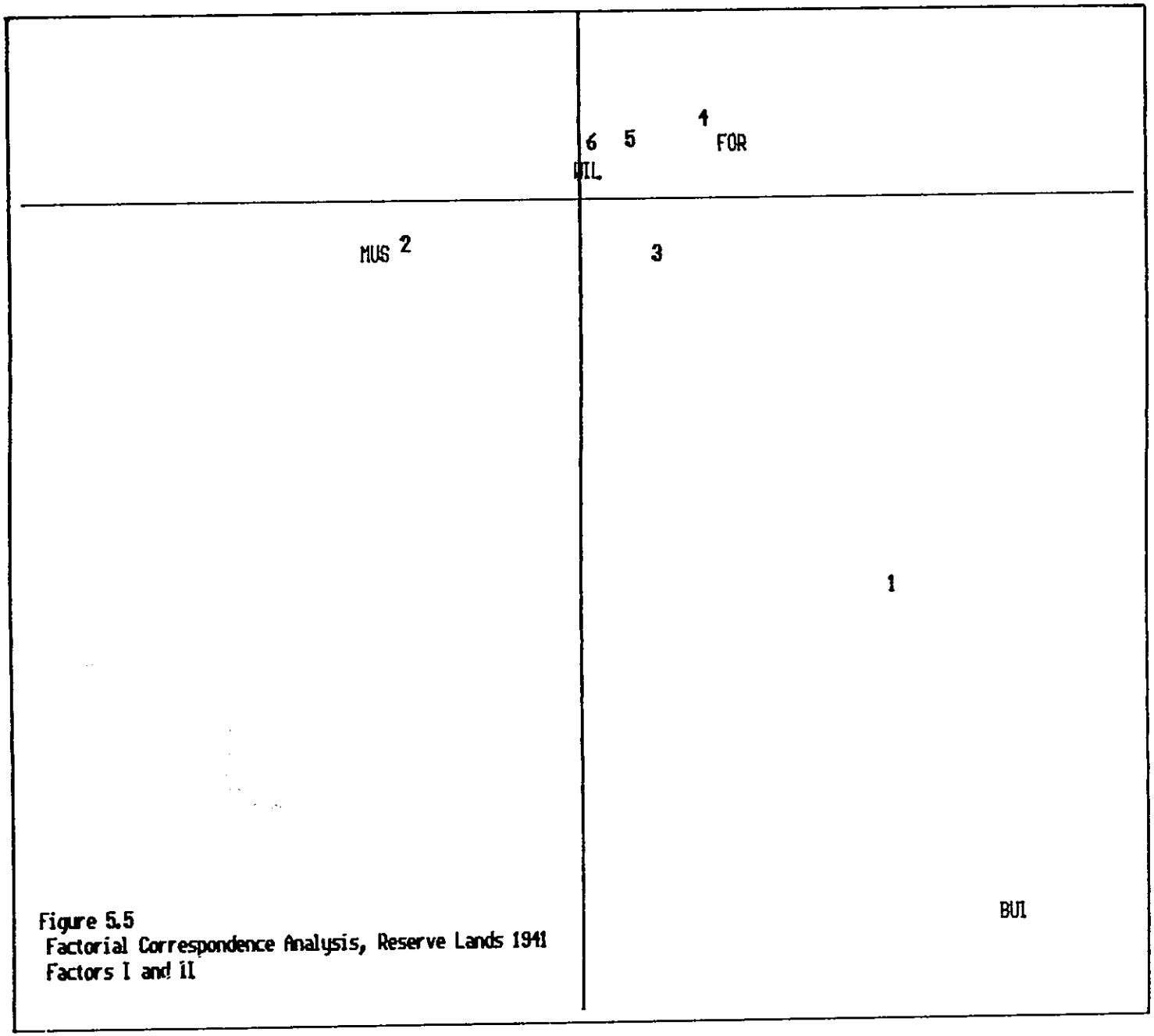
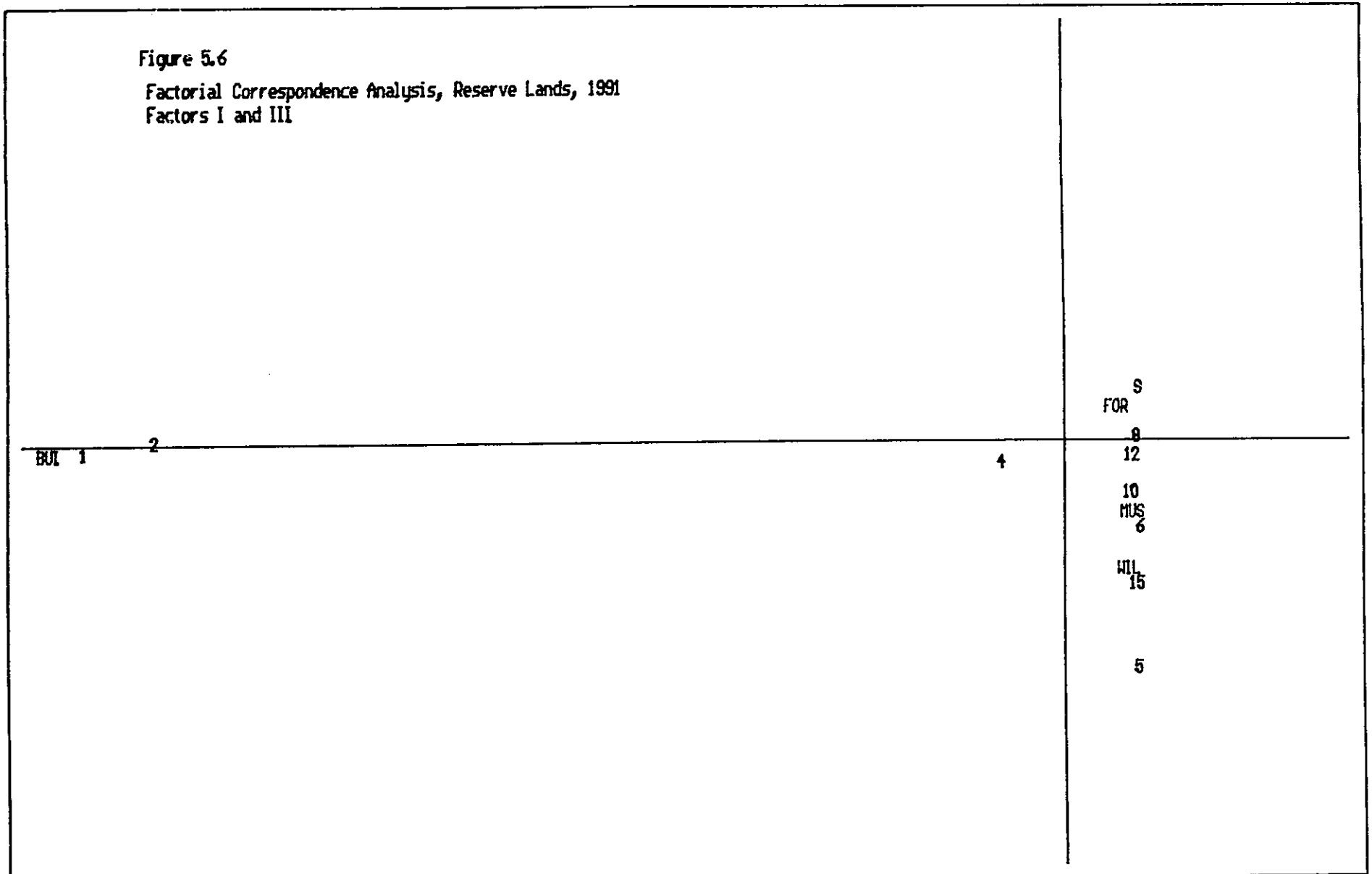


Figure 5.5
Factorial Correspondence Analysis, Reserve Lands 1941
Factors I and II

Figure 5.6

Factorial Correspondence Analysis, Reserve Lands, 1991
Factors I and III



Forest Management Licence Area (FML)

In the FML, a similar transition of the forest cover is apparent even from the frequency distribution of the various categories. For example, forest cover increased from 434 to 639 sites, while willow bush decreased substantially from 220 to 47 sites (Table 5.4). That was the major change in the Reserve lands as well. Also, the built area increased from 26 sites in 1941 to 58 in 1991. Those changes resulted in an overall decrease of initial entropy of the FML landscape from 1.14 to 0.81.

While the forest regime begins with an initial entropy similar to that of the Reserve lands, the final entropy is very low, 0.59 in 1941 and 0.50 in 1991. The redundancy in the managed forest was reduced from 1941 to 1991, from 48.7% to 38.0%. Human activity, economic use and enhancements tend to block or counteract ecologic factors.

Here, though, the environmental specificity of forest increased slightly from 0.28 to 0.31, indicating that the spatial organization was becoming clearer. All other categories were associated with a decrease of landscape specificity with time, contributing to a decrease of redundancy from 48.7% to 38.0%. All the buildings in the FML and associated lands were restricted to the townsite, to temporary bush camps close to cutting areas as well as temporary machine and warming sheds in cutting areas. From the beginning all structures were contained within the townsite area, following faithfully the original design. The decrease of landscape specificity of the built area was not associated with abandonment of the townsite plan. Rather, the initial construction had been centred on a clay ridge, while later buildings were put on sites away from that distinct place. Consequently, the environmental specificity decreased, even

though the actual organization remained highly structured. The main restricting factor on the original design, which was actually incorporated into the plan, was the presence of many rock outcroppings, the townsite being nestled in among them.

The contribution of landscape variables to redundancy was quite stable over the time frame of this analysis. Elevation provided 52.9% of spatial organization in 1941 and even more, 65.2%, in 1991. As in the Reserve analysis, water related factors of relief and topography and excessive wetness were important.

Table 5.4: Measures of Topo-ecological Order, Forest Management Regime (FML)

	FOR	CLE	BUI	WIL	MUS	TOTAL
1941	434	43	26	220	55	778
1991	639	12	58	47	66	822

LANDSCAPE ORGANIZATIONAL INDICATORS	1941	1991
Initial Entropy	1.14	0.81
Final Entropy	0.59	0.50
No. of Landscape Forms	20	11
Redundancy	48.7%	38.0%
Environmental Entropy	2.58	1.95

ENVIRONMENTAL SPECIFICITY OF LANDUSE CATEGORIES		
Forest (Conifer and Broadleaf)	0.26	0.31
Cleared	0.63	0.45
Built	0.72	0.62
Willows/Alders	0.33	0.08
Muskeg (Dwarf Spruce, Marsh, Beaver Floods)	0.63	0.26

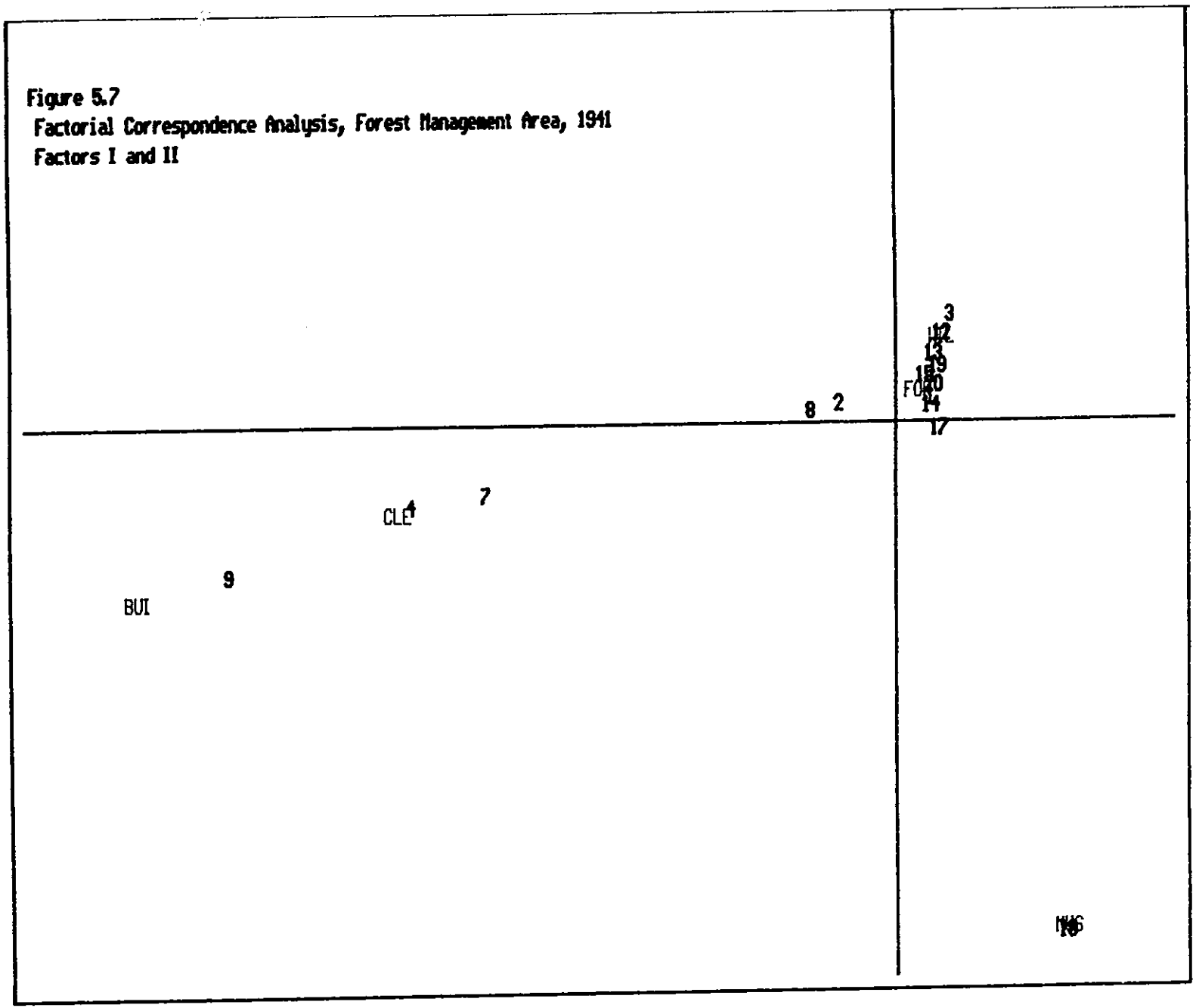
CONTRIBUTION OF ACTIVE LANDSCAPE VARIABLES TO REDUNDANCY (per cent)		
Soil Texture	9.0	2.2
Soil Profile	5.3	
Gley Horizons	1.7	2.7
Natural Drainage	4.7	
Relief/Topography	15.4	
Excessive Wetness		26.6
Vegetative Competition	3.6	
Elevation	52.9	65.2
Proximity to Roads and Trails	7.4	
Proximity to Water		3.3

The similarity to the natural landscape evolution of the Sagkeeng regime does not support the idea that industrial forest management would result in a very different organization. The same forces appear to be at work in the FML as in the SAGkeeng regime, for the time frame studied. However, that does not eliminate the possibility that significant change has been effected in the larger management area. First, initial selection of timber berths in the 1920s was based on their economic potential (see Chapter Six for details about timber selection), so natural factors favouring the valuable species may be reinforced. As well, as stated earlier, the requirements of the PEGASE procedure for an extensive data base precluded the use of substantial areas of the FML. Only the edge was used. Finally, the categories used to compare the three land use regimes were quite general. These categories group together many types of tree species, including the desired spruce as well as other conifers and broadleaf species (mainly trembling aspen and poplar). A detailed breakdown of tree species into broadleaf and conifers showed the proportion of broadleaf stands increased from 33% in 1941 to 43.3% in 1991. This is related tc natural regeneration of the cutting areas without any site preparation or replanting.

Factorial Correspondence Analysis

Both the 1941 and 1991 plots show a clear spatial division of human settlement from forest land (Figures 5.7 and 5.8). Many of the landscape forms have only minor differences between them, related to differences in soil texture and elevation. The patchy arrangement is relict of the previous mechanism of vegetation regeneration: fire. This is in conjunction with differences of texture (mineral or organic soil) and moisture.

Figure 5.7
Factorial Correspondence Analysis, Forest Management Area, 1941
Factors I and II



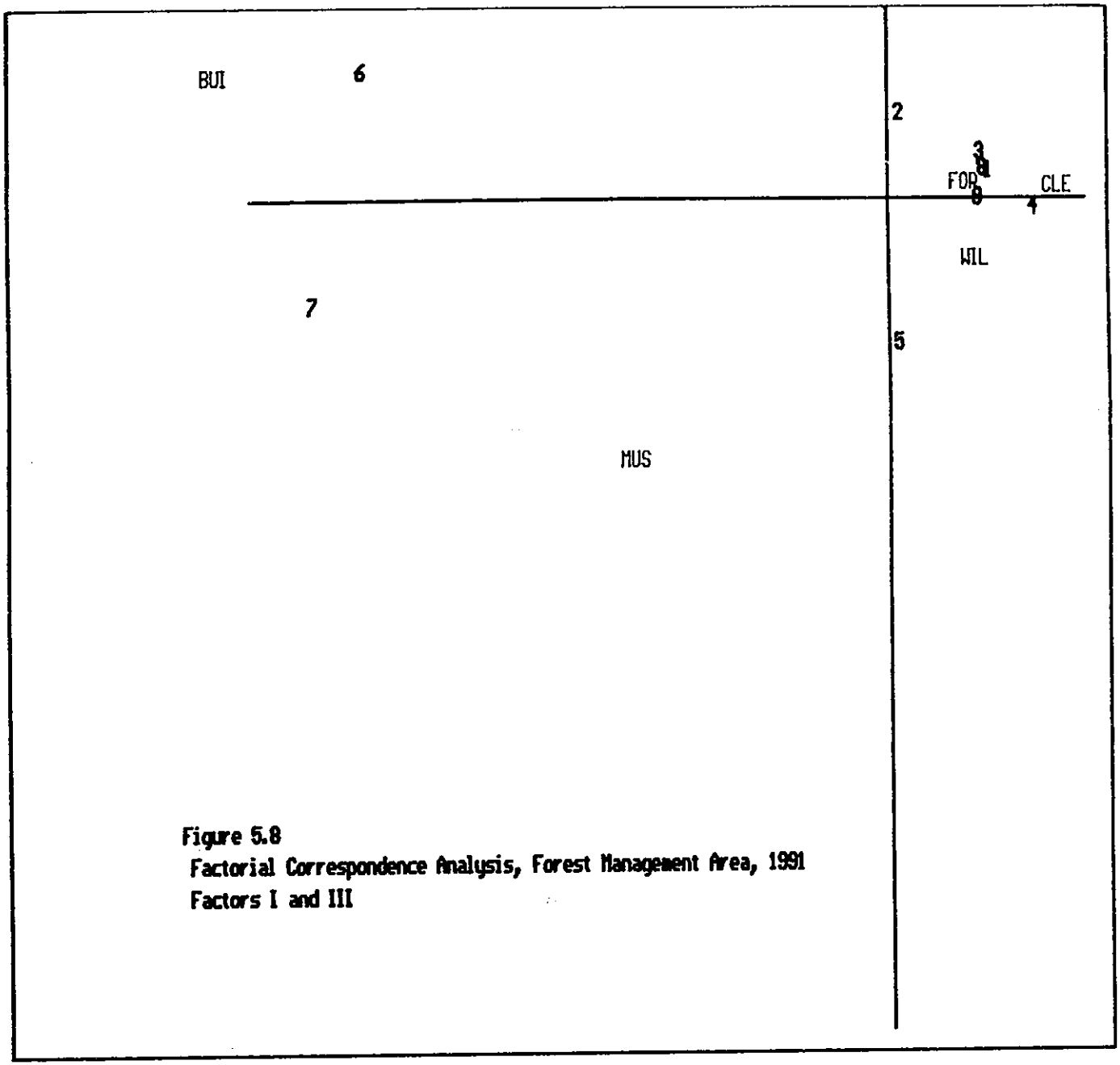


Figure 5.8
Factorial Correspondence Analysis, Forest Management Area, 1991
Factors I and III

Agricultural Lands (AGR)

The substantial increase of land under cultivation can be seen from the maps Figures 5.3 and 5.4. There were 118 sites cleared for cultivation in 1962 and 417 in 1991. Most of that increase was at the expense of willow bush, while forest remained relatively constant.

In 1962, the landscape order was fairly high, 43.7%, compared to 29.1% for the same area in 1991 (Table 5.5). There was a substantial reduction of entropy from 1.35 to 0.76. The final entropy was higher in 1991 (0.86) than in 1962 (0.76), where a lot of the placement of land use categories was not explainable in relation to environmental factors.

During the period 1962 to 1991 there was a large decrease of landscape specificity of most of the land use categories. particularly cultivated land from 0.47 in 1962 to 0.21 in 1991. Willow and built stayed relatively constant through the period while the others decreased. There was an overall decrease of landscape organization illustrated by the drop of redundancy from 43.7% in 1962 to 29.1% in 1991.

In 1962, agricultural capability classes were important contributions to redundancy at 28.5%, followed by water-related conditions (elevation and excessive wetness) and edaphic (soil profile) variables. However, in 1991, agricultural capability class was not present at all as an important factor. A more complex combination of edaphic and water-related factors were important, as well as locational factors such as proximity to roads and to water.

In the early period landscape organization and human land use were highly constrained by agricultural capability and by the bad drainage situation. As new land was brought under cultivation, those factors became less important. It is difficult to say which caused which. New

roads improved accessibility and made it possible to reach other areas and to bring in equipment. Also, the road network served as drainage routes for excess water, thus improving the conditions under which agriculture could take place.

The agricultural regime created a landscape organization quite different from that of Forestry or the Reserve. The obvious changes to the landscape coupled with decisions made by individuals on relatively small plots of land have resulted in a distinctive cultural landscape.

Table 5.5: Measures of Topo-ecological Order, Agricultural Regime (AGR)

	FOR	CLE	BUI	WIL	MUS	TOTAL
1962	286	118	9	214	101	728
1991	241	417	46	58	47	809

LANDSCAPE ORGANIZATIONAL INDICATORS	1962	1991
Initial Entropy	1.350	1.22
Final Entropy	0.760	0.86
No. of Landscape Forms	22	30
Redundancy	43.7%	29.1%
Environmental Entropy	2.711	3.04

ENVIRONMENTAL SPECIFICITY OF LANDUSE CATEGORIES		
Forest (Conifer and Broadleaf)	0.389	0.235
Cleared (Agricultural)	0.474	0.211
Built	0.293	0.274
Willows/Alders	0.313	0.326
Muskeg (Dwarf Spruce, Marsh, Beaver Floods)	0.382	0.238

CONTRIBUTION OF ACTIVE LANDSCAPE VARIABLES TO REDUNDANCY (per cent)		
Soil Texture	6.3	15.6
Soil Profile	15.7	14.9
Gley Horizons		3.3
Slope	6.4	7.3
Agricultural Capability	28.6	
Climatic Limitations	3.8	1.7
Excessive Wetness	16.1	15.0
Elevation	18.3	15.1
Proximity to Roads and Trails		10.1
Proximity to Water	4.7	12.2
Proximity to Drainage Ditch (1991)	na	4.9

In the Agricultural areas, the dependence of land use on the relationship between soil characteristics, topography. Moisture regimes have been confounded by the introduction of artificial mechanisms to control soil moisture, by economic decision-making and by the influx of non-farm residents. Extended road access further altered the availability of land, of whatever type, for agricultural activity. Agriculture here in the more recent period tends to be an adjunct to other economic activity. The land is of limited potential (Smith and Ehrlich, 1967), so non-topo-ecological factors are important in locating the activities.

The progressively delineated cultural landscape was accompanied by a clear reduction in landscape organization according to natural environmental factors. The clearing of land for crops, pasture and hay as well as for homes and farm buildings was carried out to maximize the benefits of soil factors, economic enhancements and accessibility.

Three indicators illustrate how carefully land was chosen in the earlier settlement period. The high redundancy indicates a careful use of land to maximise environmental attributes and economic investment. The environmental specificity of cleared land, 0.47, was much more constrained than in 1991 when drainage and non-farm construction obscured the environmental factors.

The general land use categories of built structures (0.29 to 0.27) and willows/alders (0.31 to 0.33) did not change from 1962 to 1991. However, the impact of forest clearing and drainage management were readily apparent regarding the environmental specificity of forest (0.39 down to 0.24), cleared (0.47 down to 0.21), and muskeg (0.38 down to 0.24). Economic and infrastructural factors have become increasingly important in land use decisions in that area.

While a variety of environmental factors, mainly indicators of soil status, do continue to play a role in land management, many natural deficiencies for agriculture can be circumvented.

Factorial Correspondence Analysis

The marked alteration of the natural-cultural balance of landscape organization is apparent from the plot of correspondences of land use types. In 1962 (Figure 5.9), one can see the progression from forest to willows and muskeg areas, showing a trend dominated by moisture status. Separate from that is the cleared land chosen according to potential for agriculture, and the built areas associated mainly with individual holdings.

In 1991 (Figure 5.10) the situation is much less clear. Topo-ecologic factors have been overshadowed by economic or logistical concerns. The relatively straightforward connection between moisture balance and vegetation type and of locations of built areas has been abandoned in the agricultural portion of the landscape. Here, the road network and artificial drainage system have allowed a landscape organization very different from that possible without those structures.

Conclusion

This chapter has looked at the evolution of the physical landscape of the Lower Winnipeg River during the twentieth century. It contrasted the transformation of landscapes subjected to different types of human intervention.

Figure 5.9
Factorial Correspondence Analysis, Agricultural Lands, 1962
Factors I and II

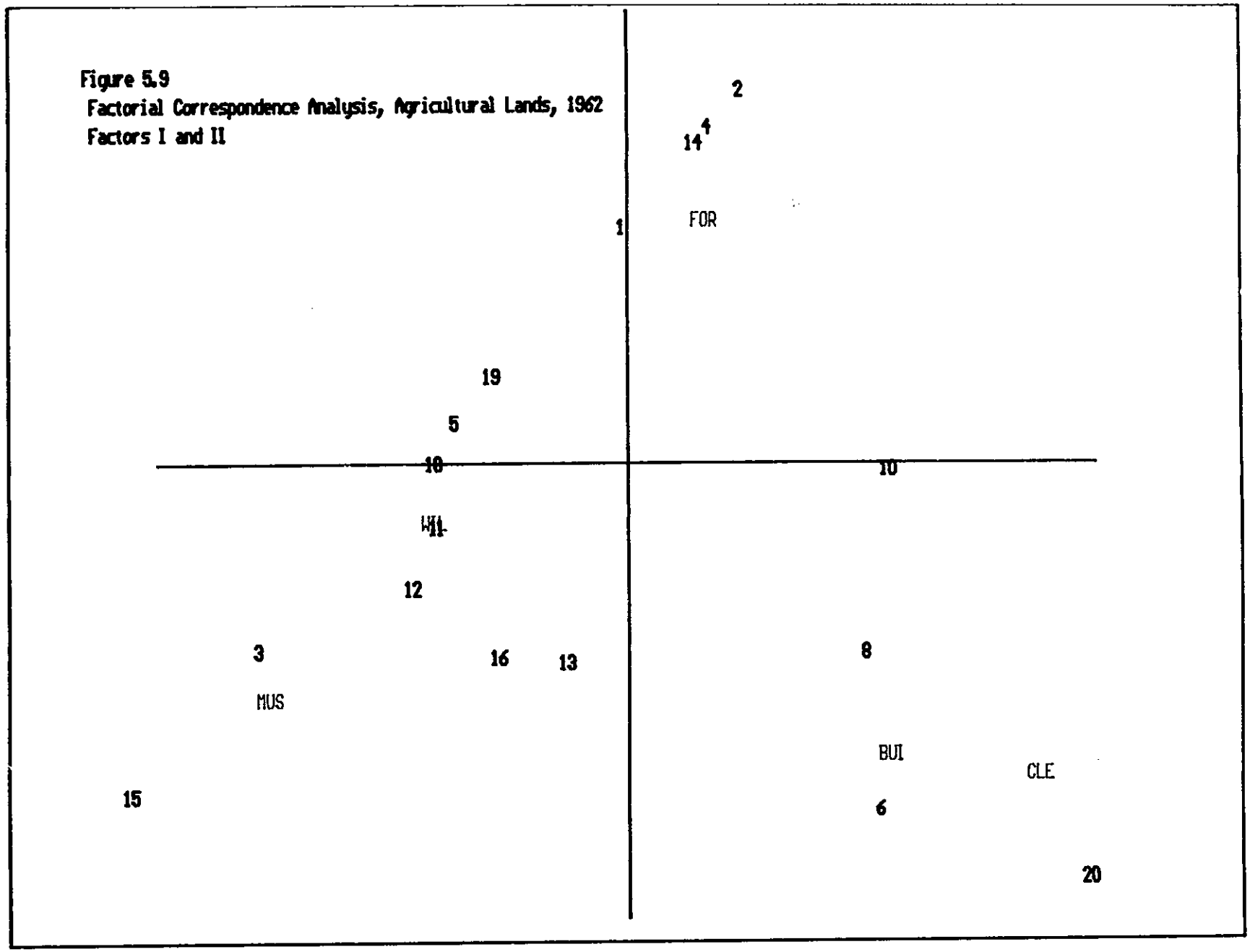
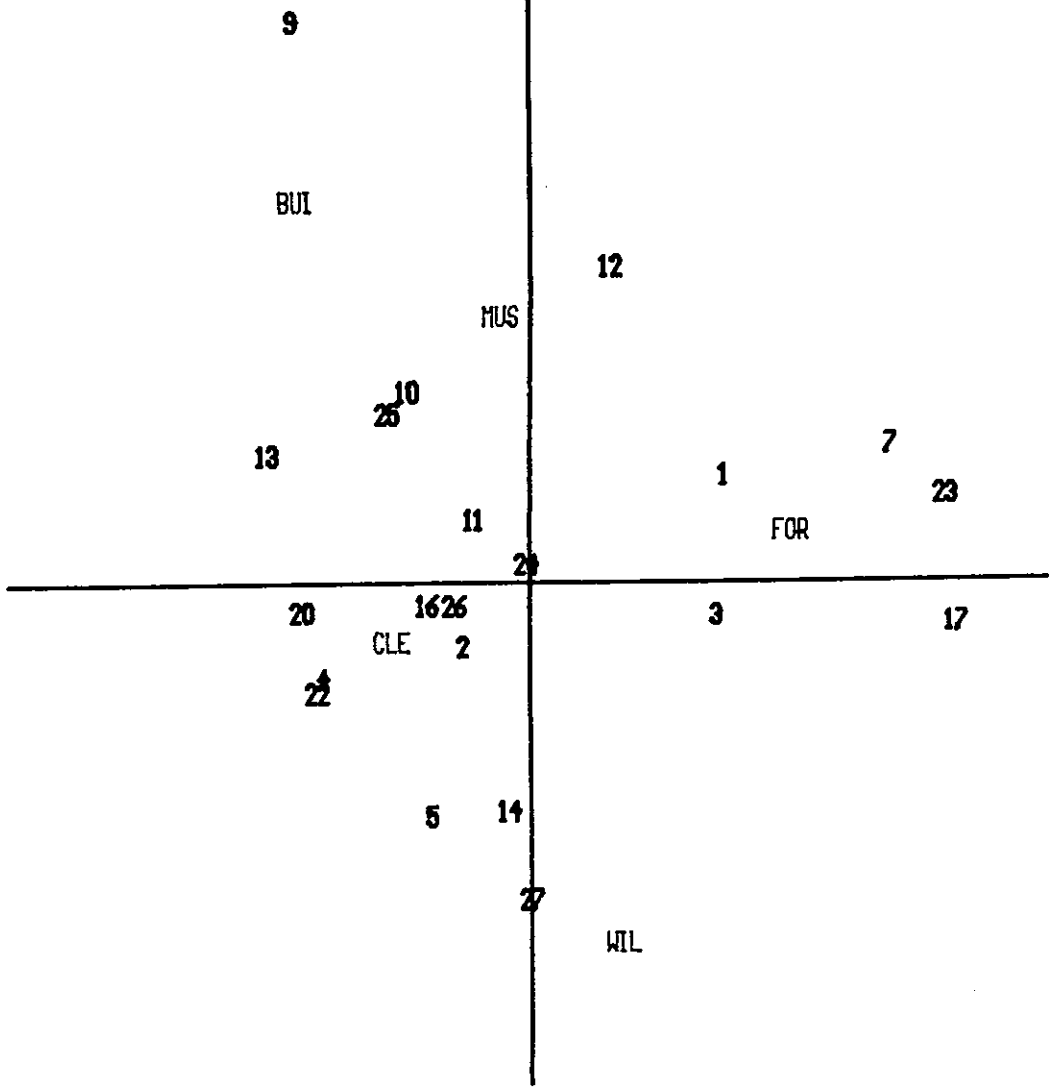


Figure 5.10
Factorial Correspondence Analysis, Agricultural Lands, 1991
Factors I and II



The topo-ecological landscape analysis has provided an empirical perspective of the changes to the structure and organization of the landscape under three different land use regimes. At the beginning of the twentieth century the study area was fairly homogeneous in vegetation cover. There are now substantial differences, depending on the concerns of industrial forestry, agricultural pursuits and settlement, which have imposed changes on the visible landscape.

The most visibly apparent and statistically meaningful change was that of areas subjected to agricultural land use. There, relatively small parcels of land were denuded and channelled to a quite different non-native vegetation type. There was little difference in the area examined between the landscape of the forestry management area and that of the Reserve. Both appear responsive to natural landscape evolutionary processes. However, only a small portion of the edge of these areas was analyzed, limited by data availability. Further analysis using more readily available information could provide a clearer distinction.

The description and interpretation of landscape change is only one side of the picture of this micro-region. It is imperative to broaden the approach to "[reveal] the mutual interdependence of social structure and spatial form" (Smith, 1984. The next section moves to the third question posed at the beginning: "how has land use been patterned by internal (cultural, land based) activities and how has activity been imposed by external factors: economics, industry, world events. How much control have local people had?"

Chapter Six

The Context of Industrial Land Use in the Lower Winnipeg River Area

"All the searing consequences of geographic regions - these things are seldom the result of decisions taken in the local space by the local people of the region"

(Gould, 1991)

A close look at the ongoing social, political and economic life of any location, while unique in some ways, draws out the close connections between land-based activity there and that in the wider world. The need to draw those linkages has never been more critical to the understanding of the effect of external events on a small community of people than it is in the present climate of globalization and restructuring of industry. In March of 1994, four years of negotiation and lobbying by a small management-led group finally succeeded in arranging a buyout of the Pine Falls Paper Company from its parent, Abitibi-Price. A new era starts where a tiny company will attempt to compete in a global market.

This part of the thesis tells the story of the involvement of economy in the region. It shows how continual expansion of activity and continual input of increasing amounts of energy

and materials are necessary to merely maintain economic viability. It relates to Table 3.1, which contrasted natural and anthropogenic landscape systems. That is, once the system of resource exploitation was in place, continual adjustments have had to be made to maintain the activity based on a 'natural' system in the face of the explosion of demand and changes in the economic situation.

Each time period has complex issues and ramifications. For each there is apparent conflict between corporate interests and government regulations. Decision-making about the dominant land use activities is done at distant locations and is related to economic business perspective. The more local and naturally emergent aspects of land use are within the controls of the local players, but the predominant interests of business control their options.

PART I: Power and Finance in Eastern Manitoba

The Canadian pulp and paper industry was born in the early years of the twentieth century. In 1896 Canada exported $3,953 worth of paper to the U.S. By 1900 that amount had increased to $29,741 (Ambridge, 1953). In 1900 the province of Ontario prohibited the export of pulpwood from Crown lands in order to encourage development of a domestic industry (House of Commons Debates, 1921). The other Canadian provinces soon followed suit. Meanwhile, demand for newsprint was climbing in the U.S., so in 1909 the U.S. government reduced the tariffs on newsprint imports. In 1913 the tariff was removed altogether. As a result, export of paper from Canada to the U.S. climbed to a value of $160 million in 1920. In a period of less

than twenty years a Canadian pulp and paper export industry replaced a wood exporting industry (House of Commons Debates, May 17, 1921; Abitibi, Jan. 1953).

The Manitoba Pulp and Paper Company Limited was chartered in 1916 to exploit extensive areas of timber in northeastern Manitoba. The owner, J.D. McArthur, had built up a wealth of expertise in railway construction through muskeg, rock and marsh during the construction of the transcontinental line. He was a major player in the Edmonton, Dunvegan and British Columbia Railway, building the railway to the Peace River district in northern Alberta. he helped open the area to agricultural settlement as well as to coal fields and large tracts of timber.

McArthur recognized the potential value of Canada's vast timber resources and was involved in several forest based operations in western Canada. He planned to build a 50-ton per day pulp and paper mill in Manitoba on the Winnipeg River, a short way downstream from Pine Falls. This was the last falls with hydro-electric potential on the river. McArthur had acquired the lease to develop hydro-electric power.

Working in McArthur's favour was the drive for industrial development in Manitoba. Bankers and legislators were urged to facilitate the exploitation of natural resources. "We should get seriously busy in getting the wealth out of our province and making it liquid for this and future generations" (Wallace, 1927). The Province perceived the Dominion Government to be an absentee landlord, not only unwilling to manage the exploitation of forest resources, but even unknowledgeable of the extent of forest reserves which could be made available to corporate interests (Man Free Press, Jan. 13, 1927). Concessions at the provincial and Dominion levels,

leveraged by personal efforts of powerful individuals were instrumental in establishing McArthur's presence in Manitoba.

The initial impetus for the establishment of the Manitoba Paper Company was played out far from the Winnipeg River. It was probably never appropriate to speak of the industrial landscape of Pine Falls as emergent; rather, it was imprinted onto the natural landscape. Eastern Manitoba before 1918 was a semi-wilderness populated by semi-nomadic aboriginal people, subsistence farmers and small scale hydro-electric generating stations serving a nearby urban area. By 1928, it was a cog in the wheel of international business based on exploitation of natural resources. Sir John A. MacDonald's National Policy had been based on utilization of the immense natural resources of Canada - mineral, forest, marine, agricultural - to fuel the economic development of the country. The same philosophy was in place in the Liberal government of William Lyon Mackenzie King in the 1920s. J. D. McArthur was in a strong position to benefit from that philosophy. According to Williams (1956) "McArthur was a staunch Liberal whose contributions helped keep the party's coffers filled. Among his friends were Sir Wilfrid Laurier (Prime Minister 1896-1911), the Honourable Clifford Sifton, Minister of the Interior 1896-1905 and the Honourable Arthur Sifton, Premier of Alberta (Liberal)".

The activity which took place in Manitoba was not confined only to the formidable influence of individuals. Even in the 1920s multinational corporations had already accumulated interests in hydro-electric power and the pulp and paper industries. In the House of Commons on February 28, 1929, J. A. Glen, the Member for Marquette, Manitoba, commented that "the financial interests of Canada constitute a hydra-headed monster so that no sooner do you hit one head than another rises, and in many cases you do not know where these financial interests have

their head at all." Two extremely large corporations, one in pulp and paper and one in public utilities, had interests in southeastern Manitoba.

Abitibi: The Abitibi Power and Paper Company Limited was incorporated in 1914. By 1928 the company and its subsidiaries comprised the largest newsprint producer in the world (Financial Post, 1929). The company had acquired an interest in the Manitoba Pulp and Paper Company in 1926, along with other plants in Ontario. In the fall of 1927 Abitibi merged with Spanish River Pulp and Paper Mills, Ltd., acquiring the remaining stock of the Manitoba Paper Company and several others. In 1928, acting with Canada Power and Paper Co.(a subsidiary of Power Corporation), Abitibi purchased paper mill interests in Thunder Bay.

By 1928 the Manitoba Paper Co. had a capacity of 78,000 tons per year, with wood reserves of 6,000,000 cords within exclusive timber berths areas. Manitoba Paper Co. also had a contractual agreement with the Dominion Government for the "priority right to the development and use, for its own purposes, of the Pine Falls water power adjoining its plant" (Financial Post, *op cit.*).

Power Corporation: Power Corporation of Canada had been organized in 1925 "primarily for the purpose of acquiring the control of, or a substantial interest in, hydro-electric and public utility companies" (Financial Post, *op.cit.*). By 1928 it was a major corporation which controlled power utilities all over Canada, with substantial interest through stock and bond investments in public utilities in the United States, Brazil and Japan. Some of these interests were in pulp and paper companies, for example Canada Power and Paper, the above-mentioned ally of Abitibi.

The Winnipeg Electric Company, incorporated in 1904, was controlled by stock ownership by Power Corp. It operated the street railway and gas business in Winnipeg, St. Boniface and

other smaller municipalities in the Winnipeg area. The Northwestern Power Company, a wholly owned subsidiary of Winnipeg Electric, was incorporated in 1928 to construct and operate a hydro-electric generating plant at Seven Sisters. Following construction, the Company would have a 50 year lease on the site. The Manitoba Power Company, incorporated in 1910 and controlled by the Winnipeg Electric Company, was formed to develop and distribute hydro-electric power for the Winnipeg Electric Co. from the power plant at Great Falls. It also had a contractual agreement to supply power to the Manitoba Paper Company at Pine Falls.

Friends in High Places

Ever since Manitoba was organized as a province in 1870 (and Saskatchewan and Alberta in 1905), the federal government had been administering their natural resources as a trustee in exchange for subsidies to the provinces. By the 1920s era of growth and development, pressure was mounting to transfer control over natural resources back to the prairie provinces. Prior to and during the period of negotiating for repatriation of resource jurisdiction to the province of Manitoba, a series of agreements were set in place which have set the direction and tone of all activity in the area to the present.

A crucial player in that major change in jurisdiction over natural resources was the Honourable Charles Stewart. In addition to his broad impact on the national scene, he was involved in setting up the timber berths and water power lease in Manitoba, thanks to his personal and official relationship with J. D. McArthur.

The Honourable Charles Stewart won a seat in the Alberta Legislature by acclamation in elections of 1909 and 1913 (Who's Who in Canada, 1927). He was appointed Minister of Municipal Affairs in 1912, exchanging that portfolio for the Ministry of Public Works in 1913. Following re-election in 1917, he was appointed Premier of Alberta and Minister of Railways and Telephones. (These events all took place during the time that McArthur was building and operating railways and cutting timber in northern Alberta.)

Stewart was again elected by acclamation to the Alberta Legislature in the General Election of 1921. He resigned his seat in the Alberta legislature less than a month later when he was appointed Minister of the Interior and Mines and Superintendent General of Indian Affairs

in the Dominion Government. He was parachuted into a seat in the House of Commons in a by-election several months later in 1922. He was elected for Edmonton West in general elections of 1925 and 1926, once again holding the Ministry of the Interior portfolio in the cabinet of William Lyon Mackenzie King.

Prior to the beginning of his political career Stewart had been a strong advocate of provincial control of resources. He had made a speech to that effect to the Young Men's Liberal Club of Calgary in 1901, before Alberta had even achieved provincial status (The Albertan, 1901). In 1920, as Premier of Alberta, he had again pursued the issue, in correspondence with the current Dominion Minister of the Interior, regarding difficulties of managing the coal mining industry without effective jurisdiction (Edmonton Morning Bulletin, Mar.16, 1920). Then in 1922, just after his appointment as Dominion Minister of the Interior, he repeated his goal (Killam News, Jan. 13, 1922).

During his tenure of public office at the Alberta provincial and dominion levels, Stewart nurtured contacts in railways, public utilities and natural resources. These contacts were important in his role as Minister of the Interior at a time of rapid growth of industry and economy in Manitoba. At that time many of the legislative and contractual deals were made which control the structural and organizational landscape of the Lower Winnipeg River area today (for example PC3423, 02/14/21; PC 2344, 11/02/22; PC930, 02/14/21; PC885, 06/05/25; PC908, 08/08/25). They affected settlement, industry, management of the Winnipeg River for hydro-electric generation and control of land and power on the Sagkeeng First Nation, formerly Fort Alexander Indian Reserve (see House of commons Debates April 25, 1924; July 4, 1924;Feb. 25, 1926;Feb. 26 & 27, 1927; Feb. 27, 1929).

Carving an Industry into the Wilderness

The establishment of the pulp and paper industry at Pine Falls was an uncertain venture from the beginning, taking several years to get off the ground. There were two impediments. Financing of the project was problematic, partly due to uncertainty about wood supply. The other aspect was simply the competitive nature of the pulp and paper industry. It was characterized from the very beginning by constant reaction to vagaries of international market conditions and by fierce competition among producers.

In May of 1921, McArthur secured a timber berth of 718 mi^2 on the east side of Lake Winnipeg, at public tender for $2.45 per cord of spruce, including bonuses. The authorization to dispose of the rights to this berth was provided by the Dominion Minister of the Interior by Order-in Council (no. PC3423, Feb. 14, 1921). However, a subsequent Order-in-Council (PC 2344, Nov. 3, 1922) indicated that McArthur said there would be insufficient pulpwood in that berth to supply what was now planned to be a 100-ton per day mill. Furthermore, they would be unable to raise capital to proceed unless a larger area was provided. The Minister therefore requested and received "authority to issue yearly permits to the company to cut pulpwood on the available lands in tracts contiguous to the Pulpwood Berth #1 ... subject to dues at the rate of $0.80 per cord of spruce and $0.40 per cord of other species". The permit to this extra area would be renewable on a yearly basis as long as the company was entitled to permits on the original berth.

The House of Commons was upset about the granting of 555,000 additional acres without tender. Members of Parliament were concerned that the paper company would leave idle the

timber berth it had acquired by public tender for $2.45 per cord. They would instead supply the mill from the berth it had received by Order-in-Council, without public tender (May 23, 1923, Debates) at the base price. Stewart responded that without an additional grant of land, McArthur could not secure financing. "... It is doubtful if, even with the additional area, the industry can be started in that locality, notwithstanding the fact that the company appear to have a lease of a very desirable water power" (House of Commons, May 29, 1923).

Wood Supply and International Competition

Attempts to acquire a secure wood supply went on for several years. The problem was exacerbated by periodic increases in the size of wood supply needed. The increases were necessitated by the second problem: international competition. The competitive nature of the newsprint business had two effects on the Manitoba Paper Company. Interference and obstruction by various groups was used to prevent finalization of the financial backing necessary to pursue development of the project. The other was to force the company to keep increasing the capacity of the proposed mill in order to maximize profit potential.

The company tried to purchase another block of timber rights, called Timber Berth #2, on the west side of Lake Winnipeg. However, in December of 1924, McArthur announced that his financial backers had pulled out of the deal and he would have to refinance the project. He said he would even approach the Manitoba provincial government for assistance (Manitoba Free Press, Dec. 20, 1924). Several months later, it was suggested that large international pulp and paper interests wanted to prevent this project getting underway, in order to stifle competition

("Poker and Pulpwood", Manitoba Free Press, June, 1925). The previous year, McArthur had been negotiating with American interests, but they had wanted to delay the development of Manitoba pulpwood reserves for up to ten years. Prior to 1925, the Spanish River Pulp and Paper Company had opposed the Manitoba project. Now it joined forces with McArthur. This new partnership then attempted to get timber berth #2 without paying bonuses, as 1A had been granted, by Order-in-Council. They were unsuccessful.

The projected capacity of the proposed mill had now increased to more than 200 tons per day. They hoped a larger mill would be more profitable, as newsprint prices were in a slump. The difficulty in securing financing to get the project off the ground therefore led to an escalation of the initial problem of wood supply.

Two Birds With One Stone

Agreement between the company and the Dominion government was reached on June 8, 1925, (Manitoba Free Press,"Pulp Mills to be Built in Manitoba this Year"). An Order-in-Council was passed in cabinet approving the exchange of pulpwood berth 1A for one equal in extent on the east side of Lake Winnipeg. This meant that a block that the company had been given without tender, amounting to 1080 mi^2, would be exchanged for up to 30 blocks, each of at least 30 mi^2 in area, to an aggregate total of 1080 mi^2. The total area from which the pulpwood limits could be selected was thus much larger in extent than the 1080 mi^2 block they had received without tender in 1922.

Timber selection in the berths would be made by the Dominion forestry department, in blocks of at least 30 mi^2. The company could accept or reject the blocks. It was generally believed that for the paper company, a corollary of the block selection process was to tie up the pulpwood concessions in such a way as to prevent any other company from getting a foothold. This new agreement would certainly fulfil that purpose. On one hand, it would allow Manitoba Paper Company to reserve all the blocks which would give the best return. Meanwhile, remaining blocks of timber would be too small and isolated to be economically exploited by another company. Secondly, the blocks of timber passed over at this stage would ultimately be sold to the company anyway (Manitoba Free Press, June 2, 1925).

The selection process got underway in the summer of 1925. Now, the company wanted to increase the capacity again and requested another increase in area, an extra 1800 mi^2. The Dominion government agreed to this but was resistant to guaranteeing a specific quantity of pulpwood. Also, the additional 1800 mi^2 of blocks would have to be selected from the area reserved in the agreement of 1925, south of township 46. Reservation of massive areas of timber was not to curtail development, but to save the timber for other interests known to members of parliament and the provincial legislature (House of Commons Debates, June, 1925).

When the mill was built and ready to commence operation, pulpwood negotiations had still not been finalized. On Dec. 18, 1926, The Minister of Interior had still not made a decision about exchanging the pulpwood limits. It was only on January 10, 1927, two weeks before the mill went into production, that a new policy was adopted in the pulpwood negotiations. The company agreed to drop its application for an additional 1800 mi^2, in exchange for a guarantee to 6 million cords of pulpwood.

The wording of the agreement implied that the company had been forced to accept a decision imposed by Minister of Interior Stewart. However, either version of the agreement would benefit the company. By this time, the extent, quality and distribution of the wood was well known. After two field cruising seasons, many blocks had been rejected because they were less than 30 mi^2 in area, or were not easily accessible by existing transportation technologies. The pulpwood would eventually be utilized, so they could potentially realize about 30% more timber than the amounts they were selecting. The agreement would effectively block any other mill from being built in the Winnipeg or Selkirk areas.

Also, in the new agreement, wood selection would "not be confined to fairly large blocks. All estimable stands of pulpwood are to be included." Selection was no longer restricted by the 30 mi^2 blocks size; blocks as small as 1 mi^2 would contribute to the total. If there was insufficient pulpwood south of township 46, they could proceed north for selection. If there was still insufficient supply on east side of Lake Winnipeg they could continue around the northern limit and down the west side. "The price to be paid for all the wood is to be the average price for the first 2 concessions - berth #1 and the additional 1080 mi^2."

The fears of 1923 came true. While not leaving the expensive limits idle, the company had negotiated a deal to get a much cheaper average cost for its wood, after getting the initial lease by bidding a substantial bonus. As well, the company gained a guarantee of wood supply, where selection would be extended over a larger and larger area until the needs of the mill were satisfied.

According to Travers Sweatman, former President of the Winnipeg Board of Trade and legal counsel to Spanish River Paper Company Limited, "the government shall guarantee to the

company that no other pulpwood concession or concessions providing for other pulp mills or mills shall be granted on Lake Winnipeg unless and until it shall be determined by examination and experience that there is enough wood to justify its continuous operation." That assured the financial backers and the company that they had a wood supply in perpetuity (Manitoba Free Press, Jan 11, 1927).

The timber agreement thus addressed both critical issues: wood supply and competition. It guaranteed a wood supply and squeezed out competition in the province. The arrangement also reflected government encouragement for the business. When the mill opened, it was set up to operate at 125 tons per day. According to Sweatman, the government told them to go ahead with one machine in anticipation of greater knowledge regarding wood supply. Once operational, the government would allow the plant to expand to a 250 ton per day mill. Also, as an existing mill they would be given more wood without competition (Manitoba Free Press, Jan 27, 1927). In addition, wood was purchased from private woodlots and an agreement had been made to purchase all cordwood available from the Fort Alexander Reserve (Winnipeg Evening Tribune, Feb. 17, 1926).

Setting the Stage for the Future with Scenery Cast in Stone

The negotiations for wood supply had been made by the Dominion Department of the Interior on behalf of the Province of Manitoba with a succession of principals and corporate reincarnations: Manitoba Pulp & Paper Co., J. D. McArthur, Spanish River Pulp & Paper Co., and Abitibi Pulp & Paper Co. The Manitoba Forest Act was enacted in 1930, transferring

responsibility for forest resources to provincial jurisdiction. However, agreements that had been made previously under the Dominion Lands Act were to apply *mutatis mutandis* to the Manitoba Forest Act (Sec. 42).

The act helped to establish the paper company and made it difficult for other companies to enter the field. Timber berths for disposal by public auction could not exceed an area of 25 mi^2 (Sec. 9(a)). The term of timber licences would not exceed one year, but could be renewed yearly for 15 years (Sec. 11(1)). Purchase of a timber berth was made dependent upon the construction of a pulp and paper mill explicitly (Sec 12(1) & (2)) and implicitly, by requiring all pulp and one half of all the paper to be manufactured within the province of Manitoba (Sec. 12(4) & (5)). The establishment of new pulp and paper concerns was made difficult by requirement of a $50,000 bond (Sec. 12(1)) and by restriction on the size and tenure of a pulpwood berth (Sec. 18 (2) & (3)) (Manitoba Forest Act, 1930).

The first roll of newsprint was manufactured on January 25, 1927, but the favourable arrangement for wood supply and the protection guaranteed by the forest act did not ensure the success of the company. The mill shut down in February of 1932, a casualty of the great economic depression (Winnipeg Free Press, Feb 5, 17, 18, 25, 1932), which devastated the entire industry. Canadian Pulp and Paper Co. had crashed in June of 1931. Abitibi Power and Paper Co., was forced into receivership in September of 1932, along with Price Brothers and Company and Lake St. John Pulp and Paper Company (Winnipeg Free Press, June 2, July 2, Aug 1, Sept. 3, 1932). The receivership of Abitibi lasted 14 years and was the longest in Canadian history.

The precipitating event in Abitibi's failure was over-extension of the company in a hydro-electric development concern in Ontario. However, the disaster was but the culmination of two

decades of rapid expansion, overextension of credit and oversupply of newsprint. Abitibi's expansion to remain competitive had included the purchase of three other newsprint mills in the late 1920s. Newsprint prices continued to fall, fuelled by over capacity and exacerbated by decreasing demand for newsprint in 1930 (Mathias, 1976:181).

The initial establishment of the Manitoba Paper Company at Pine Falls was thus not in any meaningful way a local initiative. Decisions were made by individuals, corporate bodies and government institutions far from Pine Falls. The workers and their families came from all over the province, from Ontario and elsewhere. The people of the Reserve retained a very peripheral role once the surrender of a portion of their land was finalized. Wood supply was negotiated from the point of view of business and political factors. From the first day the enterprise was connected to an international market and to a philosophy of resource exploitation for financial gain.

The Intimate Connection of Pulp-and-Paper and Hydro-Electricity

While the recurring themes directly related to the pulp and paper industry in Manitoba were those of wood supply and international competitiveness, the industry had to be concerned from the very beginning with energy supply. It is an energy consuming industry.

When McArthur initially undertook to develop the pulp and paper operation, it was to be the first step in a broader plan of action. The location had been chosen to facilitate extension of the rail line to a mining area opening up farther north (House of Commons, April 25, 1924) and to accompany ongoing development of hydro-electric generating stations on the Winnipeg River (Winnipeg Evening Tribune, March 4, 1926). His interest in the northern mining area was never realized. The hydro-electric interest was essential to the success of the pulp and paper mill.

The Manitoba Paper Company was originally incorporated under a Manitoba charter in 1916. On February 23, 1923, The Manitoba Pulp and Paper Company, Limited was incorporated under a Dominion charter. In addition to the supply of timber and manufacture and sale of pulp and paper, the charter gave the company the right to "develop, acquire, by lease, purchase or otherwise, steam, electric, hydraulic, or other power" (Canada Gazette, 1923). The company had acquired the rights to Pine Falls, upstream of the proposed mill-site. On March 26, 1926, a group led by Travers Sweatman (legal counsel for Spanish River Pulp and Paper Company and former president of the Winnipeg Board of Trade) was incorporated to "acquire and take over as a going concern the undertaking and all the assets of the Manitoba Pulp and Paper Company Limited". The same principals also incorporated the Pine Falls Power Co., Limited, dated March

11, 1926 (Canada Gazette, March 20, 1926, p. 2635) to construct, operate, generate and distribute electric power.

J. D. McArthur's lawyer and business partner, Bruce Thompson, drew comparisons to Ontario and Quebec in a speech to a business group about the pros and cons of the pulp and paper business in Manitoba. Thompson said Manitoba was at a "distinct disadvantage in ability to supply wood in sufficient quantity to justify the operation of a pulp and paper mill". Ontario and Quebec were more profitable because their supplies and operations were more centralized. The one advantage that Manitoba had was the readily available power facility from the generating capacity of the Winnipeg River (Manitoba Free Press, Dec. 11, 1924). For this reason, it is essential to draw in aspects of the hydro-electricity situation, to see its interconnection with the pulp and paper industry.

Hydro-Electricity from the Winnipeg River in Manitoba

A systematic survey of the Winnipeg River watershed had been carried out by the Ministry of the Interior in 1911 to evaluate power potential and the best means of exploiting it. By 1928, plants were already in operation under the ownership and management of various institutions and corporations: Pinawa, Pointe du Bois and Great Falls were operated by the Winnipeg Electric Company (Power Corporation). Slave Falls, on the Winnipeg River, had been reserved by a Dominion Government Order-in-Council, June 25, 1921, for the City of Winnipeg.

The Pine Falls site was also reserved. Under the Dominion Water Power Regulations, the paper company had the exclusive right, for a period of ten years, to develop the hydro-electric

potential of the Pine Falls. "The Minister recommends that the Pine Falls water power site be reserved from any disposition other than as a source of power for the utilization of the pulp-wood resources tributary to the southern part of Lake Winnipeg (Manitoba Premier Reports, 1928).

In 1928 a project was initiated to develop hydro-electric power at Seven Sisters Falls, on the Winnipeg River system. It is outside the study area, but the negotiations which brought it into fruition, the issues of resource jurisdiction and control, as well as the allocation of the power generated, are crucial to the understanding of the area. In February of 1928, Dr. T. H. Hogg of the Ontario Hydro Commission was asked to carry out a feasibility study of the "the power possibilities of the Pinawa-Seven Sisters reach of the Winnipeg River and its relation to the power situation in the Province of Manitoba. ... [and to] review the power resources of the Winnipeg River as a whole and the importance of these most valuable natural assets to the Province" (p. 72, Manitoba Premier's Report).

The spectre of a power shortage was presented as a justification for acting quickly to issue a licence and get development underway. There were doubters who questioned the sudden development of a crisis of power supply in the province. "Subsequently an effort has been made to show that a shortage of power will take place by 1929, according to Mr. Anderson, K.C., although Mr. McLimont puts it at 1931, and apparently there is no doubt in the minds of any of the promoters for the electric company that there will be no difficulty in disposing of the power to the consuming public. . . . It is somewhat remarkable that this immediate need should develop in so short a time, and should take the form of a stampede" (House of Commons Debates, June 25, 1928).

Commissioner Hogg was opposed to private enterprise development of natural resources, particularly water resources. He expressed concern about allowing a monopoly which would later lead to increased consumer costs. He thought the Manitoba situation was optimal, with a publicly-owned utility to develop and distribute electricity in the City of Winnipeg, a publicly owned Manitoba Hydro Commission to distribute to the rest of the province, and the Winnipeg Electric Company (Power Corporation), a private concern developing and distributing power in the city.

The Dominion Government, specifically the Minister of the Interior, had the jurisdiction to dispose of resources in Manitoba. He was involved in the negotiations over Seven Sisters Falls. This took place simultaneously with the provincial attempts to transfer natural resources jurisdiction back to the provinces. A resolution was moved by Woodsworth (Member of Parliament for Winnipeg North) that "no disposition of the natural resources, under the control of the federal government, shall be effective until ratified by parliament." (House of Commons Debates, February 28, 1929). In May and June of 1928 Manitoba Members Parliament had pressured the Minister of the Interior to refrain from signing a licence for hydro development until it had been approved by the legislature of Manitoba, as the people of Manitoba should have final say over their own resources. Much the same situation developed regarding disposition of hydro electric rights as had been the case in timber allocation for forest industry: when the province of Manitoba gained control over hydro-electric resources in 1930, prior agreements made by the Ministry of the Interior had already tied up hydro-electric potential for several decades.

As Seven Sisters Falls hydro development neared completion, the Winnipeg Electric Company arranged bus tours to take Winnipeg housewives out to see the plant. At that time, Winnipeg had the highest per capita electricity consumption in the world (Manitoba Free Press, May 26, 1931). Electricity was being promoted in all settled portions of the province that had access to power, with the idea that "the more they use, the less the rate would be". On July 15, 1931, the day the Seven Sisters Falls generating station went into operation, the Winnipeg Electric Company ran a big ad for appliances, saying "this is our contribution to the growth of Winnipeg and Manitoba" (Manitoba Free Press, July 15, 1931).

In 1932 there was an increase of hydroelectricity use in Manitoba, while there was a decrease in Ontario and Quebec. 88% of industry in Manitoba was electrified but the major user of electricity in the province was the pulp and paper mill in Pine Falls. Its need for more power had increased, as the initial projected mill of 50, then 100 tons per day was by now a 200 - 250 ton per day operation. But in February of 1932 the paper mill at Pine Falls closed down. On March 17, 1932 (Winnipeg Free Press) the Seven Sisters Plant ceased operation, siting the drop in power demand due to the paper mill closing.

PART II: Post-War Expansion

When the paper mill in Pine Falls shut down, it had a significant effect in the area, proof of the dominant influence of the industry. There was no other employment for the workers and their families. As well, it demonstrated the inability of the enterprise to survive outside the external price- and supply-driven industry.

Three major interrelated events of the 1940s and early 1950s set an indelible mark on the landscape of the Lower Winnipeg River. Rural electrification was an international crusade being carried out to extend electrical service (and demand for appliances) beyond urban and municipal areas. Second, the last major hydro-electric project on the Winnipeg River system was slated for development. A commission, again chaired by T.H. Hogg, was established to consider the present and future direction of hydro-electric generation and distribution in the Province of Manitoba. Third, a new federal forest policy was announced in 1950 and Manitoba enacted a new Forest Act in 1953.

The paper mill had reopened in 1935, but expansion began only after the Second World War, when Abitibi was reorganized and returning servicemen poured into the townsite. Following the Second World War, governments searched for ways to organize industry and the economy in such a way as to prevent another great economic depression such as that which had devastated the world in the 1930s. The goals of government fit in well with those of industry, which desired to transfer military production to non-military uses and to build markets for goods and services. There was a surge in demand for paper following the war. Equipment upgrades

allowed an increase of production to 400 tons per day and later to 500, in order to meet the demand (Cavers & Munro, 1976;Winnipeg Free Press, March 15, 1955).

Post World War II - Farm Electrification and Employment

During the 1920s and 1930s electrification had reached most urban areas and industries. The sale of appliances had saturated the market and a new market had to be created. Farm electrification had been promoted elsewhere as a government initiative to encourage regional economic development. Perhaps the best known example was the Tennessee Valley Authority in the United States. TVA poured money into electrification, land reclamation and water management during the 1930s[1].

The farm electrification program in Manitoba was not initiated without thought. In 1942, the Province of Manitoba commissioned E.P. Schmidt of the University of Minnesota to undertake a feasibility study. His report covered the background of agricultural economy in Manitoba up to the Second World War. The Commision did a survey of farms in six well-populated rural townships regarding their willingness to participate in an electrification program.

Manitoba's farm economy, like that of the forestry industry, was closely integrated with international agribusiness rather than responsive to internal needs. The agricultural community was impelled to react to external events. After the initial wave of settlement, there should have been "consolidation of progress made during the period of settlement, to eliminate uneconomic

[1]Chandler, (1984) concluded that government sponsored rural electrification schemes did not efficiently promote security and development. The infrastructure was often put in place where people were simply too poor to accommodate the amount of equipment and appliances necessary to make it worthwhile.

development, and to reach out for a permanent agricultural economy" (Manitoba Electrification Enquiry Commission, Schmidt, 1942). However, the First World War with accompanying wartime inflation was followed closely by several years of uncertainty and some 'readjustment' (i.e., the economic depression and extremely low prices). Manitoba along with the rest of the West then experienced the expanding North American boom of the 1920s. During the 1920s wheat acreage was expanded. This led to oversupply as European countries worked toward self-sufficiency during the 1930s. Crop researchers created wheat varieties adapted to growing conditions world wide, further increasing wheat growing competition, while at the same time reducing the risk of growing wheat in the prairies.

As Dr. Schmidt summed up the situation as follows:

> "Thus in the past forty years, changes and economic upheavals followed each other so fast that adjustment to them (in the light of hindsight) was always late and imperfect. At no time in this period is there any extended number of years which might be treated as a norm toward which the economy might be consciously encouraged to conform. During most of this period, and over the greater part of the world, there was great instability of monetary and commercial policies and unpredictable reversals of trend in international capital movements. It was during this period that the West became settled and became a major world food-surplus-producing area."
>
> Dr. E.P. Schmidt, Commissioner
>
> Manitoba Electrification Enquiry Report, 1942, p.10

The agricultural situation was similar to that of forestry, Manitoba's other major resource-based industry. Both were subject to unpredictable and uncontrollable international conditions. Both were integral to the Province's economic prosperity. Both relied on strict management and exploitation of biological resources. Schmidt proposed that rural electrification in Manitoba would allow the province to compete in the international market, would promote postwar employment and would reduce some of the farmers' drudgery and increase their income. Rural electrification was deemed necessary "if Manitoba's economy was to retain its place in the world economy." (Schmidt, p. 10).

During the same period there was a commission to assess the province's future demands of hydro electricity and its ability to meet that demand. An analysis of Manitoba hydro resources and potential was undertaken by T.H. Hogg (who had studied the Seven Sisters development in 1928). He was to investigate Manitoba's hydro electricity requirements up to 1953. The scale and type of hydro-electric developments required to meet those needs was to be determined. Commissioner Hogg was to make specific recommendations about power sites to be developed. As well, he was to "investigate the need or otherwise for co-ordination in the operation of various hydro electric installations on the Winnipeg River in Manitoba, and, if such need is manifest, to advise and make recommendations to the Government of Manitoba regarding methods and choice of method" (Hogg; Water Power Commission, *op cit.*, p. 1).

Table 6.1 shows the situation of electric power resources in Manitoba as of 1946. The network served Winnipeg and adjoining municipalities, the Central Manitoba mining area, the Manitoba Power Commission (which distributed power to rural areas) and the Manitoba Paper Company at Pine Falls. Hydro-electricity generated on the Winnipeg River in Manitoba also

supplied some power to the newsprint industry in Kenora, Ontario (Hogg, *op cit.*:7). By 1946, the pulp and paper industry was consuming more electricity (72,300 H.P. years) than either the mines (68,650 horsepower years) or all other industries combined (65,600 horsepower years). The amount of electricity consumed by the pulp and paper industry in 1946 (21.8% of capacity) was greater than that for any other use.

The 31% increase in electricity use for the pulp and paper industry from 1941 to 1946 was much greater than that for mines (9.7%) or for other industries combined (16.7%). The increase was due to technological enhancement which increased the speed of the paper machines. The increase was not only in speed, but in volume. The mill's capacity was now 400 tons per day.

Table 6.1: Distribution of Power Sold in Manitoba (Hogg, Manitoba Power Commission Report, p. 7)

	1941 H.P. Yrs	%	1946 H.P Yrs	%	Increase H.P. Yrs	1941-46 %
Municipal	6,000	2.3	6,400	1.9	400	6.7
Street Railway	5,450	2.1	7,350	2.2	1,900	34.9
Manitoba Power Comm	7,550	2.8	13,700	4.1	6,150	81.5
Domestic	50,300	19.0	65,300	19.7	15,000	29.8
Commercial	21,700	8.2	32,800	9.9	11,100	51.1
Mines	62,600	23.6	68,650	20.7	6,050	9.7
Pulp and Paper	55,200	20.8	72,300	21.8	17,100	31.0
Other Industries	56,200	21.2	65,600	19.7	9,400	16.7
TOTAL	265,000	100	332,100	100		

The Government of Manitoba's "hands were tied" by the previous decisions and actions of the Dominion Government Department of the Interior. "By the time the Province gained control of its water power resources, the Pointe du Bois site had been leased with no specific provision for recapture. Great Falls, Seven Sisters and Slave Falls sites had been licensed under conditions which made them subject to recapture by the province only in 1962.

"The Pine Falls site had been reserved for the use of the Manitoba Paper Company" (Hogg:20). These agreements had been arranged in a series of Orders-in-Council signed under the authority of the Minister of the Interior, most specifically P.C. 908, June 8, 1925. The others were P.C. 330, February 14, 1921; P.C. 2344, November 11, 1922; and P.C. 885, June 5, 1925; all assured hydro-electric power for the paper company.

Prior disposition of the hydro-electric facilities concerned Hogg, who favoured public control and ownership of the utility production and distribution. Pine Falls was an excellent site. If granted to the Winnipeg Electric Company (Power Corporation), the Province would likely have to purchase it back later on. In addition, the contractual obligation to the Manitoba Paper company was a serious impediment. To meet the terms of the contract and to protect the power requirements of what was considered an extremely valuable industry, any development would necessitate:

> ". . . a clear stipulation to the effect that the power requirements of the paper industry are to be a first charge upon the output from the site in question, together with adequate provision with respect to the cost of such power to that important industry. The probable necessity of including in any license to the Pine

> Falls site a provision to this effect, particularly when considered in conjunction with probable recapture provisions effective, say, in 1962, would, from the standpoint of either or both of the existing power producing utilities, detract considerably from the attractiveness of an otherwise attractive site." (p. 29-30).

Dr Hogg was to suggest a series of alternate plans for Manitoba to approach future power needs. Four were presented in his report and they were discussed and analyzed extensively in the press during April and May of 1948. Hogg favoured a plan to completely reorganize the hydro-electric generation and distribution system under public ownership. One reason was "the present problem with respect to the Pine Falls site would be readily soluble by a contract between the generating agency and the Manitoba Paper Company wherein the former undertook to supply power to the latter at rates which would bear a close relationship to the costs of developing power at Pine Falls" (Hogg:p.37).

That plan would also meet the need to integrate the hydro-electric potential of the Winnipeg River in order to coordinate the water flow. The power plants were close together. The hydraulic head had to be managed for peak generating efficiency. That would be easier if the system was united.

In 1949 a new Water Power Act for the province was introduced. While it was eventually put on hold, the more urgent legislation required to give the Province authority to develop the hydro-electric resource at Pine Falls was set in place. Construction was soon under way. As part of the construction, provision was made for a vehicular traffic bridge across the dam. This would lead the way to development of the northeastern parts of the province. It would also lead to

accelerated development in the Broadlands. As well, the Province at that time also granted $370,000 to drain and improve marshy lands for agricultural settlement in the province, including the Catfish Creek area, in the south east portion of this study area (Member of the Legislative Assembly Roxy Hamilton, April 7, 1950).

Wood Supply and Competition

The Manitoba Paper Company had originally been planned as a 50 ton per day operation, then 100. It had eventually opened with the plan to expand to 250 tons per day. With the expansion in the post-war years to 500 tons per day, there was a consequent requirement for much more electric power and pulpwood than originally planned. The extra power needed after the 1950s expansion would be supplied by the Pine Falls dam, now being constructed to make life easier for the farmers of Manitoba.

Of course, the demand for pulpwood increased dramatically from the amount allotted in original pulpwood allocations for the mill. The extra wood also had to be secured. In 1950 a new National Forest Policy was presented to Canadians, to "contribute to national welfare through the development of forest resources" (Winnipeg Tribune, May 18, 1950). Manitoba also updated its forest act in the post-war years.

The circumstances under which the original timber berths had been assigned to the Manitoba Paper Company came under attack. Errick Willis, the leader of the Progressive Conservative Party, then in opposition, said that much of the blame for the allowing of such broad concessions to the company could be laid at the feet of the Federal Government's actions

(i.e. The Minister of Interior's Orders-in-Council). However, there was no need to "perpetuate this monopoly for another 25 years" (Winnipeg Tribune, March 29, 1952, 'Forest Act Held Over'). However, the act finally passed. Keeping with the terms of the old act, the company retained its option to renew its agreement for another 25 years. Meanwhile, under the terms of the new act, it could now surrender its holdings which were scattered in smaller berths around the area in exchange for a new consolidated timber berth closer to the mill.

The new road access across the Winnipeg River at the Pine Falls hydro-electric dam was an important consideration. In the original timber cruises carried out jointly by the Dominion Ministry of the Interior and the company, timber berths accessible to streams were preferred. Pulpwood cut in winter was swamped to the shores of rivers and piled on the ice. The streams were dammed up and then blasted out in the spring. The logs floated down to catchment places where they were contained in log booms and floated down or pulled by tugboat up to the mill pond (F. Fontaine, pers. comm. 1991). Road access meant a different configuration of pulpwood supply locations was more favourable.

The Manitoba Forest Act of 1953 renewed the agreements made prior to July 15, 1930 (i.e., Sec. 12(2), re: the Abitibi licence). It made provision for the licensee to "consolidate, revise, or amend the licence, arrangement, contract, or agreement" (Sec. 12(8)) and also to "surrender such berth or any portion thereof, and in lieu thereof, may grant to the licensee, without competition, a substituted area or areas" (Sec. 12(9)). So, a timber licence, two thirds of which had originally been acquired by Order-in-Council of a Minister of the Crown without public competition and over the objections of other elected representatives, was now entitled to

be exchanged, again without public competition, for a new area (Revised Statues of Manitoba, 1952).

Work in the Woods Operation was changing. Bridge access and road construction into timber areas allowed increased mechanization and increased efficiency along with reduction of labour and associated costs (Abitibi, May/June 1958). Until the 1960s, huge draft horses had hauled pulpwood to the shorelines and roadways. In the 1962-63 season 140 horses were still in service, but they were used in the cutting operations in 1966-67 for the last time (Abitibi, Winter 1967-68:p. 57). Cutting was increasingly mechanized. Gas-powered chain saws were used to cut wood and gradually gave way to mechanical harvesters. (Those fuels constituted a further input of energy from outside the area.) During cutting operations in the 1950s and 1960s, immature wood and non-targeted species were left; the horses wove their way between them and plenty of trees were left standing. In 1992, areas harvested under that system were to be cut again, using mechanical harvesters. A worker who was involved in both operations commented that thirty years from this cut, there will be no pulpwood there to cut (M.C., pers. comm. April 22, 1992).

Industrial activity to gain access to international markets was taking place elsewhere in Canada at that time. In 1956 modern, efficient paper mills were built at Hinton, Alberta and Prince Albert, Saskatchewan. That was followed in the next decade by a major expansion of paper mills in the United States and reorganization of the global pulp and paper industry. By 1958, world newsprint capacity was 10 to 15 per cent larger than demand and principals were counting on growth in the U.S. economy to close the gap.

In the 1930s, the Canadian industry had attempted to prevent Russian pulpwood from entering the North American market using the ploy that Russian pulpwood was produced by convict labour[2] (Manitoba Free Press, Feb. 11, 1931). In 1930 Russian exports of pulpwood to the US amounted to 150,000 cords, compared to Canadian exports of 1.5 million cords. Stalin's projections of a 5-year industrialization plan would increase exports by as much as 700%. In the 1950s and 1960s, the threat came from the Scandinavian countries attributed to lower wages there (Ambridge, D.W., Abitibi, April 10, 1959). In the late 1960s, paper mills were being built in the United States, where there were lower wages, faster tree growth and year-round accessibility. The paper mill in eastern Manitoba was struggling to "compete" with all others in what was an increasingly demanding international market, using a forest resource that had been considered marginal at the beginning.

Many major changes took place in the area in the period following the early 1950s. Some were related to the forest industry, some to the hydro-electric development, some to changes in agricultural production and commerce.

The installation of the hydro-electric generating station at Pine Falls had numerous consequences in that small area. Establishment of the hydraulic head to generate electricity required the backing up and management of water. Manitoba Hydro purchased land from farmers along the shores of the Winnipeg River and the Maskwa River, knowing that some inundation and erosion would take place. In most cases the amounts were relatively small acreages. Silver Falls, upstream from the plant, was inundated, leaving fast water with some rapids, but without its former glory. Several large islands and three sets of rapids and falls were inundated. Pine

[2]Meanwhile, Canada was actively pursuing an agricultural trade alliance with the Union of South Africa, whose production was based on slave labour.

Creek, Maskwa River and Little Bear Creek also backed up and continue to adjust to the new banks. Residents accepted the change stoically, saying the "electricity would make life so much more easy for rural people, that they were quite willing to lose the falls" (G. Lalor, Nov. 23, 1991).

Part of St-Georges was inundated. It was necessary to move the graveyard, the convent, the *fromagerie* and other buildings. Again, the residents accepted that the new developments meant progress. The agricultural activity around St-Georges and in the Broadlands had been diversified and generally included extra-farm economic activity. Many farmers worked as cutters in the bush camps during the winter. As the paper company adopted mechanized cutting technologies, the employment opportunities for farmers decreased.

In the early period, there had been a ready market for the produce of the area. Milk, eggs, etc. were sold to grocers, or processed at the *fromagerie* and dairy. After the *fromagerie* closed due to flooding, milk was transported by vehicle to Winnipeg for processing. Modern health regulations destroyed the market for small-scale agricultural production. It was ironic that a program to make it possible for farmers in the prairies to diversify, was accompanied by government regulations and changes in public perception which made their labour and enterprise redundant.

The effect on the Reserve seems to have been minor as far as their relationship with the river was concerned. The dam and upper reaches were not within the boundaries of the reserve. The road access merely made accessibility more secure for those on the North Shore who were employed in the paper mill. Previously they crossed by boat in summer and over the ice in

winter. During break-up and freeze-up workers had to move temporarily to the South Shore in order to continue working.

PART III: The Corporate Shuffle

In the modern period, the changes in wood supply and government support for the industry helped the company to stave off the competition. The multinational nature of the business and need for large size to realise economy of scale were the major aspects of the industry in this period. Events and initiatives in Pine Falls showed the close relationship between business and government to maintain exploitation of the forest.

Wood Supply and International Competition

In October of 1962, a delegation of Abitibi Officers, including the President of Abitibi, the Vice Presidents of Finance and Woodlands, the Chairman of the Board and several Directors, including the Chairman of Wood Gundy investment firm and representatives of Abitibi's team of legal firms (Toronto, Montreal and New York), came to Pine Falls to open the new high school, comprising four classrooms, a library and a science lab. Also present were representatives of the Provincial government: the Deputy Minister of Education, the Minister of Industry and Commerce and the Minister of Natural Resources. "Earlier in the day a Directors' meeting was held in Manitou Lodge" (Abitibi, Spring, 1963). In March of 1963 it was

announced that the forest industry was hampered by lack of long term tenure to timber (Winnipeg Tribune, March 23, 1963).

The old problem of wood supply which initially had affected the feasibility of the mill at the development stage was back. Now it was hampering the expansion needed to deal with the other, economic, constraint: competitiveness on the international market. Manitoba proclaimed a new Forest Act in 1964.

Under the new Act, forest areas were organized into Forest Management Units. Timber licences would be in the form of quotas, based on previous timber cutting. Timber cutting rights could be refused "if the bid or tender is considered by the director to be (a) detrimental to an established wood using industry or to the establishment of a new one; or (b) unfair to established operators in the area; or (c) made by a person or a group of persons not qualified or equipped to conduct the operation" (Sec.12(2)). The Act recognized the requirement for a continuous long-term timber supply, allowing granting of licences for periods up to 20 years, with renewal for further periods of not more than twenty years each (Sec. 19(1) & (2)). As in previous Acts, the area of wood supply would be expanded if the capacity of the mill increased (Sec 19(6)). A further clause confirmed the licence sold prior to July 15, 1930, with renewal each year while commercially valuable supplies of timber lasted, (Sec 22(1)) and renegotiation for "surrender" of a berth for a cash settlement or other terms, such as exchange for another area (Sec 23) (Revised Manitoba Statutes, 1964 Forest Act).

The 1960s in the paper industry were characterized by amalgamation and growth. Abitibi acquired mills from other companies as a means of increasing productive capacity without the capital expenditure of building new mills.

"The newsprint industry is a world wide one . . . [and] its health is determined by world markets. . . Paper itself is a low-cost product; the bulk of the cost is in transporting it, and newspapers buy their newsprint supply from the mill that is geographically closest" (Composite statement. See Ambridge, 1959; Rosier, 1967; Munro, 1976; Pitre, 1991). The major survival strategy of the industry has been, from the beginning, to consolidate holdings and expand capacity and hope that other companies would succumb to downward pressure on prices. In the 1970s the large newsprint corporations in Canada and the U.S. were becoming even larger in order to become more competitive. The rationalization process was supported by analysts in the Canadian government (Govt of Canada, 1973; Malcolm (Winnipeg Tribune, 1978; Mathias, 1976).

In 1967-68 Abitibi purchased several mills in order to diversity its holdings: City Papers Limited and Hilroy Envelopes and Stationery Limited. Abitibi also acquired Cox Newsprint, Inc., at Augusta Georgia. This particular acquisition would be Abitibi's short term solution to the dual problems of secure wood supply and competition. It also engendered fierce competition within the company itself, between efficiency, capacity and profitability of individual operations. That plant, built in 1966, was among the largest and most modern in the world. The plant would provide worldwide access to Abitibi customers. The operation came with 95,000 acres of softwood forest within 65 kilometres of the mill, accessible by road year round (Abitibi, Summer 1968).

In 1974 Abitibi merged with Price Corporation, with which it had previously been in direct competition. Rationalization and consolidation into a few extremely large companies was the overall trend in the industry in North America. By the 1980s, Abitibi-Price had fallen under

the control of Olympia and York, a transnational firm heavily involved in real estate. Olympia and York itself collapsed under the weight of its real estate debts while constructing the Canary Wharf megaproject in London, England, in 1992.

Each stage of activity in the industrial forestry has exhibited the tension between ecology and economy; that is, the double issue of wood supply and competition. In addition, the energy requirement of the industry has expanded significantly. The supply of electricity to the mill has been part of the dynamic of eastern Manitoba. Again, ecology is meant in the broad sense of the deterministic yet chaotic interaction of physical, biological and climatic interaction of matter and energy of the "natural world". The economy is meant in the broad sense of the abstract, structured and directed utilization of material and energy resources to generate monetary return.

Table 6.2: Chronology of Manitoba Paper Company in Pine Falls.

Year	Item	Notes
Status prior to 1921	Export restrictions on Can. pulpwood. Reduced tariffs on import of pulp and paper to U.S.	1890 pulp and paper export $120 1920 pulp and paper export $160-million protective tariff created industry in Canada (House of Commons Debates, May 17, 1921)
1921	Pulpwood berth #1, 718 mi² **100 ton per day mill**	Sealed tender, public auction of timber berth, base price $0.80/cord (for spruce) + bonuses -- $2.45/cord
1923	Pulpwood Berth #2 extra 500,000 acres **200 tons per day**	Added by Minister of Interior by Order in Council without tender, at 1/3 price per cord of original tendered purchase (House of Commons Debates, May 29, 1923)
1926	Land acquired for townsite and millsite of Manitoba Pulp and Paper Co.	Surrendered by Fort Alexander Indian Band: Originally 520 acres for 99 year lease at $1040/yr ($104,000). Changed, with assistance of Indian Agent J.R. Bunn, to surrender for sale of 390 acres for approx. $15,000 (H. of C. Debates, Feb 18, 1926)
1927	Changed basis of pulpwood selection and areas **300 tons per day**	Guarantee to 6,000,000 cords. Changed requirements of minimum block size from 30 mi² to 1 mi², more timber, same area
1930	Manitoba Forest Act	Timber and pulpwood licence, guaranteed pulpwood berth granted to Abitibi before Act. Clause to require $50,000 to establish new paper mill, preventing other companies.
1931	Whiteshell Forest Reserve	Added to previous reserves established with Act
1932	Mill closed 1932 to 1935 Abitibi in receivership from September 1932 to May 1946	Repealed section of Forest Act which required mill to operate 10 months each year or forfeit licence, in exchange for amendment to allow export of pulpwood to U.S. while mill closed (previous law required all pulp and 1/2 of paper, to be manufactured in Canada.(Forest Act Amendment, April, 1932, Winnipeg Free Press, 18/1/32)
1949	**400 tons per day**	Speed up of machines to meet increased demand for paper
1950	New National Forest Policy	"contribute to national welfare through the development of forest resources"
1952	Renewal of Timber Pact	Manitoba Forest Act, 1952: rearrangement of timber berths allocated at start of operation, original agreement expired 1951, company exercised option to extend further 25 years, option to exchange part of timber berth for other of similar quality, without competition - consolidated holdings close to Pine Falls - size of licence to be governed by output of mill
1955	Mill expansion **500 tons per day**	Modernization and expansion of Pine Falls mill announced by Minister of Natural Resources
1964	New Manitoba Forest Act	Change tenure rights to ensure long term access to wood. - forest management units, quota holders, quotas based on previous years' cutting. Forest Management Licence (FML)for 20 years, renewable for 20-year periods, licence area expandable if mill capacity increased.
1974	Abitibi-Price merger	Enhance international competitiveness, increase holdings without building new mills, (supported by Can. govt., in policy paper in 1973, re rationalization of industry)
1979	Forest Management Licence Agreement:Province and Abitibi-Price	Industrial forest uses take precedence in province. Company has timber cutting rights, can construct and control access roads, must submit plans, pay stumpage (which is allocated for forest renewal), undertake reforestation activity.
1989 to 1992	Clean Environment Commission environmental review of Forest Management Licence **500 tonnes per day**	Renewal of licence to cut timber on FML - approximately 38% of mill requirements comes from FML, remainder from private woodlots, Integrated Wood Supply Area, Duck Mountain Forest, out of province.
1991 to present	Buyout process **600 tonnes per day** **(ultimately 700 or even 800)**	Plans to upgrade machines, install new woodroom, install de-inking plant to allow recycling, new gas pipeline for steam & electricity generation plant, expand production

Chapter Seven

Economic Development or Environmental Sustainability?

Globalization and external control of local land use decisions were evident from the first days of the pulp and paper company. Boom and bust periods in the industry and waves of industry-wide buyouts, mergers and collapses characterized the history of pulp and paper manufacture in Canada. It in turn dominated internal control within the area itself.

The present period marks another critical time in the history of the Lower Winnipeg River area. Global and national scale interests are having a profound influence on the communities. While the previous periods were clearly dominated by economic and supply issues, non-economic long-term issues of environmental sustainability are becoming increasingly important in industry, particularly in relation to natural resource exploitation.

The pulp and paper operation in Pine Falls, indeed the industry as a whole, have provided a battleground on which to resolve the tensions between the environment and economy. The crisis in the community and legitimate concerns over the future of the area, are directly related to the constraints imposed by massive dependence of the area upon one industry. For 65 years

energy and labour at the local level and imported from elsewhere have transformed raw materials into a commodity which has been removed for liquidation in the global financial exchange.

The paper mill is currently involved in several major critical processes. One is the finally-realized buyout of the mill and woods operation from the parent company by a group composed of members of local management, a majority investor based in Montreal (who is a former executive of a competing transnational Canadian pulp and paper corporation), the trades and labour unions and individual investors (Public Meeting, Oct. 2, 1991; Community Voice, Oct. 5,1994). The buyout was approved in March of 1994. Sagkeeng First Nation, the band of Fort Alexander Indian Reserve, has been an on-again, off-again partner, depending on the status of issues related to specific land claims, pollution of the Winnipeg River and economic development.

Second, under new legislation, (Forest Act 1983), a review by the Clean Environment Commission of the Province of Manitoba was, for the first time, required for renewal of Abitibi-Price's Forest Management Licence area. This involved an environmental impact assessment as well as public hearings. Particular aspects of the situation, mainly related to withdrawals of parts of the licence area for parks, had implications for the broader community. The uncertain future for the mill due to its age, size and location have created anxiety in the community. The social and psychological effects are similar to those observed in many single industry communities in threat of closure (Bradbury & St-Martin, 1983; Quenneville, 1992). Consequently, the process has involved intense lobbying in the media and to government officials, by the company and a variety of groups and individuals on every side of the issue.

Conflicting Interests

Within the company itself, structural and functional organization has historically isolated the various components of the corporation. The Woods Operation is land-based and sensitive to environmental conditions. Activity is seasonal. The workers, both operational and professional, have expert theoretical and practical experience in the forest environment. The mill is an industrial operation, with engineering and management professionals and skilled and unskilled workers. Many of those skills are unique to the pulp and paper industry. Furthermore, since the beginning of the operation, the company has been extremely centralized, with financial, research-and-development and corporate activity taking place at the head office in Toronto. The townsite itself is company owned and operated, with no independent local government process.

As stated earlier, the role of government is necessarily complicated because government is responsible for both protection and exploitation of resources. Government must address itself to both the corporate interests and to the community at large, whose interests include social support, environment, infrastructure, etc., in addition to the economy. These competing interests have been exploited to a great degree in the context of tensions between ecology and economy.

The entire period of operation of the pulp and paper mill has been carried out with government involvement and assistance. The part played by government in the development and growth of the forest industry in Manitoba was addressed earlier. However, in the relatively recent past, issues related to environment, including pollution abatement and prevention, forest yield management and recognition of other non-monetary values of forest have been recognized as important factors. Government at all levels has a clear mandate to address these concerns.

In connection with those competing factors, two fallacies have been continually perpetuated. The perception was actively fostered that 'Government' is against 'Business' and that government intervention through taxation and regulation inhibit competitiveness. This has been repeated regularly, in the annual reports to employees published in Abitibi magazine, by company officials in public meetings with community members and in addresses by company officials to labour groups and shareholders. The other misconception is that the wood supply has been reduced by government action.

Wood Supply

The company claims that its wood supply has been continually eroded by government withdrawals since the 1930s. Evidence is the creation of Whiteshell Provincial Park in the 1950s, Nopoming Park in 1976 which was surimposed on the limits of the Forest Management Licence area and the establishment of Atikaki Wilderness Park in 1984, with canoe route corridors along rivers, where some of the most valuable and accessible timber is located. Forest fires from 1980-89 decreased pulpwood reserves in one cutting area about 50% and in the Forest Management Licence Area by 33% (Forestry Canada, 1990; Public Meeting, March 23, 1992).

Forest management in the Forest Management Licence Area is carefully planned and monitored because the company is under public scrutiny, but also because it makes good business sense to maintain the productive capacity of land under its control. A specific stumpage rate is charged against the company for cutting there and placed in a Forest Renewal Trust Fund to be used for regenerating the wood supply. The stumpage rate in the Forest Management Licence

Area is based on the price of newsprint. It was charged at the rate of $\$4.66/m^3$ until 1993, increasing to $\$6.29/m^3$ thereafter (Keenan, Clean Environment Commission, Oct. 16, 1991).

The boundaries of the present Forest Management Licence Area have changed over the years. In addition, there have been reductions due to fire, insect infestation and withdrawals for parks. Nevertheless, the volume of wood taken from Manitoba's forests for the paper mill at Pine Falls has increased substantially from the first days of the operation. Currently, only 38% of the wood supply comes from the Forest Management Licence Area. The remainder comes from an integrated Wood Supply Area north of the Forest Management Licence Area (27%), from other scattered areas in the province (21%) and from southeastern Manitoba (13%). Much of the wood is transported cheaply by barge and rail (Peacock, Oct. 16, 1991). The stumpage rate outside the Forest Management Licence Area is $\$2.21/m^3$ (Keenan, Clean Environment Commission, Oct. 16, 1991). There, reforestation and management is a provincial responsibility.

The agreement between the Company and the Province states that if timber is removed from availability, an equivalent amount of merchantable timber must be made available. Cheap transportation to the mill is cited by the company as a critical factor in keeping the cost of production at a minimum, enabling it to remain competitive with other mills with a more accessible wood supply. Inability of the company and government to agree upon compensating blocks of timber to replace those removed is an economics and transportation issue, not one of wood supply or willingness to offer alternatives.

The mill currently has a productive capacity in excess of 500 tonnes per day. The company plans to upgrade the existing machines and then to install a third paper machine, raising the capacity to as much as 800 tonnes per day (Wingate, Oct. 2, 1991). That is a significant

increase from the initial 125 ton per day mill on which the company commenced operation on January 25, 1927. Future wood supply will almost certainly come from areas on which the company is not accountable and on which the general population of the province of Manitoba will be responsible for regeneration.

The issue is very simple. The amount of pulpwood required to feed a 700 or 800 tonne per day mill cannot be supplied from a resource base initially assigned to supply a 150-250 ton per day operation.

An additional cost is related to new requirements in the United States of America, the major market for Canadian newsprint. The requirements call for a specific content of recycled fibre. In order to meet those requirements, the plant must install a de-inking machine. The fibre supplied for that process will not replace timber removed from the sustained yield formula, or reduce pressure on the forest resource. It is a response to a market-driven requirement in order to keep the mill in operation so that it can be expanded (Public Meetings, March 23 & 25, 1992). The actual result will be a substantial increase in wood requirement.

The requirements for forest management and renewal, maintenance of and retirement of logging roads and stringent regulations regarding forestry operations, pesticide use and habitat protection are expensive. As well, the company paid the cost of the environmental impact assessment and intervenor funding for the recent review process. Management agreed that it would be more cost-effective to cancel the licence and procure wood from other sources (F. Pitre, Nov. 13, 1991).

However, cost efficiency is not the sole consideration in a climate of increasing environmental awareness and concern for the future. The company considers the possession of

an environmental licence for its Forest Management Licence area "could be used as a marketing tool to enhance product acceptance" (Clean Environment Commission, *op cit.*). It is also a critical asset in the company's strategy to maintain its ever increasing demand for wood. It ties in most clearly with the concept of "sustainable development".

"Sustainable development" is defined by local proponents as "the ecologically and economically responsible use of a renewable resource" (Manitoba Model Forest News, 1993). Earlier, forestry-related definitions and concepts about "sustainable development" were addressed. It is also of importance in relation to Manitoba and the Pine Falls Paper Mill in particular. Manitoba's recently stated goals for its lands and forests include:

"1. To sustain resources, enhance productivity, and improve environmental quality, including human health,

2. to improve and diversify income and job opportunities through the management, protection, and development of land and water resources

3. to manage resources and related activities in order to preserve development options for the future, and

4. to protect ecological systems, maintain the genetic diversity of species and preserve the resilience and productivity of the natural environment." (Province of Manitoba, 1994)

The Pine Falls situation exemplifies clearly the observation of Evernden (1984) and Livingston (1994) that naming something as a resource is not a call to protect it but an invitation to exploit it. In this situation it appears that interest in the environment is used as a hook on which to expand the exploitation of it.

"Model forests" are used to demonstrate state-of-the-art forest management practices through "effective working partnerships with industry, provinces and other stakeholders" (Forestry Canada, 1990) and to enhance Canada's international reputation in "sustainable development". A Model Forest has been awarded to the paper company in the Forest Management Licence Area in Pine Falls. In an area of one million hectares, it includes logging areas in the closest transportation radius to the mill, heritage rivers and wilderness park areas. It provides a delineated area in which to carry out ecological studies, forestry-related research and a showcase of multi-use management of forest areas. Many international observers have already been shown the set-up. The Model Forest is of critical importance to the continued operation of the paper mill.

International Competition

The newsprint industry is based upon high cost machinery, relatively high wages, labour requirements which reflect the amount of automation and therefore reflect the age of the plant and a balance between proximity to raw material and proximity to the market. The classic Weberian industrial location model applies well. The most competitive mills with respect to this mill's potential market are the high-speed modern mills in the southern United States which have

technological advantages, in addition to other factors. Wages tend to be lower and taxation is lower because the U.S. does not support social, medical and educational programs to the degree that has been the norm in Canada and other western nations. Trees mature in 15 to 30 years, rather than 75 to 100 as in Manitoba. The climate is less severe and roads are open year round, so mills need carry only a 15-day inventory of pulpwood in the yard. Canadian mills must carry a much larger inventory to avoid disruptions in supply (Rosier, *op.cit.*).

International agreements and public pressure now require stringent environmental and pollution-abatement technologies and procedures. As this has traditionally been part of what industry considers "The Commons" they have been unwilling to pay any costs which are not reflected in lower overall costs or increased profits. Research and development funds, channelled through Forintek, Paprican, etc., has been for increasing efficiency and productivity and for marketing to enhance cost competitiveness (Science Council of Canada, 1987). Pollution abatement equipment was not previously installed in the Pine Falls plant because legislation instituted by Fisheries included a grandfather clause which exempted mills built prior to 1971 (Pitre, *op.cit.*). The company has in the past approached government for funding assistance to implement pollution abatement schemes (Rosier, *op.cit.*).

The company has continually stressed the quality of newsprint from the mill and averred that many customers prefer newsprint from the Pine Falls mill (Oct. 2, 1991). The paper is good quality and it is preferred if it can be purchased at the same price. The entire operation remains wedded to exigencies of the global newsprint business.

Another aspect of the global newsprint business which is of critical importance to such a small 1927-vintage mill was expressed by Forestry Canada. Canada's traditional competitors,

the Nordic countries and America, use intensive forest management and support research and development to a degree 2.5 times that of Canada, proportionately. On the other hand, newcomers from Southeast Asia and South America have "abundant fibre, lower cost skilled labour, access to the latest technology and a regulatory regime often less stringent than those in North America and Scandinavia" (Forestry Canada, 1990). Those factors alone make long-term viability of this mill uncertain.

Energy

Energy supply continues to be important in the pulp and pager operation at Pine Falls. To recap; the presence of a good hydro-electric site awaiting development was critical to pushing through the pulp and paper mill deal in the 1920s, when it was to operate at 50 to 100 tons (1 ton = 0.91 tonne) per day. Initially at 22-kilometre transmission line was laid in to supply power to the mill and townsite. Shortly thereafter, a generation plant was built at Seven Sisters Falls to supply power to the 250-ton per day plant, although a potential energy shortage in Winnipeg was cited as the major impetus for development.

The upgrade of speed and capacity in the late 1940s and early 1950s was made possible by the bringing on stream of the Pine Falls generating station; the paper company had a contractual claim on power generated, notwithstanding the provincial initiative to supply electricity to rural residents of Manitoba under the farm electrification program.

Now, more energy is required if the production of the mill is to increase. The recent cancellation of a hydro-electric megaproject which was to have fulfilled an agreement between

Manitoba Hydro and Ontario Hydro had two impacts on the paper company. One of the proposed corridors for the transmission lines would have been located along the east side of Lake Winnipeg. If it had gone through, an additional source of hydro-electric power would have been available with only minor construction costs for infrastructure to connect to the grid. Also, the presence of the corridor would have enhanced pressure for construction of road access up the east side of the lake. That would have made accessible for harvest a whole area of timber which the company had been interested in exploiting since 1956 (Winnipeg Tribune, 12/09/56). At that time officials of Abitibi and their investment bankers had been checking out northern timber reserves to piggy back on proposed mining development on the Nelson River.

However, another energy source is made available. The company has been negotiating with a British Columbia-based gas company to install a facitility to generate steam and electricity for the plant. It would involve help from the Province as well as construction of an extension from the trans-Canada gas pipleline further south (Pitre pers.comm,1991;Public Meeting, May, 1992; Wpg. Free Press, Sept. 13,1993). The pipeline is being presented as an alternative energy source for the people of the area. Partly paid for by the Province, it would enhance the infrastructure and energy for the expanded operation.

Speculation on Strategy

It is difficult to understand the confidence expressed regarding the viability of a one mill operation in a marginally productive area, far from the marketplace. For six decades officials of the company maintained the position that success in the newsprint business is possible only

with larger and larger plants and companies. The historical practice has been to consolidate mills into large scale companies. The market has, since the beginning of the industry in Canada, been one in which low prices and discounting are the norm.

Each expansion to meet external economic requirements has increased pressure on the forest. It has encompassed a larger and larger resource base. It has necessitated more intensive, mechanized and chemically supported exploitation. Energy supply requirements have been extensive in the past and must now be met from outside the region.

It is here that the current interest in the "environment" and in "sustainable development" have become critically important to the future. It has been by using the environmental issues of concern today that the company hopes to succeed exploiting the forest resource. A plausible scenario is that "sustainable development" and co-management of resources will be used as a bargaining tool to keep the mill in operation until it can be upgraded for sale. Similarly, the requirement for recycling has been accepted not primarily as a source of fibre for the mill, but as a tool to gain public support and to preserve product acceptability. "We put in some environmental controls and the environmentalists will not say boo. In a few years when we are recycling, they'll think we're heroes" (Wingate, *op cit.*).

Abitibi-Price wanted to divest itself of Pine Falls operation because it is old. The mill now requires significant upgrades of environmental technologies and plant modernization for which the long-established company was unwilling to pay and for which it could not secure government funding. But the plant is still viable if it can be upgraded.

The federal "Model Forest" is politically advantageous to the area. By withdrawing from the parent company, by embracing the concept of co-management and forming a "stakeholders"

group in an advisory capacity, and by involving the Sagkeeng First Nation in the "ownership", the new company would be more sure of getting government funding and support for running the paper mill.

The on-again, off-again involvement of Sagkeeng First Nations in the buyout and longstanding problems and resentment over pollution in the Winnipeg River have been serious issues. Aboriginal participation had been necessary in order to attract government funding to upgrade the 1927-vintage paper mill. When asked at a community meeting why the Band had an interest in the proposed company, management stated that "we offered it to Fort Alexander to make it easier to get government assistance. Any other community involvement would not have helped" (Meeting, October 2, 1991). The model forest, as part of the Canadian government initiative of "sustainable development", serves a similar function.

The new Board of Directors of the Pine Falls Paper Mill include individuals with many years of expertise in large forest industry companies. These include Abitibi-Price, Consolidated Bathurst, and Stora. On one hand, it is to the advantage of the company to have the expertise of these officials. On the other hand, it is worthwhile to consider the long-term picture.

Government funding, garnered from taxpayers, would be used to upgrade the facility, install pollution abatement equipment and install a gas co-generation facility to meet increased energy requirement of a higher capacity plant. Once the operation has been modernized and upgraded, it could then be sold to a large corporation which can be more competitive on the international markets.

Chapter Eight

Conclusion

The goal in this thesis has been to study twentieth century landscape change in an area with a resource-based livelihood. There would be an investigation of the affects of an increasingly globalized un-grounded economy on the land-based *genre de vie* of the area. I would attempt to meld three major geographic themes: the region, human-land interaction and landscape. Landscape would present the visible interface where both natural biophysical and anthropogenic industrial and economic worlds meet. A contextual analysis of the development of (mainly) industrial land use would serve as a frame on which to incorporate an understanding of the local-global connection of activity and the tension between environment and economy.

Some characteristics of sequent occupance studies of the past have been incorporated. For example, significant stages in the life of the microregion were used to elucidate unifying themes and recurring motifs. In many previous studies, sequent occupance was utilized to demonstrate how the place became what it was at successive stages. In the Lower Winnipeg River Study, however, the stages can be viewed as jumping-off points.

Here, events or watershed decisions set in motion a form and level of land-based activity which was meant to continue into the future. Invariably, each temporal watershed resulted in an expansion of activity and increased demand for material and energy. In the startup phase this was of course inevitable, for an industrial process was being established where one had not existed before. At the second, past-World-War-Two threshold, expansion was also expected, planned and understood. A stated goal at the time was to expand industry to meet the growing demands of a consumer society. The third threshold, that of "sustainable development", has been decked out in a cloak of stability and setting of limits on growth. Nevertheless, the actual expression of this phase is clearly one of expansion of requirements for materials and energy.

At this point, it is useful to look again at the conceptual framework for the study (see Figure 2.__, page ___), and to see some of the findings of the study in light of it. Table 8.1 summarizes the major findings.

Topo-ecological Landscape Analysis

A topo-ecological analysis of three distinct land use regimes - aboriginal, industrial forestry and agricultural - compared the evolving landscape organization of an area which was more-or-less uniformly patchy prior to Euro-Canadian settlement. The visible landscape was used as a device with which to trace changes in the human-land interaction. Spatial entropy based on the formulation of Boltzmann incorporated a statistical method to evaluate the changing order and structure in the three land use regimes. Changes were linked to underlying topo-ecological factors and to management practices.

The agricultural land experienced the most obvious change, where small portions of land were removed of cover, enhanced by drainage and other technology-assisted management, and planted to economic crops. Both the industrial forest areas and the Reserve lands experienced a decrease in apparent order from 1941 to 1991. However, that of the Reserve lands was natural maturity, creation by vegetation of its own environment and gradual overcoming of local conditions of drainage, soil and relief. In the FML, decrease of ecological order was associated with management of land to support particular species at the expense of others, gradually confounding the natural topo-ecological factors.

There were some problems in this part of the study.

1. PEGASE requires a large database of topo-ecological variables. Forest management operates over an extensive land base, on large tracts of land. Topo-ecological information was available for only a part of the forest management licence portion of the study area. Therefore, only a small corner of the area could be used. It is expected that the results would have been much clearer if a larger sample area could have been selected.

As a corollary to that, it must be remembered that the FML is not the only area where wood is harvested for the paper mill. Only 38% of the wood originates in the FML, of which only a small fraction was included in the analysis. Landscape change is more extensive and involves more territory throughout the province.

2. There are many land use maps and inventories available for the forested area, as well as a limited volume for adjacent, non-industrial lands. However, there have been changes in photogrammetry and estimating techniques and changes in the type, amount and format of

information collected. It is therefore difficult to compare data from various time periods, with difficulty increasing as the time span increases.

3. In this particular study area, some topo-ecological factors were similar in their effect on vegetation. Indicators which would influence moisture status were quite uniform. The overall range of elevation for the entire area was about 50 metres. The relief varied from gently sloping to flat to depressional and natural drainage ranged from poor to good. As such, the iterative search for determining topo-ecological characteristics tended to be unstable with respect to which of the closely related factors would be chosen at the appropriate step of the procedure.

Contextual Analysis

Reflection on the attributes of the three time periods showed the direct relationship between the microregion and the "global" system of economics and industry: the expansion of the capacity of the mill even during the planning and construction phase was tied to the rhetoric of the time that natural resources were to be exploited to generate prosperity and progress. While the timber limits finally agreed upon were adequate to the new mill, they had been negotiated within an ever-changing definition of what was an appropriate timber block size, whether there should be exclusive use, and what area were to be included. Those were political and business decisions as much as they were based on actual knowledge about timber. At that time, industrial activity answerable to remote economic considerations gained control over a biophysical process responsive to biophysical mechanisms. However, at that initial period, there was a balance

between the material, the capacity of the mill to process it and the energy to carry out the process.

The second period studied was also characterized by the need for growth of capacity and speed. The driving force was again economic factors related to increased demand for the product. When the capacity of the plant increased so did the need for pulpwood to feed into it. It was no longer supplied just from the original timber limit negotiated. Indeed, some areas were exchanged for new ones. Increasingly, timber was brought from elsewhere. At the same time, an additional power source was developed to handle the increased capacity. Accordingly, by then it was already escaping the bounds of the original balance between material, energy, and output. Thus began a further period of increased exploitation of the biophysical resource, much larger than that originally intended less than a human generation, and far less than a forest's generation ago.

The third period is the one characterized by the notion that an industry can achieve sustainability by a process where a certain amount of planting, tending and management of forests will, over a foreseeable time period, be able to replace that harvested for the industrial process. However, there have been further increases in capacity (of the mill), with further increases to come. The company actively practises forest management, but that alone is insufficient to supply the fibre needed. As well, environmental regulations require use of recycled fibre which is not viewed as a means of reducing pressure on the existing forest but as a cost-effective means to increase capacity and further harvesting. Furthermore, the competitive situation world-wide demands price discounting, feeding the spiralling increase of production to maintain market share through economies of scale. In addition to the factors directly related to

supply and demand, there is the recurring issue of energy supply. The local supply has been exhausted and the future needs will have to met from outside the microregion. The clearest indications of this analysis have been that harvesting, output and energy use have increased throughout the period. If the company proves successful, that trend will continue.

The presence of the paper mill in eastern Manitoba was not ever in its history contingent mainly on the forest resource. Neither was the venture secured by the hydro-electric facility, although that was an important advantage due to the large power requirements of paper manufacture. It was the combination of wood and power potential coupled with the enterprise and boosterism of the principal players, notably J. D. McArthur and the Dominion Minister of the Interior, which pushed forward the operation. In addition, the drive for industrial development and desire for liquid financial resources impelled the establishment of the industry on the Winnipeg River. From the initial period of timber cruising and plant construction, the exigencies of external markets and financial interests were paramount. (That alone supports the need for a methodology which incorporates both physical and cultural geographical ingredients in research relating to land use.)

At the beginning there was, as there should have been, a controversy over the viability of a plant in a marginally productive region. The pressure for industrial development in the young province of Manitoba won the day. Once in operation, it was deemed necessary to keep pace with requirements of the market by increasing speed and capacity in order to protect the investment. Now that a third generation of workers is operating the machinery, it has become an issue of community survival. Yet again, there is pressure to expand to remain competitive as well as to meet newly enacted environmental restrictions. It has truly become a dilemma.

"Sustainable Development" in a Globalized Environment?

It is unfortunate indeed that the term "sustainable development" has enjoyed such popularity. People are rightly concerned about the future of their children, whether the concern is focused on means of livelihood, standard of living, ecosystem viability, or outright survival. "Sustainable development" is a straw to grasp onto, because it is being touted as a legitimate means of promoting economic growth.

It would be perverse to suggest that there is an easy solution, or any solution at all, to the dilemma with which we are faced. In the case of the paper mill situation in Pine Falls and its dominating influence on the area as a whole, there is clearly no going back. The present geographical predicament has evolved as a result of decisions made in the past. It is lamentable, however, that the situation has been manipulated to pit jobs against "environment". On a wider scale, the most helpful course of action would be to first of all eliminate the term "sustainable development" from discourse about environment. It merely raises false hope that there is a solution that will allow humanity to continue with the *status quo*.

A major part of the dilemma in the Lower Winnipeg River Microregion is the choice of what is to be sustained: the community, the economy or the environment. In that small microregion, as in similar places throughout the world, the same questions are being raised. Consequently, it is a global issue, a critical issue as we enter what is being called the **Biospheric Age**. The biosphere is a complex integrated entity, encompassing the entire envelope around the globe. To von Humboldt it was the Cosmos, to Lovelock and Margulis it is Gaia (1979).

The saying that no one gives up power without a fight seems to apply collectively to humanity. One need search no further that the observation of Yi-Fu Tuan regarding humanity's propensity to extend our influence over the earth and its materials.

> "The deliberate withholding of power in the interest of a 'land ethos' and against claims of perceived material benefit is, and was, probably very rare. We use what power we possess at the expense of nature and of other people should they stand in the way;..."
>
> (Tuan, 1971,p.9-10)

Many hope that the multidimensional models and discourse about the biosphere could mean a transformation back to an integrated view of life on this planet. However, the biosphere is a commodity; as long as environmental discourse and action remain wedded to globalized financial and materialist interests, every aspect of the environment has a negotiable, abstract, monetary exchange value. The paradox of the biosphere age is that the controlling mechanisms of essentially ecologic processes are increasingly abstract and spatially ungrounded.

For example, the elimination of the manufacture and use of chlorofluorocarbons (which are destructive to the ozone layer) was addressed in a scientific forum, but it was resolved only after a solution was reached which was acceptable to industry (Koehler & Hajost, 1990). Maintenance of biodiversity is an issue for transnational petro-chemical corporations and governments in developing countries as much as it is for ecologists and biological scientists (George, 1988; McNeely, 1989; Rifkin, 1991). Economic think tanks are working to put permits to emit CO^2 and other substances into the financial exchanges so that corporations, large and

small, can purchase emission allowances on the open market, if it would be more cost effective than reducing emissions. They suggest that governments and environmental organizations may wish to purchase permits, in order to take them off the market (Block, 1990; Heggelund, 1991). There are proposals in place now to suggest that consumers in the industrialized world will pay for biodiversity in tropical rainforests and will pay to prevent deforestation and release of carbon dioxide into the atmosphere, based on the existence value of rare vegetation and animals and on their desire to have relatively unpolluted air (Goldenberg, 1991; McNeely, *op.cit.*).

The ranges of solutions offered so far exemplify the control over the process by technocrats. One argument is that "sustainability will require a significant expansion in agricultural, forestry and other research to implement more environmentally compatible technologies and significantly more environmental monitoring and assessment. They envision sustainability as a matter of fully optimizing people's interaction with nature" (Norgaard, 1992). This seems to be a call for maintaining the status quo, providing security of industry and trade, and providing funding for research into technological development and monitoring. But in no way is it meant as a rejection of the principle of leaving a secure environmental base for future generations. Rather, it is rationalized by the perception that "future generations will be compensated for the current generation's use of resources through increased knowledge, capital equipment and infrastructure and an improved environment" (Pearce, 1992). These are unrealistic assumptions in the face of the mountain of debt shouldered by the present generation in the wake of previous increase of knowledge and infrastructure and the people unemployed through technological advancement. The toxic wastes resultant from current industrial activity projected

to remain highly dangerous for decades or for hundreds of thousands of years (for example Caulfield, 1989; CIR & Moyers, 1990) are also part of the legacy to the future.

A study such as this one cannot easily supply solutions to a dilemma such as that discussed here. Those decisions must be made by **all** those concerned. What has been accomplished here is the presentation and demonstration of a framework which can be used to see the overall interaction of environmental, economic and social forces which affect regional integrity, human-land interaction and landscape transformation. It can be used to evaluate the effect of land use on the area, and to plan or forecast what may transpire in the future. It could help to avoid pitfalls where a more clearly economic, behavioural, statistical or ecological approach may miss critical influences on land use, factors attributed to experimental error, random variability, or unforeseen events.

The Lower Winnipeg River Microregion

One of the reasons for choosing this study area was the juxtaposition of a variety of phenomena, images, places and geographically important structures and forms within a small area. Even though this thesis covered a broad spectrum of ideas and aspects of both the physical and cultural geography of the microregion, there are many other studies that could be undertaken.

It is located within a transitional zone between Canadian Shield and Manitoba Lowlands, so the different physiographic regions are represented in terrain and structure of landforms. The interesting aspects of the land itself are balanced by water. The Winnipeg River, an integral

component of Manitoba's hydro-electric generating system, also provides water for domestic and industrial uses.

Economically, the region is important for the presence, if not the financial value, of varied land-based activities: hydro-electricity generation, forestry for pulp and newsprint production, mixed agriculture and recreation and tourism. These all take place within the same geographic area.

Along the Winnipeg River are many different cultural groups, such as traditional French community transplanted at the end of the nineteenth century from Quebec. There remains a stable culturally viable French village(St-Georges), based on agriculture. There is a First Nation reserve (Sagkeeng, also known as Fort Alexander Reserve) and two communities formed for industrial or commercial reasons (Pine Falls and Powerview). There are linguistic differences, cultural and historical differences and clear differentiation of local economy, to which they are indeed connected.

One could look at the political structure of the area for insight. St-Georges, Powerview and the surrounding rural areas form part of the rural municipality of Alexander. They are concerned with all aspects of community life including industry, transportation, infrastructure and economic development. On the other hand, Pine Falls is a company-owned and -operated townsite, and appears on the census of Canada as unorganized territory. The people who live in the townsite have no independent political voice regarding municipal government or local politics. The Sagkeeng Reserve operates according to the Band regulations. It would be interesting to delve further into the dynamics of this situation. This is particularly relevant now because the woods-related aspects of forest management requires input from a stakeholders'

advisory body. Others in the areas have input through their rural municipality, village council, etc., while employees of the major industry, who are directly involved, enjoy no avenue for individual participation in the process.

Regarding the physical geographical evolution of the area, the paper company has thousands of maps which depict vegetation, cutting areas, temporary roads, bush camps (important for environmental history as well as Canadian history in general), land inventory, etc. Some of this information about the area could form an interesting cartographic study.

This becomes more important as time goes by. The company, in association with Manitou-Abi Model Forest, is poised to institute a new system of land inventory classification to manage cutting blocks, volume estimation. Satellite imagery will be utilized to estimate forest status. This will provide detailed information in the future, but may make knowledge about the past forest status difficult to interpret. That is, each successive technological innovation which lead to an increase in information gathering also lead to a change in format and type of information collected. This was seen in the landscape analysis of this present study (see above). Detailed species analysis could not be compared easily due to change of format. In the 1940s the stand information was for fairly large areas, and included descriptors of stands based on percentage cover by a dominant species, with codes identifying other species, or the stands were identified as mixes of types of trees, eg. 65% conifers, 85% broadleaf, etc. In the 1980s, the land inventory provided detailed maps showing small stands of uniform species, as well as information about the status: age and size classes were detailed. Therefore comparisons between 1941 and 1991 were not possible because the classes of information mapped were not consistent over time. This is of particular concern when a stated goal of most initiatives related to "sustainable

development' is to be able to monitor and evaluate changes in the forest inventory. This is not possible if changing format detail make time-series analysis non-comparable. Possible a method could be found to maintain some consistency of information.

Finally, the intriguing events surrounding the allocation of timber berths, hydro-electricity and transportation infrastructure invite further investigation. The allocation of rights to manage and exploit natural resources as well as some of the major infrastructure to enable that was undertaken at a critical time in Canada's environmental and industrial development. During the 1920s the prairie provinces were becoming politically mature and wished to gain control over administration of their natural resources. While this endeavour was underway, rights to energy and resources were being handed out by the Dominion Ministry of the Interior. In the case of the paper company in Pine Falls it was done in a less than democratic fashion, and the situation was contractually established for the future. A logical next step will be to investigate further into the broader impact of that situation, as it affected other areas and sectors in western Canada.

Table 8.1: Summary of Findings of Contextual Anslysis, According to Conceptual Framework

Factors Providing Context for Regional Activity	Common Threads of Human-Land Inter	
	Wood Supply	International (
Early Period: 1920s LIQUIFY NATURAL RESOURCES FOR FUTURE OF YOUNG PROVINCE AND COUNTRY	Negotiation of timber berths for wood supply. Several requests for extra berths and calculation of blocks. Mill capacity proposed originally at 50 tons/day. Mill built to 250 ton/day capacity.	During planning several upgrades ensure competiti Delays caused p from competing
Middle Period: 1950s & 1960s POST-WAR ECONOMY TO BOOST CONSUMPTION, PROVIDE EMPLOYMENT AND PROSPERITY	Consolidation of timber holdings to guarantee security of supply. Exchanged some holdings forthose with better road access, Increase mill capacity to 500 tons/day, with increased need for wood.	Rapid increase i newsprint after Companies beca takeovers and n existent mills.
Recent Period: 1980s & 1990s "SUSTAINABLE DEVELOPMENT"	38% of wood from Forest Management Licence. (The land base is sustainable for original capacity of mill.).Remainder from other sources in province and elsewhere, recycling. Capacity projected to increase to as much as 800 tonnes/day.	Overcapacity of worldwide. La consolidating o mechanized hig secure wood su Discounting pri market share.

:eptual Framework

of Human-Land Interaction			Tensions, Power Relations
	International Competition	Energy Supply	
s	During planning and construction several upgrades of capacity to ensure competitive size. Delays caused partly by pressure from competing interests	Local. Initial construction of line from existing hydro-electric station at Great Falls. Paper company formed separate company with right to develop and use hydro-electric power at Pine Falls. Construction of hydro-electric station at Seven Sisters Falls ensured adequate energy supply.	Rapid growth of newsprint industry during early twentieth century. Negotiation for wood supply by industrial interests during period ofjurisdictional power struggle. Boosterism in support of regional economic growth
d	Rapid increase in demand for newsprint after Second World War. Companies became competitive by takeovers and mergers, purchasing existent mills.	Local. Hydro-electric station at Pine Falls developed in 1949-51. Part of rural electrification programs, however, Pine Falls had contract for as much power as required for its operational needs.	Public discussion in Province of Manitoba regarding public and private involvement in hydro-electricity. Apparent strong public support for economic development.
r l	Overcapacity of newsprint mills worldwide. Large companies consolidating operations in newer mechanized high-capacity mills with secure wood supply. Discounting prices to maintain market share.	Local and External. New energy requirements to meet increased capacity, recycling plant and pollution-abatement equipment. - pipeline to import natural gas from western Canada - new hydro-electric developments in northern Manitoba, with possible route of corridor down east side of Lake Winnipeg	Utilization of current public concern for "sustainable development" and interaction between economy and environment to ensure continued extraction of wood fibre for newsprint production. Conflict over "environ-mentalism" vs. way-of-life.

	Tensions, Power Relations	Landscape
of line c station at ıy formed ht to ctric power tric station ıred	Rapid growth of newsprint industry during early twentieth century. Negotiation for wood supply by industrial interests during period ofjurisdictional power struggle. Boosterism in support of regional economic growth	Some agricultural settlement along banks of Winnipeg River, expanding to meet needs of new families. Some clear cut and some selective cut of timber, depending ono site characteristics. Rapid development of forest industry installation.
ion at Pine 1. Part of ms, ontract for d for its	Public discussion in Province of Manitoba regarding public and private involvement in hydro-electricity. Apparent strong public support for economic development.	Consolidation of timber berths. Flooding of lands adjacent to Winnipeg River, Maskwa River and Little Bear Creek to maintain water level for hydro-electric station. Increased agricultural settlement after road access provided. Beginning of drainage system in peatlands.
to meet ing plant quipment. al gas from lopments in ossible st side of	Utilization of current public concern for "sustainable development" and interaction between economy and environment to ensure continued extraction of wood fibre for newsprint production. Conflict over "environ-mentalism" vs. way-of-life.	Model Forest - multiple use. Development of variety of environmental education installations to display industrial forestry and other land use. Increase of rural settlement along Winnipeg River.

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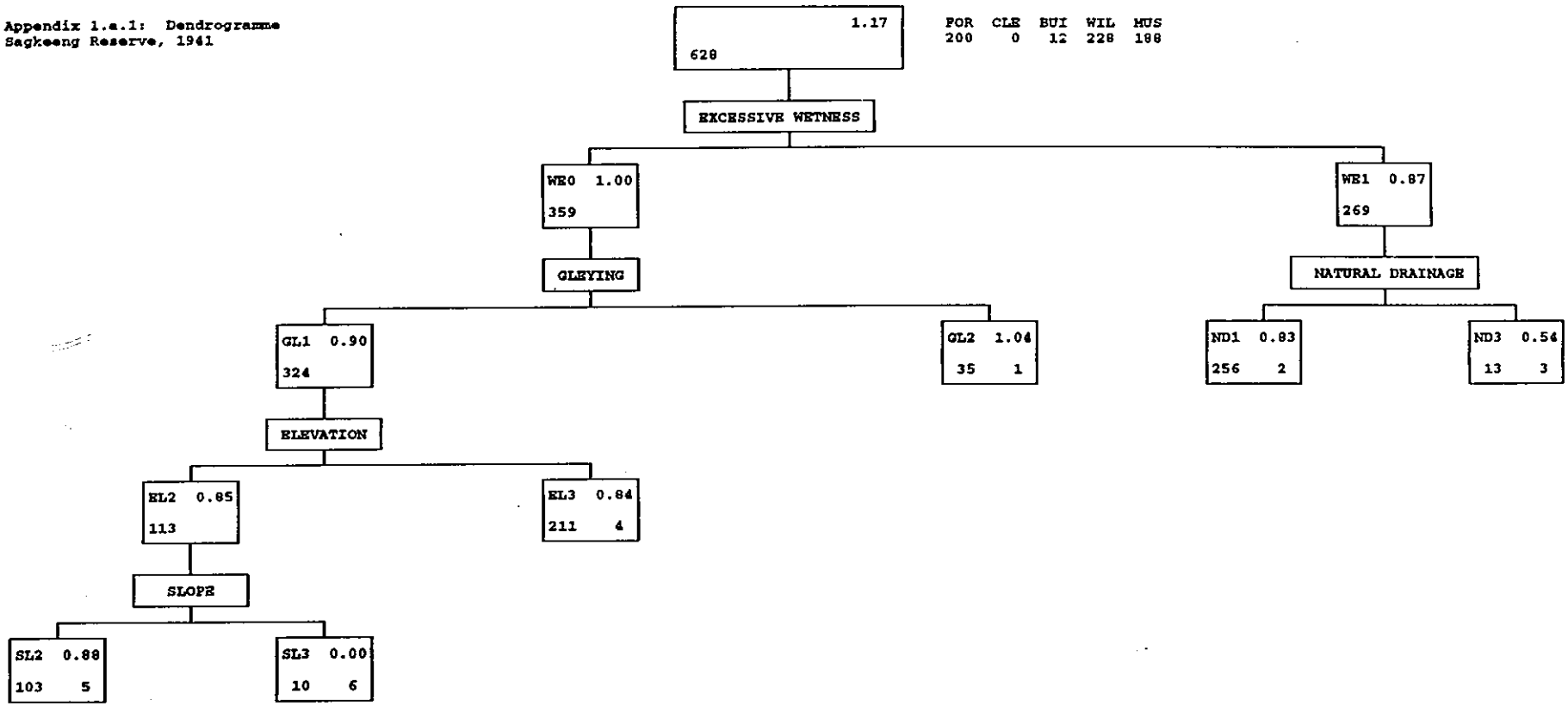
APPENDIX 1.A

Dendrogrammes Generated by PEGASE

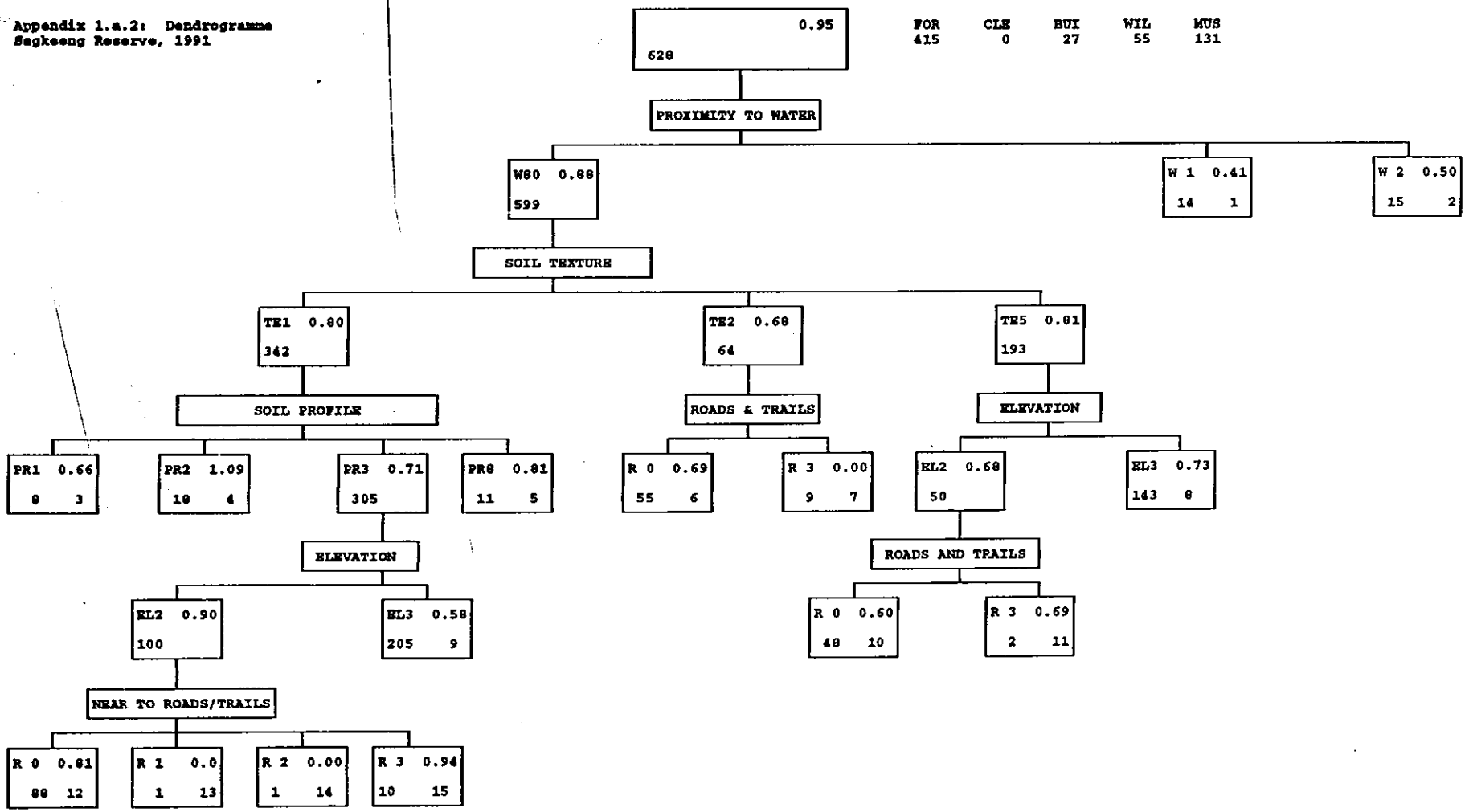
Appendix 1.a.1: Dendrogramme
Sagkeeng Reserve, 1961



Environmental Factor Code	Entropy
# of sites	Landscape Unit

Initial Entropy	1.17
Final Entropy	0.83
% Redundancy	28.8%
Environmental Entropy	1.34

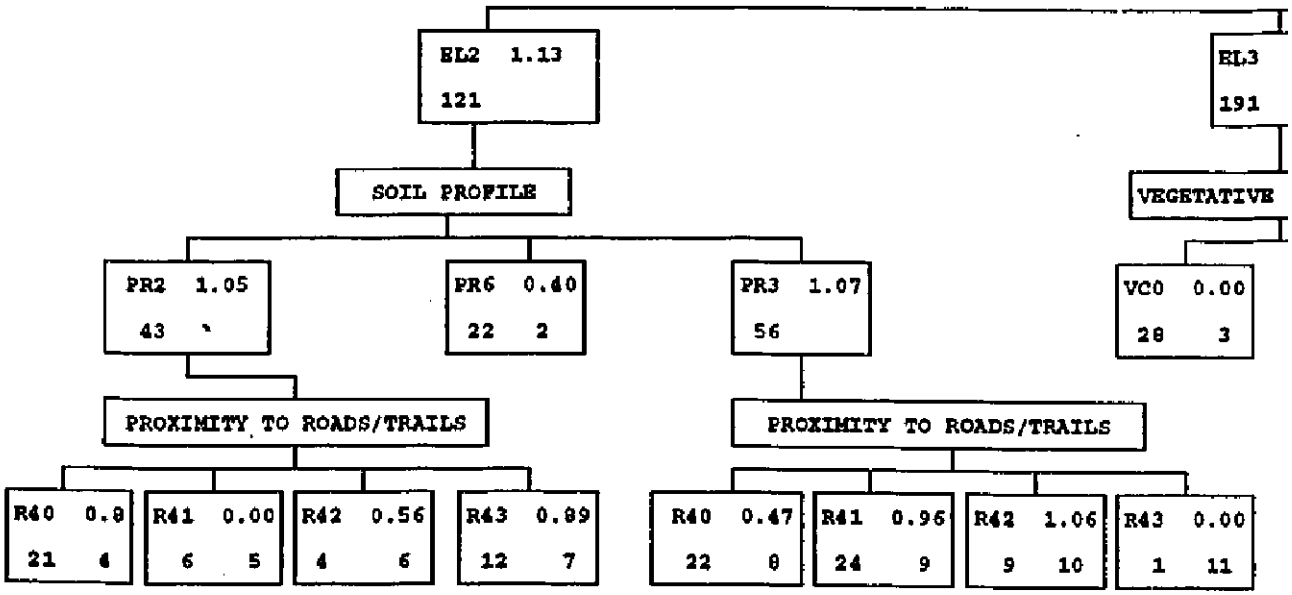
Appendix 1.a.2: Dendrogramme
Sagkeeng Reserve, 1991

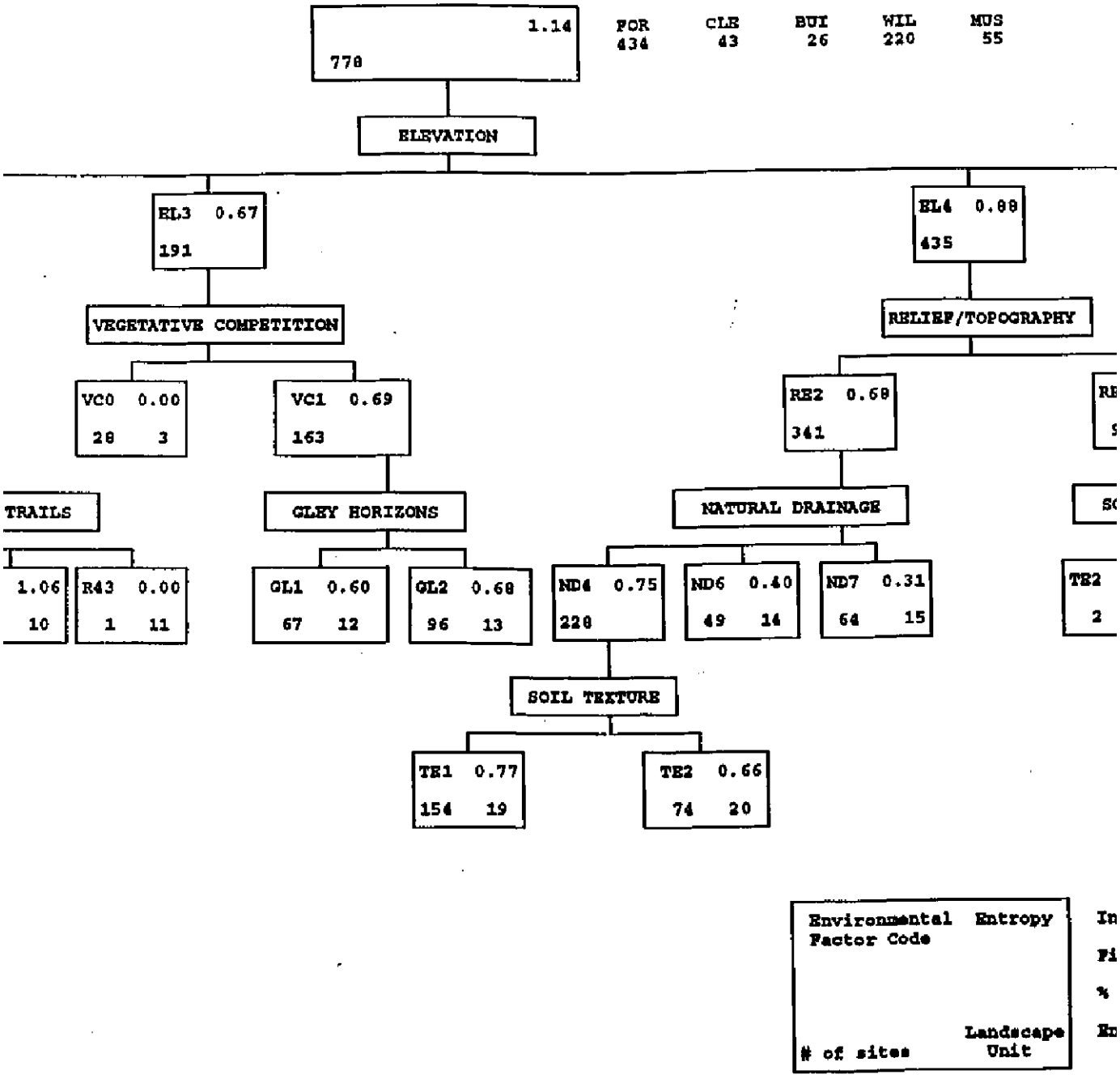


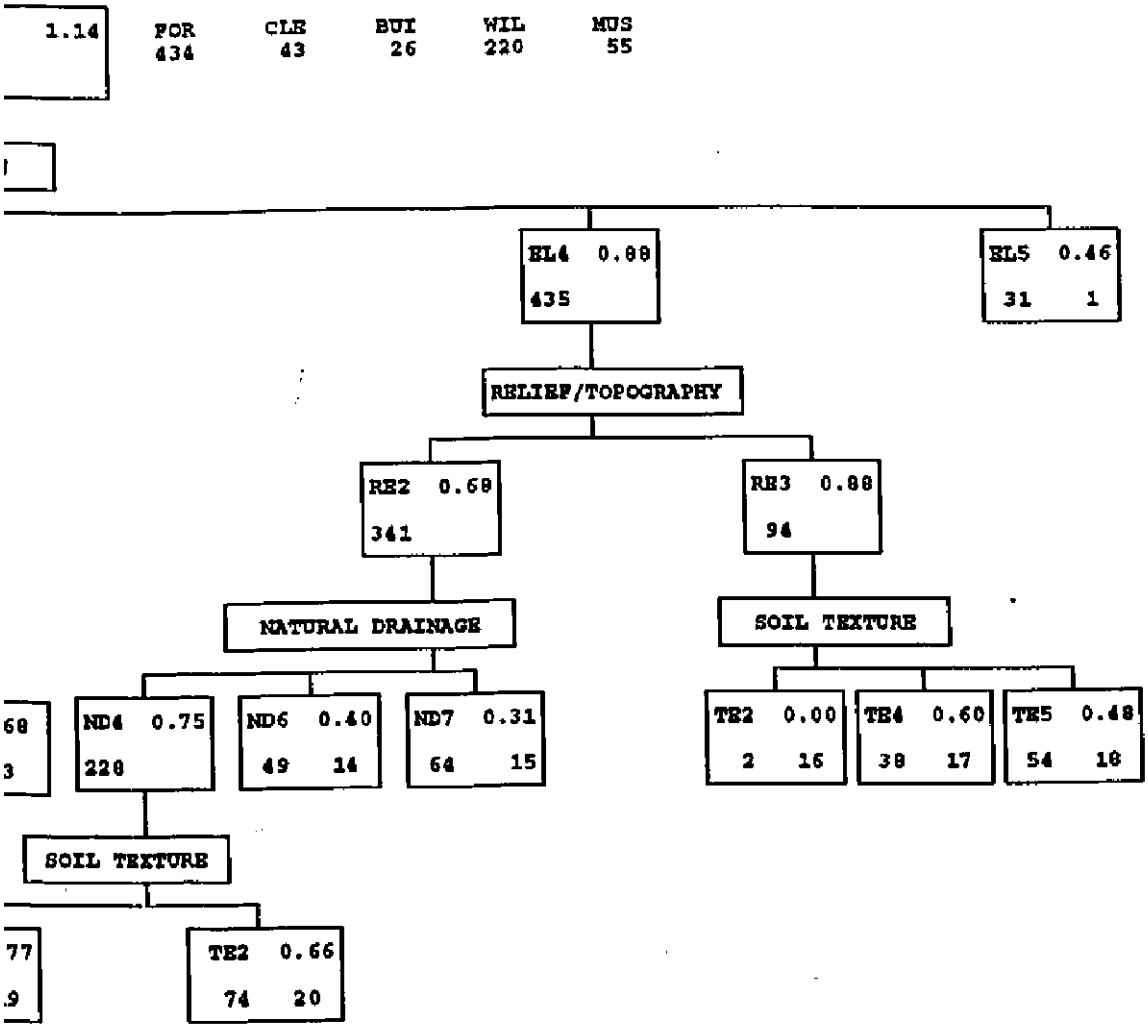
Environmental Factor Code	Entropy
No. of sites	Landscape Form

Initial Entropy	0.95
Final Entropy	0.67
% Negentropy	29.4
Environmental Entropy	1.96

Appendix 1.a.3 Dendrogramme
Forest, 1961



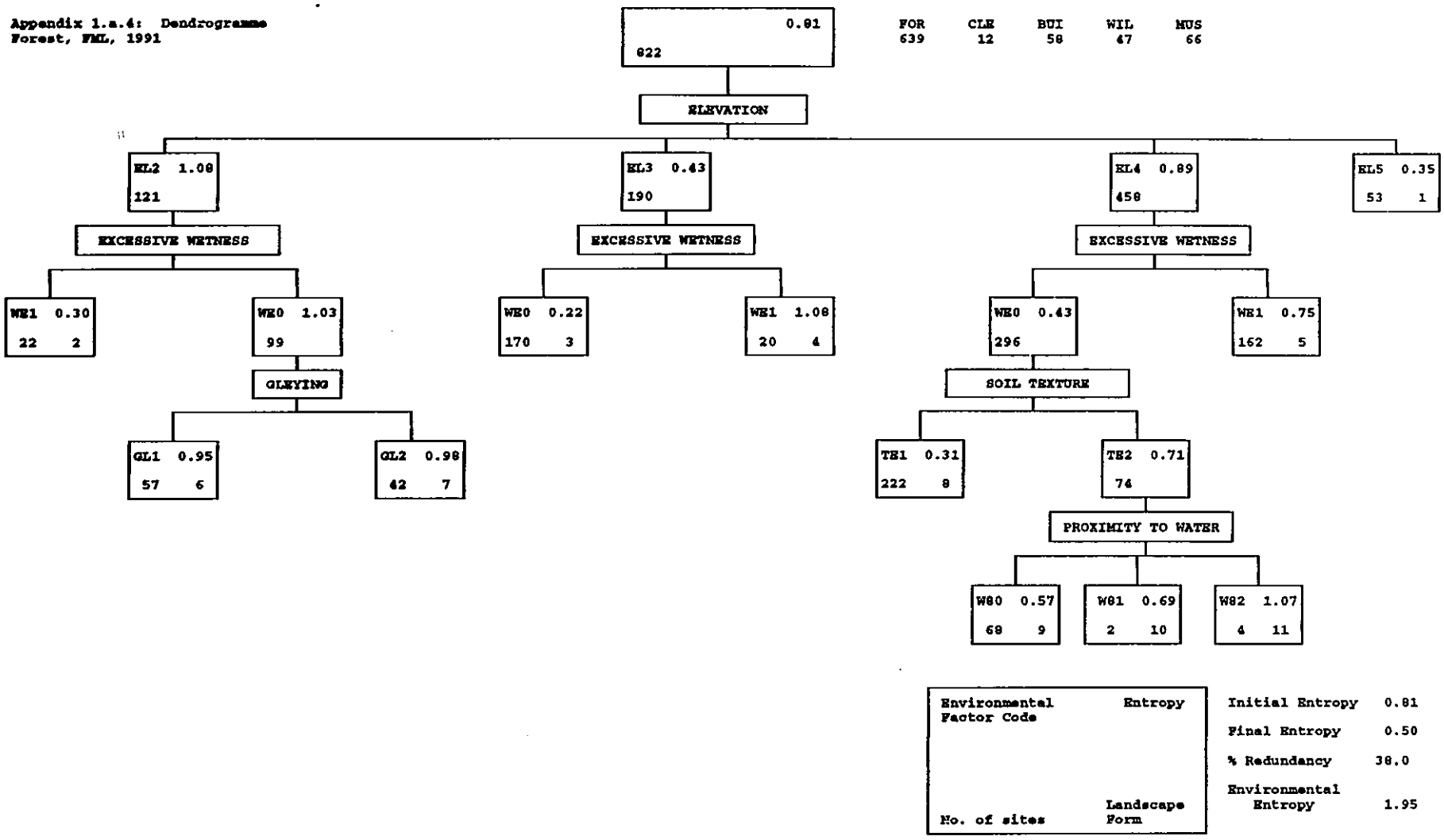

1.14
770
FOR 434
CLE 43
BUI 26
WIL 220
MUS 55
ELEVATION
EL3 0.67
191
EL4 0.00
435
VEGETATIVE COMPETITION
RELIEF/TOPOGRAPHY
VC0 0.00
28 3
VC1 0.69
163
RE2 0.60
341
TRAILS
GLEY HORIZONS
NATURAL DRAINAGE
1.06
10
R43 0.00
1 11
GL1 0.60
67 12
GL2 0.60
96 13
ND4 0.75
220
ND6 0.40
49 14
ND7 0.31
64 15
TE2
2
SOIL TEXTURE
TE1 0.77
154 19
TE2 0.66
74 20
Environmental Factor Code
Entropy
# of sites
Landscape Unit



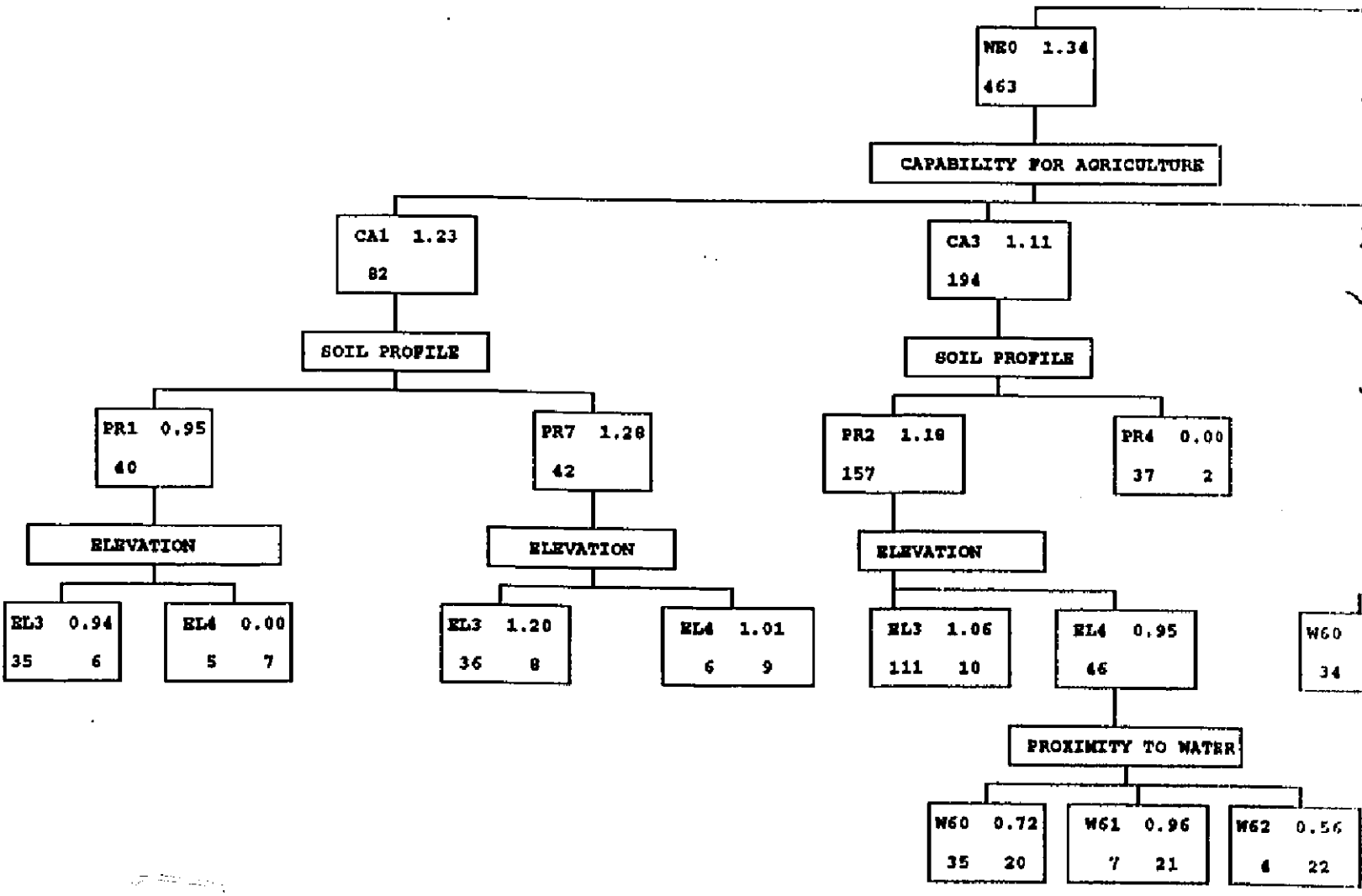
Environmental Factor Code	Entropy
# of sites	Landscape Unit

Initial Entropy	1.14
Final Entropy	0.59
% Redundancy	48.7
Environmental Entropy	2.58

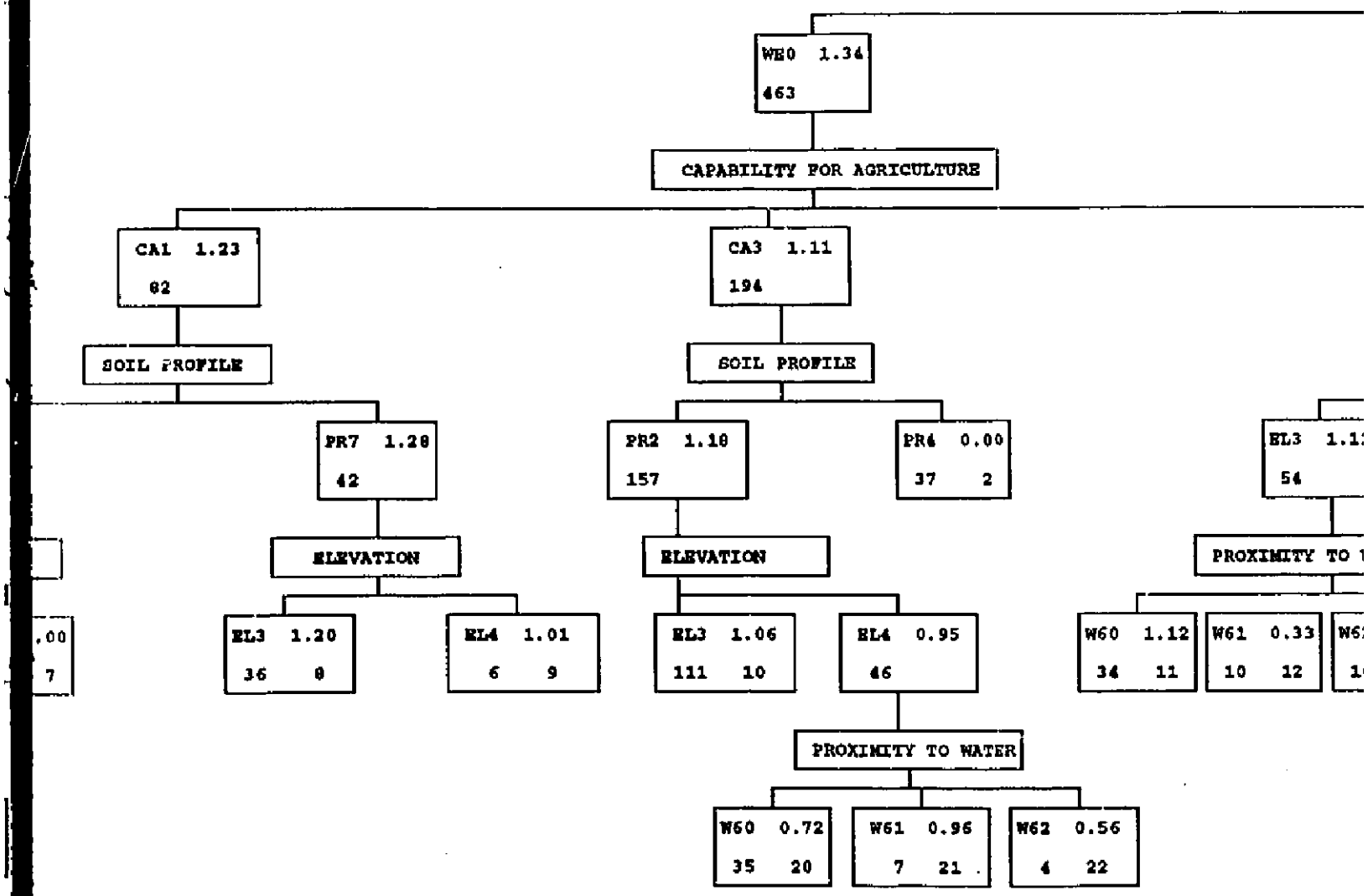
Appendix 1.a.4: Dendrogramme
Forest, FML, 1991

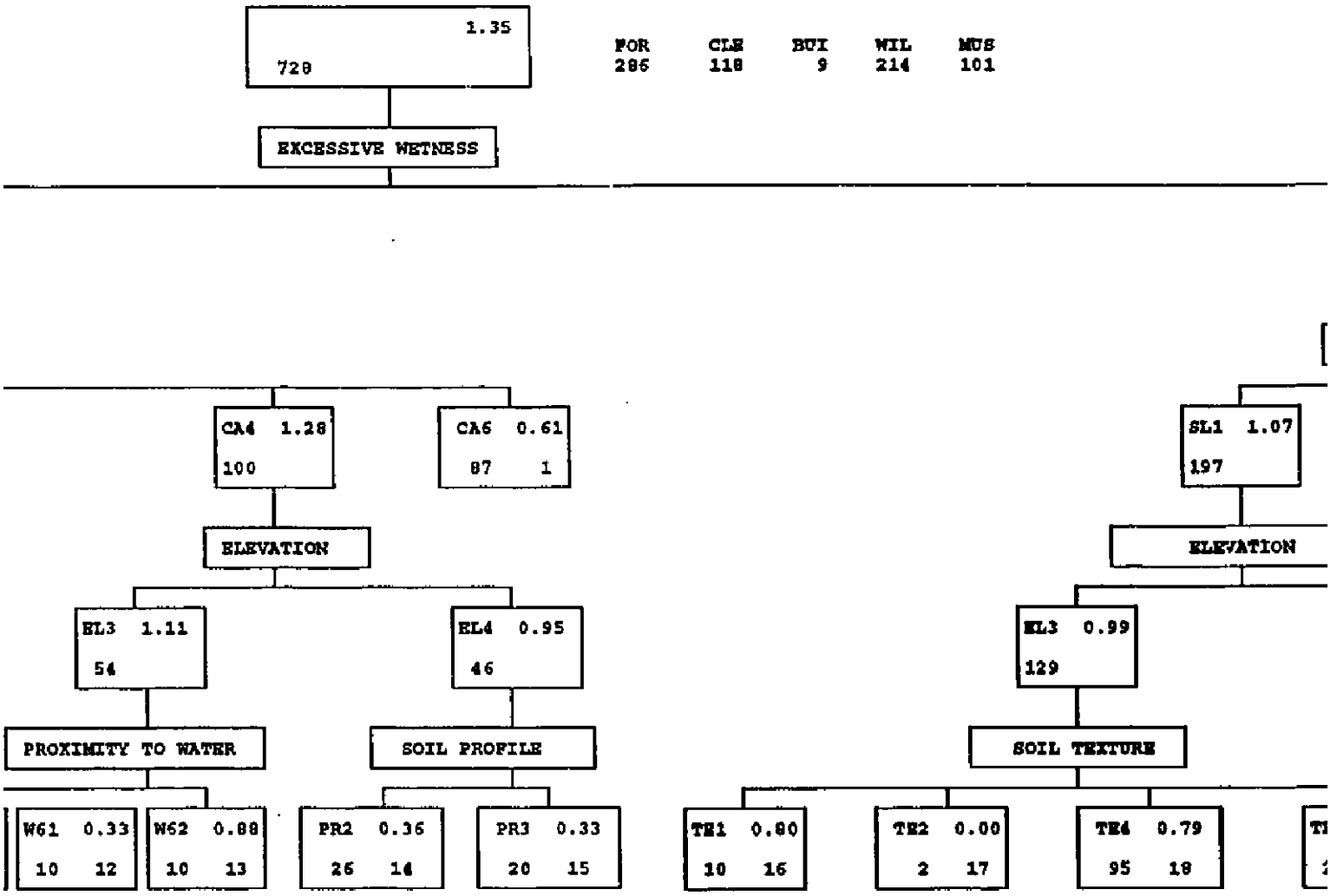


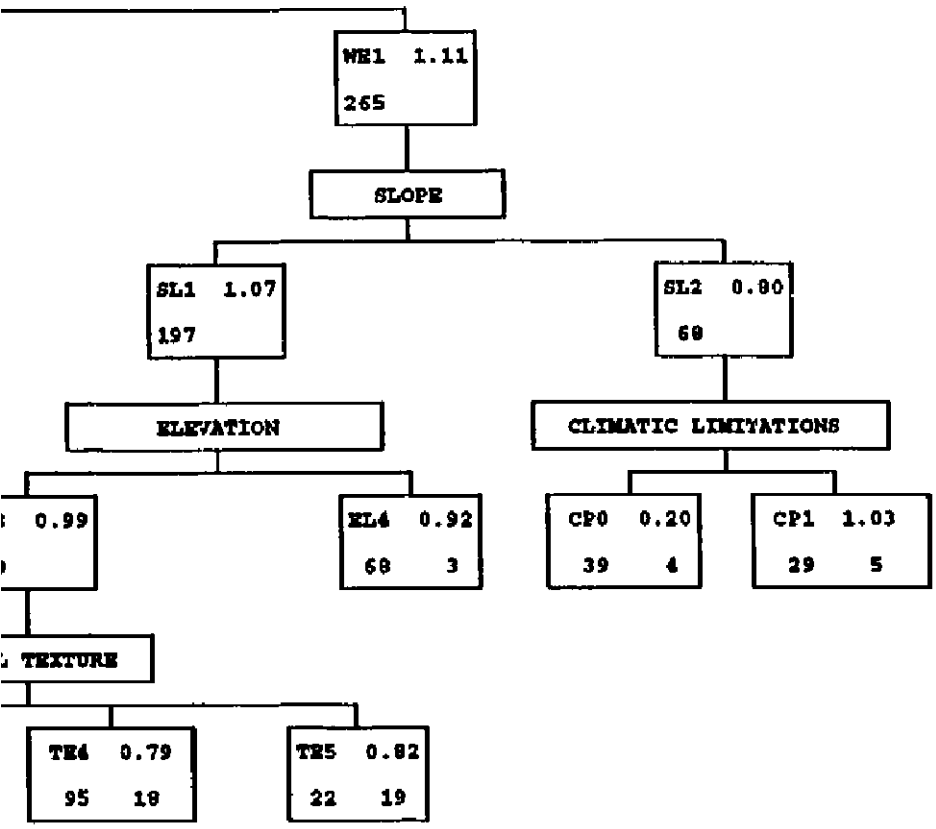
Appendix 1.a.5: Dendrogramme
Agriculture, 1962



ogramme


WE0 1.34
463
CAPABILITY FOR AGRICULTURE
CA1 1.23
82
CA3 1.11
194
SOIL PROFILE
SOIL PROFILE
PR7 1.28
42
PR2 1.10
157
PR4 0.00
37 2
EL3 1.1
54
ELEVATION
ELEVATION
PROXIMITY TO
.00
7
EL3 1.20
36 0
EL4 1.01
6 9
EL3 1.06
111 10
EL4 0.95
46
W60 1.12
34 11
W61 0.33
10 12
PROXIMITY TO WATER
W60 0.72
35 20
W61 0.96
7 21
W62 0.56
4 22

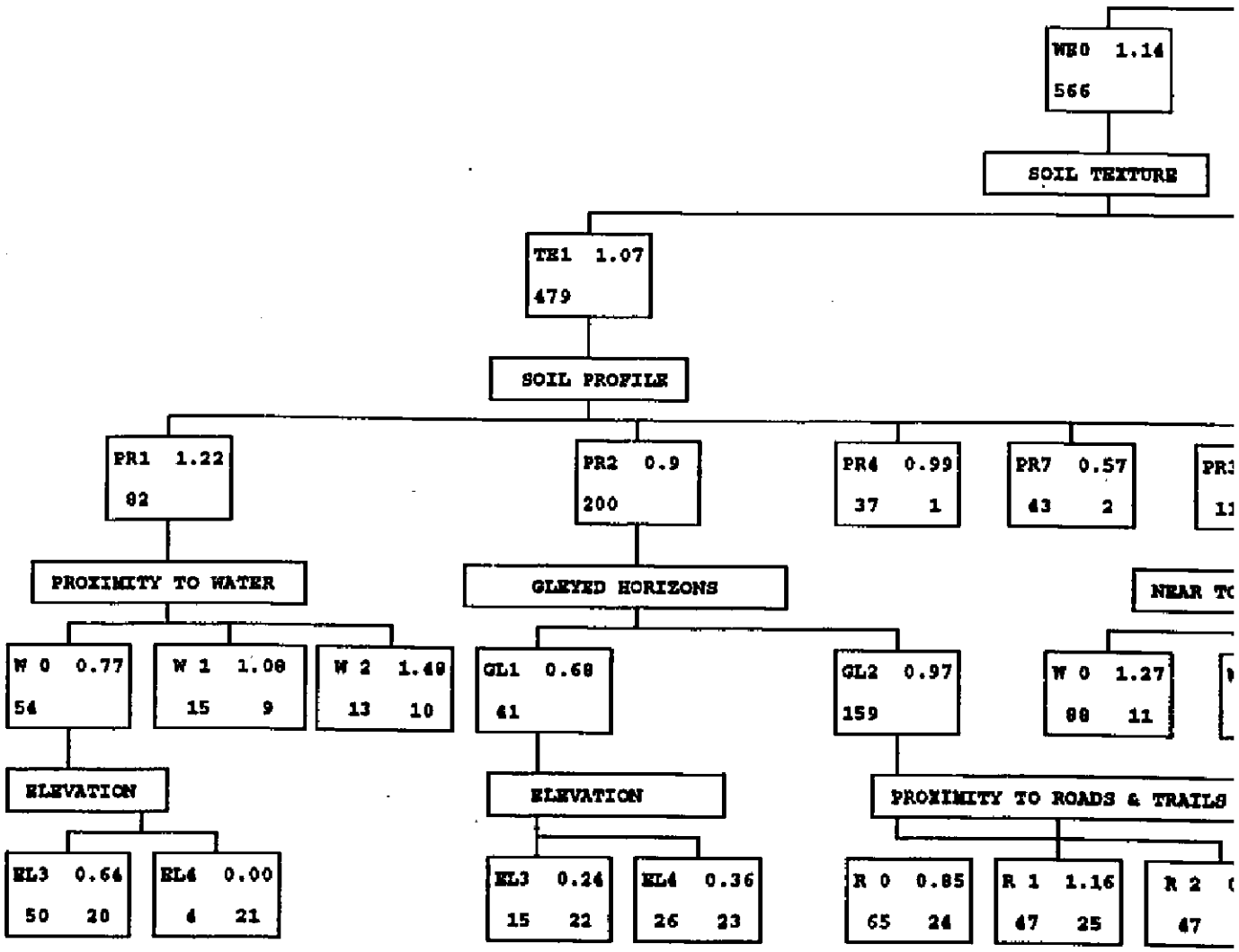

1.35
720
FOR CLE BUI WIL MUS
286 118 9 214 101
EXCESSIVE WETNESS
CA4 1.28
100
CA6 0.61
87 1
ELEVATION
EL3 1.11
54
EL4 0.95
46
PROXIMITY TO WATER
SOIL PROFILE
W61 0.33
10 12
W62 0.88
10 13
PR2 0.36
26 14
PR3 0.33
20 15
SL1 1.07
197
ELEVATION
EL3 0.99
129
SOIL TEXTURE
TE1 0.80
10 16
TE2 0.00
2 17
TE4 0.79
95 18

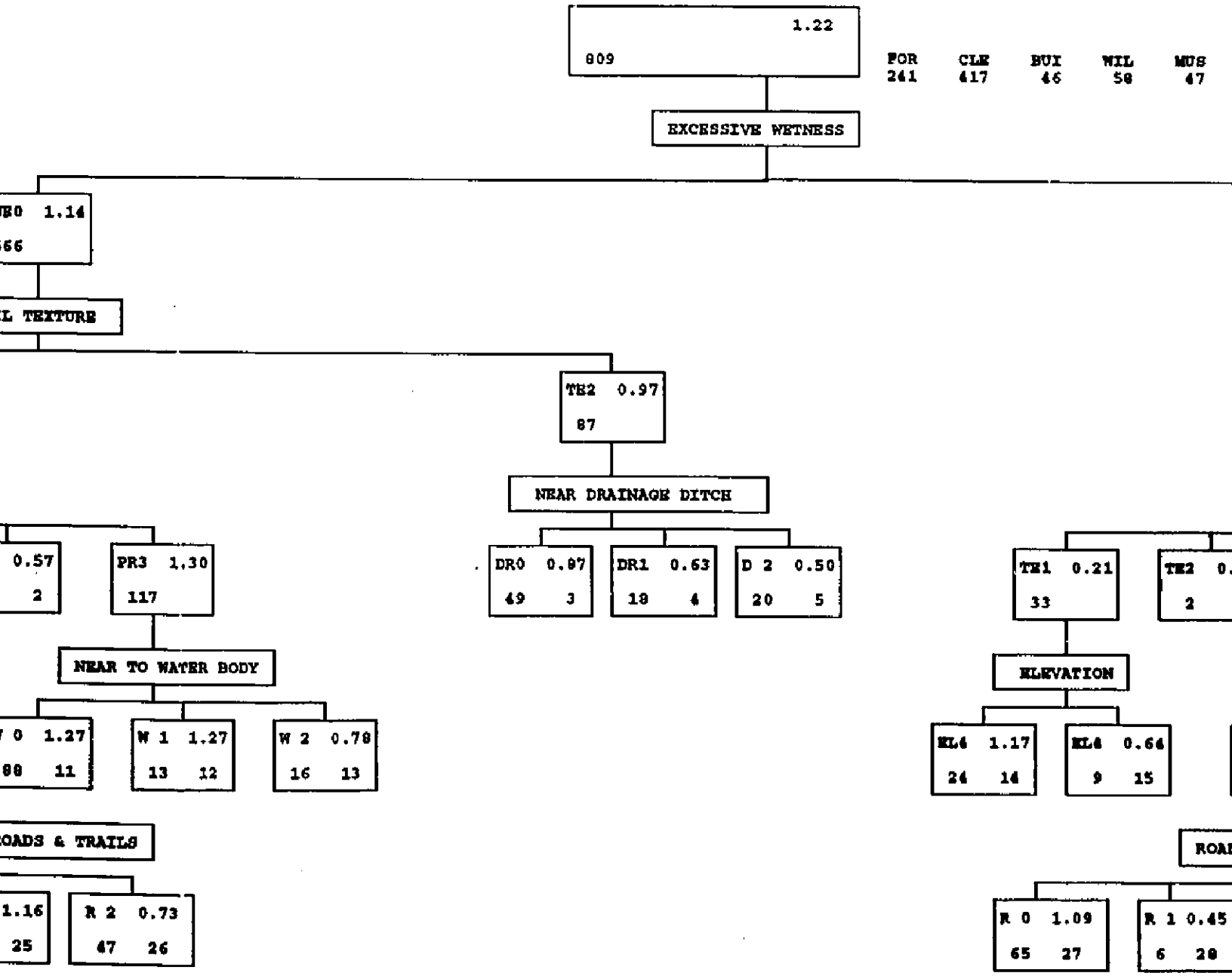


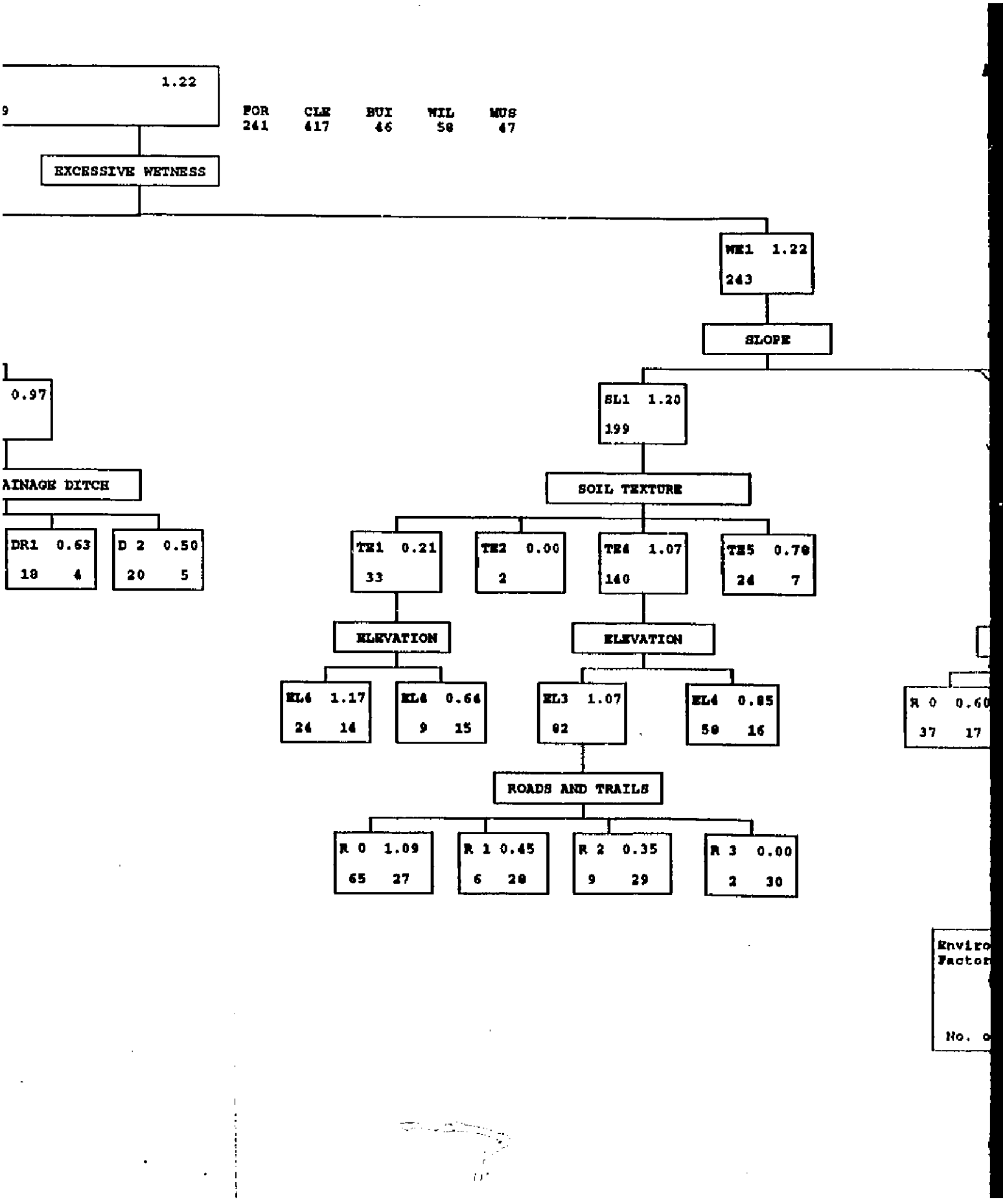
Environmental Factor Code	Entropy
No. of sites	Landscape Unit

Initial Entropy	1.35
Final Entropy	0.76
% Redundancy	43.7%
Environmental Entropy	2.71

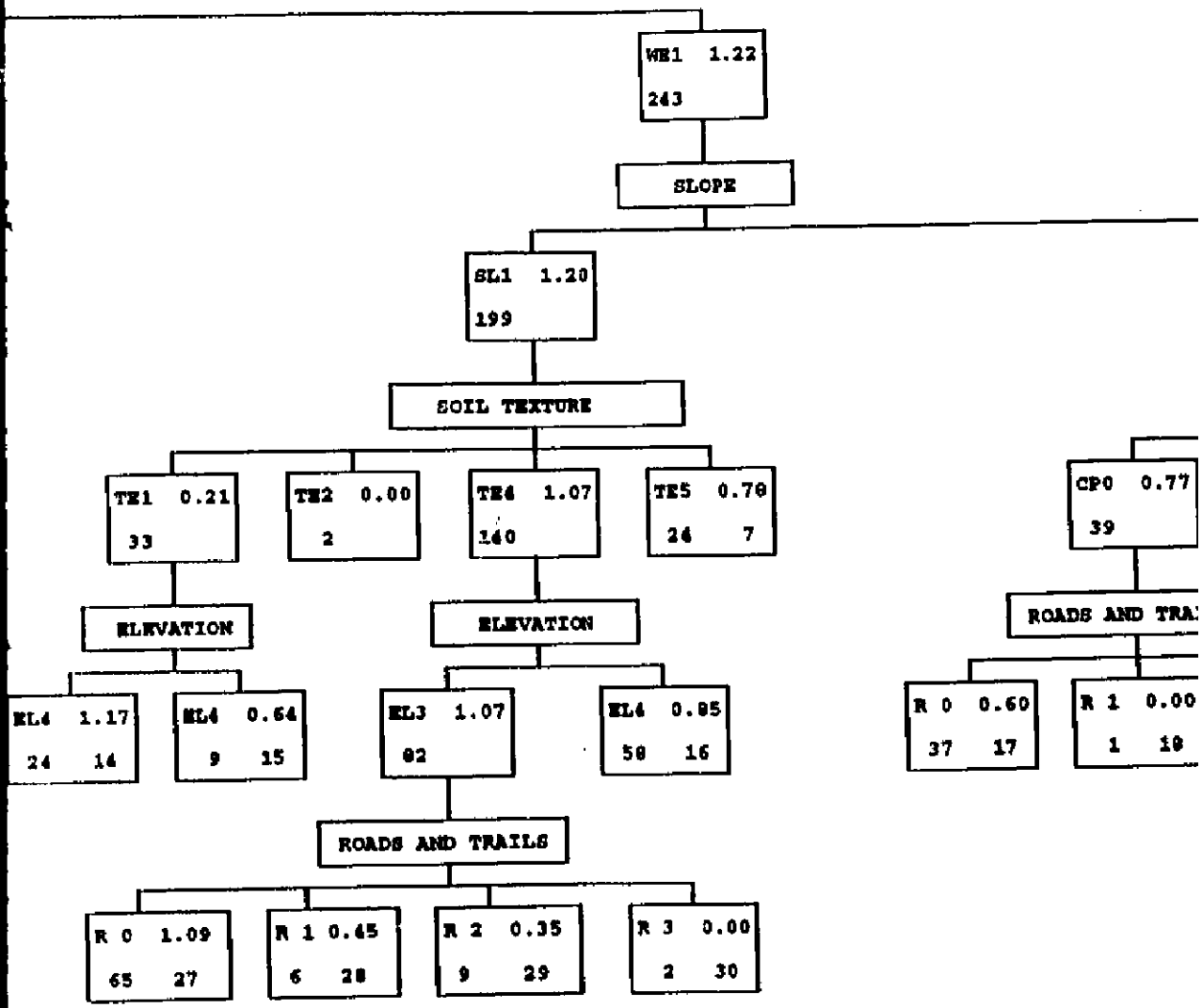
Appendix 1.a.6: Dendrogramme
Agriculture, 1991



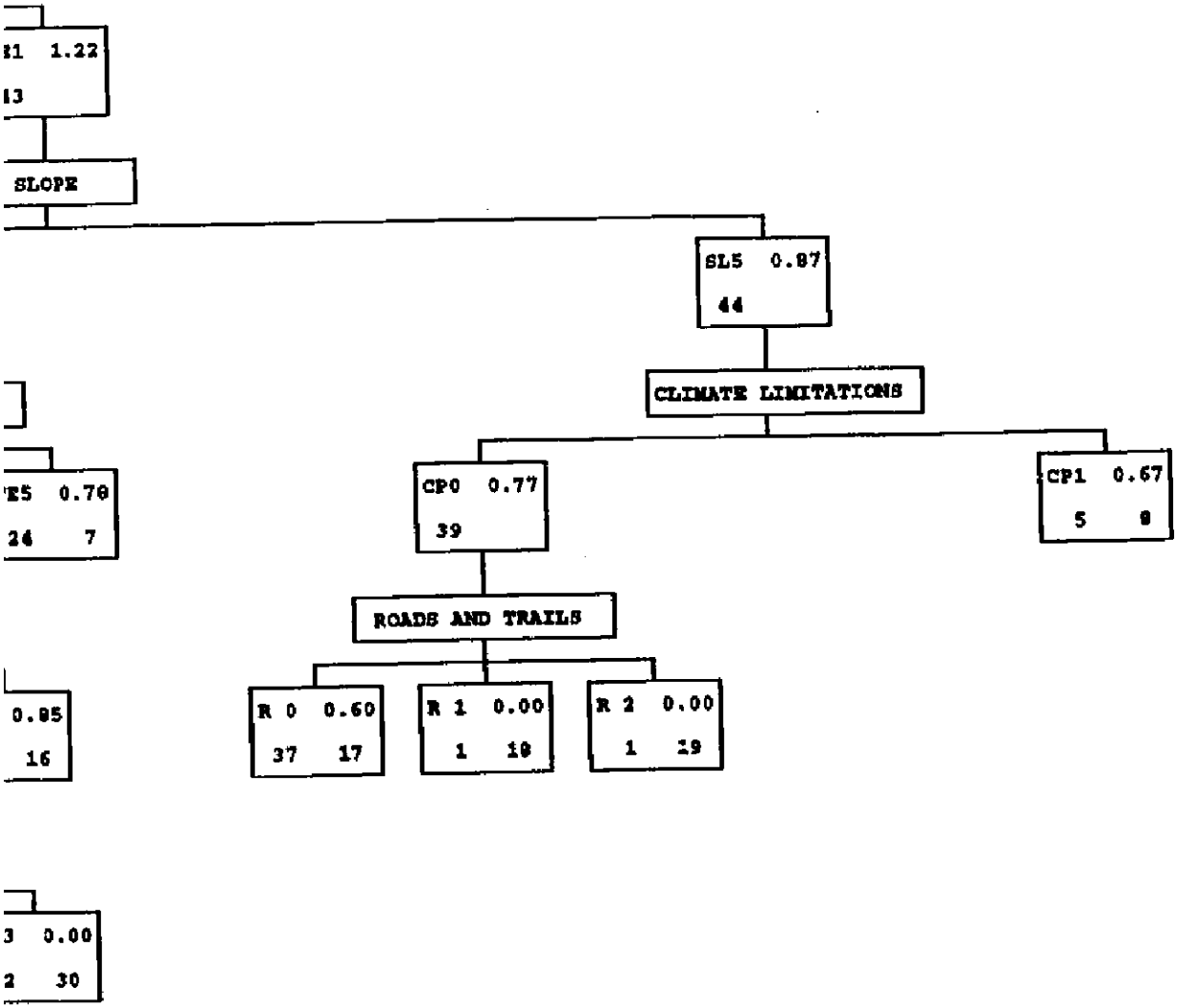

1.22
809
FOR CLE BUI WIL MUS
241 417 46 58 47
EXCESSIVE WETNESS
E0 1.14
66
L TEXTURE
TE2 0.97
87
NEAR DRAINAGE DITCH
0.57
2
PR3 1.30
117
DR0 0.97
49 3
DR1 0.63
18 4
D 2 0.50
20 5
TE1 0.21
33
TE2 0.
2
NEAR TO WATER BODY
0 1.27
88 11
W 1 1.27
13 12
W 2 0.79
16 13
ELEVATION
EL4 1.17
24 14
EL5 0.66
9 15
OADS & TRAILS
ROA
1.16
25
R 2 0.73
47 26
R 0 1.09
65 27
R 1 0.45
6 20


1.22
9
FOR CLE BUI WIL MUS
241 417 46 58 47
EXCESSIVE WETNESS
WE1 1.22
243
SLOPE
0.97
AINAGE DITCH
DR1 0.63
18 4
D 2 0.50
20 5
SL1 1.20
199
SOIL TEXTURE
TE1 0.21
33
TE2 0.00
2
TE4 1.07
140
TE5 0.70
24 7
ELEVATION
ELEVATION
EL4 1.17
24 14
EL4 0.64
9 15
EL3 1.07
92
EL4 0.85
50 16
R 0 0.60
37 17
ROADS AND TRAILS
R 0 1.09
65 27
R 1 0.45
6 20
R 2 0.35
9 29
R 3 0.00
2 30
Enviro
Factor
No. o

CLE 617 | BUI 66 | WIL 50 | MUS 47



Environmental Factor Code	
No. of sites	



Environmental Factor Code	Entropy
No. of sites	Landscape Unit

Initial Entropy	1.22
Final Entropy	0.86
% Redundancy	29.1%
Environmental Entropy	3.04

APPENDIX 1.B

Terminal Landscape Subsets Generated by PEGASE

Appendix 1.b.1

SAGKEENG (RES), 1941
Landscape Subsets

	FOR	BUI	WIL	MUS	TOTAL
1	17	11	7		35
2	17		75	164	256
3	1	1	11		13
4	133		63	15	211
5	32		62	9	103
6			10		10
	200	12	228	188	**628**

Appendix 1.b.2

SAGKEENG (RES), 1991
Landscape Subsets

	FOR	BUI	WIL	MUS	TOTAL
1	2	12			14
2	3	12			15
3			3	5	8
4	11	2	2	3	18
5	5		6		11
6	26			29	55
7				9	9
8	99		5	39	143
9	168		14	23	205
10	34		14		48
11	1			1	2
12	61		10	17	88
13		1			1
14	1				1
15	4		1	5	10
	415	27	55	131	**628**

Appendix 1.b.3

FOREST (FML), 1941
Landscape Subsets

	FOR	CLE	BUI	WIL	MUS	TOTAL
1	27			3	1	31
2	19	3				22
3				28		28
4	2	16	1	2		21
5			6			6
6		3	1			4
7	4	7	1			12
8	18	4				22
9	4	6	14			24
10	2	4	3			9
11	1					1
12	19			48		67
13	56			40		96
14	44			3	2	49
15	58			6		64
16				2		2
17	31			4	3	38
18	10				44	54
19	84			67	3	154
20	55			17	2	74
	434	43	26	220	55	**778**

Appendix 1.b.4

FOREST (FML). 1991
Landscape Subsets

	FOR	CLE	BUI	WIL	MUS	TOTAL
1	47			6		53
2	20		2			22
3	163	1	1	4	1	170
4	8	7		5		20
5	117			11	34	162
6	16		33		8	57
7	3		22	1	16	42
8	206	1		12	3	222
9	57	1		8	2	68
10		1			1	2
11	2	1			1	4
	639	12	58	47	66	**822**

Appendix 1.b.5
AGRICULTURE (AGR), 1962
Landscape Subsets

	FOR	CLE	BUI	WIL	MUS	TOTAL
1	61			26		87
2	37					37
3	6			27	35	68
4	37				2	39
5	11			13	5	29
6		21	1	11	2	35
7				5		5
8	9	18		6	3	36
9		1		2	3	6
10	58	41	3	6	3	111
11	7	2		196	6	34
12			1	9		10
13		1	2	7		10
14	23			3		26
15				2	18	20
16		2		7	1	10
17				2		2
18	22	1		67	5	95
19	13			1	8	22
20	2	28	2		3	35
21		2		1	4	7
22		1			3	4
	286	118	9	214	101	**728**

Appendix 1.b.6
AGRICULTURE (AGR), 1991
Landscape Subsets

	FOR	CLE	BUI	WIL	MUS	TOTAL
1	22	11	2		2	37
2	11	32				43
3	27	19		3		49
4	1	15	1	1		18
5	2	14		4		20
6		2				2
7	17			2	5	24
8	2	3				5
9		1	7	1	6	15
10	2	5	3	1	2	13
11	19	46	5	4	14	88
12	6	2	3		2	13
13	1	11	4			16
14	3	12		7	2	24
15	6	3				9
16	10	41		1	6	58
17	29			7	1	37
18		1				1
19		1				1
20	3	41	5	1		50
21	4					4
22	1	14				15
23	23	3				26
24	23	38	4			65
25	9	25	10		3	47
26	12	33	2			47
27	8	31		24	2	65
28		5			1	6
29		8			1	9
30				2		2
	241	417	46	58	47	**809**

APPENDIX 2.A

Government Documents Cited

Canada, Official Report of the Debates of the House of Commons of the Dominion of Canada. Ottawa: King's Printer.

5th session of the Thirteenth Parliament, 1921

2nd session of the Fourteenth Parliament, 1923

3rd session of the Fourteenth Parliament, 1924

1st session of the Fifteenth Parliament, 1926

1st session of the Sixteenth Parliament, 1926-27

2nd session of the Sixteenth Parliament, 1928

3rd session of the Sixteenth Parliament, 1929

Manitoba Clean Environment Commission, (1992) Report on Public Hearings. Abitibi-Price Inc. FML (#01) Forest Resource Management Plan, 1991-1998. Winnipeg: Manitoba Environment.

Manitoba, Premier's Reports, (1928) Relating to Development of Seven Sisters Power Site on the Winnipeg River and Agreement for Supply of Power to the Provicial Hydro-Electric System. Winnipeg: King's Printer, 99 p.

Manitoba, Province of, (1942) A Farm Electrification Programme, Report of the Manitoba Electrification Enquiry Commission. Winnipeg: King's Printer for Manitoba, 1943.

Manitoba, Province of, (1987) Reenacted Statues of Manitoba, 1987. Lois Réadoptées du Manitoba, 1987. Winnipeg: Queen's Printer for the Province of Manitoba.

Manitoba. Water Power Commission. (1948) Report of the Manitoba Water Power Commission, Commissioner T. H. Hogg. Winnipeg: C.E. Leech, Printer to the King, xi, 69 p.

Revised Statues of Manitoba, (1954) Revision and Consolidation of the Public General Acts of the Legislature of Manitoba to and Including Those of 1953 (2nd Session). Chapter 90. The Forest Act 1952.

Revised Statues of Manitoba, (1970) Revision and Consolidation of the Public General Acts of the Legislature of Manitoba to 1969 (2nd Session). Queen's Printer for Province of Manitoba, 1970. Chapter F150. Manitoba Forest Act 1964.

Smith, R.E. and W.A. Ehrlich, (1967) (with section by Zoltai on Forestry) Soils of the Lac du Bonnet Area, Soil Map of Reconnaissance Survey of Lac du Bonnet. Winnipeg: Manitoba Soil Survey, 118 p. + map.

Statutes of Manitoba, (1930 Vol. I and II. 20 George V. Chapter 14. An Act respecting Crown Timber and Forest Reserves

Statutes of Manitoba, (1931) Vol. I and II. 21 George V. Chapter 17. An Act to amend The Forest Act"

Statues of Manitoba. (1932) Vol. I and II. 22 George V. Chapter 12. An Act to amend "The Forest Act".

APPENDIX 2.B

Relevant Articles from Abitibi Magazine

January, 1953 "Pioneer in the North", D.W. Ambridge - (tribute to Frank H. Anson, founder of Abitibi Co.)

March, 1953 President's annual report to employees

May/June 1958 "Annual Meeting of Shareholders" p. 2-4:

"At present it is generally believed that there is more capacity for newsprint manufacture in the world than can be used to the extent of 10% or 15%. This is not a serious situation and in the event that the economy of the US resumes its normal growth I would expect that more newsprint capacity will be required before the end of the next decade. ¶Likewise capacity in the **world** is considerably in excess of what is required at this time, but it is impossible to believe that the use of pulp in the thousands of products of which it now forms a part will suddenly cease to grow entirely in spite of the very great increases in population and improvement in the standards of living."

roads: Important - allow use of newly-developed equipment / improve efficiency of operations, / important in reducing costs and improving efficiency - need more mechanization, less hand labour and rising labour costs.

September/October 1958: Editorial by D.W. Ambridge entitled "Standards of Living" re comparing standard of living of Canadian vs U.S. workers

Summer, 1968 page 3: "Abitibi Expands Southward" extended operations into southern U.S.

- Augusta, Georgia

May/June, 1959

"Industrial Peace" - address by Abitibi president D. W. Ambridge, to Ontario and Manitoba Council of Pulp and Paper Mill Unions Annual Convention at Sault Ste. Marie, April 10, 1059

March April 1960

Pine Falls Woods Operation, 32-33

Mechanical Operation at Camp 25: "Camp 25, Black River, is a 100% mechanical pulpwood operation. The pulpwood was cut by power saw, forwarded by Johnson skidder, loaded by crane, hauled by semi-trailer, and unloaded by a tractor-operated pusher on the ice of Winnipeg River."

Spring, 1963, opening of new high school on hand: D.W. Ambridge, Chairman (recently retired president) of Board of directors of Abitibi, and officers of co. P.E. Roberts, W.S.Rothwell, E.E. Grainger, E.W. McBride, and Craig Dick Directors: Joseph P. Ripley, John S.D. Tory, Charles L. Gundy, and C. Antoine Geoffrion, Provincial Officials: Hon. Gurney Evans, Provincial Minister of Industry and Commerce, Hon. C.H. Whitney, Minister of Mines and Natural Resources, Scott Bateman, Deputy Minister of Education, and Manager Newman McLenaghen / school designed by Engineering Dept. under W.C.E. Wood "Earlier in the day a directors' meeting was held in Manitou Lodge"

Spring, 1963: from Annual report to employees: "As pointed out in last year's report, the return of the Canadian dollar in June, 1961, to a discount position in terms of the U.S. dollar, materially improved earnings in the second half of that year. The year 1962 had the benefit of a further devaluation of the dollar and this is the major contributing factor to our good showing. If our dollar had remained at its 1961 exchange level, earnings from Canadian operations in 1962 would have been lower than in 1961."

Winter 1967-68; Talk Given by C.H. Rosier (Senior V.P., Planning and Development) on September 22, 1967 to 30th Annual Convention of Central Canada Council of Pulp and Paper Mill Unions at Sault Ste Marie, Ontario

Spring 1970 "Annual Report to Employees" by T. J. Bell": '1969 was also the year that public attention focused on pollution problems. Much has been said about pollution by the pulp and paper industry with little recognition of the improvement made in recent years. Abitibi has been engaged for years on a continuing program of pollution abatement. In the past 10 years, Capital expenditures for this purpose have exceeded $17,000,000. Many of the remaining problems are complex and very costly to overcome. The industry has asked the various levels of government for assistance in the form of grants and financial incentives."

APPENDIX 2.C

Newspaper Articles

Newspaper Articles Related to the Pulp and Paper Industry

1901 (n.d.) The Albertan, p. 11

Our Territorial Lands: A Brief Statement of the case for provincial control of the Crown Domain (address delivered before the Young Men's Liberal Club of Calgary

January 13, 1922 Killam News

One Big Canada and natural Resources for the West is Aim of Honourable Charles Stewart

Feb 17, 1926. Winnipeg Evening Tribune

Indians Sell Site for Fort Alexander Mill

Feb. 18, 1926 Winnipeg Evening Tribune

Indians Receive Share of Sale Price

March 4, 1926, Winnipeg Evening Tribune

Local Men Plan Railway to Gold Mines

March 8, 1926 Winnipeg Evening Tribune

Spanish River Official Heads Manitoba Paper Co. / J. D. McArthur Resigns Presidency / Party of 200 from City Visit Mill Site

March 8, 1926 Winnipeg Evening Tribune

Pulp Mill Taking Shape - photographs and March 9, 1926

March 16, 1926 Edmonton Bulletin

Premier Strewart Hears from Sir George Foster - Question of handing over natural resources to province is receiving consideration

March 16, 1926 Winnipeg Evening Tribune

Proposed route to Gold Fields - map Pine Falls - McArthur and Mining interests - access to mines and to pulpwood

December 18, 1926 - Manitoba Free Press

Stewart Says He Will Make Pulpwood Decision / Bracken Government to be Kept Fully Advised by Hon. Charles Stewart / Application by Manitoba Paper Company for Further two million cords

January 10, 1927 (Monday) Manitoba Free Press

New Policy Adopted in Pulpwood Negotiations

January 11, 1927 - Manitoba Free Press

Thorson Strong for Stewart's Proposal / Says interests of Manitoba not to have large pulpwood area locked up / Reaches Winnipeg from ottawa and holds conference with Premier Bracken

January 11, 1927 Manitoba Free Press

Pioneer Contractor of Manitoba is Dead / J. D. McArthur dies from pernicious anemia after returning to Winnipeg

January 12, 1927 (Wednesday) Manitoba Free Press

Paper manufacturing plant at Pine Falls opens Monday / Final touches at big mill built by Manitoba Paper Company marks new epoch in industrial development of province new town brought into being.

January 12, 1927 Manitoba Free Press

Seeks further data in pulp[concessions / Premier Bracken declines to commit government to new proposals

January 13, 1927 Manitoba Free Press

Government should afford protection to pulp plant, declares Portage member / Manitoba Paper Company should be guaranteed sufficient cordage, says E.A. McPherson: industry is asset to Manitoba

January 13, 1927 Manitoba Free Press

Editorial: How not to protect our resources - Dominion government in charge of forests and did not know how much they had - absentee landlord - to Broaden Manitoba's development "The beginning of a paper production at Pine Falls on Monday is a milestone in the development of the province

January 13, 1927 (Thursday) Manitoba Free Press

Quebec Proposes Protection for Pulp Industry

January 20, 1927 - Manitoba Free Press

Urges development of Natural Resources [Speaking at University of Manitoba] Prof. R.C. Wallace tells Bankers Club about the Hidden Wealth of Manitoba "We should get seriously busy in getting the wealth out of our province and making it liquid for this and future generations." - Canadian Bankers Club theme for meeting The Natural Resources of Manitoba: Their Problems and Their Financing"

January 26, 1927 Manitoba Free Press

Business Men of Winnipeg Witness Newsprint Being Made at Manitoba Plant/ Party of Three Score citizens Visit Mill at Pine Falls and Receive Demonstration of Turning Wood into Paper / Modern Town Centres Around Village Green Where Few Years Ago Only Wilderness Existed /Winnipeg Business Men See Paper Made

January 27, 1927 (Thursday), Manitoba Free Press

Sweatman Questions Sincerity of Mayor in Pulpwood Dispute /

February 1, 1927 Manitoba Free Press

Webb declares his sincerity Realized (re Sweatman's remarks yesterday"

February 2, 1927 Manitoba Free Press

Pulpwood Controversy is Fast Reaching Fever Heat / Backus Says No Second Mill if Manitoba Paper co. is granted latest request / Sweatman Challenges Webb to meet him at Meeting today / Declares He Will Expose Mayor's Relations With Backus

February 11, 1931 Manitoba Free Press

Russian Lumber, Pulpwood is Barred from U.S. Market / Effect of Treasury order, placing on Russian government burden of proving they are not products of convict labour / interest to Canada whose trade has been offered direct competition by exports from Russia

1930 exports from USSR to US 70million ft. timber, 150,000 cords pulpwood

1930 exports from Canada to US 1Billion ft.timber, 1.5 million cords pulpwood

- not seen as problem like that by if success of 5-year industrialization plant, imports from Russia could run to 500million ft^3 timber with a corresponding increase in pulpwood

March 21, 1931 Manitoba Free Press

- Canadian export of softwood to U.S. is threatened by tariff

June 8, 1931 Manitoba Free Press

Canadian Power and Paper Collapsed (Crashed) - also editorial and political cartoon

June 3, 1931 Winnipeg Free Press

Failure to pay amount Technical Default by firm / Statement by Abitibi Power and Paper company is Issued / Toronto June 1: The Abitibi Pulp and Paper Co. Ltd. Wednesday night placed itself in technical default

February 5, 1932 (Friday) Winnipeg Free Press

Paper Mill on Full Time Until April 1 / Pine Falls Will Then Shut Down, State Abitibi Officials at Toronto

February 17, 1932 (Wednesday), Winnipeg Free Press

Pine Falls Plant to be Closed in March / Operations to Cease About Three Weeks Earlier than at First Expected.

February 18, 1932 (Thursday) Winnipeg Free Press

Plan Syndicate to Keep Mill at Pine Falls Going / Delegation of Business Men Confers With Manager of Plant and Abitibi Officer

February 25, 1932 (Thursday) Winnipeg Free Press

Machinery at Paper Mills to Stop Today / Only Few Men Will Remain on Pay-Roll of Pine Falls Plant on Friday

February 27, 1932 (Saturday) Winnipeg Free Press

Close of Paper Mill is Marked by Workers' Trek from Town of Pine Falls (byline Burt Gresham

March 1, 1932 (Tuesday) Winnipeg Free Press

Manitoba's Only Paper Mill Closes - photographs

March 17, 1932 (Thursday) Winnipeg Free Press

Says Pine Falls Mill may Reopen at End of Year / Representative tells legislative body temporary export of pulp not opposed.

June 3, 1932 Winnipeg Free Press

Price Reorganization Reported Effective

June 11, 1932 Winnipeg Free Press

Report Abitibi Deal with Ontario Hydro - June 10

June 17, 1932 (Friday) Winnipeg Free Press

Abitibi Power Company Security Holders Form Committee / Action Taken on Failure of Company to Pay Interest on First Mortgage Bonds

June 25, 1932 - Winnipeg Free Press

Ontario to Purchase New Power Project / Will Take Over Private Development of Abitibi Canyon / Transaction Reported Necessitated by Financial Difficulties of Company

July 2, 1932 Winnipeg Free Press

Abitibi to Default on Bond Interest in Ontario Public Service

July 7, 1932 Winnipeg Free Press

Work on Abitibi Power Project to close Down Today - 800 unemployed

July 28, 1932 Winnipeg Free Press (From Montreal wire service)

Abitibi Board Withholds Bond Interest Statement

July 30, 1932 (Saturday) Winnipeg Free Press

Abitibi Bond Interest Not Likely to be Paid

August 1, 1932 Winnipeg Free Press

Suspended Payment of Abitibi Bond Interest

August 2, 1932 Winnipeg Free Press

Bond Interest Defaulted by 3 Canadian Newsprint Companies / No action taken by directors of Abitibi Power and Paper Col - 60 days of grace in default of first mortgage bonds expires - Price Bros. & Co. and Lake St. John Pulp and Paper Co. Bond Interest Due Monday, is Unpaid

August 6, 1932 (Saturday) Winnipeg Free Press

Gardens and Pine Falls Factor in Workless Relief - MacNamara Praises Activities of McIlwraith in Promoting Undertaking - allows cut of relief payments.

August 10, 1932 Winnipeg Free Press

Seeking to Have Pine Falls Mill Re-opened Soon - Stanbridge Addresses Series of Open Letters to Natural Resources Department

August 11, 1932 Winnipeg Free Press

Leo Schanus, Well known Manitoba old-timer, dies "The present townsite of Pine Falls was purchased from Mr Schanus" - citizen of Fort Alexander and St-Georges district

September 3, 1932 (Saturday) Winnipeg Free Press

Receivership Planned for Abitibi Power and Paper Co. / Montreal Paper States Petition Will be Made in Toronto Court at Early Date (Canadian Press Despatch)

November 5, 1940 Winnipeg Tribune Clippings (Canadian Press)

Necessity of Abitibi's Power Plants Stressed

November 5, 1940 Winnipeg Tribune Clippings

Abitibi Receiver Reorganization Plan Requested (Canadian Press)

November 7, 1940 Winnipeg Tribune Clippings

Place Estimate on Valuation of Abitibi Plants

December 11, 1940 Winnipeg Tribune Clippings

Symington Testifies at Abitibi Hearing [receivership]

January 6, 1941 Winnipeg Tribune Clippings

Commission Hears New Abitibi Plan [reorganization as consequence of receivership]

January 7, 1941 Winnipeg Tribune Clippings

Abitibi's Clarkson Opposes Asset Sale [consequence of receivership]

January 8, 1941 Winnipeg Tribune Clippings

Abitibi Commission Concludes Hearing

April 1, 1941 Winnipeg Tribune Clippings

Abitibi Paper Plan for Reorganization Now in Legislature

May 1, 1941 Winnipeg Tribune Clippings

Change of Text of Abitibi Report

May 18, 1950 Winnipeg Tribune Clippings

A National Forest Policy / New Canada Forestry Act - Royal Assent on December 10, 1949. "contribute to national welfare through the development of forest resources"

March 7, 1952 Winnipeg Tribune Clippings

Timber Pact Renewal for Firm - rearrangement of timber berths allocated to the co. when it started operations - original agreement expired in June 1951

March 29, 1952 Winnipeg Tribune Clippings

Forest Act Held Over - last minute objection by a Progressive Conservative member Friday held up passage of a bill to amend Forest Act which would empower the licensee of a timber berth to surrender part of it, and under certain conditions, receive in return additional areas without competition" A.W. Harrison, Killarney, was not prepared to consent to third reading "the bill which has aroused vigourous argument among its proponents and opponents was stood over in committee."

March 14, 1955 Winnipeg Tribune Clippings

Multi-Million Dollar Plant Expansion for Pine Falls: Abitibi to Make Changes - to increase capacity to 500 tons

May 25, 1955 Winnipeg Tribune Clippings (Canadian Press story)

Abitibi Workers Get 5 Per Cent Boost in Wages

May 26, 1956 Winnipeg Tribune Clippings (Canadian Press story)

Abitibi Permit for $7,330,575

September 14, 1956 Winnipeg Tribune Clippings

Forestry Meet to Probe Timber Waste, Educative

$35M mill built at Hinton Alberta

$65M mill built at Prince Albert, Sask.

March 28, 1963 Winnipeg Tribune Clippings

Manitoba Forestry Future Outlined "The big drawback right now is that firms engaged in the industry !ack long term tenure rights to the vast timber lands"

June 1965 Winnipeg Tribune Clippings

Revamped timber Rights Proclaimed by Province - Manitoba's New Forestry Act will have Quotas

June 12, 1970 Winnipeg Tribune Clippings

Newsprint Keeps Town [Pine Falls] Running

March 26, 1974 Winnipeg Tribune Clippings

Government May Buy equity in Abitibi

March 27, 1974 Winnipeg Tribune Clippings

Green Denies Equity Plan on Abitibi

March 28, 1974 Winnipeg Tribune Clippings

Talks On: Green

March 30, 1974 Winnipeg Tribune Clippings

Green Denies equity bid

July 26, 1974 Winnipeg Tribune Clippings

Abitibi plans to purchase Pope and Talbot Inc. stud mill operation in Hudson, Ont.

October 21, 1974 Winnipeg Tribune Clippings

Wood Shortage hits paper mill

October 26, 1974 Winnipeg Tribune Clippings

Paper Mill Returns to Full Production

October 26, 1974 Winnipeg Tribune Clippings

Abitibi having good year, net earnings for 1st 9 months of 1974 #36M, comp. to $16.3M same period last year

November 16, 1974 Winnipeg Tribune Clippings

Abitibi Interested in The Price Co.

December 13, 1974 Winnipeg Tribune Clippings

U.S. Concerned by Merger of Canadian Pulp Firms

April 27, 1976 Winnipeg Free Press

Abitibi Stand Helped Slow Pay Spiral: Chief Executive

August 13, 1976 Winnipeg Tribune Clippings

Abitibi celebrates 50 years

September 5, 1976 Winnipeg Tribune Clippings

[Maurice] Strong buys Abitibi shares

January 4, 1978 Winnipeg Tribune Clippings

Vast Changes Due for Forest Industry (by Andrew H. Malcolm New York Times Service)

December 5, 1978 Winnipeg Tribune Clippings (Canadian Press)

Bid is rumoured for Abitibi Co.

Newspaper Articles Related to Manitoba Hydro:

March 3, 1931 Manitoba Free Press

Settled portions of Manitoba to get cheaper electricity / legislation Monday, March 2/31 "More they use, less the rate will be

May 26, 1931 Manitoba Free Press

Women to tour hydro plants - Winnipeg highest per capital electricity consumption in the world.

July 15, 1931 Manitoba Free Press

Seven Sister Falls open, big ad for appliances - full page ad

'This is our contribution to the growth of Winnipeg and Manitoba' - Winnipeg Electric Company.

March 17, 1932 Winnipeg Free Press

Seven Sisters Plant to cease Operations / Affected by Closing Down of Paper Mill / Only skeleton Crew to be Retained / generation of 60,000 less horsepower daily

June 6, 1932 - Winnipeg Free Press

Consumption of Hydroelectricity Shows Increase

1931 increase in Manitoba, decrease in Ontario and Quebec; 88% of manufacturing industries in Manitoba is electrified.

June 15, 1942 Winnipeg Tribune Clippings Editorial/Analysis

Rural Electrification

September 18, 1942 Winnipeg Tribune Clippings

Large Scale Rural Electrification Seen as Provincial Aim

January 2, 1943 Winnipeg Tribune Clippings

Capital Cost Estimated at $673 Per Farm

January 2, 1943 Winnipeg Tribune Clippings

Plan to Supply Power for Rural Homes Drafted (byline L.F. Earl)

January 12, 1943 Winnipeg Tribune Clippings

Would Service 1,000 Farmers in First Year

February 13, 1943 Winnipeg Tribune Clippings Editorial/Analysis

Electricity of U.S. Farms

April 7, 1943 Winnipeg Tribune Clippings

Reduction of Service Charge with April Bill, 142 Towns Affected

May 21, 1943 Winnipeg Tribune Clippings

Rural Power Consumption Doubled in 5-year Period

June 18, 1943 Winnipeg Tribune Clippings

Rural Electrification Urged for Post-War (by the Canadian Press)

July 14, 1943 Winnipeg Tribune Clippings

Electro-Agriculture

August 24, 1943 Winnipeg Tribune Clippings

Electricity and the Farm (from the Ottawa Journal)

January 17, 1944 Winnipeg Tribune Clippings

Helping the Farmer (From the Emporia Gazette)

March 16, 1944 Winnipeg Tribune Clippings

Manitoba's Rural Electrification Network

February 12, 1949 Winnipeg Tribune Clippings

Speed Up Hydro, Urges Campbell (Premier)

February 14, 1949 Winnipeg Tribune Editorial

The Power Shortage: A Difficult Decision

February 25, 1949 Winnipeg Tribune Clippings

Cost-Plus Contract to Speed New Hydro

March 12, 1949 Winnipeg Tribune Clippings

Pine Falls Power Tenders Requested

May 11, 1949 Winnipeg Tribune Clippings

#10 Million Pine Falls Power Contract Signed

April 11, 1949 Winnipeg Tribune Clippings Editorial

Pine Falls Contract

April 18, 1949 Winnipeg Tribune Clippings

Tenders Opened for Pine Falls Hydro Project

April 29, 1949 Winnipeg Tribune Clippings

Speed Power Plant Merger, Urges City Hydro Official

May 2, 1949 Winnipeg Tribune Clippings Editorial/Analysis

Power to be Had (Winnipeg and English River)

July 19, 1949 Winnipeg Tribune Clippings

Premier Inspecting Pine Falls Project

August 30, 1949 Winnipeg Tribune Clippings

Construction Hits Fast Pace in Pine Falls Power Project

October 5, 1949 Winnipeg Tribune Clippings Editorial

End the Confusion (re: government hydro-electric program)

November 8, 1949 Winnipeg Tribune Clippings Editorial

Pine Falls Contract (Re cost-plus basis of construction contract)

December 23, 1949 Winnipeg Tribune Clippings

Power Project Meets Schedule; Complete in '52

January 4, 1950 Winnipeg Tribune Clippings

Pine Falls: A Beginning

February 18, 1950 Winnipeg Tribune Clippings

House Group to Study Power Province's Aim

February 22, 1950 Winnipeg Tribune Clippings

Power Project Pay Attacked in House

March 22, 1950 Winnipeg Tribune Clippings

Even Cemetery to be Shifted in Move as Power Project Pushes Village Aside

May 17, 1950 Winnipeg Tribune Clippings

Pine Falls May Blow Dam as River Threatens Power

May 18, 1950 Winnipeg Tribune Clippings

Pine Falls Power Dam Blown Up

May 19, 1950 Winnipeg Tribune Clippings

Coffer Dam Blasted in Flood

May 19, 1950 Winnipeg Tribune Clippings Editorial

Heartbreaking Decision

June 15, 1950 Winnipeg Tribune Clippings

Pine Falls Power Still 1951 Target

March 14, 1950 Winnipeg Tribune Clippings

Pine Falls Costs Up $1.5 Million

June 13, 1951 Winnipeg Tribune Clippings

Third of Pine Falls Power 'This Year'

April 30, 1952 Winnipeg Tribune Clippings

Program Fulfilled