ECOLOGICAL LAND CLASSIFICATION PROJECTS IN NORTHERN CANADA AND THEIR USE IN DECISION MAKING

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ABSTRACT

Ecological land classification project, where a range of environmental parameters rather than single discipline approaches were used, have been undertaken in northern Canada. Although the studies were not coordinated, almost all used the ecoregions and their broad subdivisions, ecodistricts. Mapping criteria included parent materials, relief, vegetation, soils, and drainage. Most projects were intended as baseline studies prior to development. One project, in the Mackenzie Valley, went through the appraisal and final decision process. Ecological land information was used to identify possible impacts along the pipeline route.

RÉSUMÉ

Divers projets de classification écologique du territoire ont été réalisés dans les régions septentrionales du Canada. La formule adoptée faisait intervenir toute une gamme de paramètres environnementaux plutôt que des disciplines uniques. Bien que non coordonnées, les études ont pour la plupart été axées sur les écorégions et leurs grandes subdivisions, les districts écologiques. Le matériel-mère, le relief, la végétation, les sols et le mode de drainage constituent les éléments cartographiés. Les travaux de recherches étaient pour la plupart des études de base préalables à des projets de développement. Une étude entre autres, visant la vallée du Mackenzie s'est rendue jusqu'à l'étape finale du processus d'évaluation et de décision. Les renseignements sur l'écologie du territoire ont servi à déterminer les incidences possibles du pipeline sur l'environnement, le long du trajet choisi. (Trad. Éd.)

INTRODUCTION

Northern Canada, lying north of the 60th parallel, comprises nearly 40% of the country. This vast area, nearly 4 million km^2 (over 1.5 million mi^2) displays a wide variety of physiography from the highest mountain in Canada to featureless plains. Permafrost, continuous over all but the southwestern part of the area, creates unique soil conditions. The harsh climate causes nearly barren areas in the far north, varying through treeless, but otherwise well vegetated shrub and grass tundra to stunted subarctic forests and to closed-canopy boreal forests in the south.

In the north the value of vegetation is often not readily apparent. Although commercially exploitable timber grows in the southern Yukon and Mackenzie Valley, timber values elsewhere are negligible. Wood may be locally utilized for fuel or building materials, but the main value of the vegetation lies in its role as part of the environment. In the Subarctic, moss effectively insulates the ground, preserving the permafrost and the integrity of the terrain. Disturbance of the living vegetation will result in summer thawing of the ground, which releases large amounts of water and mud. Vegetation provides food and shelter to wildlife, often the only harvestable resource of the north.

Under northern conditions a land classification program stressing the productivity of the land is inadequate. The land-vegetation relationships must be examined from both the engineering and environmental aspects to produce ecological units meaningful to all disciplines. Various investigators have tried different methods of integrating the information into ecologically meaningful units. In this paper the approaches used in recent ecological land classification programs in the Northwest Territories are outlined, and their similarities and usefulness in the decision making process by land managers are evaluated. This paper is largely based on material presented at a symposium on Ecological Land Classification (Zoltai 1977).

ECOLOGICAL SETTING

A brief introduction into the ecological setting of northern Canada is provided by the Ecological Regions ("Land Regions" of Subcommittee on Biophysical Land Classification, 1969; "Site Regions" of Hills, 1961; "Biogeoclimatic Zones" of Krajina, 1972). In all cases the regions were characterized by examining the

Figure 1: Provisional Map of Ecological Regions in Northern Canada

LEGEND

A_H -- High Arctic
A_M -- Mid Arctic
A_L -- Low Arctic

S_{Hw} - High Subarctic, west
S_{He} - High Subarctic, east
S_L - Low Subarctic

A_{Hx} - High Alpine Complex
A_{Mx} - Mid Alpine Complex
A_{Lx} - Low Alpine Complex

S_{Hx} - High Subalpine Complex

B_H - High Boreal
B_{Hd} - High Boreal, dry

Table 1: Brief characteristics of the Ecological Regions of the Northwest Territories and Yukon.

High Arctic (AH)	Scattered vegetation (less than 50% ground cover) of perennial herbs, dwarf shrubs, mosses, and lichens. Continuous permafrost.
Mid Arctic (AM)	Discontinuous vegetation (50-90% ground cover) of low shrubs, perennial herbs, mosses, and lichens. Continuous permafrost.
Low Arctic (AL)	Complete ground cover of shrubby lichen-heath tundra. Continuous permafrost.
High Subarctic (SHw) (West)	Open-canopied, stunted black spruce-shrub-lichen forest (white spruce near tree lines). Continuous permafrost in mineral soils, discontinuous in peatlands.
High Subarctic (SHe) (east)	As in west, but with large expanses of Low Arctic tundra.
Low Subarctic (SL)	Open-canopied, black spruce-lichen forests. Permafrost widespread, but discontinuous in mineral soils and in peatlands.
High Boreal (BH)	Closed canopy forests of aspen-spruce-feathermoss. Sporadic permafrost in imperfectly drained mineral soils and in peatlands.
High Boreal (BHd) (dry)	Low rainfall area with open stands of white spruce and lodgepole pine. Sporadic permafrost in peatlands.
MOUNTAIN COMPLEXES	
High Alpine Complex (AHX)	Dominantly resembles High Arctic regions, but lower slopes and valleys resemble Mid and Low Arctic regions.
Mid Alpine Complex (AMX)	Dominantly resembles Mid Arctic regions, but with higher peaks resembling High Arctic, and low valleys resembling Low Arctic and High Subarctic regions.
Low Alpine Complex (ALX)	Dominantly resembles Low Arctic regions, but some higher peaks resembling Mid Arctic regions, and some valleys resembling High Subarctic regions.
High Subalpine Complex (SHX)	Dominantly resembling High Subarctic regions, but with peaks resembling Low Arctic regions, and valleys resembling Low Subarctic regions.

undisturbed vegetation on well-drained soils on a gentle slope having adequate nutrients (normal sites, Hill 1961). Brief descriptions of Ecological Regions are given in Table 1, and a provisional map of the Northwest Territories and the Yukon is shown in Figure 1.

ECOLOGICAL LAND SURVEYS

Ecological land surveys conducted in the Northwest Territories in the past were influence by two main factors. The dominant one was the fact that nearly all were instituted in reaction to proposed developments in the north, mainly pipelines. This meant that because of the urgency and short term of the projects, proper planning and development of priorities and methodologies were often not possible. The second factor was the great expense associated with northern field work because of the remoteness from supply points and the total dependence on air transportation.

The result of such pressures was that in most cases the lead agency (controlling the mapping methodology, field operations, and logistics) was in the discipline of Pleistocene geology (Terrain Sciences, Canada Department of Energy Mines and Resources). Members of other disciplines, such as plant ecologists, botonists, pedologists, and wildlife biologists, were attached to the terrain scientists, sometimes as an integral part of the term, but often as an afterthought. Thus, some of the resulting maps were based entirely on geomorphological features, with ecological characterization added.

Seven of the recent studies were related to various pipeline proposeals (Figure 2): Mackenzie Valley (Hughes et al., 1972a, b; Rutter et al., 1972; Tarnocai, 1973; Zoltai and Pettapiece, 1973; Hanley et al., 1975), Mackenzie Valley south (Crampton, 1973), eastern Melville Island (Barnett et al., 1975, 1976a; Barnett, 1976), Bathurst and Cornwallis islands (Barnett et al., 1976b; Tarnocai, 1976), Boothia Peninsula and northern Keewatin (Tornocai and Boydell, 1975; Tarnocai et al., 1976; Tarnocai and Netterville, 1976), central Keewatin (Tarnocai, 1977), Somerset Island and northern Prince of Wales Island (Zoltai and Woo, 1976; Woo and Zoltai, 1977). Two studies were made of potential national park sites: South Nahanni River (Scotter et al., 1971) and Fort Reliance-Artillery Lake (Kelsall et al., 1970). One project dealing with caribou rangelands is under way in the Great Slave Lake area, but will not be considered here because no reports are available.

The purpose of all but two studies was to provide baseline information on terrain and environmental characteristics for the assessment of pipeline development proposals. Consequently, those aspects that affect the engineering performance of the terrain or that supply granular materials for construction were stressed. However, as the role of vegetation in preventing thermal erosion became clear, and as ecologically sensitive areas were encountered, biological studies became part of the mapping projects. Thus, biological information was present only as additional characterization of the mapping units in the early studies (Mackenzie Valley), but later, vegetation and soils aspects also became mapping criteria, along with the geomorphological features. In the two projects oriented toward providing information on the natural environment of potential national park areas, the large scale mapping (1:50,000) permitted the production of separate terrain and vegetation maps.

METHODOLOGY

Because the projects were initiated at different times and at different locations and by different government organizations, there was no opportunity for applying any one classification system. It is interesting to note, therefore, the similarities in the classification approaches (Table 2).

All but two studies divided their area into broad regions (level 1) on the basis of climate. The two that did not (Table 2, studies 3 and 4) were studying areas that were entirely in the same climatic region. The main criterion for this broad regionalization was climate as reflected by the distribution growth, and successional trends of vegetation communities. Some studies included such climatically controlled factors as the occurrence of dominant Great Soil Groups or soil genesis and the distribution pattern of permafrost.

The next lower level (2) of detail was handled differently by some of the investigators. Most studies used the Land District concept of the Biophysical Classification (Subcomm. 1969), in which the districts are recognized as areas of broadly similar patterns of geomorphological and geological features and soil parent material and permafrost conditions. Vegetation distribution would also follow a recognizable pattern within the climatic region. On some of the Arctic islands the bedrock formations were taken as the corresponding level of subdivision. This was prompted by the virtual absence of glacially transported materials: the surface materials therefore reflected the underlying bedrock. In the southern Mackenzie study the parent material was used to distinguish areas at this level of detail.

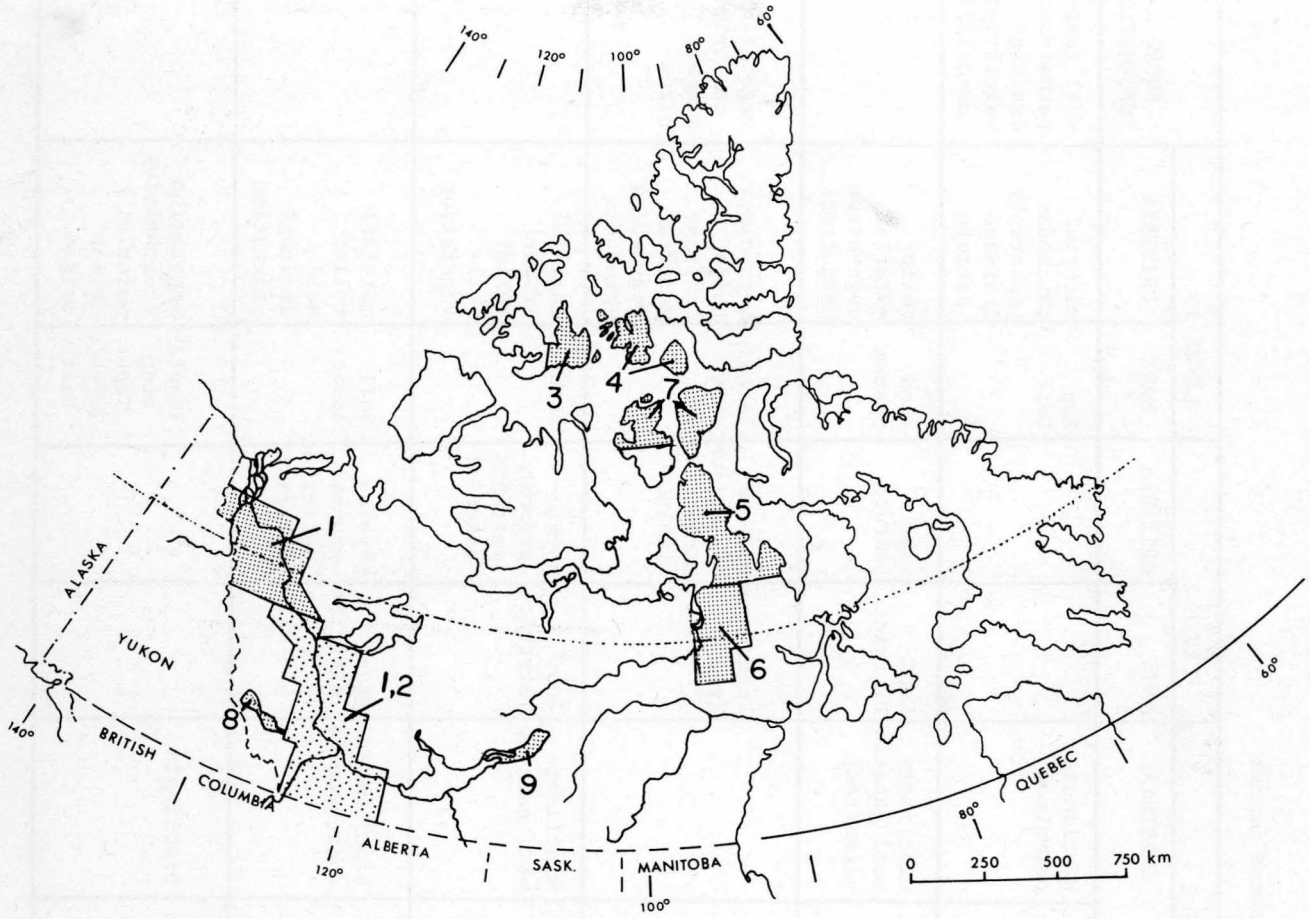

Figure 2: Ecological Land Classification Projects in the Northwest Territories

LEGEND

1. Mackenzie Valley
2. Southern Mackenzie Valley
3. Eastern Melville Island
4. Bathurst and Cornwallis Islands
5. Boothia Peninsula and Northern Keewatin
6. Central Keewatin
7. Somerset and Rince of Wales Islands
8. South Nahanni River
9. Fort Reliance - Artillery Lake

Table 2: Ecological Land Classification in Northern Canada

STUDY	DISCIPLINES (lead)	LEVEL 1		LEVEL 2		LEVEL 3		ADDED INFORMATION
		NAME	CRITERIA	NAME	CRITERIA	NAME	CRITERIA	
1. Mackenzie	Pleistocene Geology Soils Vegetation	Land Zone Ecological Zone	bioclimate permafrost			Map Unit	material thickness topography drainage pattern	soil texture permafrost drainage vegetation association
2. South Mackenzie	Geography	Land Region	bioclimate soil genesis permafrost	Land District	soil texture	Land System	relief material vegetation permafrost	
3. East Melville Island 4. Bathurst and Corwallis Is.	Pleistocene Geology Vegetation Mammals Soils			Landscape Type	bedrock formation marine limit	Terrain Unit	morphology relief drainage material weathering products	vegetation communities mammals birds
5. Boothia Peninsula 6. Central Keewatin	Pleistocene Geology Soils Vegetation	Ecoregion	bioclimate soil genesis	Eco-district	physio-graphic pattern& material	Ecoarea	material origin relief soil vegetation	
7. Somerset Is.	Pleistocene Geology Soils Vegetation	Ecoregion	bioclimate soil genesis	Eco-district	physio-graphic pattern& material	Soil Assoc.	material relief soil drainage vegetation	
8. South Nahanni 9. Great Slave - Artillery Lakes	Wildlife Vegetation Pleistocene Geology	Vegetation Zone	bioclimate			Vegeta-tion Type Terrain Unit	vegetation communities material relief origin	

At the mapping level (3) all studies used parent mate ials and relief as criteria. In some biophysically oriented studies vegetation, soils, and internal drainage were included in the mapping criteria. In some studies additional criteria were the geological origin of the surficial material and permafrost conditions.

Under arctic conditions, where catastrophic disruptions of the vegetation (fire, clearing, etc.) are rare, the existing vegetation reflects the vegetation communities best adapted to each kind of land surface. The physiographic conditions, such as parent material, nutrient status, soil moisture, active layer depth, slope, aspect, etc. will result in distinctive vegetation and soil conditions within climatic zones. The understanding of such interrelationships between the terrain and vegetation allows the plant ecologist to make use of physiographic information for an ecological land classification.

USE OF ECOLOGICAL LAND CLASSIFICATION STUDIES

Two studies were oriented toward the initial evaluation of potential national parks. The information was used by park planners and in preselection publicity to highlight scenic or outstanding features of the two areas. In addition, the study was used in the Fort Reliance-Artillery Lake area to justify the size of the proposed park, including both summer and winter ranges of caribou. The South Nahanni area was subsequently developed into a natural park, but the Fort Reliance-Artillery Lake area was rejected, chiefly due to objections by native groups.

All of the other studies were oriented toward the assessment of possible environmental impact of two proposed pipeline projects, one in the Mackenzie Valley and one from the Arctic Islands through the District of Keewatin, west of Hudson Bay. At the present time both proposals have been formally submitted, but only the Mackenzie Valley proposals went through the environmental impact assessment process. All remarks will, therefore, be directed toward the assessment of the Mackenzie Valley pipeline proposals.

During the years preceeding the submission of the proposals, both the proponent and government agencies conducted environmental studies in the broadly defined Mackenzie Corridor. The location of the proposed pipeline was based on studies by the proponent and did not become publicly known until the submission of the proposal. Government studies, therefore, did not influence the route selection.

The assessment process involved several groups. The Environment Protection Board, an independent group sponsored by the major pipeline proponent, did not conduct ecological land studies, nor did it use the studies conducted by government agencies for its impact assessment (Environment Protection Board, 1974). The federal government established two assessment groups: the Pipeline Application Assessment Group, concerning itself with the environmental and socioeconomic impact of the proposal, and a regional environmental task force, looking into the environmental impact only. Both groups made full use of the available environmental land information (Pipeline Application Assessment Group, 1974; Department of Environment Task Force, 1975).

The ecological land classification studies, along with other studies, were submitted to the Mackenzie Valley Pipeline Inquiry. In addition, individuals involved in the ecological land studies testified at the formal hearings of the inquiry as expert witnesses. These studies and testimony contributed to the discovery and substantiation of several serious environmental concerns.

The Mackenzie Valley experience showed the serious lack of knowledge of land-vegetation relationships in northern Canada. The results of the studies were urgently needed, giving rise to uncoordinated efforts. By the time the results were emerging, they could only be used in the final assessment process, as it was too late to influence the initial route selection. The same situation obtained for the proposed Polar Gas route in the Arctic Islands and Keewatin, where again only quick, ad hoc studies could be made.

These experiences highlighted the need for a broad ecological overview study of northern Canada. In this, the Land Regions (or Ecoregions), as well as the main Land Districts can be determined. A tentative Land Region map is presented in Figure 1, based on localized regional studies. The broad land-climate-vegetation relationships, presently lacking from large parts of the Arctic, would be established at this level. Should another Mackenzie Valley situation arise in Northern Canada, such background information would only need filling out by detailed, local studies, thereby avoiding duplication, panic, and waste of resources and manpower.

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