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Agriculture Potential and Climate Change in the Yukon

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Yukon
Renewable Resources

AGRICULTURAL POTENTIAL AND CLIMATE CHANGE IN THE YUKON

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Introduction

In assessing the capability of land for agricultural use, three components must be considered: soil and landscape properties and climate. It has been estimated that there are 700,000 ha of land with potential for agricultural production in the Yukon. Of this, 2,000 ha is now being cultivated. Most of this 700,000 ha has class 5 agricultural capability and is best suited for producing forage crops and cold-hardy vegetables. The main limiting factor for agricultural production, providing the other two components are not limiting factors, is the cold climate, which results in a short growing season.

It has been estimated that doubling the carbon dioxide content of the atmosphere could cause a global mean annual temperature rise of 2-4°C (Kerr, 1986). It has also been suggested (Kerr, 1986) that northern Canada will have even greater temperature increases, but no evaluation of the effect of these increases on northern agriculture has yet been made. It is thus important to reevaluate the agricultural potential of the Yukon in order to provide some predictions for the future of the agricultural industry.

In this paper, climate data will be provided for both the 1x carbon dioxide (present) and 2x carbon dioxide climates for selected Yukon climatic stations. The interpretation for agricultural land capability for the 2x carbon dioxide climate scenario, as well as the impact of climate change on the growth of the Yukon's agricultural industry, will also be given.

Materials and Methods

Data on the temperature and precipitation changes for the 2x carbon dioxide scenario were provided by the Atmospheric Environment Service (AES) in a personal communication. They are based on the general circulation model (GCM) experiments using the Goddard Institute for Space Studies (GISS) model (Hansen et al., 1981). The temperature and precipitation changes for the GISS model were provided for a network of grid points spaced 8 degrees latitude by 5 degrees longitude apart. Interpolation was used to obtain the temperature and precipitation changes for the various Yukon climatic stations (Figure 1).

Historic weather data for the years 1951 to 1980 for fifteen Yukon weather stations were also obtained from AES (1982). This data was used both for the historical normals (baseline data) and as the base on which the 2x carbon dioxide climate scenario was imposed.

Using the mean monthly temperature and precipitation changes for the fifteen Yukon stations, the number of growing days (Stewart, 1981), mean summer temperatures, number of degree days above 5°C and the corn heat units (Brown, 1964) were calculated using a model developed by the Soil and Climate Section, Agriculture Development Branch, Agriculture Canada. They also provided information concerning the total summer precipitation, evapotranspiration, potential evapotranspiration and the moisture deficit for the 2x carbon dioxide scenario. Based on the 2x carbon dioxide data for the Yukon stations, the biometeorological time scale for wheat (Robertson, 1968) and barley (Williams, 1974) was also calculated in order to provide an estimate of the potential for growing these crops in the Yukon.

Temperature and Precipitation Changes

The monthly and the annual temperature changes resulting from doubling the carbon dioxide concentration in the atmosphere are given in Table 1. This indicates that the mean annual temperatures will increase approximately 4°C in the southern areas of the Yukon (stations 1-9, Table 1), 5°C in the central areas (stations 10-12, Table 1) and approximately 6°C in the northern areas (stations 13-15, Table 1). The temperature increase during the summer months will be approximately 2-3°C, but during the winter months this increase will be much greater (5-9°C).

The precipitation ratios (assuming the present precipitation is 100) for the 2x carbon dioxide scenario are given in Table 2. In general, the annual increase in precipitation because of climate change is estimated at 20-30%. For the summer months, the precipitation increase is predicted to be somewhat higher.

Table 3 provides information concerning the temperatures and precipitation and Table 4 gives information on the growing season for the Yukon climatic stations. Both the present values (1x carbon dioxide), based on historical data, and the predicted values, based on the GISS model (2x carbon dioxide), are given.

The growing degree days above 5°C are an indication of the climatic land capability and the potential of the climate for plant growth. Comparisons were made between the growing degree days above 5°C projected in the 2x carbon dioxide scenario for some of the Yukon climatic stations and other areas of Canada where similar growing degree days now occur. It was found that Whitehorse and Watson Lake in the Yukon have values similar to those presently found at the Quesnel and 150 Mile House climatic stations in the southern part of the Fraser Plateau in British Columbia and at the Edmonton, Camrose, Lloydminster and Pincher Creek climatic stations in Alberta. The area in which the Alberta climatic stations occur falls within the Black Chernozemic Soil Zone (Clayton et al., 1977). These areas in Alberta and British Columbia lie approximately 1200 km to the south of Whitehorse and Watson Lake.

The growing degree days above 5°C projected by the 2x carbon dioxide scenario for Dawson in the Yukon are similar to those presently found at lower elevations in the Kootenay (the Kaslo climatic station) and Cariboo (the Williams Lake climatic station) areas of British Columbia and at the Claresholm, Forestburg and Hanna climatic stations in Alberta. The area in which the Alberta climatic stations occur falls within the Dark Brown Chernozemic Soil Zone (Clayton et al., 1977). These areas in Alberta and British Columbia lie approximately 1900 km south of Dawson.

Characteristics of the Growing Season

The current growing season data (1x carbon dioxide) and that for the 2x carbon dioxide scenario are presented in Tables 4 and 5. The increase in temperature resulting from climatic warming will significantly increase the length of the growing season. While the present growing season length ranges from 40 to 80 days in the southern and central Yukon, doubling the concentration of carbon dioxide in the atmosphere will increase it to from 100 to 120 days.

Interpretation for Agricultural Capabilities

There are three components in the assessment of land for agricultural use: soil properties, landscape properties and climate. Climate change will only affect the capability rating of land if the other two components are not limiting. The following discussion relates specifically to the climate component of capability assessment.

Methods Used in Classifying Climate for Agriculture

The climatic properties of most relevance to agriculture are the frost-free period, heat accumulation through the growing season expressed as growing degree days (GDD) >5°C, and moisture deficit or "aridity". Systems that attempt to classify climate as to its agricultural capability generally employ rating schemes with class limits for each of these properties or factors. Capability is generally presented as a numerical class with an associated "most limiting" factor.

All classification systems are based on the Canada Land Inventory (1965) format in which classes are defined ranging from class 1 (no climatic limitations for conventional

Canadian agricultural crops) to class 7 (unsuitable for agriculture), with each class corresponding to increased land limitation and decreased range of crop options. Recent modifications of this system use slightly different ways of establishing capability class, but all express this rating using a more-or-less standard class definition (Table 6).

The first wide scale systematic assessment of agroclimatic capability of the Yukon was produced by Eley and Findlay (1977). They modified the exisiting British Columbia system of the day (Runka, 1973) for use in the Yukon and Northwest Territories. Table 7 outlines the limits defined for each of their classes. Subsequent soil surveys used these limits to complete soil interpretations for agricultural development.

As experience with these limits increased, modifications were made. A revised system of climatic capability classification for agriculture in British Columbia was prepared, (Climatology Unit, 1981), (Table 8), and used by Kenk and Cotic (1983) in a land capability classification system incorporating variable soil water storage capacities into a soil moisture deficit rating. This system has had some application in the Yukon.

Most recently, the Alberta Soils Advisory Committee (ASAC, 1986) devised a numerical rating system employing class limits, but with a refined growing degree day value defined by a five day thermal period in the spring and first frost after July 15. A weighted monthly moisture deficit is used to calculate a seasonal deficit.

There are numerous limitations to our method of predicting land capability changes for agriculture. More refined systems of climate evaluation for agriculture require more detail than the GISS model presents for the 2x carbon dioxide environment. In a strict sense, it is incorrect to use seasonal rather than monthly moisture deficits or daily GDD values in the calculation of climate capability. We have adjusted figures slightly to compensate for the requirements of each system. These differences include the use of weighted and unweighted monthly moisture deficit values, day length factors and various seasonal GDD definitions.

We have used generated seasonal values, which allows some approximation of how each of these systems would rate the 2x carbon dioxide climate. Three agricultural areas, for which climatic data are available (Table 9), were selected to calculate the change in land capability. These changes are seen in the response of the three climate classification systems that have been used in the Yukon.

Results of Classification

This paper demonstrates the changes in land classes resulting from changes in climate projected for doubling of atmospheric carbon dioxide concentrations. Less importance is placed on the absolute class values. The results presented in Table 10 are for the climatic component of the land capability for agricultural rating. These results are for fine-loamy, moderately well drained soils where no additional soil or landscape limitations exist.

Whitehorse: All three systems classify the present Whitehorse climate as class 5, suitable only for forage and cold-hardy vegetables. Present experience shows this to be a valid rating (Bisset, 1987). This is a thermal limitation (GDD) not improvable by irrigation. With climate change, two of the three systems show no increase in non-irrigated capability because of the significant moisture deficit that would develop as a result of higher evapotranspiration rates. The present thermal limitation would be replaced by an aridity limitation of equal severity. Removal of this limitation through irrigation would render a most favourable growing condition (class 2) in this area.

Dawson City: All three systems classify the present climate of Dawson City as suitable for forage and vegetable production but marginal for grain maturation. Although these systems would all rate the Dawson GDD value as class 5, this has been adjusted upwards to class 4 because of the long sunlight hours and frost-free periods, factors that are not accounted for in these systems. Present experience indicates these ratings to be valid (Bisset, 1987). As with Whitehorse, under a 2x carbon dioxide scenario the thermal limitation that presently affects agriculture would be replaced by an aridity limitation, although not one as severe as at Whitehorse. Under irrigation there is a three class improvement to a class 1 rating, and a wide range of crops could be grown, including corn. The classification systems vary in their response to climate change without the input of irrigation. It would appear, however, that cereals could be matured without the benefit of irrigation, particularly on soils with high water storage capacity.

Watson Lake: The data for Watson Lake show a climatic condition at present suited to producing forage crops only. Experience shows this to be true on the Liard Plateau at elevations equal to the Watson Lake airport (Bisset, 1987). The aridity limitation that would develop under the 2x carbon dioxide scenario is less severe here than at the other two locations. Non-irrigated agriculture would do well (at least class 3) and the area could produce cereal crops. Irrigation would remove all aridity limitations and allow production of a wide range of crops, including corn and warm season vegetables.

Impact of Climate Change on the Growth of Yukon's Agricultural Industry

Based on the projections of the GISS model and expressed in general terms, major conclusions that can be drawn on the impact of climate change on the character and growth of the Yukon agricultural industry are as follows:

1. Increases in precipitation (20%) will be offset by greater increases in potential evapotranspiration such that crops will need additions of water through the growing season.

2. Projected warming would have a very favourable impact on Yukon agriculture, but increased aridity would create the necessity for irrigation in most parts of the territory, especially the Whitehorse area.

3. There could be an expansion from the marginal growing conditions of the present to conditions in which cereals, warm season vegetables and even corn might be grown in some locations (Table 11).

4. Grain production would be possible in a number of locations where it is impossible now (Table 12).

5. The agricultural industry would have a climate base from which a significant amount of the territory's food products could be produced locally and perhaps even exported to other northern markets.

6. Soil and landscape limitations would determine the potential area of land and the degree of increased productive capacity that might result from the projected climate change.

7. The growing degree days above 5°C projected for Whitehorse and Watson Lake by use of the 2x carbon dioxide scenario is comparable to the situation now existing in the Black Chernozemic Soil Zone of Alberta (climatic stations at Edmonton, Camrose, LLoydminster and Pincher Creek) and the southern part of the Fraser Plateau in British Columbia (climatic stations at Quesnel and 150 Mile House).

8. The growing degree days above 5°C projected for Dawson by use of the 2x carbon dioxide scenario is comparable to the situation now existing in the Dark Brown Chernozemic Soil Zone of Alberta (climatic stations at Claresholm, Forestburg and Hanna) and at lower elevations in the Kootenay and Cariboo areas of British Columbia (climatic stations at Williams Lake and Kaslo).

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Questions

Mr. Hume quoted an Alberta soil capability study which emphasized the latitudinal gradient in solar radiation and asked if this had been taken into account in the present study. Mr. Smith confirmed a 20% decrease in solar radiation from 49 to 60°N and said that the phenomenon had been taken into account.

Mr. Hume asked if anything could be learned from soils in northern Scandinavia. Dr. Tarnocai pointed out that Norwegian conditions are very different from those in Canada because of the Gulf Stream which makes winters warmer and the entire climate wetter. Mr. Goos noted that the seasonal distribution of degree days is different in such oceanic climates. Mr. Smith reported that this difference is the reason Agriculture Canada distinguishes coastal and inland areas in B.C.

Mr. Hume wondered if day length requirements might prevent maturation of some crops at high latitudes. Dr. Tarnocai replied that most grains should not be affected but a few varieties of corn might be.

Dr. Schilder observed that the speaker's estimates of soil moisture deficits before and after climate change suggest that runoff would be reduced. Some earlier speakers had suggested increased runoff. Dr. Tarnocai explained that the increased soil moisture deficits during the growing season, shown by the model, would be the result of much greater evapotranspiration. This would affect ecosystems. For example forests would become more open, giving way to parkland and grassland in successively drier areas. Dr. Schilder suggested that streamflows may decrease and become even more seasonally skewed than they are now.

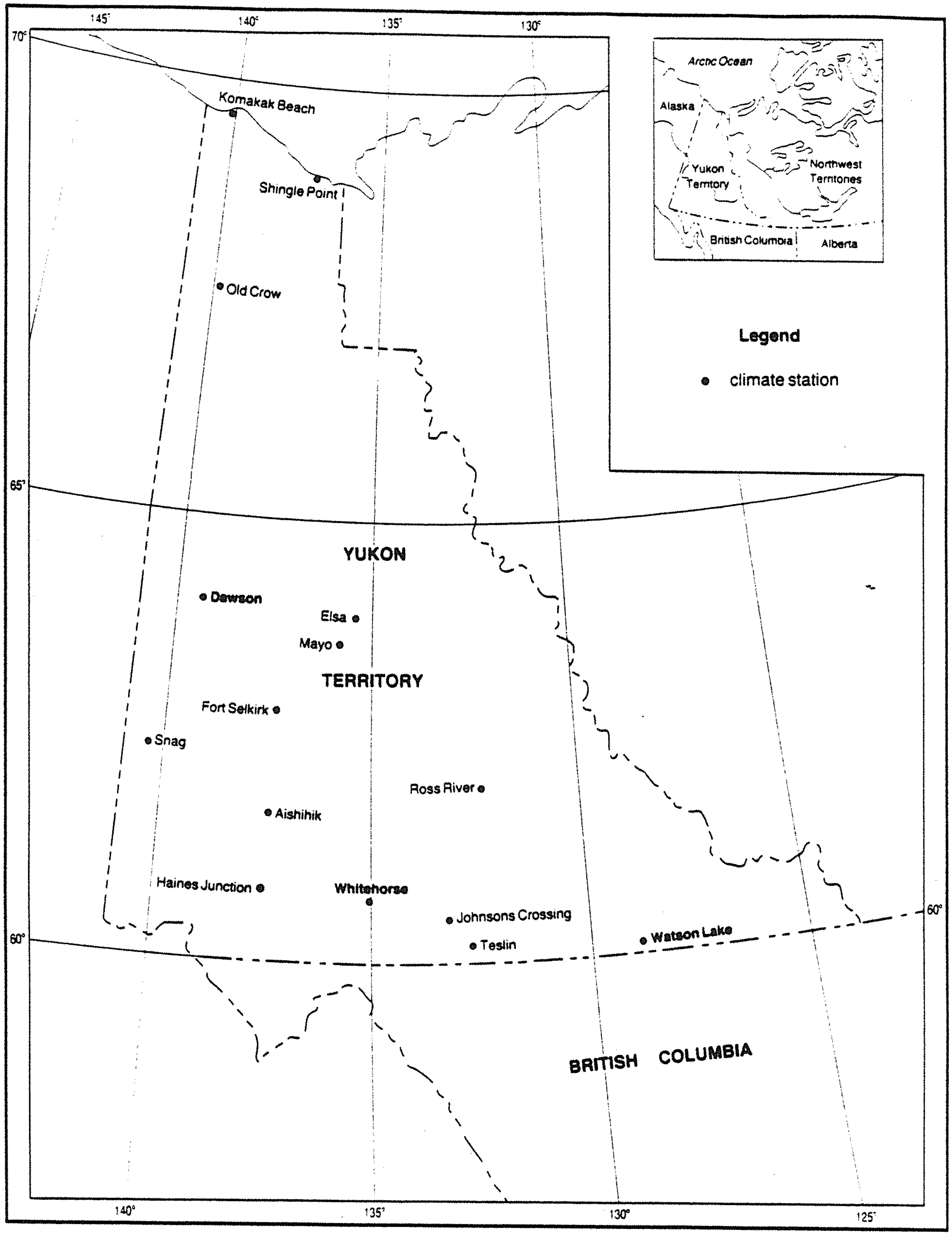

Figure 1. Locations of climatic stations; locations where agricultural capabilities were determined are in boldface.

Table 1. 2x CO_2 - 1x CO_2 temperatures (°C) derived from the GISS data.

	STATION	MONTH 1	2	3	4	5	6	7	8	9	10	11	12	mean annual	mean July
1	Whitehorse A	5.0	4.6	3.9	3.5	3.3	3.0	2.8	2.8	3.1	3.7	4.4	4.8	3.7	2.8
2	Johnsons Cr.	4.7	5.0	4.0	3.5	3.2	2.8	2.6	2.8	3.0	3.8	5.1	5.7	3.9	2.6
3	Teslin A	4.7	5.0	4.0	3.5	3.2	2.8	2.6	2.8	3.0	3.8	5.1	5.7	3.9	2.6
4	Watson Lk. A	5.4	4.9	3.8	3.4	3.2	2.7	2.6	2.7	3.1	4.2	5.9	6.0	4.0	2.6
5	Aishihik A	5.7	4.4	4.3	3.7	3.4	3.1	2.8	2.8	3.4	4.3	5.3	5.6	4.1	2.8
6	Haines Jct.	4.8	4.4	4.0	3.6	3.2	3.1	2.9	2.9	4.1	3.6	4.3	4.8	3.8	2.9
7	Ross River	6.0	5.4	4.2	3.5	3.2	2.8	2.5	2.7	3.3	4.5	5.9	6.4	4.2	2.5
8	Ft. Selkirk	6.0	5.5	4.4	3.8	3.6	3.2	2.9	3.0	3.4	4.3	5.2	5.3	4.2	2.9
9	Snag A	5.5	5.1	4.4	3.8	3.5	3.2	3.0	3.0	3.4	4.1	4.8	5.1	4.1	3.0
10	Mayo A	6.6	6.5	5.4	3.7	4.0	3.1	2.9	2.8	3.8	5.1	5.4	7.3	4.7	2.9
11	Elsa	6.7	6.5	5.5	3.9	4.1	3.2	2.6	2.8	3.9	5.2	6.0	7.4	4.8	2.6
12	Dawson	6.7	6.4	5.2	4.0	3.7	3.3	2.8	3.0	3.9	5.4	6.0	6.9	4.8	2.8
13	Old Crow	9.0	7.9	6.1	4.5	3.6	2.9	2.3	2.9	5.0	7.9	9.6	9.5	5.9	2.3
14	Shingle Pt.	9.5	8.1	6.1	4.2	3.2	2.4	1.9	2.8	5.6	9.1	11.1	10.7	6.2	1.9
15	Komakuk Bch.	9.3	8.1	6.2	4.4	3.3	2.5	2.0	2.8	5.5	9.0	10.6	10.4	6.2	2.0

Table 2. 2x CO_2/1x CO_2 precipitation ratio derived from the GISS data.

STATION	MONTH 1	2	3	4	5	6	7	8	9	10	11	12	mean annual	mean July
Whitehorse A	117.8	113.0	106.9	109.9	120.0	122.2	126.6	120.0	118.2	117.5	114.0	118.0	117.0	126.6
Johnsons Cr.	128.6	123.6	118.8	121.2	126.6	120.9	114.3	111.1	108.0	118.3	126.6	132.2	120.8	114.3
Teslin A	128.6	123.6	118.0	121.2	126.6	120.9	114.3	111.1	108.0	118.3	126.6	132.2	120.8	114.3
Watson Lk. A	129.6	126.4	117.8	120.2	122.6	120.2	113.8	107.2	108.0	116.3	128.6	130.0	120.1	113.8
Aishihik A	120.0	113.6	111.1	112.0	121.7	127.3	126.1	120.8	119.2	120.7	115.8	118.8	118.9	126.1
Haines Jct.	117.6	109.7	105.0	109.9	120.0	120.0	123.0	123.8	120.5	116.4	115.0	115.0	116.3	123.0
Ross River	129.2	126.1	122.7	122.7	130.4	123.1	118.5	115.4	112.0	120.8	129.2	133.3	123.6	118.5
Fort Selkirk	119.0	111.4	112.5	109.7	122.2	125.0	127.1	123.8	120.7	118.1	116.3	117.7	118.6	127.1
Snag A	118.2	109.4	103.3	107.7	122.7	123.8	128.6	126.1	122.2	115.6	117.3	117.1	117.7	128.6
Mayo A	126.0	119.8	112.0	115.0	123.7	121.9	128.6	123.2	131.2	125.2	122.0	122.8	122.6	128.6
Elsa	134.0	129.8	116.1	118.0	129.0	136.9	131.6	125.8	125.2	129.2	129.0	126.8	127.6	131.6
Dawson	125.2	115.4	111.3	112.7	131.7	138.8	136.6	130.1	123.0	121.6	120.2	124.1	124.2	136.6
Old Crow	133.3	125.8	122.0	123.5	135.7	142.0	140.0	133.1	126.8	127.1	130.5	131.0	130.9	140.0
Shingle Pt.	136.4	127.3	127.3	125.0	133.3	141.2	136.8	126.3	112.0	128.6	141.5	145.3	121.1	136.8
Komakuk Bch.	133.3	125.0	116.7	123.1	131.2	136.9	135.0	131.6	129.4	126.7	138.5	130.8	129.9	135.0

Table 3. 1x CO_2 and 2x CO_2 mean anuual and July temperatures (°C) and total and July precipitaion (mm).

STATION	TEMPERATURE				PRECIPITATION			
	Mean annual		Mean July		Total		July	
	1xCO_2	2xCO_2	1xCO_2	2xCO_2	1xCO_2	2xCO_2	1xCO_2	2xCO_2
Whitehorse	-1.2	2.5	14.1	16.9	261.2	313.4	33.9	44.1
Johnsons Cr.	-2.0	1.9	13.1	15.7	353.8	424.6	44.4	48.8
Teslin A	-1.8	2.1	13.4	16.0	326.5	391.8	38.1	41.9
Watson Lk. A	-3.3	0.7	14.9	17.5	425.2	510.2	58.2	64.0
Aishihik A	-4.4	-0.3	12.1	14.9	256.3	307.6	48.5	63.1
Haines Jct.	-3.2	0.6	12.5	15.4	292.5	351.0	36.3	43.6
Ross River	-5.7	-1.5	12.8	15.3	263.5	316.2	41.5	49.8
Ft. Selkirk	-4.7	-0.5	14.8	17.7	286.4	343.7	49.5	64.4
Snag A	-6.1	-2.0	14.0	17.0	338.5	406.2	61.1	79.4
Mayo A	-4.0	0.7	15.2	18.1	306.3	367.6	51.7	67.2
Elsa	-4.4	0.4	14.1	16.7	413.0	536.9	60.8	79.0
Dawson	-5.1	-0.3	15.6	18.4	306.1	367.3	47.2	66.1
Old Crow	-10.1	-4.2	14.2	16.5	214.7	279.1	18.7	26.2
Shingle Pt.	-10.4	-4.2	11.0	12.9	214.3	257.6	40.5	56.7
Komakuk Bch.	-11.4	-5.2	7.5	9.5	135.9	176.7	27.2	38.1

Table 4. Yukon growing season data for the 1x CO_2 (present) and 2x CO_2 environments.

STATION	1x CO_2					2x CO_2				
	GSL (Days)	TMEAN (°C)	GDD	CHU	P (mm)	GSL (Days)	TMEAN (°C)	GDD	CHU	P (mm)
Whitehorse A	80	13.2	806	1398	88.9	122	14.7	1282	2200	151.9
Teslin A	63	12.8	696	1230	71.9	105	14.4	1149	1977	131.3
Watson Lake A	86	13.7	888	1549	139.9	120	15.3	1350	2305	213.5
Aishihik A	34	12.0	481	870	53.6	83	13.9	941	1585	148.1
Haines Jct.	17	12.6	582	1046	19.7	85	14.3	1077	1851	111.0
Fort Selkirk	62	14.2	851	1491	85.2	106	15.9	1339	2264	158.0
Snag A	56	13.5	[illegible]	1300	107.1	101	15.3	1194	2051	209.1
Mayo A	76	14.2	891	1558	108.0	121	15.7	1407	2378	187.2
Elsa	75	13.1	702	1233	118.4	117	14.5	1163	2004	229.6
Dawson	82	14.2	944	1632	109.7	121	16.1	1440	2430	202.1
Shingle Point	39	10.9	256	467	46.6	81	11.6	521	923	138.1
Komakuk Beach	-	-	-	-	-	33	9.6	233	364	43.0

GSL: Growing days.
TMEAN: Mean summer temperature.
GDD: Growing degree days greater than 5°C.
CHU: Corn heat units.
P: Total summer precipitation.

Table 5. Soil moisture deficit* (mm) in 1x CO_2 and 2x CO_2 environments.

Station	1x CO_2	2x CO_2
Whitehorse	218.7	383.2
Teslin	116.5	263.9
Watson Lake	121.2	232.8
Aishihik	42.1	173.1
Haines Junction	30.9	215.8
Fort Selkirk	139.9	295.5
Snag	48.0	148.7
Mayo	167.2	297.0
Elsa	92.2	176.9
Dawson	166.7	265.8
Shingle Point	30.6	96.6
Kamakuk Beach	-	38.4

* Soil moisture deficit = precipitation - potential evapotranspiration

Table 6. Definitions and operational constraints of land capability classes as applied to climate for cultivated agriculture in Yukon.

Class 1: These lands have no significant limitations to use for the production of the full range of common Canadian agricultural crops (presently does not exist in Yukon).

Class 2: These lands have slight limitations that restrict the range of some crops but still allow the production of grain and warm season vegetables (presently does not exist in Yukon).

Class 3: These lands have moderate limitations that restrict the range of crops to small grain cereals and vegetables (presently exists in a few localized areas in Yukon).

Class 4: These lands have severe limitations that restrict the range of crops to forage production, marginal grain production and cold-hardy vegetables (presently exists in valleys of central Yukon).

Class 5: These lands have very severe limitations that restrict the range of crops to forages, improved pastures and cold-hardy vegetables (presently most common class in agricultural areas of Yukon).

Class 6: These lands have such severe limitations for cultivated agriculture that cropping is not feasible. The lands may be suitable for native range.

Class 7: These lands have no capability for cultivated agriculture or range for domestic animals.

Table 7. Classification of climatic capability for agriculture as applied in the Yukon and used as a basis for reconnaissance soil survey interpretations (Eley and Findlay 1977).

Class	Frost-free period (days)	Growing degree days >5°C (GDD)	Soil moisture deficit (mm) (75 mm storage)
1	> 90	> 1290	0 - 100
2	75 - 90	1145 - 1290	100 - 180
3	60 - 75	1000 - 1145	180 - 250
4	50 - 60	1000 - 1145	250 - 300
5	30 - 50	735 - 1000	300 - 350
6	< 30	500 - 735	> 350
7	< 30	< 500	>350

Table 8. Soil moisture deficit (SMD) classes as defined by Kenk and Cotic (1983) and growing degree days (GDD) limitations (Climatology Unit 1981) for use in the British Columbia land capability classification system.

Class	Frost-free period+ (days)	Growing degree days >5°C (GDD)	Soil moisture deficit* (mm)
1	90 - 119	1380 - 1504	< 40
2	75 - 89	1170 - 1309	40 - 115
3	60 - 74	1030 - 1169	116 - 190
4	50 - 59	1030 - 1169	191 - 265
5	30 - 49	780 - 1029	266 - 340
6	< 30	670 - 779	341 - 415 if native grazing is available
7	< 30	< 670	> 341 if no native grazing is available

* Soil moisture deficit = precipitation - potential evapotranspiration - water storage capacity of the upper 50 cm of the soil profile (texture-dependent).

+ for British Columbia interior

Table 9. Location of three stations used for calculating change in land capability for agriculture based on the GISS model for 2x CO_2 climate change.

Place	Elevation (m)(a.s.l.)	Latitude	Longitude
Whitehorse	700	60° 42'	135° 04'
Watson Lake	685	60° 07'	178° 50'
Dawson City	320	64° 26'	138° 17'

Table 10. Response of three land classification systems to climate change based on data generated by the GISS model for present and 2x CO_2 environments. Class values indicated are for climatic capability only and assume no additional soil or landscape limitations.

Location	Eley and Findlay (1977)		Climatology Unit (1981) and Kenk and Cotic (1983)		ASAC (1983)	
	present	2x CO_2	present	2x CO_2	present	2x CO_2
WHITEHORSE						
irrigated*	5	2	5	2	5	2
non-irrigated	5	5	5	5	5	3
WATSON LAKE						
irrigated	5	2	5	1	5	1
non-irrigated	5	3	5	3	5	2
DAWSON						
irrigated	4	1	5	1	4	1
non-irrigated	4	3	5	4	4	2

* values assume removal of any moisture deficit limitations if present

Table 11. Vegetable, forage and cereal crops correlated to agricultural climate capability classes (adapted from Eley and Findley 1977).

Crops	Climate capability classes 1	2	3	4	5	6	7
<u>Warm season vegetables</u>							
(prefer temps. 12 - 25°C							
beans	x	x					
celery	x	x					
corn	x	x					
cucumber	x						
green peppers	x						
tomatoes	x	x					
<u>Cool season vegetables</u>							
beets	x	x	x				
carrots	x	x	x	x			
peas	x	x	x				
potatoes	x	x	x	x			
onions	x	x	x				
broad beans	x	x	x				
<u>Cold hardy vegetables</u>							
broccoli		x	x	x	x	x	
brussel sprouts		x	x	x	x		
cabbage		x	x	x	x	x	
parsnips		x	x	x	x	x	
leaf lettuce	x	x	x	x	x		
radishes	x	x	x	x	x	x	
swiss chard	x	x	x	x	x	x	
<u>Domestic fruit</u>							
apples	x	x					
currants	x	x					
raspberries	x	x					
plums	x						
cherries	x						
<u>Forage crops</u>							
alfalfa	x	x	x	x			
bromegrass		x	x	x	x	x	
timothy	x	x	x	x	x	x	
sweet clover	x	x	x	x	x		
<u>Cereal crops</u>							
barley	x	x	x	x	x		
oats	x	x	x	x			
wheat	x	x					

Table 12. Capability to produce wheat and barley grain crops at some selected Yukon locations in present and 2x CO_2 environments.

Station	1x CO_2 Wheat	1x CO_2 Barley	2x CO_2 Wheat	2x CO_2 Barley
Whitehorse	N*	N	Y	Y
Teslin	N	N	Y	Y
Watson Lake	N	Y	Y	Y
Aishihik	N	N	N	Y
Haines Jct.	N	N	N	Y
Fort Selkirk	N	N	Y	Y
Snag	N	N	Y	Y
Mayo	N	Y	Y	Y
Elsa	N	N	Y	Y
Dawson	N	Y	Y	Y
Shingle Point	N	N	N	N
Komakuk Beach	N	N	N	N

* N - no, Y - yes