Agricultural Climate: Conditions & Trends

RESEARCH BRIEF

This Research Brief summarizes research conducted as part of the Columbia Basin Rural Development Institute's Regional Food Systems project. Trends and conditions were calculated in accordance with established methodologies for climate data analysis. For detailed information on these methodologies, contact the RDI.

BACKGROUND AND RATIONALE

Our region's climate, and projected changes related to temperature and precipitation regimes, are important factors influencing the long-term sustainability of the Columbia Basin-Boundary food system. Research to inform climate change adaptation efforts was identified as an important information need in the various agricultural plans in place for the Columbia Basin-Boundary region[1]. In addition, the RDI's advisory committee for the Regional Food Systems Project prioritized the need for an updated analysis of the climate variables commonly used by farmers to determine agricultural practices.

In 1981, the government of British Columbia released a report that characterized the climatic capability of various locations for agriculture[2].

Using historic climate data, the report classifies a site's agricultural capabilities based on its thermal and moisture regimes. Classes range from 1d to 7. A lower number indicates potential for a wider range of crops, with higher numbers indicating less potential. Each classification also includes a subclass which relates to the climate variable that limits the potential of the site. In our region, the three subclasses of note are A - potential is limited by the climatic moisture deficit, F - length of the frost free period, and G - the number of growing degree days. While each site is assigned two classifications—one based on its thermal characteristics and one based on its moisture characteristics—the higher classification can only be achieved with active management of moisture limitations. Since, in our region, agricultural potential is primarily limited by a lack of moisture availability,

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the thermal classification can only be realized with adequate irrigation. The 1981 classifications for sites in our region are summarized in **Table 1**.

The various classes are associated with a range of possible crops that can be produced under those climatic conditions, assuming no other significant agricultural limitations (e.g., soil type). For example, class 7 has no potential for agriculture, class 5 only has potential for forage crops, class 3 is associated with "strawberries, raspberries, potatoes, lettuce, peas, spinach, cauliflower, cabbage, cereal grains and forage crops", and class 1 has the potential for a full range of crops from tree fruits to asparagus to filberts.

Despite relying on climate data that is now over 30 years old, Basin-Boundary farmers still look to the 1981 classifications to determine certain agricultural practices. This report provides an analysis of the various climate variables that inform the climatic capability classifications. Uncertainties surrounding the analysis methodologies behind the 1981 report unfortunately prohibit a direct comparison between the data discussed in this report and that which informed the original classifications. However, our analysis of data trends can help farmers understand how the capabilities of their land have shifted, and may continue to shift in the near term due to changes in the region's climate.

OVERVIEW OF METHODS

The BC climatic capability classification scheme relies on three derived climate variables: seasonal climatic moisture deficit, annual growing degree days, and annual frost free period. Calculation of these variables requires input of three observed variables (i.e., seasonal precipitation, minimum daily temperature, maximum daily temperature) and calculation of two additional variables (i.e., daily mean temperature, seasonal potential evapotranspiration).

For variables that could be calculated with monthly data, inputs were acquired from Environment Canada's Adjusted and Homogenized Canadian Climate Database (AHCCD) and supplemented with estimated data from the University of British Columbia's Climate BC application to generate a complete dataset. For variables that required daily data for their calculation, inputs were acquired from Pacific Climate Impacts Consortium's data portal. Data from the same Environment Canada stations were gathered from the AHCCD and Pacific Climate Impacts Consortium sources.

Wherever possible, the same calculation methods described in province's 1981 publication were used for our analysis. However, in some cases where a method was not fully described, we made assumptions based on best practices in climate data analysis. The influence of these assumptions on the analysis prohibits comparison of our results with the original classifications.

Our analysis involved the only five sites for which current AHCCD data with good completeness are available for our region: Cranbrook, Creston, Fauquier, Golden, and Kaslo.

CURRENT CONDITIONS

Table 2 summarizes average values for key agricultural climate variables for the most recent 30 years of data available (1984-2013). Given the diverse geography of the Basin-Boundary region, it is not surprising that values vary significantly depending on the community in question. Cranbrook, Creston, and Golden exhibit a generally drier climate, with lower seasonal precipitation and a higher overall climatic moisture deficit. Creston, Fauquier, and Kaslo exhibit a generally warmer climate, with a higher number of growing degree days and a longer frost free period. The frost free period is approximately a month longer in these communities than in Cranbrook and Golden.

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	Columbia Gardens	Cranbrook	Crescent Valley	Creston	Elko	Fauquier	Fernie	Golden	Grand Forks	Greenwood	Kaslo	Kimberley	Revelstoke	South Slocan	Valemount	Waneta	Warfield
Thermal Class/ Improved Rating	1aF	1F	1F	1aF	1aGF	1aGF	1GF	1F	1aF	1F	1aGF	2F	1aF	1aF	3F	1aF	1cG
Moisture Class/ Unimproved Rating	6A	6A	5A	5A	4A	4A	3A	6A	7A	7A	3A	6A	3A	6A	4A	6A	5A

Table 1: 1981 climatic capability classifications for agricultural sites in the Basin-Boundary region

Station		Cranbrook	Creston	Fauquier	Golden	Kaslo
Latitude	*deg*	49.62	49.10	49.87	51.30	49.92
Longitude	*deg*	-115.78	-116.52	-118.07	-116.98	-116.92
Elevation	*m*	940	597	490	785	591
Seasonal Precipitation	*mm*	217	255	343	225	301
Seasonal Potential Evapotranspiration	*mm*	682	715	688	656	649
Seasonal Climatic Moisture Deficit	*mm*	465	460	345	431	349
Annual Growing Degree Days	*degree days*	1697	2046	1791	1548	1802
Annual Frost Free Period	*days*	122	156	158	129	158

Table 2: 1984-2013 average values for agricultural climate variables

			Cranbrook	Creston	Fauquier	Golden	Kaslo
Seasonal Precipitation	*mm/ century*	Beginning of Record	86	122	165	43	111
		1965	.	.	232	.	.
Seasonal Potential Evapotranspiration	*mm/ century*	Beginning of Record	-60	.	.	-36	40
		1965	98	207	137	.	.
Seasonal Climatic Moisture Deficit	*mm/ century*	Beginning of Record	-155	-148	-139	-73	-72
		1965	.	.	.	.	.
Annual Growing Degree Days	*degree days/ century*	Beginning of Record	186	442	151	.	302
		1965	366	659	.	.	608
Annual Frost Free Period	*days/ century*	Beginning of Record	57	57	57	55	.
		1965	.	.	.	.	.

Table 3: **Trends for agricultural climate variables.** "." indicates no statistically significant trend.

TRENDS

Table 3 summarizes the direction and magnitude of trends in key agricultural climate variables. Two time periods are reported—one since the beginning of the weather record for the relevant station (ranges from 1908 to 1913), and one over the standard period 1965-2013. The 1965-2013 period was selected as it minimizes the influence of natural climate cycles on the analysis. Using longer or shorter periods, or periods with different start or end dates, may generate results that are skewed by the impact of one or more of these cycles (e.g., the Pacific Decadal Oscillation).

Results are more conclusive for variables that influence a location's thermal regime than for the moisture regime variables. All statistically significant trends for growing degree days are positive, with trends being steeper in the more recent time period. Since the early 1900s, growing degree days have increased by a range of 151 degree days per century in Fauquier to 442 degree days per century in Creston (**Figure 1**). Cranbrook, Creston, Fauquier, and Golden show positive trends in the length of the frost free period since the early 1900s, with those stations showing increases of 55 to 57 days per century. No statistically significant trends were calculated for the length of the frost free period since 1965. This movement toward a higher thermal class is consistent with near-term projections of a summer warming trend in the Regional District of Central Kootenay, Regional District of East Kootenay, and Columbia-Shuswap Regional District[3].

All significant trends for seasonal precipitation are positive (**Figure 2**), though results show only one significant trend for the 1965-2013 time period. Since the early 1900s, seasonal precipitation has been increasing at a rate of 43 millimetres per century in Golden to 165 millimetres per century in Fauquier.

These findings are inconsistent with near-term projections of a decrease in summer precipitation, but may be explained by the influence of the spring and fall months included in the growing season calculations (May and September). Regional projections for both the spring and fall are for an increase in precipitation.

Results for the seasonal potential evapotranspiration variable are mixed, with two of three trends since the beginning of the weather record being negative, and all three trends since 1965 being positive. These results suggest high variability in the dataset, with a lack of a clear, time-independent linear trend for most stations.

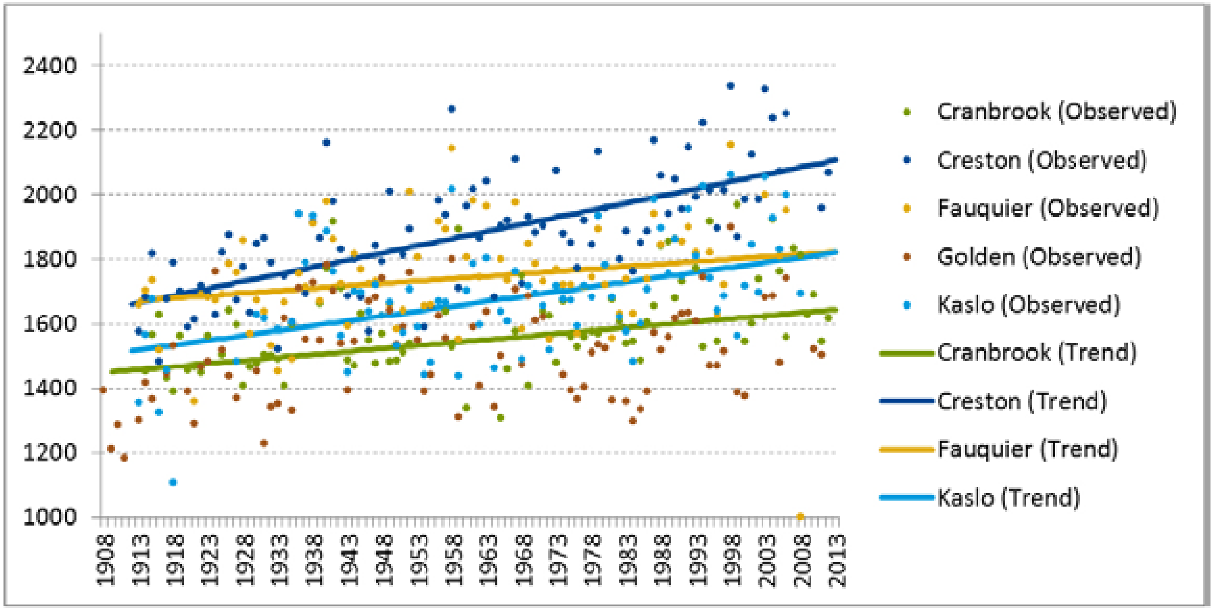

Figure 1: **Annual growing degree days, including trends, since beginning of weather record. Note no significant trend was calculated for Golden.**

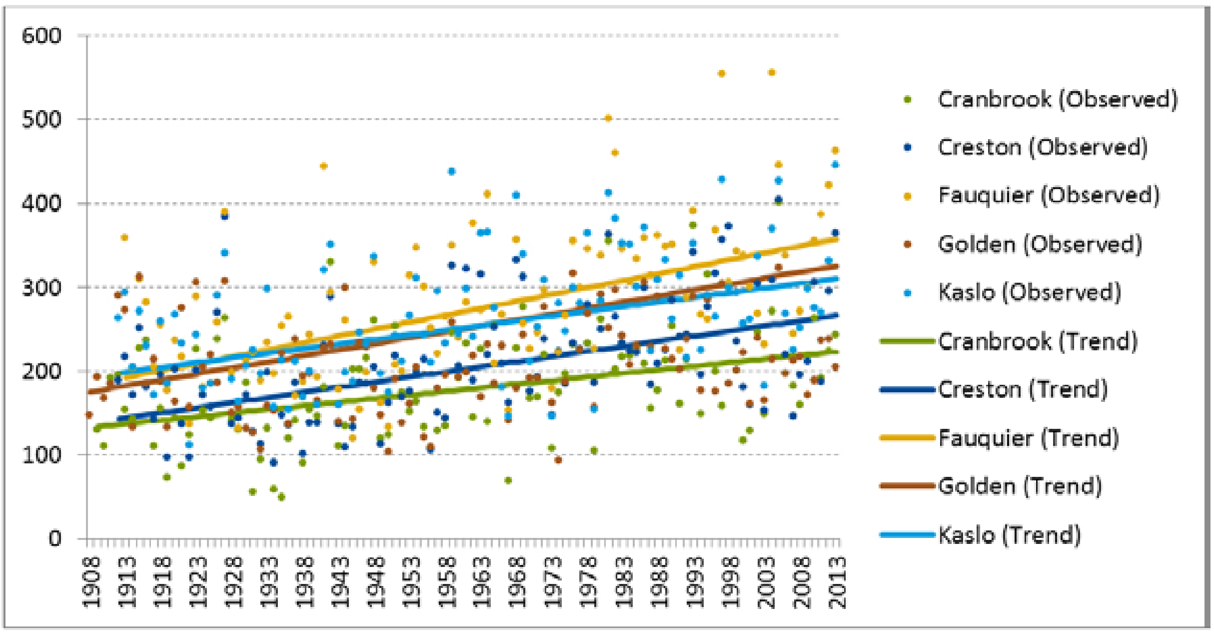

Figure 2: **Seasonal precipitation (mm), including trends, since beginning of weather record.**

All stations show a significant trend toward a lower climatic moisture deficit since the beginning of the weather record, and no clear trend since 1965. Since seasonal climatic moisture deficit is equal to the difference between seasonal precipitation and seasonal potential evapotranspiration, it appears that any increases in potential evapotranspiration have been more than offset by increases in seasonal precipitation.

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IMPLICATIONS

The transition to an agricultural climate with increased growing degree days and a longer frost free period suggests potential for growing a wider variety of crops in the region. That said, data show that an enhanced thermal regime continues to be accompanied by a moisture regime which severely limits agricultural potential. Despite long-term trends toward a lower climatic moisture deficit, current conditions for this variable remain indicative of an agricultural climate that lacks sufficient natural input of seasonal precipitation to permit cultivation of a wide range of crops. These conditions require that adequate irrigation be available to realize the capabilities associated with a higher thermal class. A recent analysis of stream flow data for our region indicates that peak and late-summer stream yield is generally declining[4]. Since many agricultural producers in our region depend on surface water for their irrigation source, these findings collectively point to the possibility of future water availability challenges for our region's agriculture industry.

Our study of regional agricultural climate trends is limited in scope and detail. Additional research could confirm if our findings are consistent with results for other stations and further investigate the impact of these trends on current and future agricultural activities. An enhanced understanding of the driving factors behind certain trends (e.g., the specific timing of increased precipitation during the growing season) would also assist with crop management decisions.

The RDI thanks Charles Cuell and Mel Reasoner for their advice on the analysis methodologies used to generate results for this report.

KEY TERMS

Seasonal precipitation: *The total amount of precipitation, in millimetres, falling during the growing season (May – September).*

Seasonal potential evapotranspiration: *The amount of water, in millimetres, that would evaporate or transpire from a standardized crop surface if sufficient water were consistently available. Our potential evapotranspiration calculations considered maximum temperature, minimum temperature and solar radiation.*

Seasonal climatic moisture deficit: *The difference between seasonal precipitation and seasonal potential evapotranspiration; the amount of supplementary water needed to maintain moisture in the soil.*

Annual growing degree days: *The difference, accumulated annually, between daily mean temperature and the standard base temperature of 5 degrees Celsius. The period of accumulation starts and stops with the first and last consecutive 5-day period when daily mean temperature is greater than 5 degrees Celsius.*

Annual frost free period: *The number of consecutive days in a calendar year with minimum daily temperature greater than 0 degrees Celsius.*

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