Climate Change Projections for Pincher Creek

Final Report
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LIST OF ACRONYMS

C	Celsius
CCCR	Canada's Changing Climate Report
CO	Carbon Dioxide
CORDEX	Coordinated Regional Downscaling Experiment
ESM	Earth System Model
GCM	Global Climate Model
GDD	Growing Degree Days
GHG	Greenhouse Gases
GIS	Geographic Information System
GMSAT	Global Mean Surface Air Temperature
IBC	Insurance Bureau of Canada
IPCC	Intergovernmental Panel on Climate Change
P	Precipitation
PARC	Prairie Adaptation Research Collaborative
RCP	Representative Concentration Pathway
SPEI	Standardized Precipitation Evapotranspiration Index
T	Temperature

1 Executive Summary

This project aimed to develop a detailed climate change projections for the Pincher Creek Region to assist in climate risk adaptation planning and management. High-resolution climate models (RCMs) were used to physically simulate the regional climate under a 3 ºC global warming scenario. We express the regional climate changes relative to levels of global warming, a new approach gaining wider acceptance than the use of fixed time horizons (e.g., 2051 - 2080). A global temperature increase of 3 ºC from pre-industrial levels is considered the “current policies” or status quo scenario (NGFS, 2021), and some climate models anticipate this scenario will be reached by 2060 - 2070.

1.1 Key Findings

This report used data for 24 climate variables from 11 RCM and Earth System Models (ESMs) to project the climate of the Pincher Creek Region under a 3 ºC global warming scenario. Following is a summary of the results:

- The Pincher Creek Region will undergo significant climate change, although there is some variability in change across variable and space.
- There is a dramatic increase in projected spring (March, April, May) precipitation – as much as 69.5 mm – while other seasons may see a decrease (e.g., summer) or contrasting departures from baseline conditions based on a strong east-west divide (e.g., winter).
- A significant increase in Minimum and Maximum Summer Temperatures of at least 4 ºC under each scenario helps drive increases in the amount of Growing Degree Days using scenarios where days are below 5 and 10 ºC, respectively.
- Warming during the growing season coincides with the number of days where the temperature is expected to surpass 30 ºC (up to 27) and 35 ºC (up to 7). Not only does this pose increase stress on water demand during the summer months where a decrease in precipitation is anticipated, but can also have negative impacts on human health, spread of vector-borne illness and disease, and the migration of invasive species.
- Despite the increase in Growing Degree Days, the potential for increased water demand and heat stress under warmer summer conditions may offset higher crop yield outcomes.
- Even though the region is small, many of the variables exhibit a relatively high degree of spatial variability due to the influence of the Rocky Mountains which pose a challenge in modeling and interpreting results on a seasonal basis.

Despite some of the positive implications for agriculture in the above findings, it is important to place these within the context of adaptation. These are non-linear projections and trends which require the balancing of a suite of factors. The costs of extreme weather events could very much offset new financial opportunities in a warmer climate. Eventually temperature, precipitation and water levels will cross thresholds beyond which chronic impacts abruptly become more acute. Examples include the permanent loss of water stored as snow and ice, higher rainfall intensity that exceeds the capacity of infrastructure to shed and store water, and the absence of low temperatures that inhibit pests and disease vectors.

2 Introduction

The earth's climate is changing, and despite mitigation efforts to slow the rate of change, further warming and significant impacts are inevitable. The widespread recognition of these inevitable impacts has raised the profile of adaptation as an essential policy response to climate change. The "adaptation imperative" (Boyer et al. 2017) has created a demand for data and knowledge about the probability and consequences of a changing climate in support of climate risk assessment and adaptation planning. Climate change and its impacts are now well documented (e.g., IPCC, 2021; Bush and Lemmen, 2019; Sauchyn et al., 2020). Boyd and Markandya (2021) recently reviewed the body of literature that clearly indicates that climate change will be costly for Canada with "overwhelmingly negative" economic impacts.

Governments have begun to respond with policies and programs in support of climate risk assessment and adaptation planning climate. Municipal governments have been at the forefront, given the impacts and costs of climate change where populations and infrastructure are concentrated (Brown et al., 2021; City of Calgary, 2011). The exposure of most sectors and industries to climate-related risks and opportunities acts as an incentive to invest in the transition to a climate-resilient economy (Kovacs et al., 2021). Thus, climate change has become a business issue.

As the analysis of climate change transitioned from a scientific to a socio-economic problem, it became conceptualized as a source of physical and financial risk. Figure 1 from the IPCC (2014) illustrates how impacts are framed as risks arising from the interaction of climate-related hazards (including events and trends) and the vulnerability and exposure of human and natural systems. While climate change is a global phenomenon, impacts and adaptive responses occur locally. Thus, implementing a conceptual risk framework requires practical methods and locally relevant information. Alberta is particularly vulnerable to climate change, given warming that is twice the global rate, a dominantly resource-based economy, frequent extreme weather events, and dependence on freshwater generated by shrinking snow fields and glaciers in the Rocky Mountains.

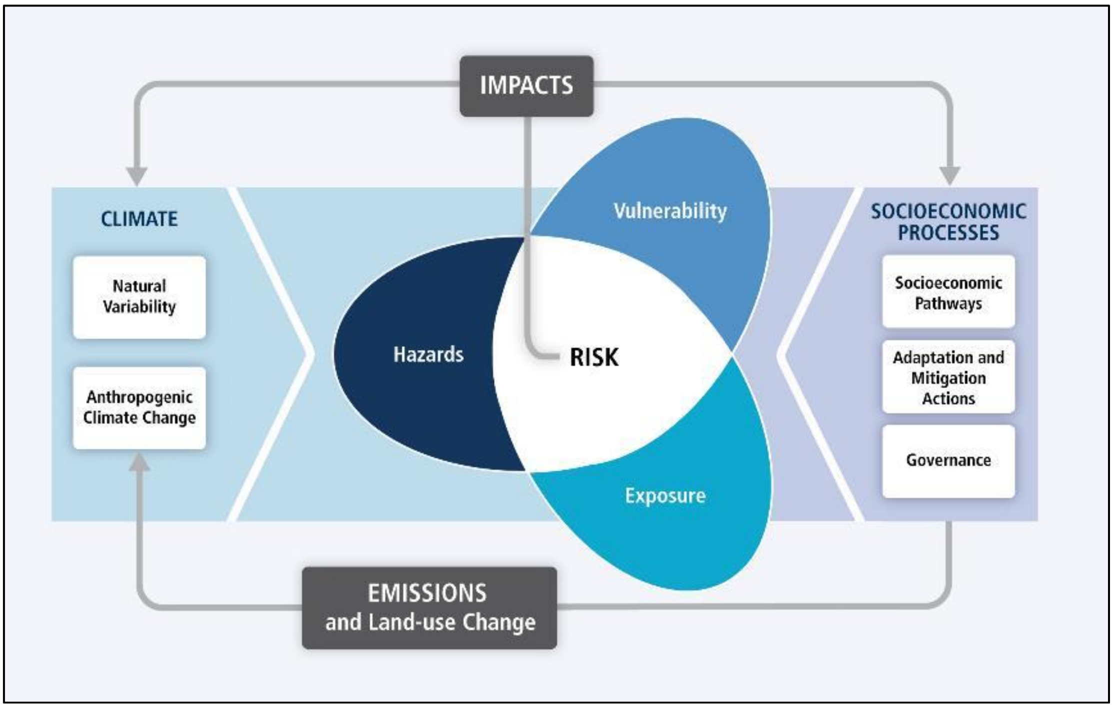

Figure 1: Risk is conceptualized as the impacts that result from the interaction of climate-related hazards (including events and trends) and the vulnerability and exposure of human and natural systems. Changes and variability in climate plus socioeconomic processes are drivers of hazards, exposure, and vulnerability. Source: IPCC (2014)

2.1 Project Deliverables

This report describes a new set of detailed climate change projections for the Pincher Creek Region derived from high-resolution (25 km) Regional Climate Models (RCMs). This source of climate data differs from the use of historical weather data and/or climate projections from Global Climate Models which is typical of most other climate risk assessments. We express the regional climate changes relative to levels of global warming, a new approach gaining wider acceptance than the use of fixed time horizons (e.g., 2051 - 2080).

The project deliverables are:

1. A set of locally relevant climate change projections based on the rise in global mean temperature.
2. Graphics that provide a visual representation of the anticipated climate changes. These graphics consist of maps of the Pincher Creek Region showing the projected changes for a set of climate variables. Tabular data underlying the graphics also are provided.
3. This report explains the methods used to develop the climate change projections and interpretation of the maps and table of data.

2.2 The Climate of the Pincher Creek Region

Climate change is a statistically significant shift in weather statistics that persists for decades. Determining if weather statistics have shifted, and by how much, requires a baseline of historical weather data to characterize the current climate. The climate change projections presented in this report are the difference in 24 variables between the recent past and a future period when global warming will exceed a specific temperature threshold. Our interpretation of these climate changes requires knowledge of Alberta's current climate. Figures 2 and 3 are maps of Alberta showing the geographic pattern of mean annual temperature and total annual precipitation, respectively. The data behind these maps are the average values from historical (1976 - 2005) runs of the 11 Regional Climate Models described later in this report. Because the climate model output was bias-corrected for any departures from the observed climate, maps based on weather observations would look very much like those in Figures 2 and 3.

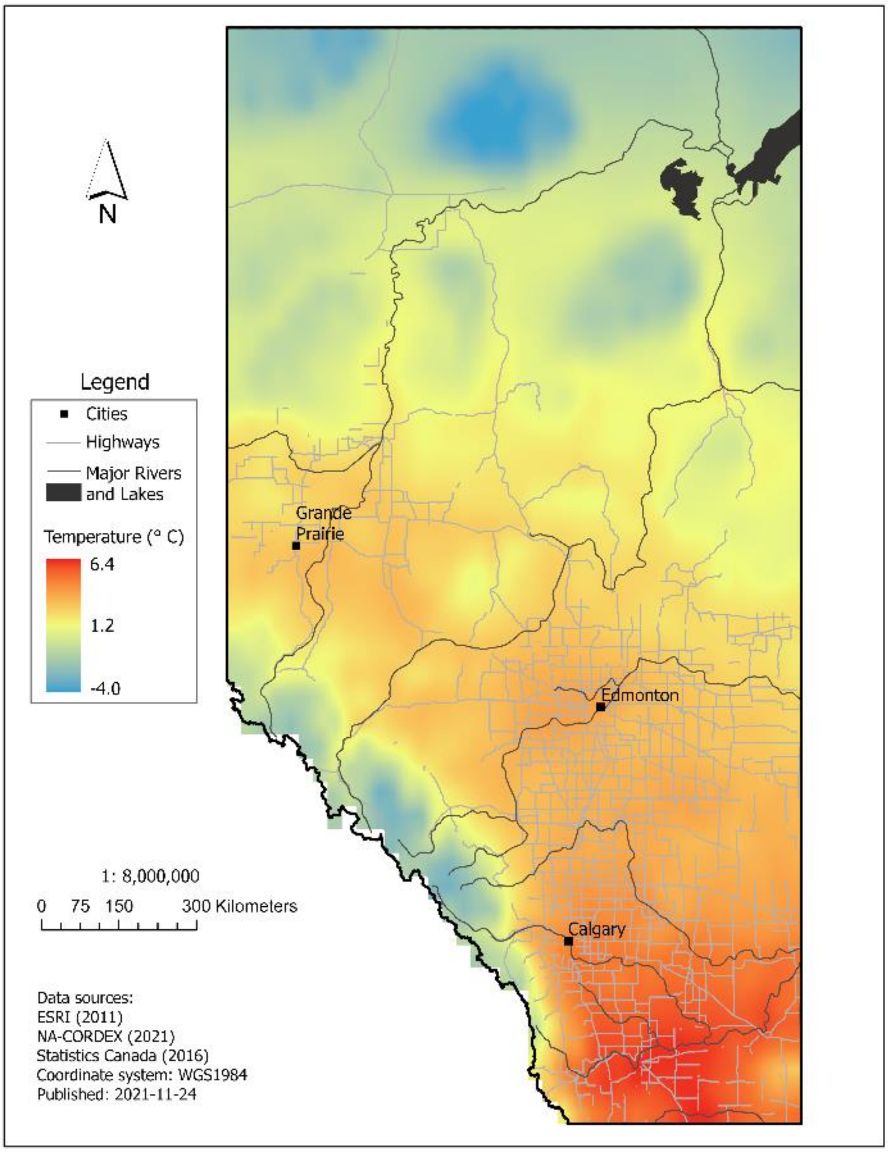

Figure 2: Mean annual temperature across Alberta for the historical baseline period 1976 - 2005.

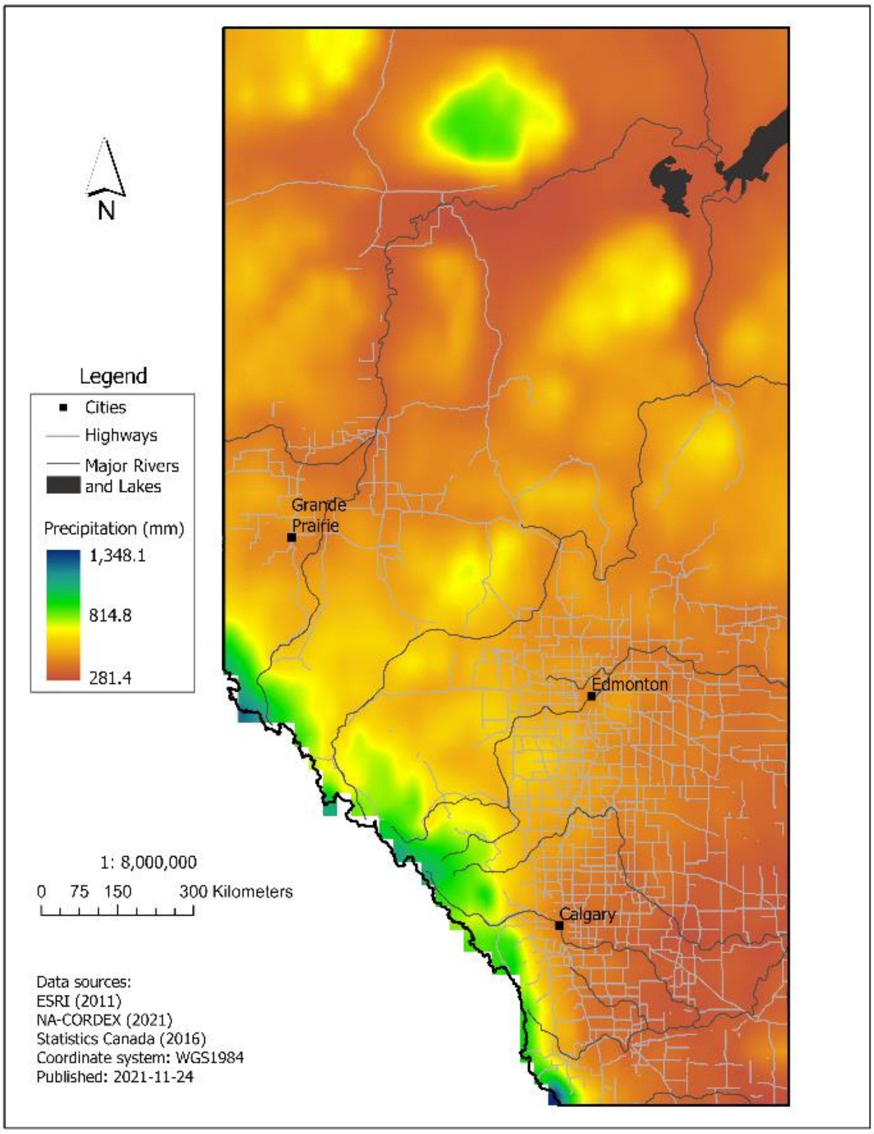

Figure 3: Mean annual precipitation across Alberta for the historical baseline period 1976 - 2005.

The maps in Figures 2 and 3 capture the temperate and precipitation gradients across the province. Temperatures decrease from south to north and towards the higher elevations of the Rocky Mountains. Alberta has a relatively dry climate, with precipitation generally below 700 mm per year, with the notable exception of much higher precipitation at higher elevations. The Pincher Creek Region spans this moisture gradient from low precipitation to the east and much higher precipitation in the western part of region on the eastern slopes of the Rockies. Figure 2 shows that the highest mean annual temperatures are in southwestern Alberta. This is relevant to our projection of climate change because the historical baseline climate is warmer than the rest of Alberta.

While maps show the variation in climate over space, time series plots show the variation in climate over time. Figures 4 and 5 are based on temperature observations at Pincher Creek; a weather record that extends back to the early 1880s, although there are many missing observations prior to the 1910s.

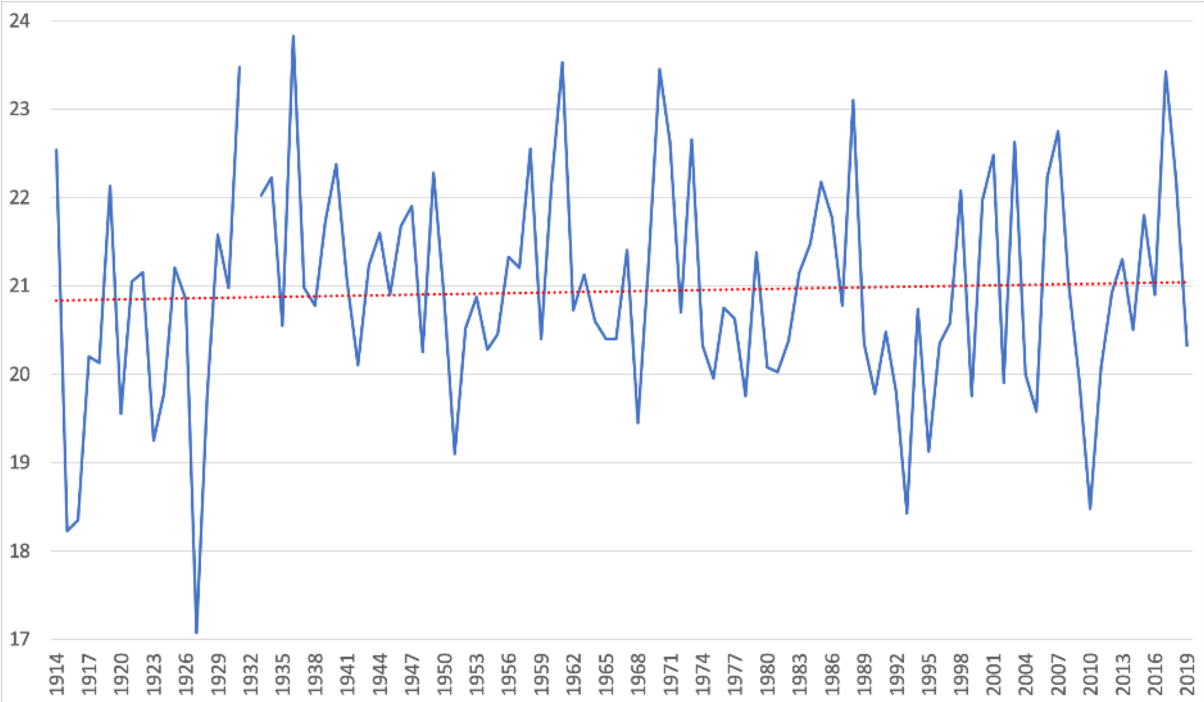

Figure 4: Mean daily maximum summer (JJA) temperature (ºC) at Pincher Creek, 1914 - 2019, and the linear upward trend (the red dashed line).

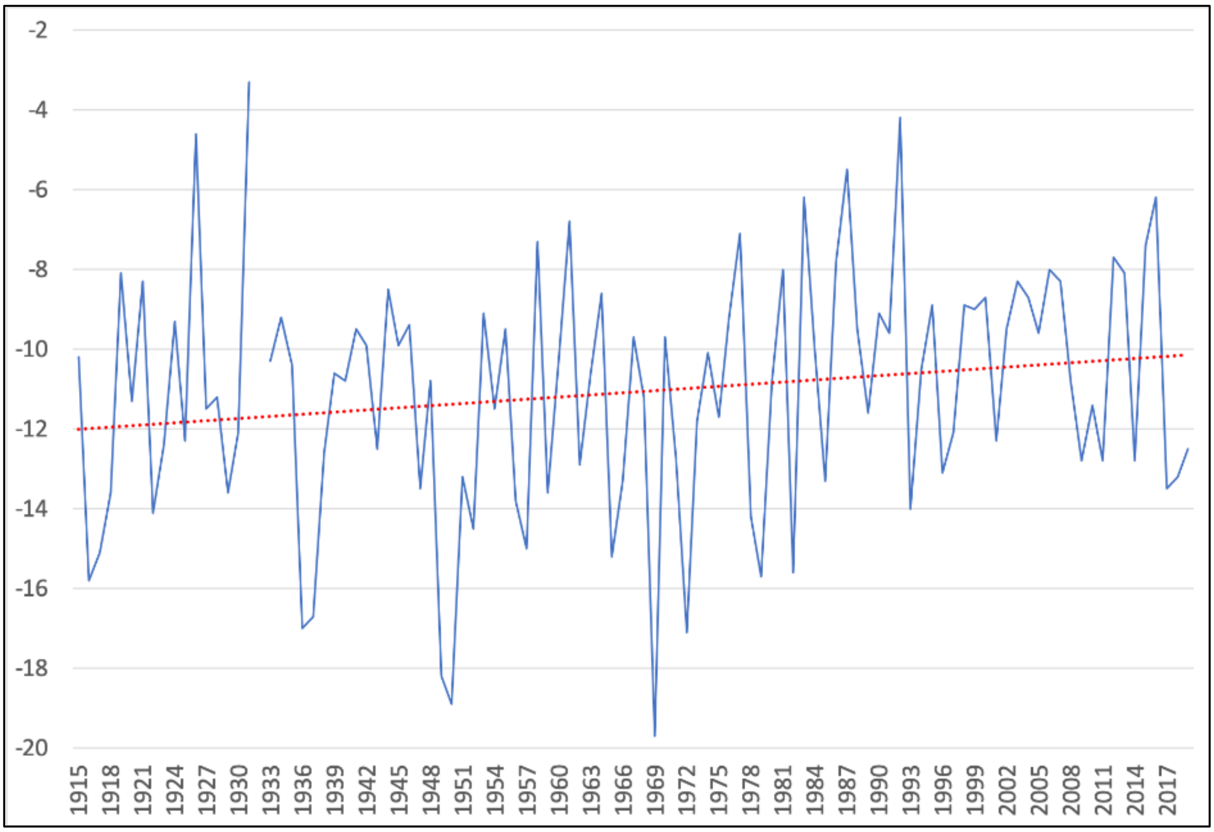

Figure 5: Mean daily minimum winter (DJF) temperature (ºC) at Pincher Creek, 1915 - 2019 and the linear upward trend (the red dashed line).

Figures 4 and 5 reveal that southwestern Alberta is not getting hotter; it is getting less cold. The highest temperatures (summer daily maximums) at Pincher Creek have increased only slightly; a linear trend that is insignificant relative to large variations from year to year. The lowest temperatures (winter daily minimums), on the other hand, have increased by 2 °C. While this is a significant change in temperature, it is small compared to the rest of Alberta, where minimum winter temperatures have risen by as much as 6 °C. Southwestern Alberta is an exception because historically its winters have been milder than the rest of the province and thus the influence of warming climate is not as noticeable.

There is large natural variability around the upward trend in Figure 5. The warm winter of 1931 was during a very strong El Niño. The clearest indication of a warming climate is the absence of severe cold since the mid-1980s. Since then, no winters have had a mean daily minimum temperature of less than -14 °C. Prior to the mid-1980s, many winters were much colder than this.

Precipitation records typically have gaps where data are missing. The most continuous record in the Pincher Creek Region is from Beaver Mines. Figure 6 is a graph of total annual precipitation (mm). It extends from 1913 to 2011 although some years have missing data. An upward linear trend reflects five recent years with more than 900 mm of precipitation. The range between years is large, from 300 to 1000 mm. In western Canada, this inter-annual variability is related to the periodic recurrence of El Niño / La Niña, which is associated with below / above average precipitation.

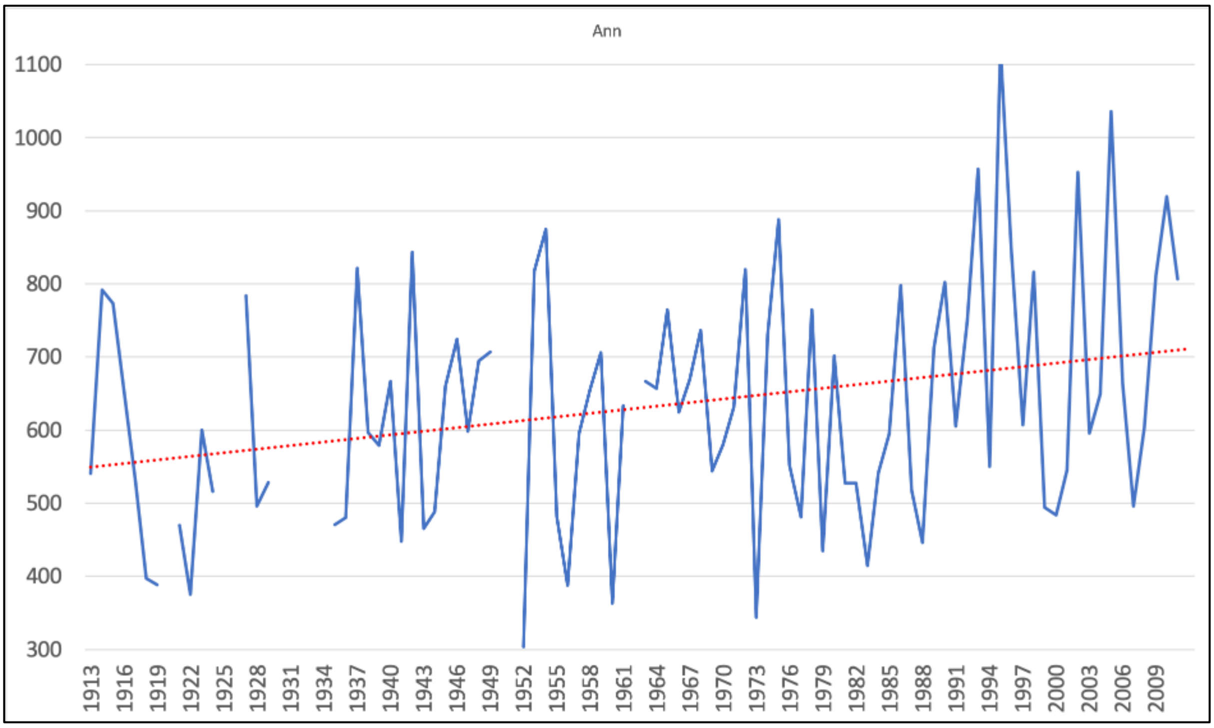

Figure 6: Total annual precipitation (mm) at Beaver Mines from 1913 - 2011 with a linear trend (red).

3 Methods of Constructing and Mapping the Climate Projections

3.1 The Use of Data from Climate Models

Numerical climate models are *"the primary tools available for investigating the response of the climate system to various forcings, for making climate predictions on seasonal to decadal time scales and for making projections of future climate over the coming century and beyond."* (Flato et al., 2013). Each climate model produces different outputs from a common set of assumptions about the anthropogenic forcing of the global climate system. Modelling centres throughout the world have built one or more climate models, each differing in how they represent the climate system. Modellers derive the mathematical expressions that best describe the earth's climate and then solve them on a three-dimensional grid defined by latitude and longitude, height for the atmosphere, and depth for the oceans. Global Climate Models (GCMs) have a horizontal grid size spacing in the range of 100 - 250 kilometres.

To address the gap between the coarse resolution of GCMs and the information required for regional climate risk assessment and adaptation planning, climate data are downscaled to a higher resolution. Outputs from a GCM can be dynamically downscaled using a higher resolution Regional Climate Model (RCM) for a limited land area. Another approach is to downscale GCM data based on the statistical relationship between local weather observations and atmospheric variables simulated by the GCM. This method can provide reliable information for single locations where a good set of weather observations is available for calibrating the statistical function linking local weather to large-scale climate patterns. On the other hand, dynamical downscaling performs better for most climate variables, because the regional atmospheric physics, and its interaction with land and water surfaces, are dynamically simulated rather than statistically estimated. RCMs have advantages in regions of highly variable topography and where small-scale (sub GCM grid) forcings and processes, such as convective clouds and precipitation, are important factors. Figure 7 illustrates the difference in resolution between the RCM grid and a GCM cell.

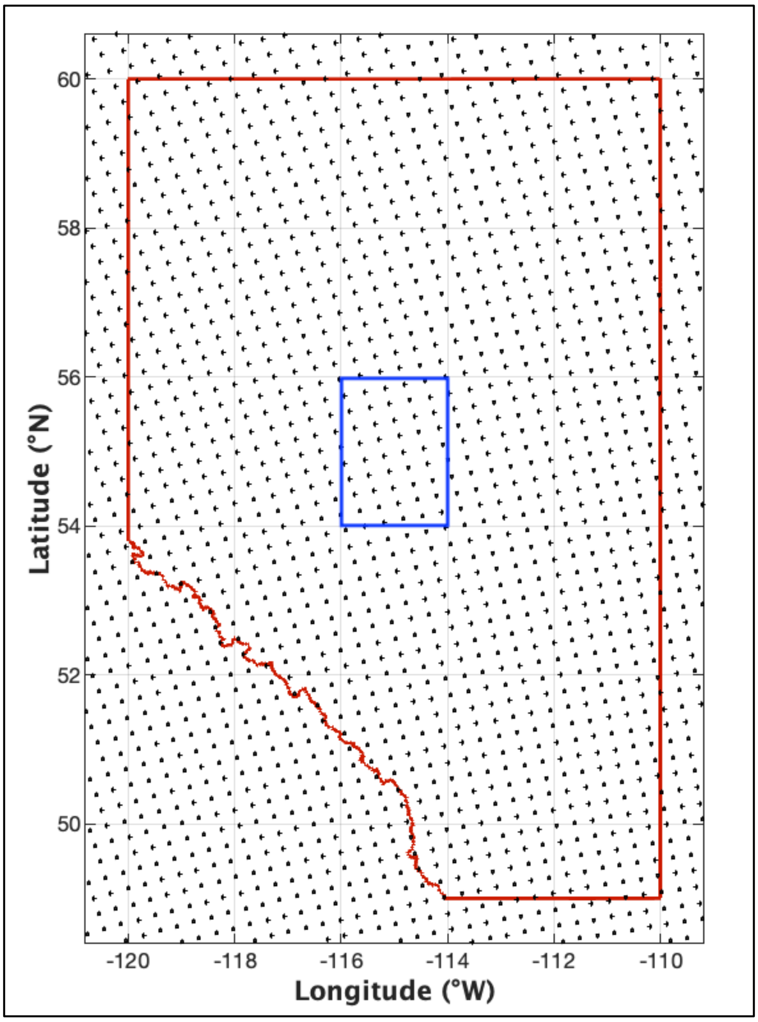

Figure 7: The boundary of Alberta and the Reginal Climate Model (RCM) grid with 25 km spacing between grid points. Shown in blue is the typical size of a grid cell from a Global Climate Model (GCM).

3.2 Constructing the Climate Projections

This project derived a new set of high-resolution climate change projections using the daily output for 24 climate variables from 11 RCMs. To define the timing of the projected changes, we first derived Global Mean Surface Air Temperature (GMSAT) data from seven Earth System Models (ESMs) to determine the years when GMSAT is projected to exceed specific thresholds. The threshold years are different for each model since the models have different dynamics that trigger a slightly different response to the same greenhouse gas (GHG) forcings. We chose ESM simulations of future climate that were forced by Representative Concentration Pathway 8.5 (RCP 8.5), which is a high GHG emission scenario and used most often by climate modelling centres, including to run the Regional Climate Models (RCMs) that comprise the Coordinated Regional Downscaling Experiment (CORDEX).

The climate change scenarios were based on a 3 °C increase in 11-year running average GMST relative to its value for the historical baseline period of 1976 to 2005. Once the 3 °C threshold was reached and surpassed, a new 30-year modeling period would begin. The year in which this temperature threshold is crossed was used to define a future period of 30 years, that is, ±15 years relative to the threshold year. A global temperature increase of 3 °C is considered the "current policies" scenario (NGFS, 2021).

We used data from the North American CORDEX (NA-CORDEX) to construct the climate projections. Daily data are available for 11 experiments based on four RCMs and six driving ESMs (Table 2). Computations of the mean climate changes and extreme climate indices listed in Table 2 were coded in NetCDF format and exported to ArcGIS Pro for making maps. Where data are provided seasonally (e.g., spring maximum temperature), standard meteorological seasons are used as outlined in Table 1.

Table 1: Meteorological definitions of seasons.

Season	Months
Winter	December, January, February
Spring	March, April, May
Summer	June, July, August
Fall	September, October, November

Table 2: The Pairs of ESMs and RCMs that Comprise the 11 Climate Model Experiments in the NA-CORDEX Climate Data Repository.

NA-CORDEX Model Name	Driver Earth System Model & Regional Climate Model
CanESM2.CanRCM4	Canadian Earth System Model second generation Canadian Regional Climate Model version 4
CanESM2.CRCM5-UQAM	Canadian Earth System Model second generation Canadian Regional Climate Model - University of Quebec at Montreal
GEMatm-Can.CRCM5-UQAM	Global Earth Model Atmosphere- CanESM2 Canadian Regional Climate Model - University of Quebec at Montreal
GEMatm-MPI.CRCM5-UQAM	Global Earth Model – MPI Canadian Regional Climate Model - University of Quebec at Montreal
GFDL-ESM2M.RegCM4	Geophysical Fluid Dynamics Laboratory – Earth System Model Regional Climate Model
GFDL-ESM2M.WRF	Geophysical Fluid Dynamics Laboratory – Earth System Model NCAR Weather Research and Forecasting Model
HadGEM2-ES.WRF	Hadley Centre Global Environment Model version 2 NCAR Weather Research and Forecasting Model
MPI-ESM-LR.CRCM5-UQAM	Max Planck Institute – Earth System Model – Low Resolution Canadian Regional Climate Model - University of Quebec at Montreal
MPI-ESM-LR.RegCM4	Max Planck Institute – Earth System Model – Low Resolution Regional Climate Model
MPI-ESM-LR.WRF	Max Planck Institute – Earth System Model – Low Resolution NCAR Weather Research and Forecasting Model
MPI-ESM-MR.CRCM5-UQAM	Max Planck Institute – Earth System Model – Medium Resolution Canadian Regional Climate Model-University of Quebec at Montreal

Table 3: The Climate Variables and Indices Evaluated using the NA-CORDEX Climate Model Data.

1. Fall Maximum Temperature (ºC)
2. Fall Minimum Temperature (ºC)
3. Fall Precipitation (mm)
4. Spring Maximum Temperature (ºC)
5. Spring Minimum Temperature (ºC)
6. Spring Precipitation (mm)
7. Summer Maximum Temperature (ºC)
8. Summer Minimum Temperature (ºC)
9. Summer Precipitation (mm)
10. Winter Maximum Temperature (ºC)
11. Winter Minimum Temperature (ºC)
12. Winter Precipitation (mm)
13. Number of Cold Days (T < -15 ºC)
14. Number of Very Cold Days (T < -30 ºC)
15. Number of Hot Days (T > 30 ºC)
16. Number of Very Hot Days (T > 35 ºC)
17. Number of Dry Days (< 1 mm)
18. Number of Very Wet Days (> 10 mm)
19. Number of Wet Days (> 5 mm)
20. Number of Frost Days (T < ºC)
21. Length of the Frost-Free Season (days)
22. Growing Degree Days (10 ºC base)
23. Growing Degree Days (5 ºC base)
24. 3-Month Standardized Precipitation Evapotranspiration Index (SPEI)

The first 20 variables in Table 3 are seasonal precipitation totals and mean maximum and minimum seasonal temperatures and the number of days each year that exceed specific temperature or precipitation thresholds. Variables 20 - 24 are climate indices that give an indication of the length and warmth of the growing season and the degree of water deficit or surplus at 3-month intervals. The Length of the Frost-Free Season is the number of days between the date of the last spring frost and the date of the first fall frost, equivalent to the number of consecutive days during the 'summer' without daily minimum temperatures equal to or below 0 °C. Growing Degree Days (GDD) is calculated as the summation of [(maximum daily temperature + minimum daily temperature) / 2] – base temperature (5 ºC or 10 ºC). In practice, GDD5 is reached when the minimum threshold for agricultural growth is exceeded by 5 ºC, whereas GDD10 represents conditions in which that minimum is exceeded by at least 10 ºC. By this practice and the above formula, several GDDs can be accumulated in one day. The Standardized Precipitation Evapotranspiration Index (SPEI) is a water balance index based on the monthly difference between precipitation and potential evapotranspiration (PET). Table 4 gives the standard classification of drought and excessive moisture based on values of the SPEI.

Table 4: SPEI Classification of Drought and Excessive Moisture

SPEI Classification	SPEI
Extreme Drought	≤ −2.0
Severe Drought	≥2.0 to −1.5
Moderate Drought	≥1.5 to −1.0
Near Normal	−1.0 to +1.0
Moderate Excessive Moisture	+1.0 to <+1.5
Severe Excessive Moisture	+1.5 to <+2.0
Extreme Excessive Moisture	≥+2.0

3.3 Mapping the Climate Projections

Mean (average) values from an ensemble of climate models were imported into ArcGIS Pro v3.1.0 and QGIS v3.28.3 – for visual representation and comparison. At this stage, data were not modified or altered; they were only adjusted for viewing based on classification and symbology (colours used to display values). Common map elements remained consistent throughout the process to ensure consistency for comparison: scale, extent, and projection. A common symbology was used for temperature data while another was used for precipitation data. Symbology was inverted where necessary for clarity.

The climate data were converted from a grid (cell-based) format to a smoother display using a bilinear resampling technique that assigns a value to each cell based on the values of its nearest four surrounding neighbouring cells. This technique was employed to more accurately represent the nature of climate data which does not conform to the constraints of a 25 x 25 km grid cell but follows more dynamic transitions over space and time. It is also the most common resampling method used for non-discrete climate data that remain spatially stable over time.

Data were classified using bivariate colour schemes commonly applied to climate variables with adequate distinction. There are many other options available for symbolizing and displaying climate data that can affect the visual appearance and contrast among values, such as user-defined intervals, standard deviation(s) from the mean, assigning a unique colour to each data value, and so on. It is important to match the nature of the data to an appropriate classification scheme so as not to misrepresent the message behind the data by exaggerating differences that may not be there or missing patterns therein. For this project, incorporating the full range of data using a continuous symbology worked well to highlight the transition of climate change across the study region.

4 The Climate Change Projections

With daily data from 11 RCMs and for 24 variables, we determined the climate changes between the historical baseline and future period corresponding to 3 °C of global warming. Given the 25 km resolution of the RCMs, we were able to produce a climate change projection for 15 grid cells. Figure 8 is a map of the boundary of the MD of Pincher Creek superimposed on the corresponding 15 RCM grid cells. The town of Pincher Creek is in the northwest corner of cell # 11.

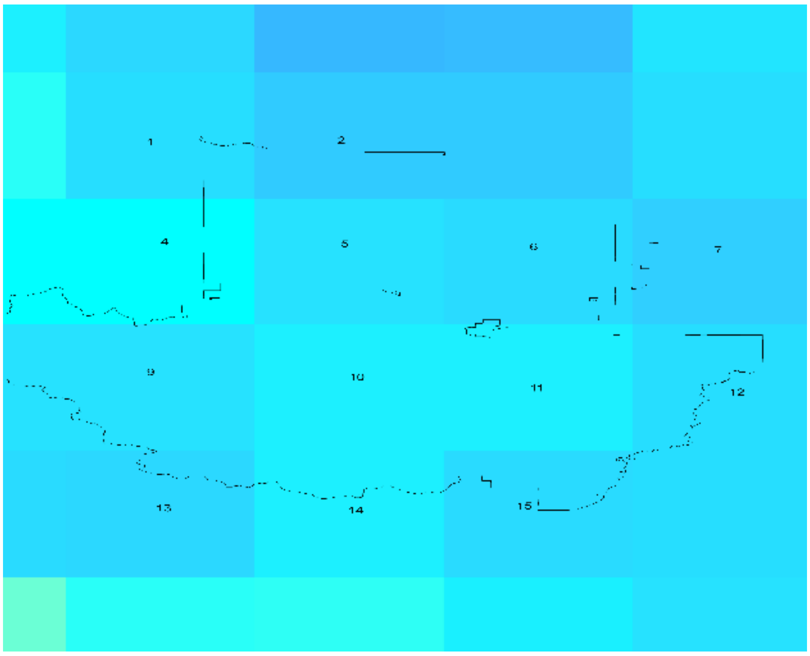

Figure 8: The 15 RCM grid cells that lie at least partly within the Pincher Creek Region. The town of Pincher Creek is in the northwest corner of cell # 11.

Table 5 gives the projected multi-model mean changes for each of the 24 variables and 15 RCM grid cells. The last column gives the spatially averaged change. The projected temperature changes for the 3 °C global warming is relatively consistent among grid cells, while the precipitation, and related indices, are more variable over time and space. This is expected as temperature is the most certain climate variable due to the simplified nature of its modeling nature relative to other climate variables.

Climate model projections are subject to various forms of uncertainty, which depend on the variable being modeled, season of interest, and a variety of other factors. Within western Canada, internal climate variability drives much of this this uncertainty (Barrow and Sauchyn, 2019). Other sources of uncertainty include uncertainty within climate models and in greenhouse gas emissions scenarios. For more in-depth discussion on climate model uncertainty, please refer to the Uncertainty Primer:

https://climatewest.ca/publications/uncertainty-in-climate-change-data-primer/

Table 5 The projected multi-model mean changes for each of the 24 variables and 15 RCM grid cells. The last column gives the spatially averaged change between the historical values and projected climate changes for the 3 °C global warming scenario.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean
Cold Days (T < -15 °C)	-20	-19	-18	-16	-17	-17	-18	-16-	-16	-16	-16	-16	-18	-16	-15	-17
Very Cold Days (T < -30 °C)	-4	-4	-4	-3	-3	-3	-2	-3	-3	-3	-3	-2	-3	-3	-3	-3
Frost Days	-63	-60	-67	-65	-62	-59	-67	-66	-66	-66	-63	-65	-65	-65	-65	-64
Frost-free Season (days)	-63	-60	-67	-65	-62	-59	-67	-66	-66	-66	-63	-65	-65	-65	-65	-64
Winter P (mm)	+6.1	+11.7	+3.2	+11.0	+12.8	+11.8	-10.5	-3.6	+13.4	+17.8	+16.4	-12.5	-5.2	+11.0	+17.3	+6.7
Winter Max. T (°C)	+3.1	+3.1	+3.0	+3.0	+3.1	+3.1	+3.1	+2.9	+2.9	+3.0	+3.1	+3.1	+2.9	+2.9	+3.0	+3.0
Winter Min. T (°C)	+4.0	+4.1	+4.0	+4.1	+4.2	+4.3	+4.3	+3.9	+4.0	+4.1	+4.2	+4.3	+3.8	+3.9	+4.0	+4.0
GDD (5 °C)	+43	+45	+44	+45	+49	+47	+45	+43	+45	+46	+50	+48	+44	+46	+47	+46
GDD (10 °C)	+47	+43	+50	+46	+43	+42	+39	+49	+48	+46	+43	+41	+47	+48	+46	+45
Hot Days (T > 30 °C)	+9	+15	+7	+11	+22	+23	+27	+5	+9	+14	+22	+26	+9	+4	+15	+15
Very Hot Days (T > 35 °C)	0	+1	0	+1	+4	+4	+7	0	0	+1	+4	+6	0	0	+1	+2
Summer Max. T (°C)	+4.3	+4.3	+4.3	+4.3	+4.3	+4.2	+4.2	+4.4	+4.4	+4.3	+4.3	+4.2	+4.4	+4.5	+4.4	+4.3
Summer Min. T (°C)	+4.4	+4.3	+4.5	+4.4	+4.4	+4.4	+4.4	+4.4	+4.4	+4.4	+4.4	+4.4	+4.4	+4.5	+4.4	+4.4
Summer P (mm)	-12.2	-6.4	-11.6	-9.9	-4.9	-3.8	-1.3	-12.6	-13.3	-13.7	-8.9	-6.0	-16.3	-28.4	-19.0	-11.2
Dry Days (P < 1 mm)	+1	-2	+1	-1	-2	-3	+2	+2	0	0	-2	+3	+5	+2	+1	+0.4
Spring Max. T (°C)	+2.7	+2.6	+2.7	+2.7	+2.6	+2.5	+2.5	+2.8	+2.8	+2.7	+2.7	+2.6	+2.8	+2.8	+2.8	+2.7
Spring Min. T (°C)	+3.5	+3.4	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5	+3.5
Spring P (mm)	+56.7	+58.8	+40.4	+51.8	+56.7	+62.5	+57.8	+39.4	+50.4	+68.2	+67.1	+62.9	+44.7	+59.6	+66.6	+56.2
Fall Max. T (°C)	+3.6	+3.6	+3.5	+3.6	+3.6	+3.7	+3.7	+3.5	+3.6	+3.6	+3.7	+3.8	+3.6	+3.6	+3.7	+3.6
Fall Min. T (°C)	+4.2	+4.2	+4.2	+4.3	+4.3	+4.3	+4.4	+4.1	+4.2	+4.2	+4.3	+4.3	+4.1	+4.2	+4.2	+4.2
Fall P (mm)	+9.1	+7.5	+11.4	+7.2	+7.5	+6.5	+5.9	+10.5	+5.6	+7.3	+6.9	+6.0	+6.2	+3.2	+6.0	+7.1
Wet Days (P > 5 mm)	+4	+5	0	+2	+5	+5	+5	-1	-1	+2	+5	+5	-2	-3	+1	+2
Very Wet Days (P > 10 mm)	+3	+4	+1	+3	+3	+3	+3	+1	+1	+4	+3	+3	+1	0	+3	+3
SPEI (3 months)	0	-0.1	0.1	0	-0.1	-0.1	-0.3	0	0	+0.1	0	-0.1	0	0	0	-0.1
SPEI (12 months)	0	-0.3	0	0	-0.4	-0.5	-0.3	0	+0.1	+0.1	-0.3	-0.5	0	0	+0.1	-0.2

The mean and absolute values of all variables for each of the 15 grid cells of the Pincher Creek Region study area are collated in Tables 6 - 20, found in the Appendix at the end of this report. These tables provide a quick reference to compare mean and absolute values from historical levels to the 3 °C global warming scenario on a grid cell by grid cell basis. For further comparison, these values are included as inset maps in the corresponding maps of projections in the next section (Section 3.1).

4.1 Maps of the Climate Projections

Following the methods described above, we generated maps of the MD of Pincher Creek using the mean values for the 11 RCMs and 24 variables. As such, each individual map represents an aggregate of multiple models and their runs. Likewise, there is a degree of uncertainty inherent in the values and trends displayed in each map.

The largest climate changes observed over the past several decades have occurred in the coldest regions of Canada and to climate variables that describe cold conditions. By focusing on a much smaller and southerly geographic region, however, we focus equally on variables of interest to the Pincher Creek Region. For ease of reference, the maps have been grouped by variable type, such as temperature, precipitation, and so on. A description of each map is provided below the figure and a discussion of the overall trends in each variable (e.g., temperature) given at the beginning of each section.

4.1.1 Maps of Temperature

These maps are presented chronologically through the seasons beginning with spring and ending in winter. Each scenario map contains a description and is accompanied by a figure to show the degree of change from the historical / baseline conditions within each grid cell. On all temperature maps, isotherms (lines connecting equal temperature) are drawn in green to assist delineation of temperature gradients.

Considerable warming is expected across the Pincher Creek Region for minimum and maximum temperatures under all seasons. Highest overall warming scenarios are projected for the summer months (Figures 9 - 10) where temperatures are expected to increase by 4.1 to 4.4 °C. This has significant implications for heat stress to humans and other species, as well as the spread of invasive species and disease. Fall months (both minimum and maximum temperatures, Figures 13 - 14) and winter minimum (Figure 15) show considerable warming from baseline conditions as well, suggesting a later start to winter and less snowpack overall. Combining this with the overall warming trend suggests more precipitation falling as rain and shift in freshet. Seasonal warming trends are summarized below in Table 6.

Table 6: Departures of seasonal warming projections under a 3° C global warming scenario from historical conditions, 1976-2005.

	Mean Anomaly from Baseline (°C)
Spring Min. T	3.5
Spring Max. T	2.6
Summer Min. T	4.3
Summer Max. T	4.2
Fall Min. T	4.2
Fall Max. T	3.6
Winter Min. T	4.0
Winter Max. T	2.9

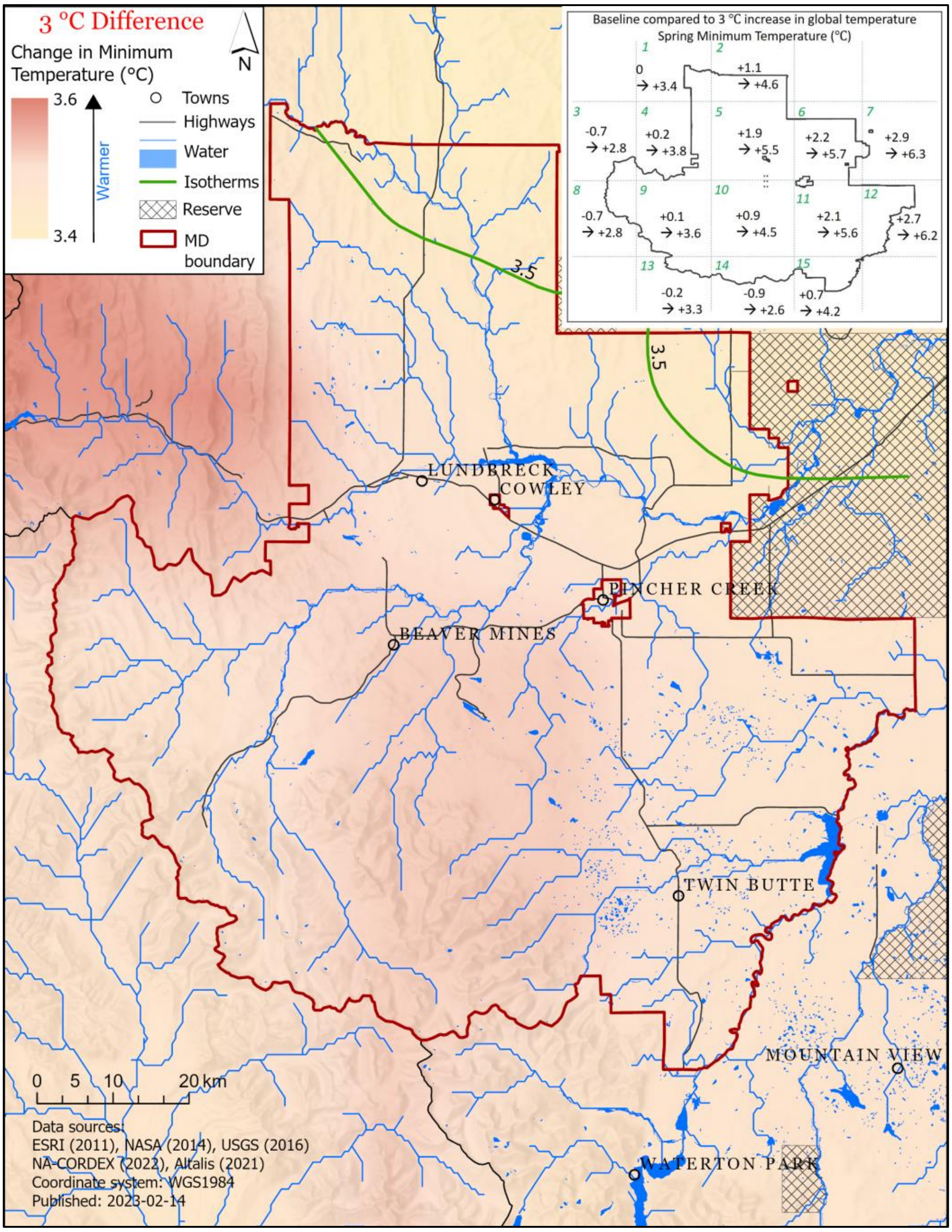

Figure 9: A map of the projected changes in Spring Minimum Temperature under a 3 °C global warming scenario. Despite very little variation over the area there is significant warming of 3.4 to 3.6 °C from baseline conditions.

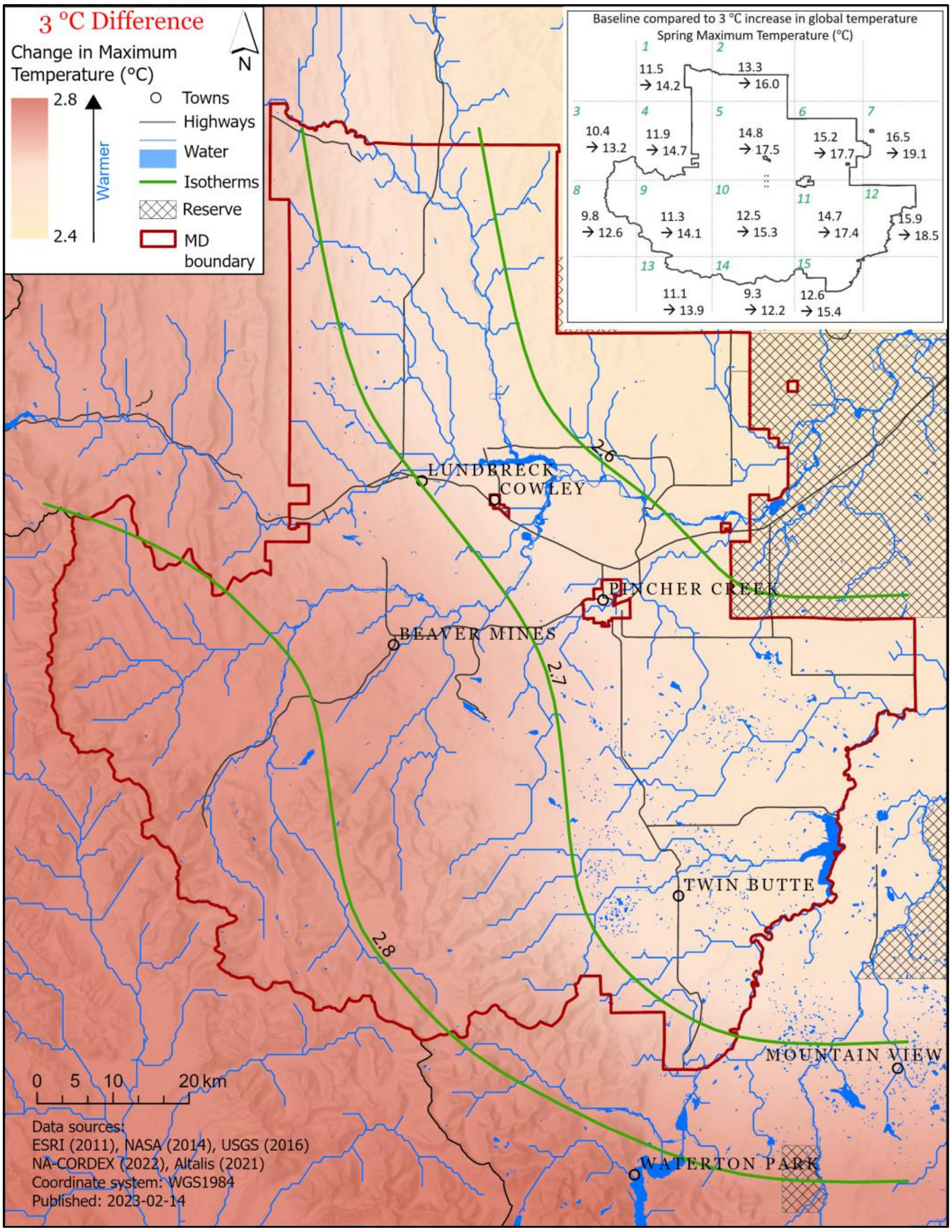

Figure 10: A map of the projected changes in Spring Maximum Temperature under a 3 °C global warming scenario. Relative increase is less than projected for Spring Minimum Temperature, which suggests less very high temperatures in the spring months. The range of 2.4 to 2.8 °C warming across the region coupled with the high base warming in minimum temperatures indicate significant spring warming.

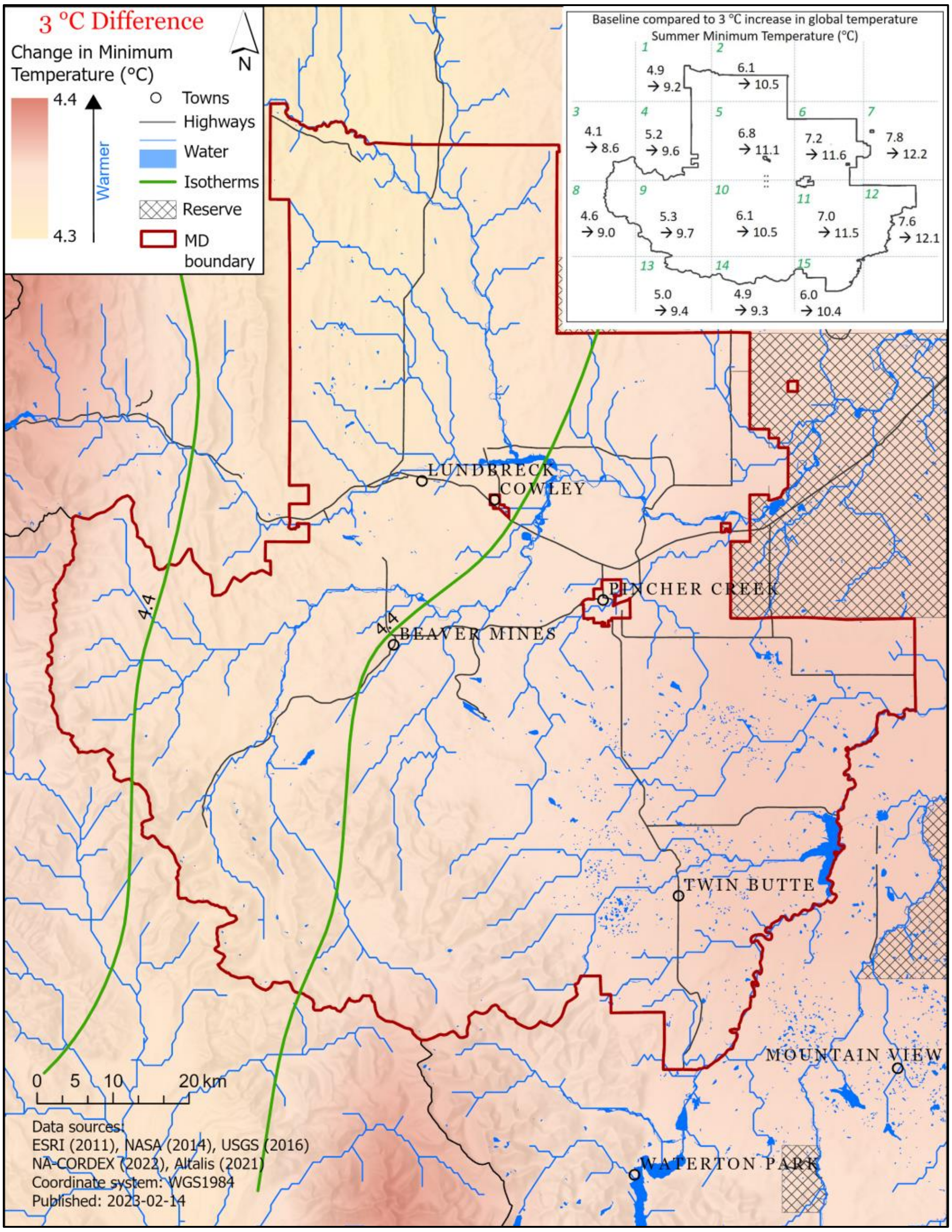

Figure 11: A map of the projected changes in Summer Minimum Temperature under a 3 °C global warming scenario. Uniform warming of 4.3 to 4.4 °C is projected over the region with respect to minimum summer season temperatures.

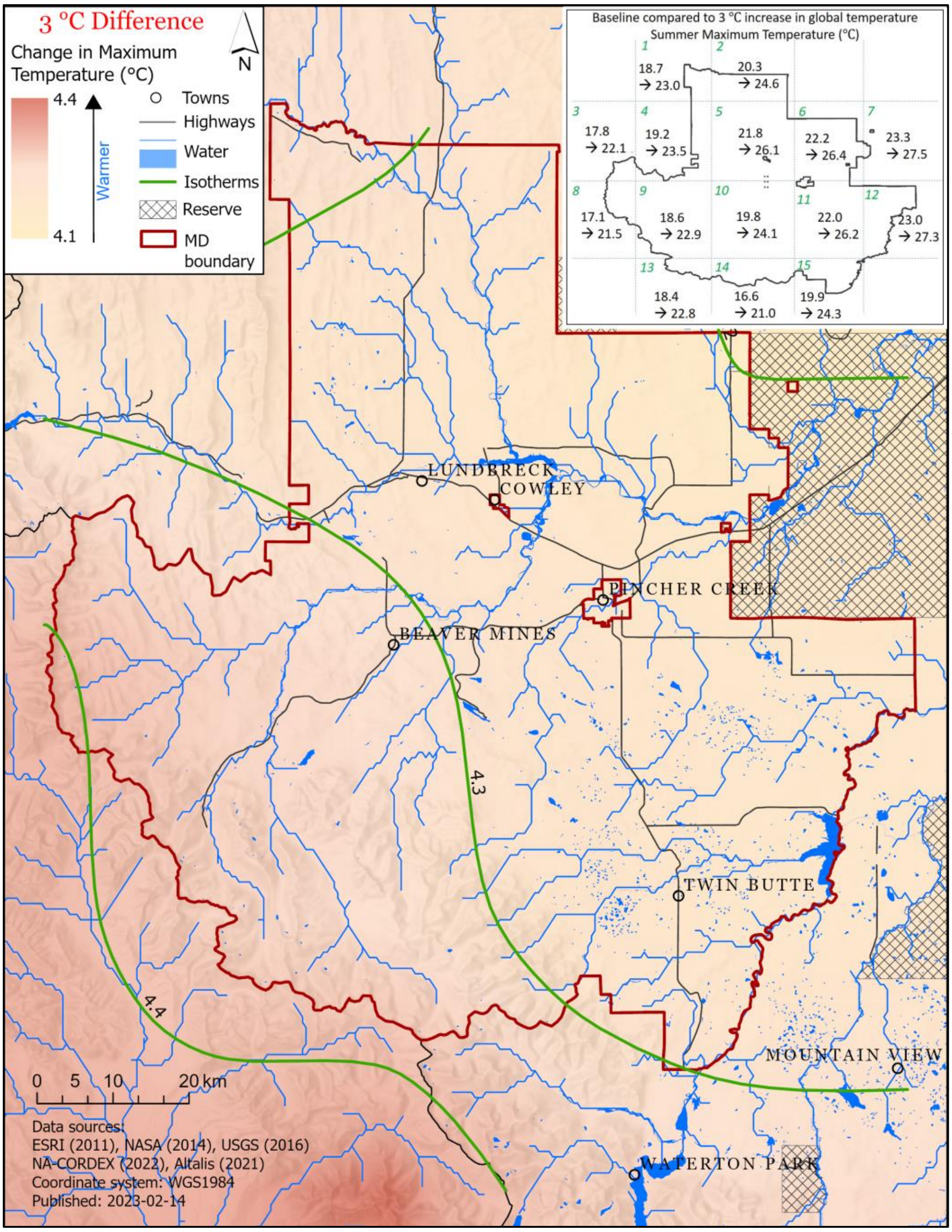

Figure 12: A map of the projected changes in Summer Maximum Temperature under a 3 °C global warming scenario. As with Summer Minimum Temperature, a high degree of warming is projected to occur with little variation in range.

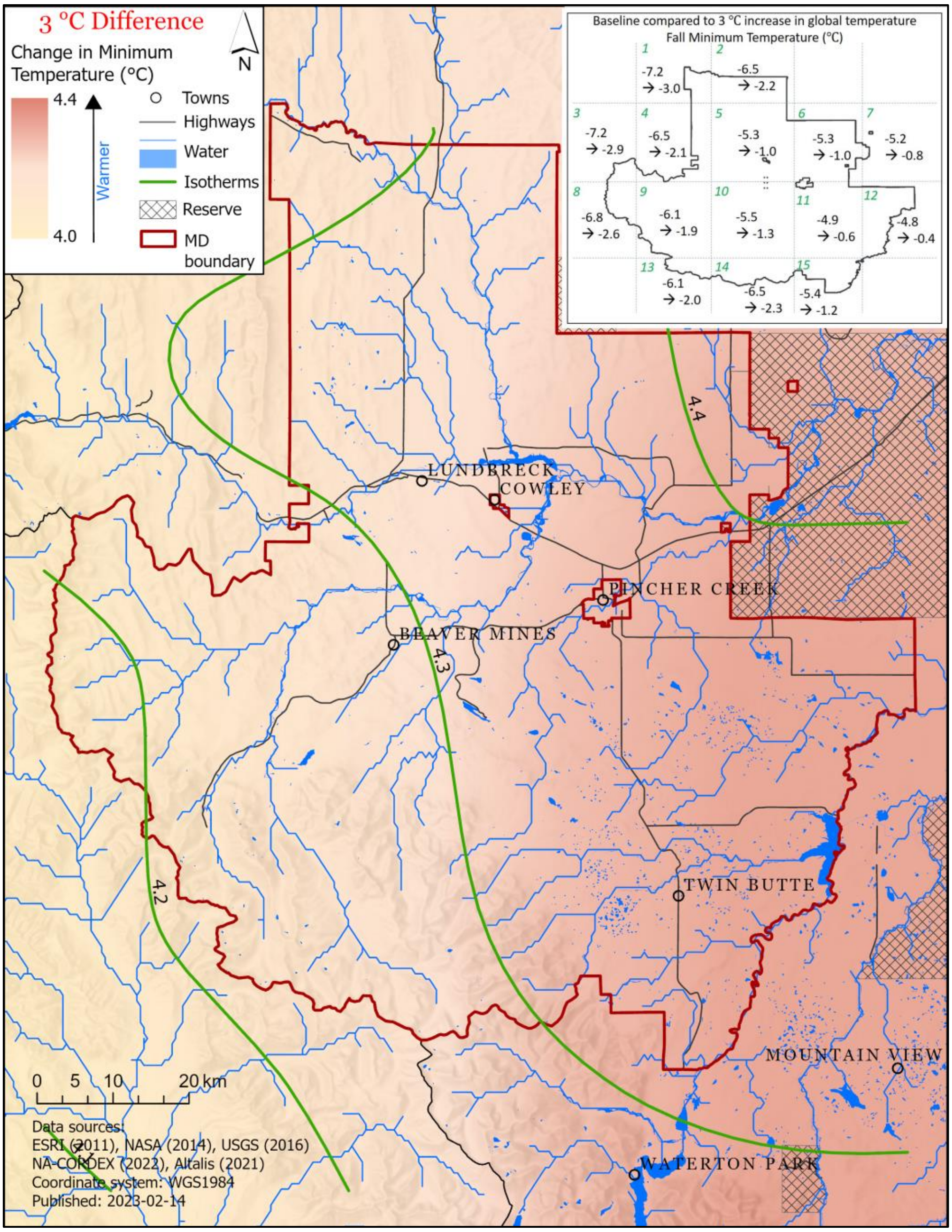

Figure 13: A map of the projected changes in Fall Minimum Temperature under a 3 °C global warming scenario. Projected changes in Fall Minimum Temperature mirror those of Summer Minimum Temperature with broad-based warming of 4.0 to 4.4 °C. A southwest to northeast warming trend is observed, however.

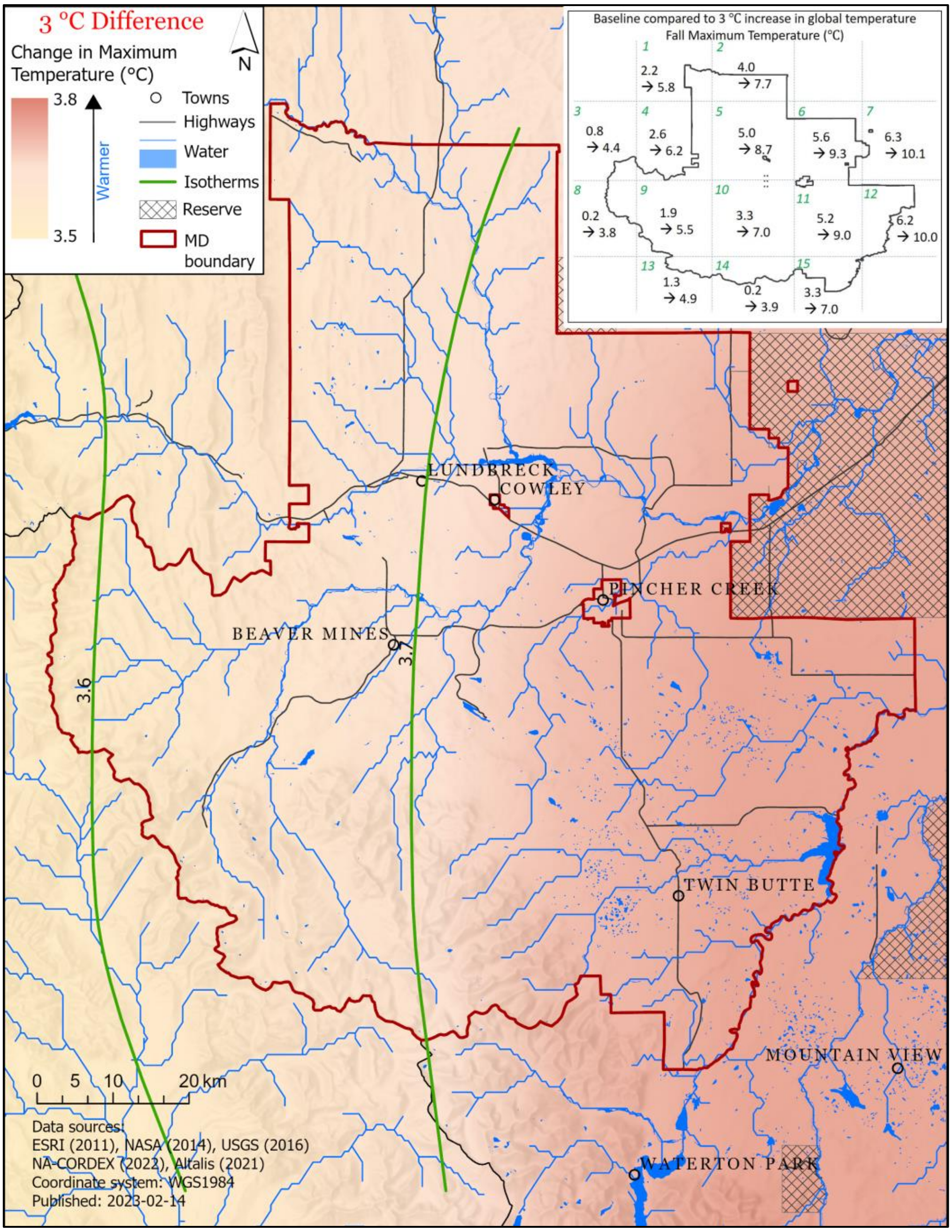

Figure 14: A map of the projected changes in Fall Maximum Temperature under a 3 °C global warming scenario. Fall Maximum Temperatures are projected to experience a slightly lower increase than the fall minimum. The same east to west warming trend is observed (Figure 18), but the longitudinal component disappears.

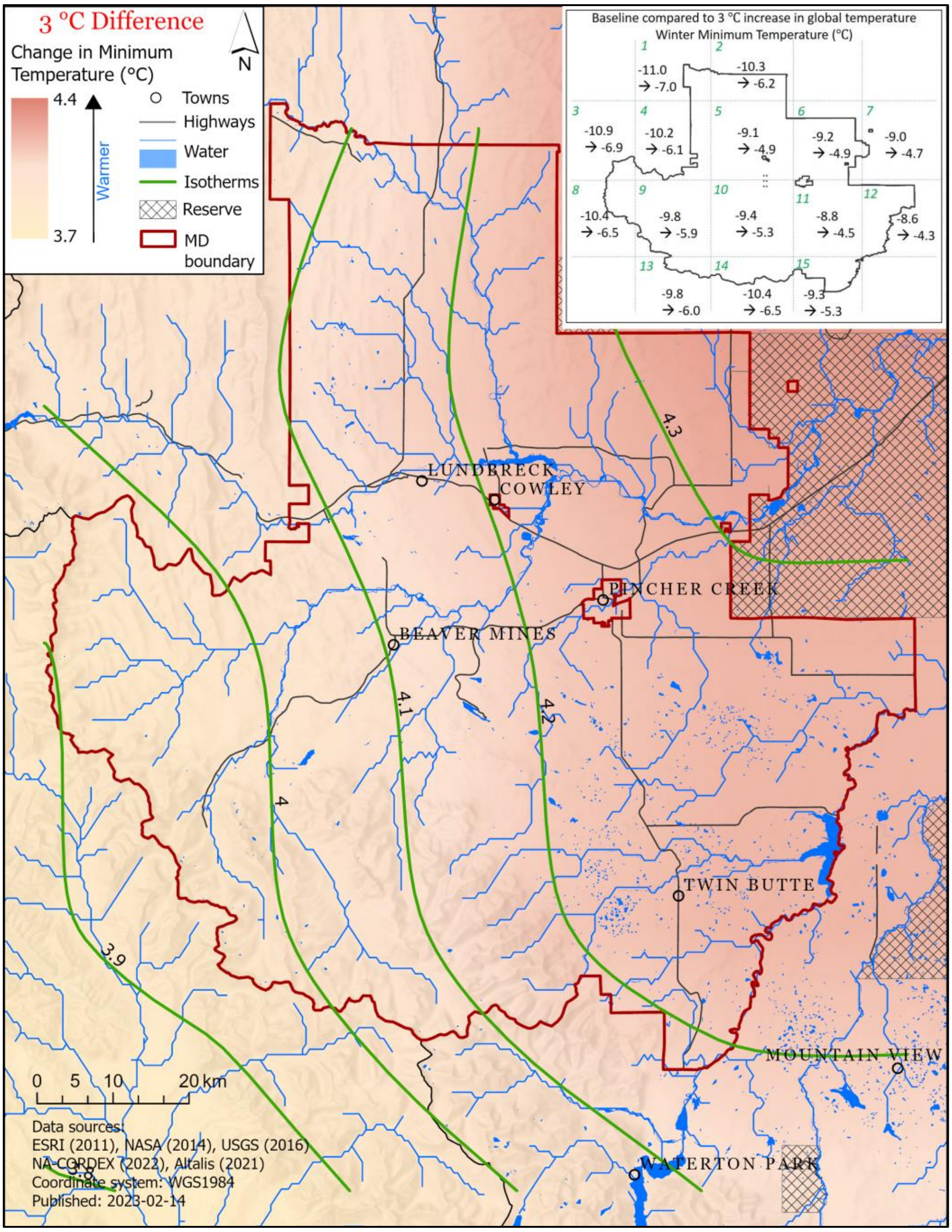

Figure 15: A map of the projected changes in Winter Minimum Temperature under a 3 °C global warming scenario. A higher degree of variability is observed, particularly along a southwest to northeast warming gradient. In winter months, this can likely be attributed to a higher albedo value at higher elevations.

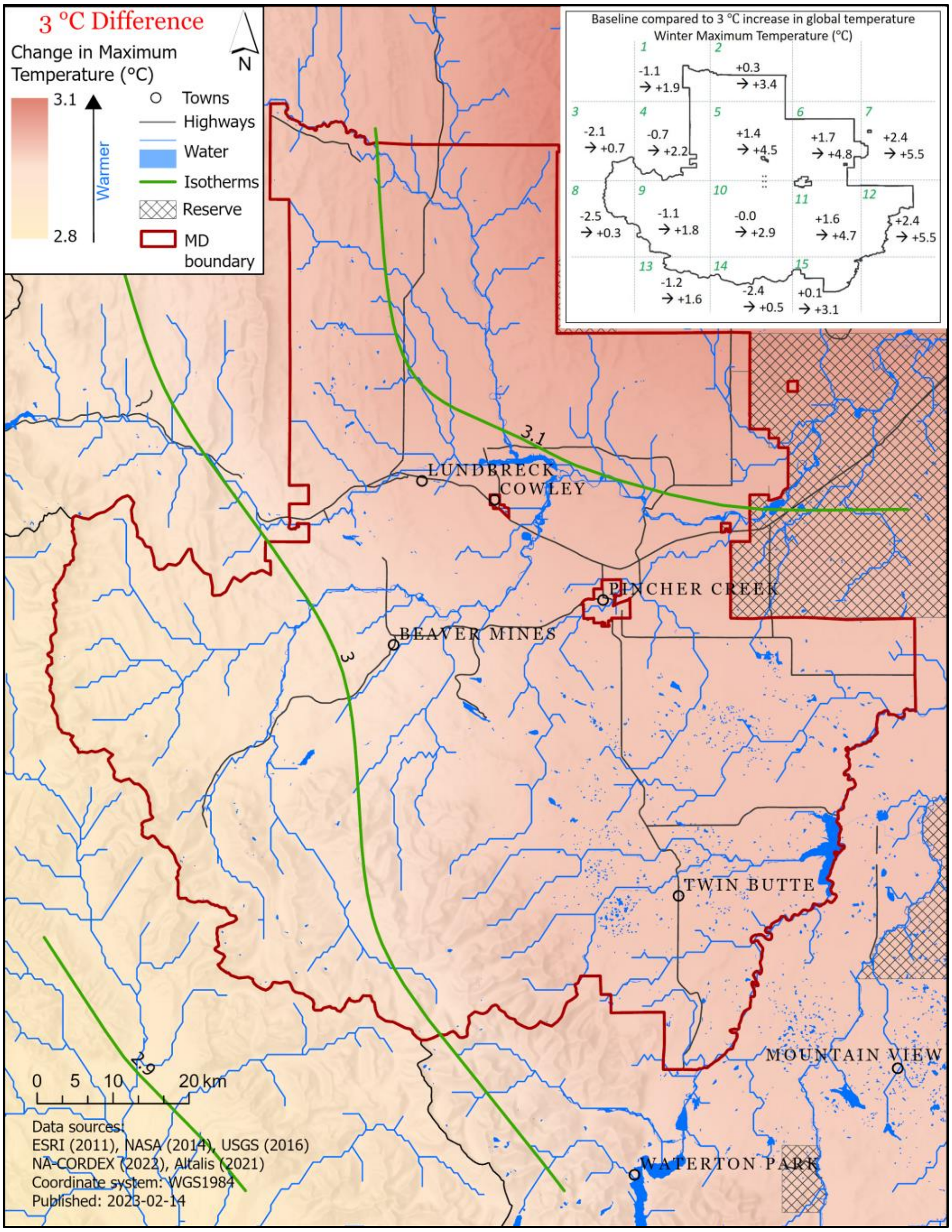

Figure 16: A map of the projected changes in Winter Maximum Temperature under a 3 °C global warming scenario. Changes in the winter maximum are more modes with temperatures project to increase up to 3.1 °C. Again, the least amount of departure from the baseline conditions is expected in the more mountainous terrain of the southwest.

4.1.2 Maps of Growing Degree Days

Projected changes in the number of average Growing Degree Days (GDDs) in Figures 17 - 18 indicate a potentially positive outlook for agricultural output and yield for most crop varieties. The higher temperatures projected in the previous maps – particularly in the summer months – result in an increase in GDDs under both 5 and 10 °C thresholds, with the 10 °C map (Figure 18) showing resemblance to Maximum Summer Temperature (Figure 12). Despite the increase in GDD, the potential for increased water demand and heat stress under warmer conditions may offset higher yield outcomes.

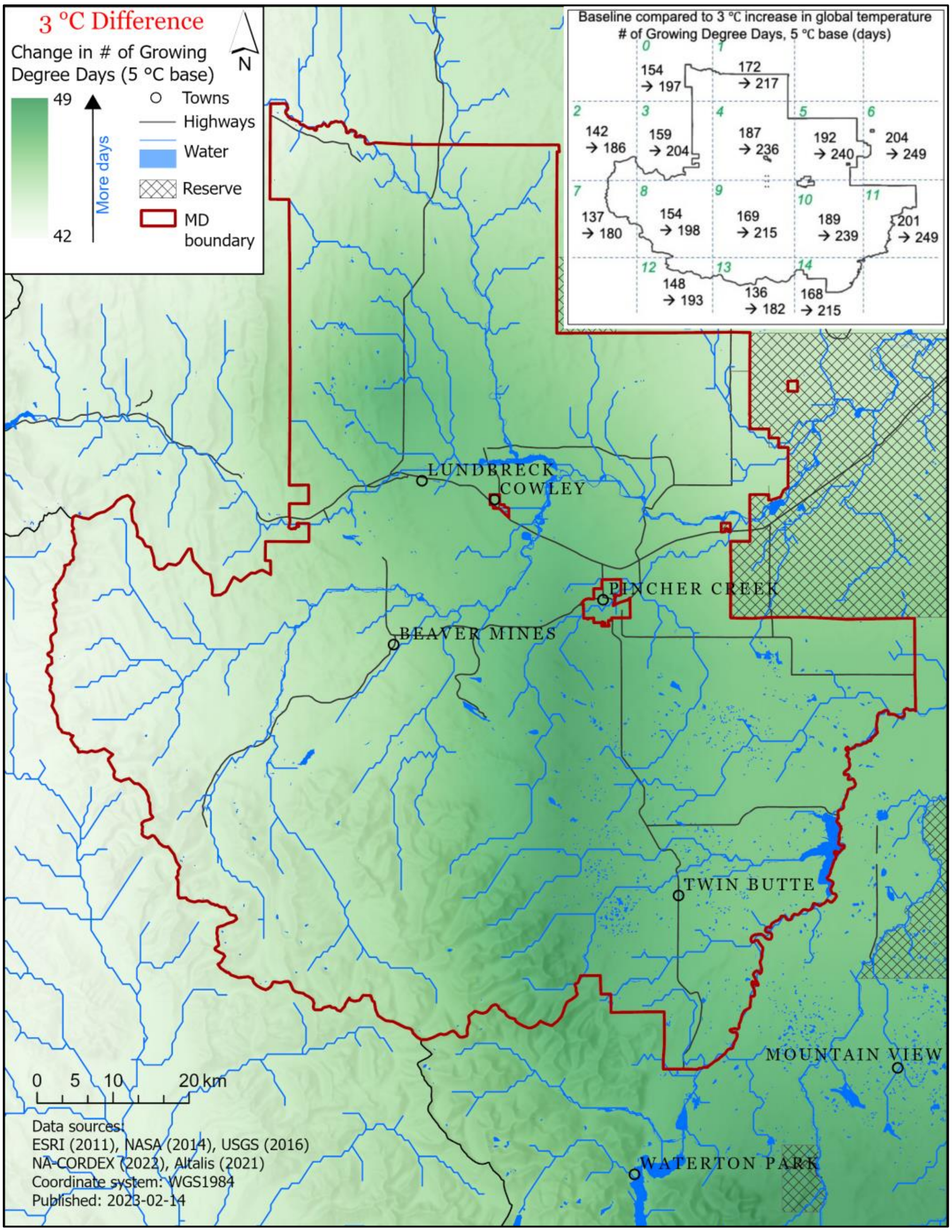

Figure 17: A map of projected changes in average Growing Degree Days (5 °C threshold) under a 3 °C global warming scenario. An increase of up to 49 days are expected in the southeast and central regions.

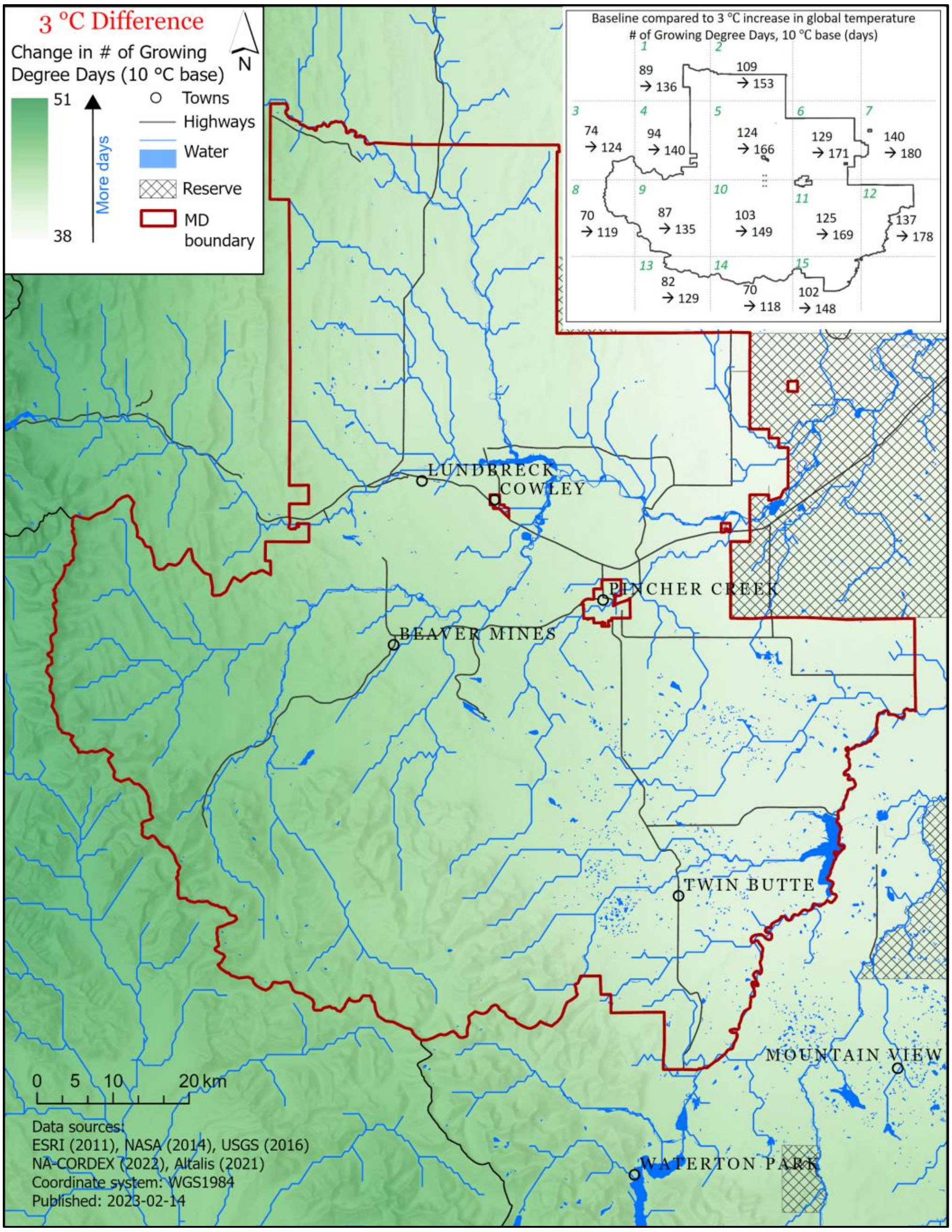

Figure 18: A map of projected changes in Growing Degree Days (10 °C threshold) under a 3 °C global warming scenario. Up to 51 extra GDDs are projected under the 10-degree threshold, indicating increased very high temperatures, as supported in the maps showing projected increases for summer temperatures (Figures 11 - 12).

4.1.3 Maps of Hot Days and Frost-free Season

Figures 19 through 21 highlight further increases in the projections of warm weather indices. Figures 19 and 20 exhibit a trend in days in which temperature will exceed 30 and 35 °C, respectively, in the eastern region of the Pincher Creek Region. The aggressive daily maximum temperatures are moderated by mountainous terrain in the east where cooler descends from the Rockies. The number of Frost-free Days in Figure 21 (up to 69 projected) suggest an earlier start and later end to the growing season.

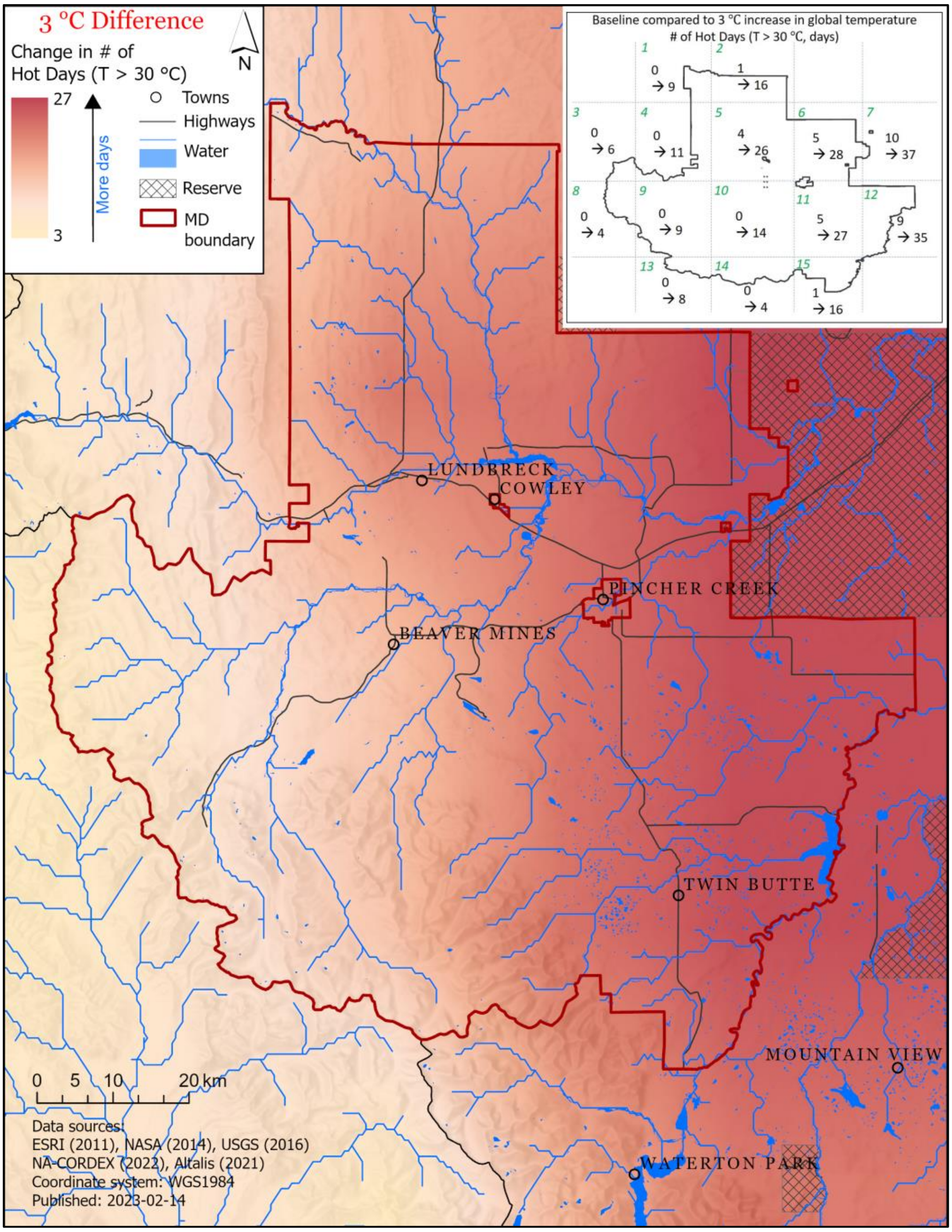

Figure 19: A map of the projected changes in the Number of Hot Days (T > 30 °C) under a 3 °C global warming scenario. There is widespread variability across the Pincher Creek Region with some areas forecast to experience up to 27 additional days exceeding 30 °C while others only 3 days.

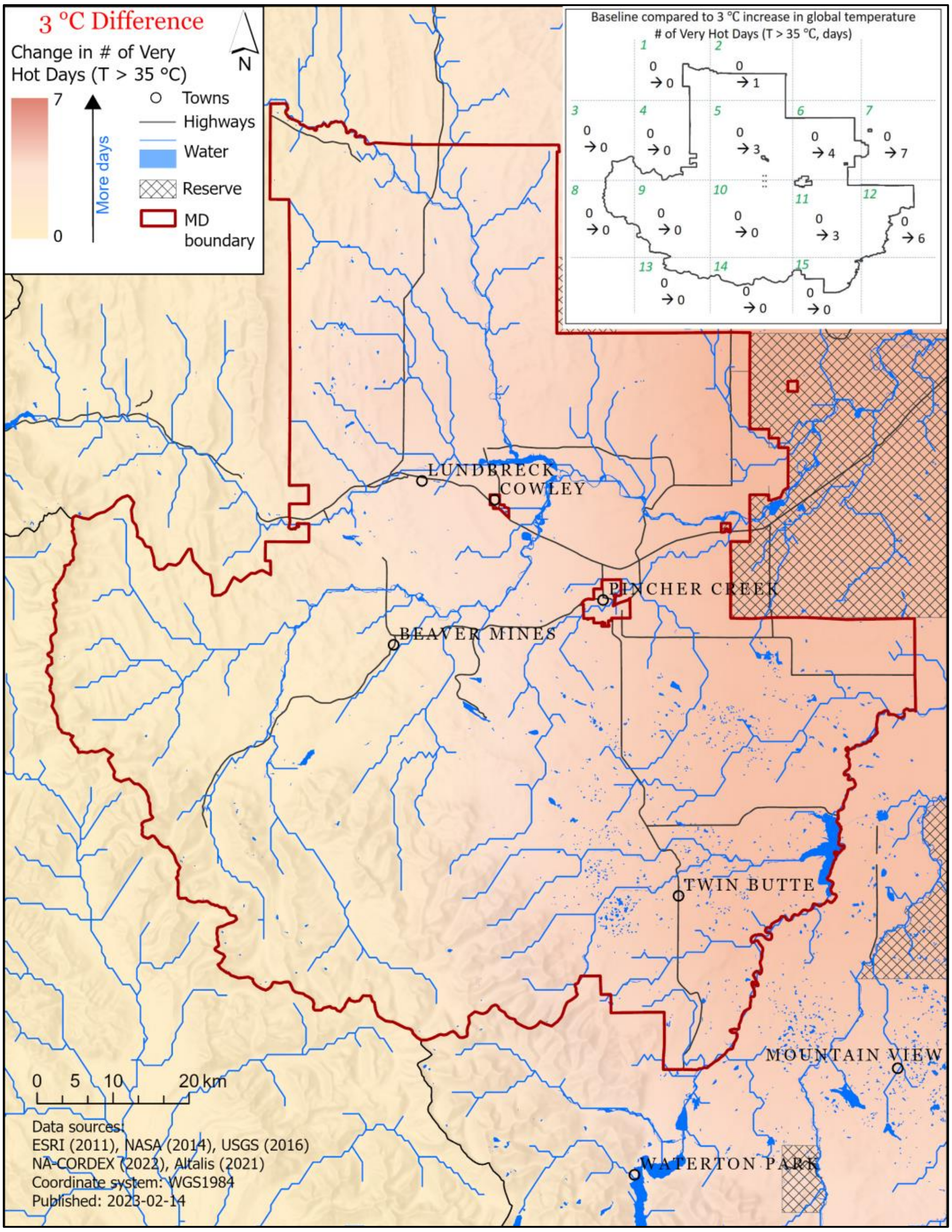

Figure 20: A map of the projected changes in the Number of Very Hot Days (T > 35 °C) under a 3 °C global warming scenario. Up to 7 additional days exceeding 35 °C are expected in the eastern region while parts of the west will see no change.

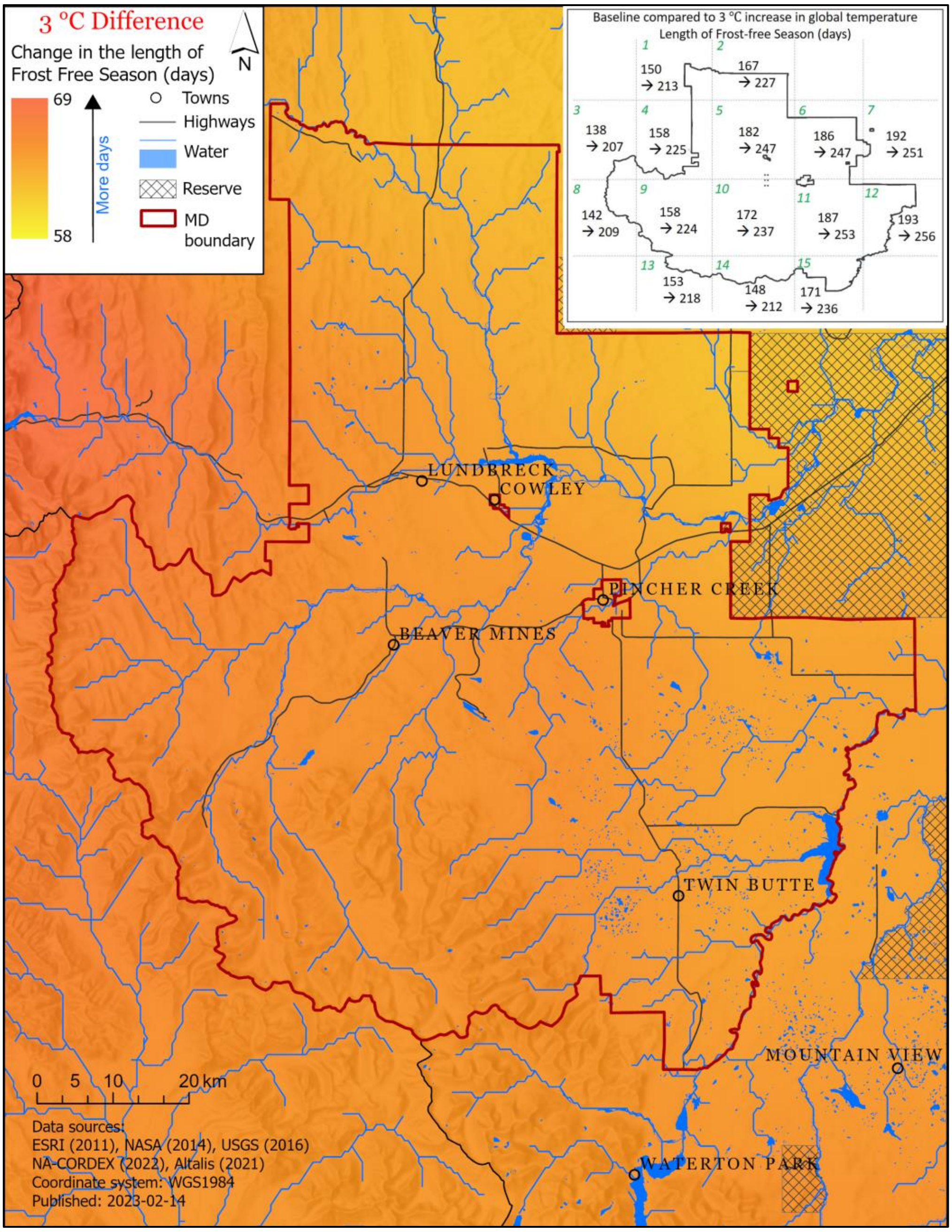

Figure 21: A map of the projected changes in the length of the Frost-Free Season under a 3 °C global warming scenario. A much-extended Frost-free Season is projected across much of the Pincher Creek Region where the region will may see 58 - 69 extra days without frost.

4.1.4 Maps of Cold Days and Frost Season

Cold Days where the temperature drops below -15 °C are projected to become far less frequent (Figure 22). As the temperature drops below -30 °C, the change from historical conditions is far less dramatic with the region only projected to experience 1 to 4 fewer “very” cold days. This change, however, is still quite dramatic when looking at the inset image in Figure 23, which shows that in most grid cells the projection is to move from 2 - 4 “very” cold days to 0. The change in the number of Frost-free Days depicted in Figure 24 is simply the inverse of the length of the Frost-free Season depicted in Figure 21. Here we simply see a similar variable with a projection of 58 - 69 *more* days without frost.

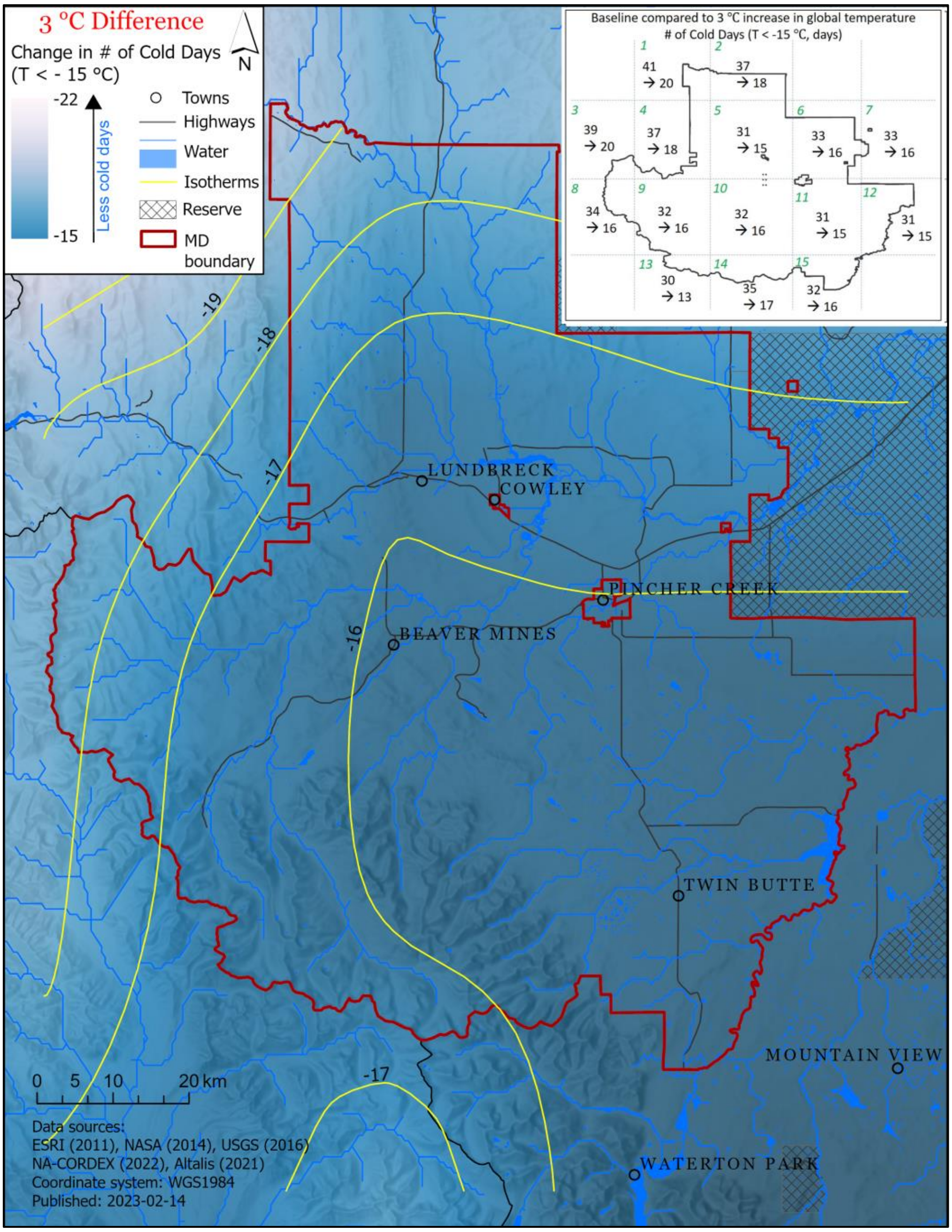

Figure 22: A map of the projected changes in the Number of Cold Days (T < -15 °C) under a 3 °C global warming scenario. The region is expected to experience cold season warming to the point where up to 22 less cold days will be experienced under this scenario, most evident in the northwest region. Yellow lines represent delineations in days across the region.

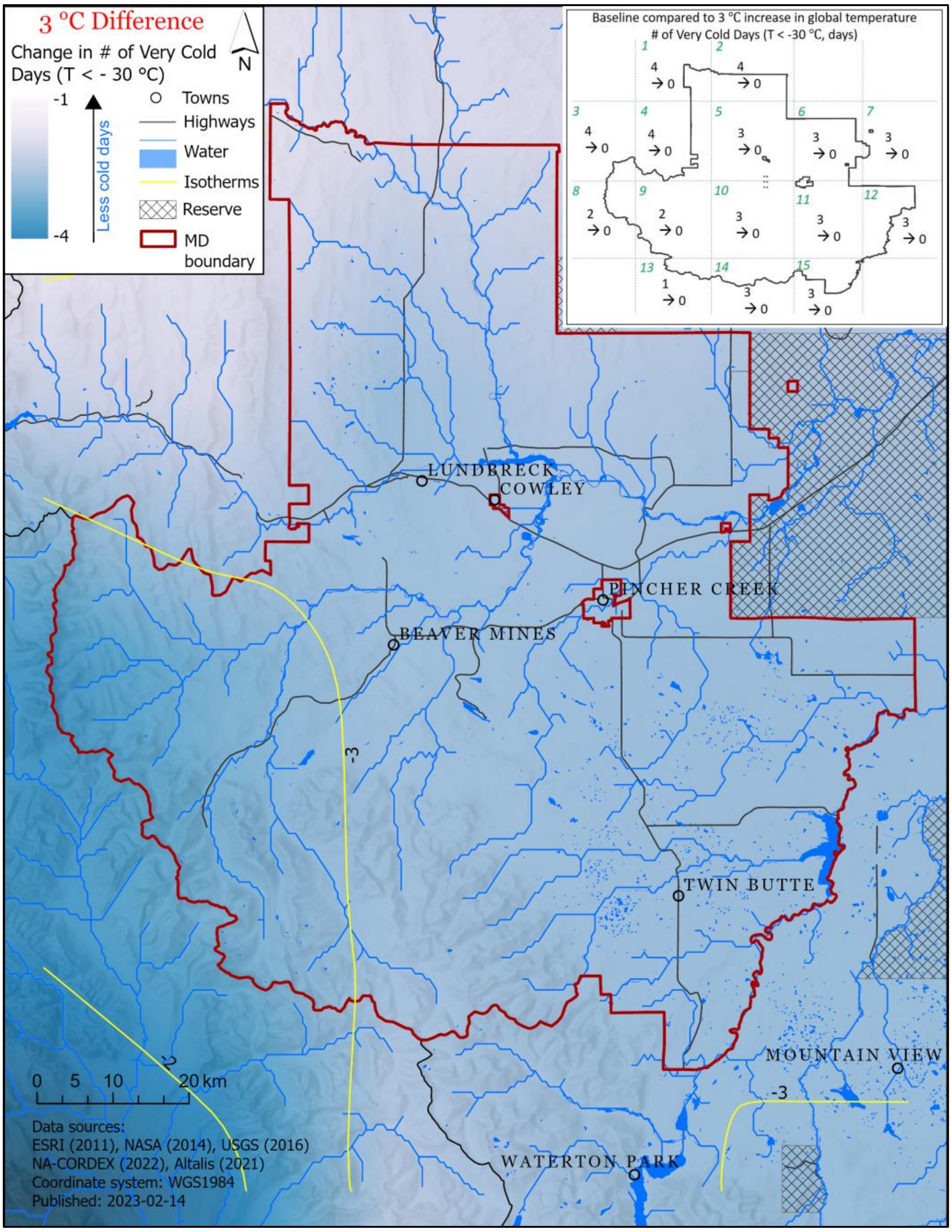

Figure 23: A map of the projected changes in the Number of Very Cold Days (T < -30 °C) under a 3 °C global warming scenario. Yellow lines represent delineations in days across the region.

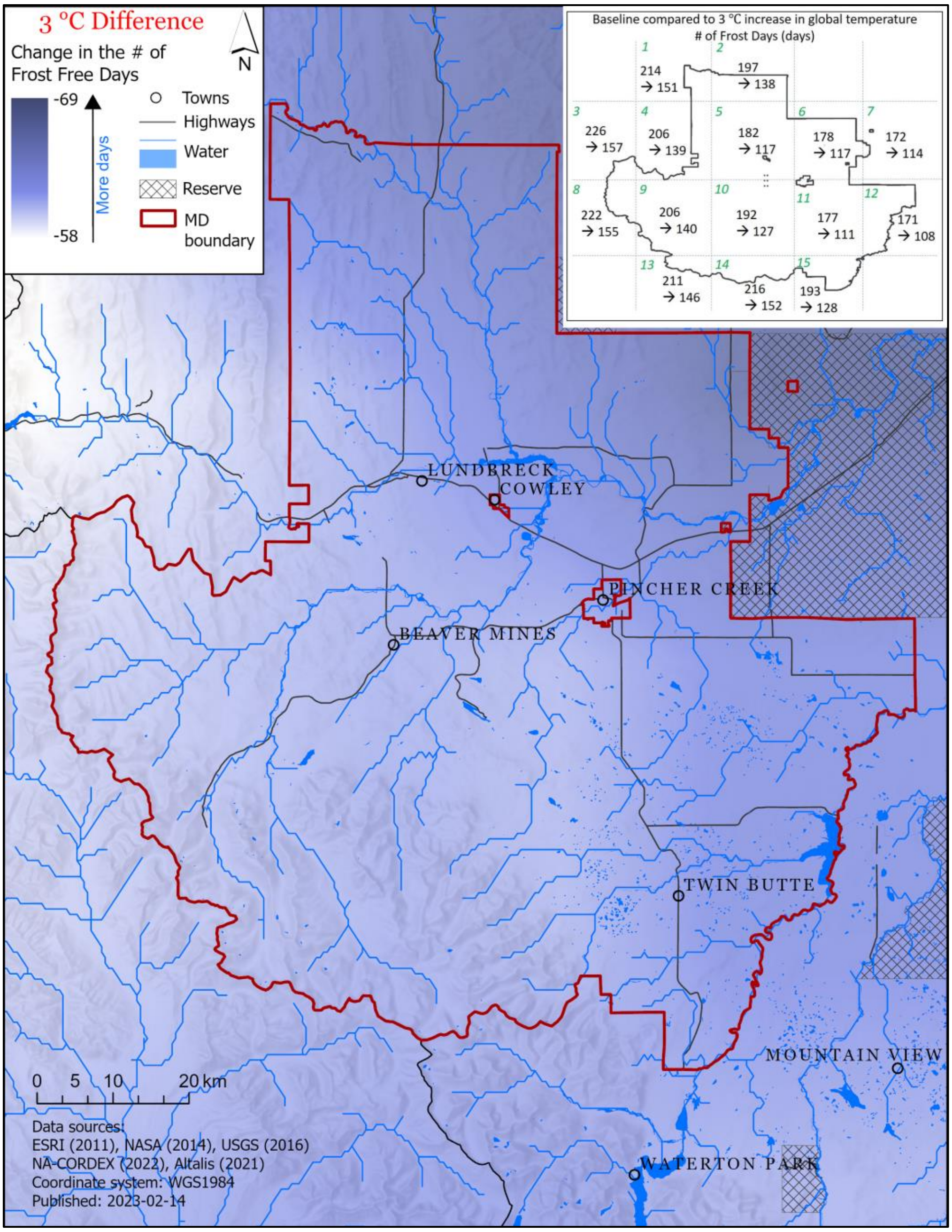

Figure 24: A map of the projected changes in the Number of Frost-free Days under a 3 °C global warming scenario.

4.1.5 Maps of Precipitation

Seasonal projections of precipitation in Figures 25 to 28 vary considerably. Spring and Summer Precipitation (Figures 25 and 26) show an increase from west to east, with spring projecting a large increase of up to 69.5 mm. The west-east contrast in winter precipitation results in either a reduction or an increase; the Rocky Mountains appear to serve as the dividing line. A net decrease in total precipitation is projected for the summer, with modest decreases projected over much of the region. In the fall, total precipitation increases from 3 to 17 mm. On all precipitation maps, isohyets (lines connecting equal precipitation) are drawn in green to assist delineation of precipitation gradients. Due to the variable distribution of precipitation among seasons, the value of these lines varies from one map to the next.

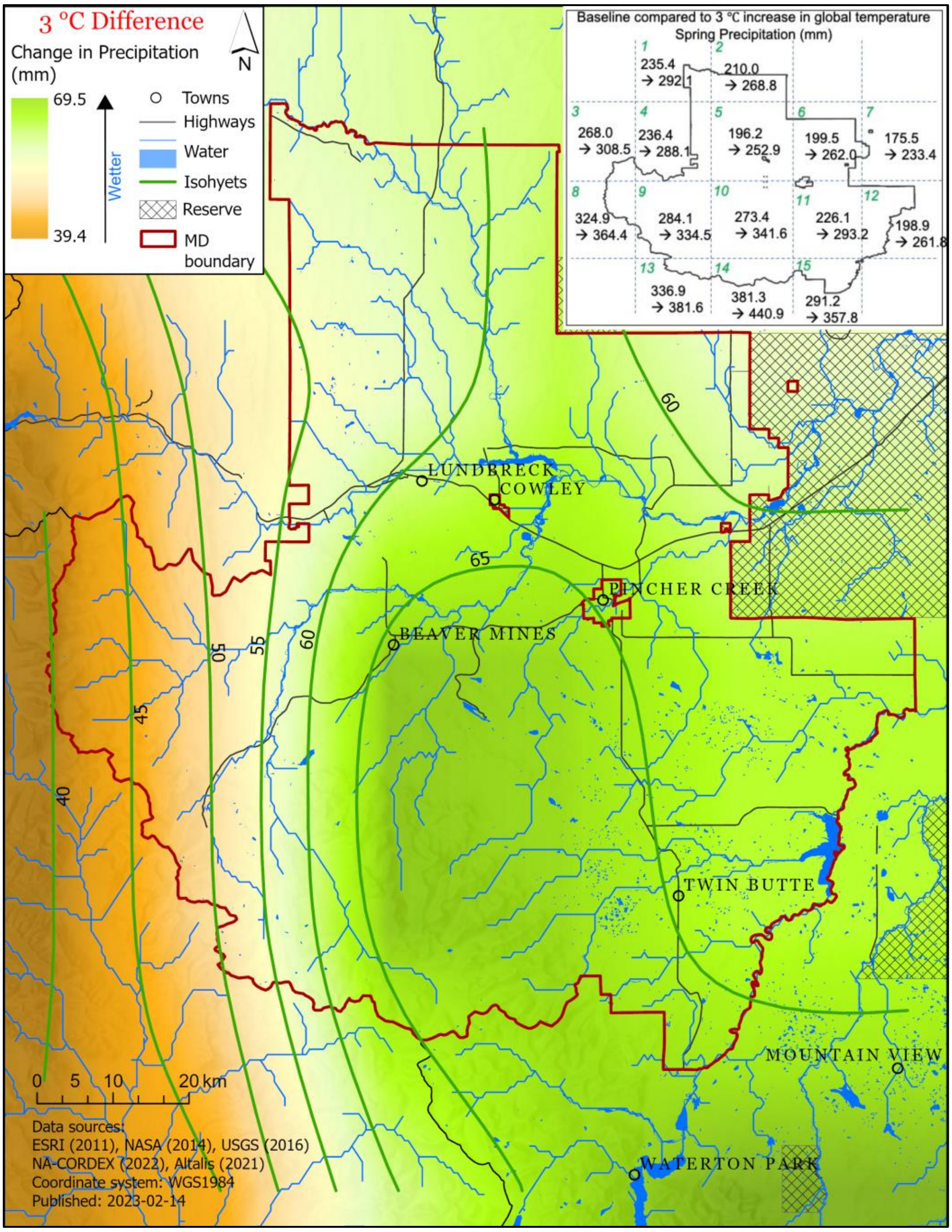

Figure 25: A map of the projected changes in Spring Precipitation under a 3 °C global warming scenario. With an increase of 39.4 to 69.5 mm projected across the region and already the wettest season, spring will continue to produce wet conditions with an increased likelihood of flooding in the east given antecedent precipitation trends in winter months (e.g., Figure 28).

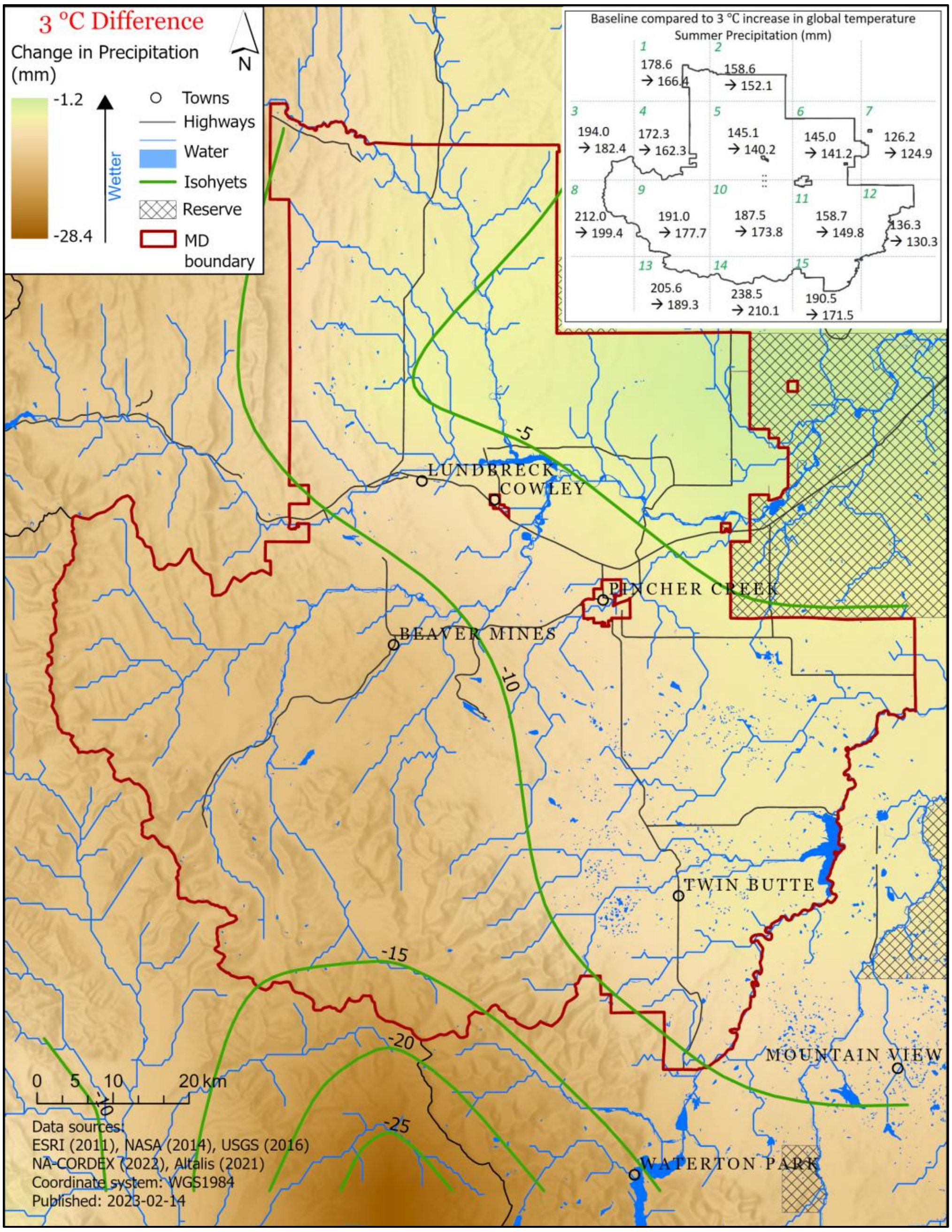

Figure 26: A map of the projected changes in Summer Precipitation under a 3 °C global warming scenario. A projected decrease is exhibited across the Pincher Creek Region, which in combination with very high increases in summer minimum and maximum temperatures (Figures 11 - 12) could place great stress on crops.

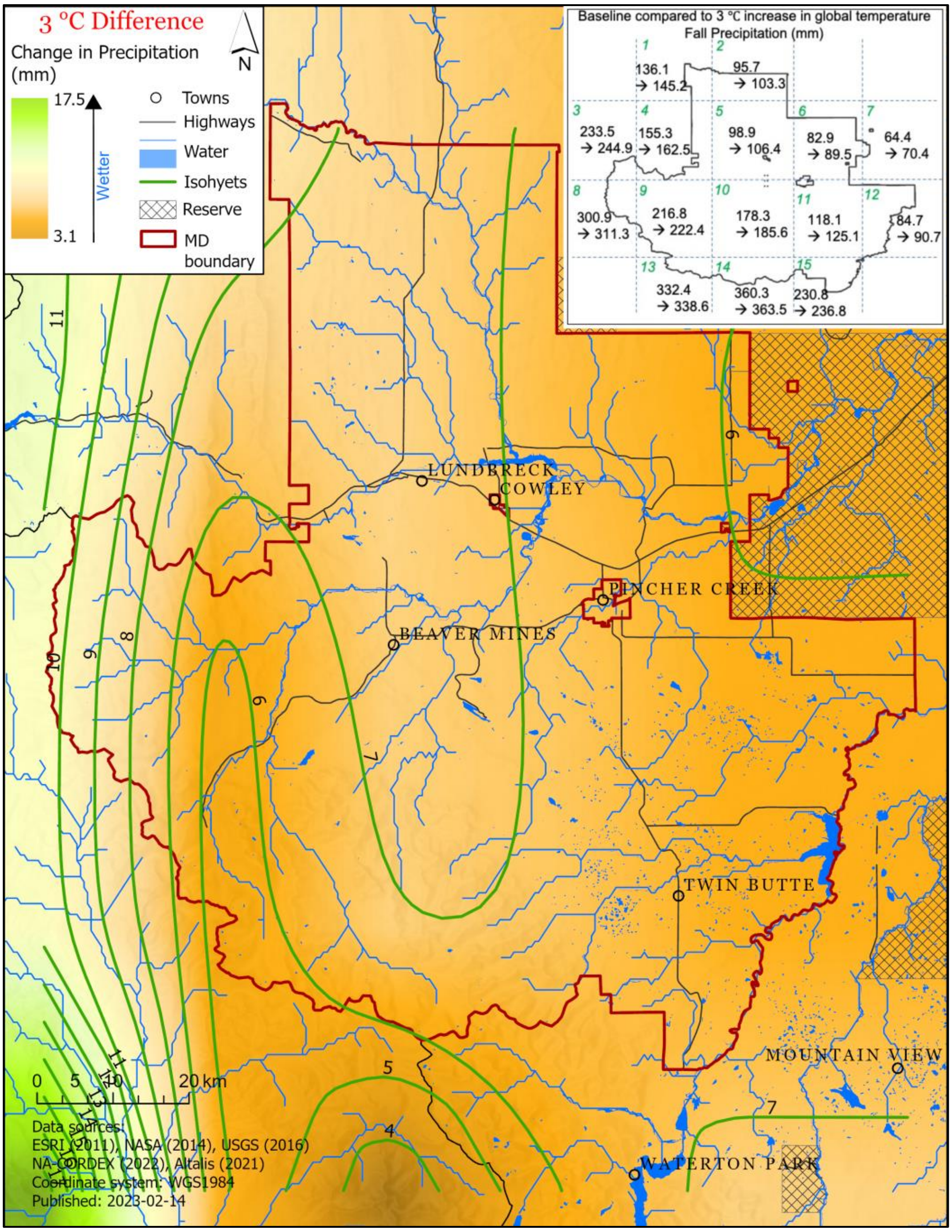

Figure 27: A map of the projected changes in Fall Precipitation under a 3 °C global warming scenario. Modest increases over the fall months are projected with only the mountainous southwest projected to see significant change.

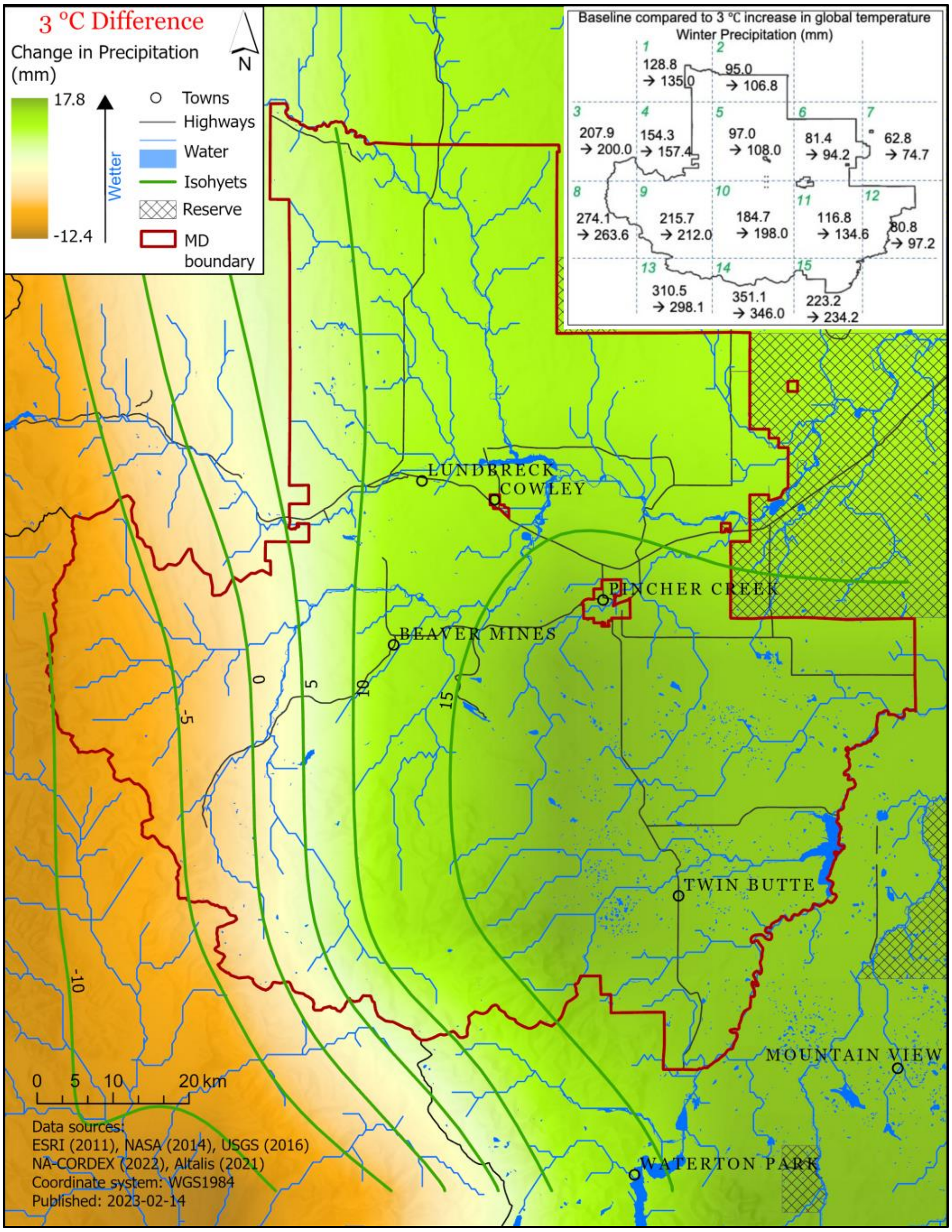

Figure 28: A map of the projected changes in Winter Precipitation under a 3 °C global warming scenario. Winter months exhibit the most discrepancy in projected changes across the region with a very distinct east-west divide separating regions of decreasing precipitation in the west from increasing precipitation in the east.

4.1.6 Maps of Moisture Indices

The final set of maps – Figures 29 to 32 – show projections of climate indices related to precipitation. With a large increase in spring precipitation and a summer decrease, the Number of Wet Days (P ≥ 5 mm) increases in the east and decreases in the west, while the Number of Very Wet Days (P ≥ 10 mm) follows a similar but more subtle trend with no change in the west. Figure 31, the Number of Dry Days (P ≤ 1 mm) shows a similar trend in the overall precipitation to Figures 29 and 30; that is, an increase in dry days in the west (up to 4) and a decrease in the east (up to 3 less). The 3-month SPEI shows water loss in the east-northeast region and only a slight surplus or nil values throughout much of the study region. This may suggest drier conditions for agriculture, as supported by summer seasonal projections of temperature and precipitation, despite higher spring precipitation and increased and earlier freshet.

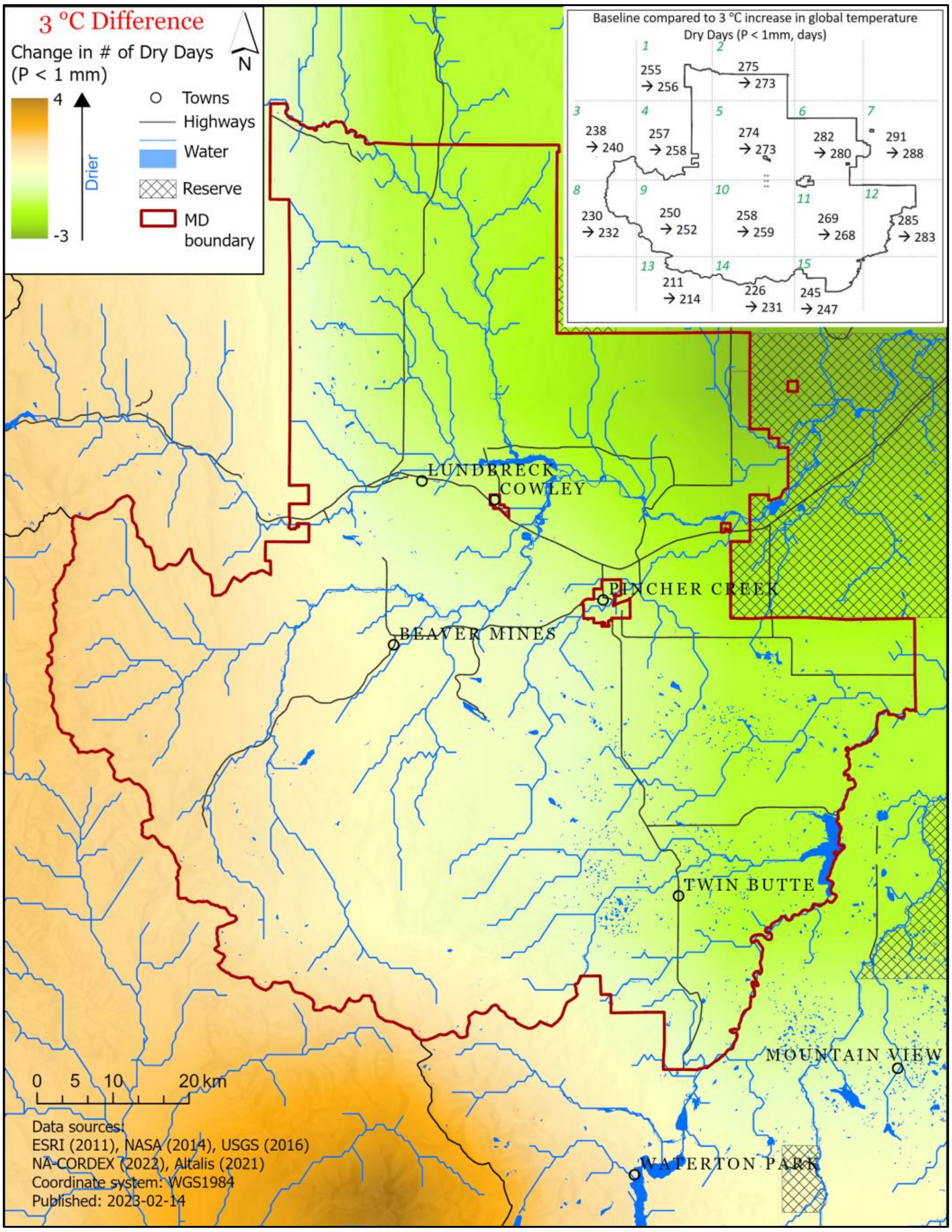

Figure 29: A map of the projected changes in the Number of Dry Days (P < 1 mm) under a 3 °C global warming scenario. Drier conditions are projected in the west and wetter conditions in the east; however, the magnitude of change is small given that there are an average of 256 historical Dry Days per year.

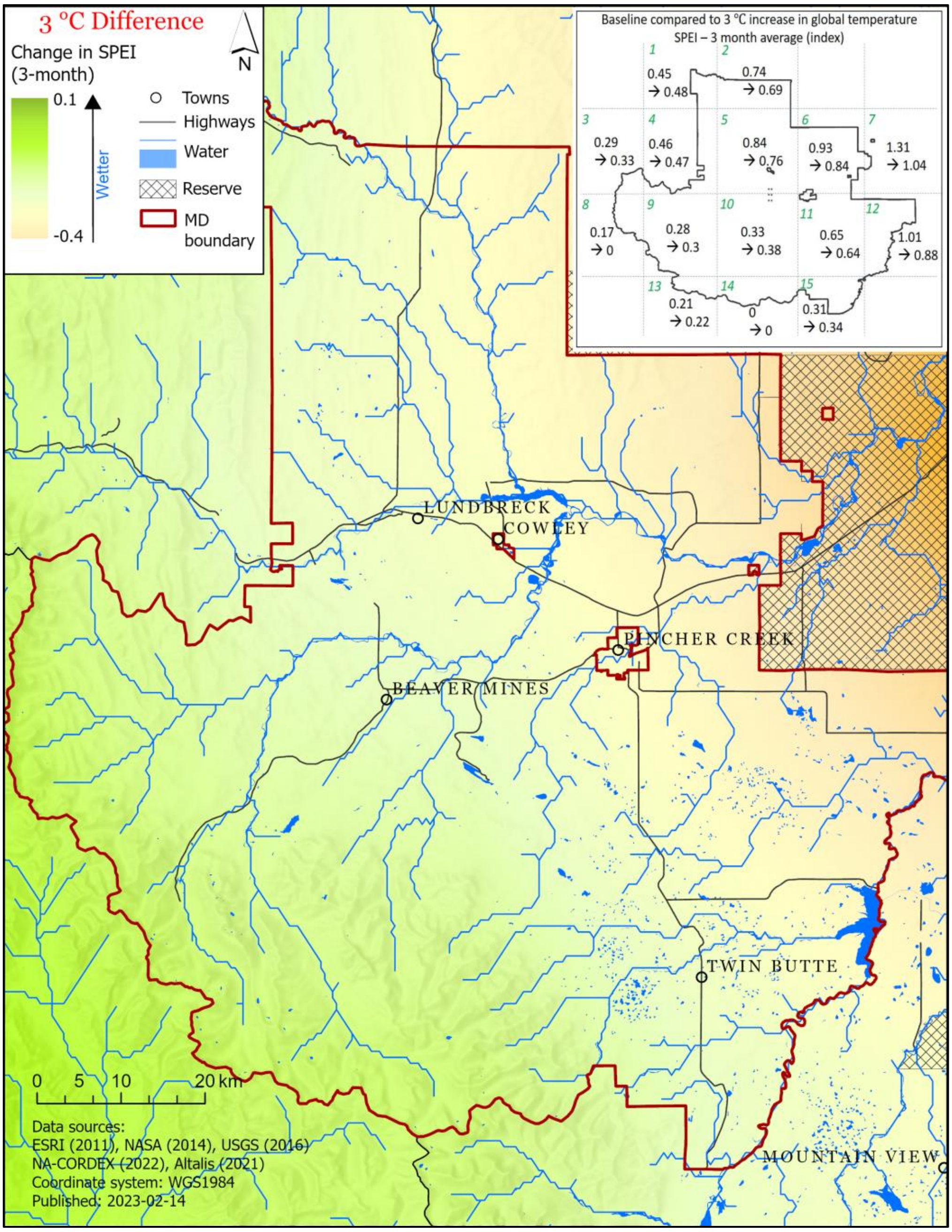

Figure 30: A map of the projected changes in the 3-month Standardized Precipitation Evapotranspiration Index (SPEI) under a 3 °C global warming scenario. The eastern region of the study area will experience dryness while the western region will see only modest wetness.

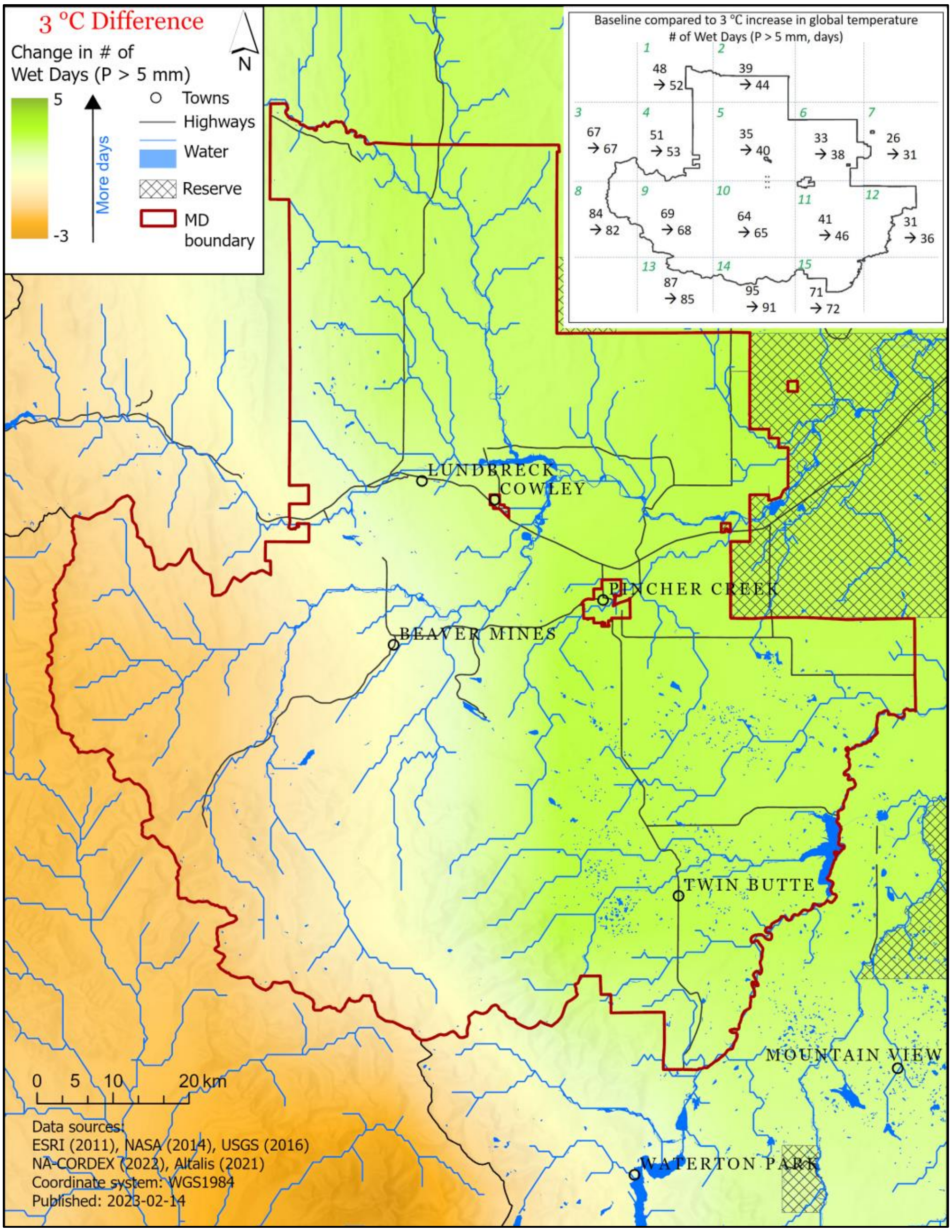

Figure 31: A map of the projected changes in the Number of Wet Days (P > 5 mm) under a 3 °C global warming scenario. As seen in the Number of Dry Days (Figure 29), a trend of increasing wetness is present in the east.

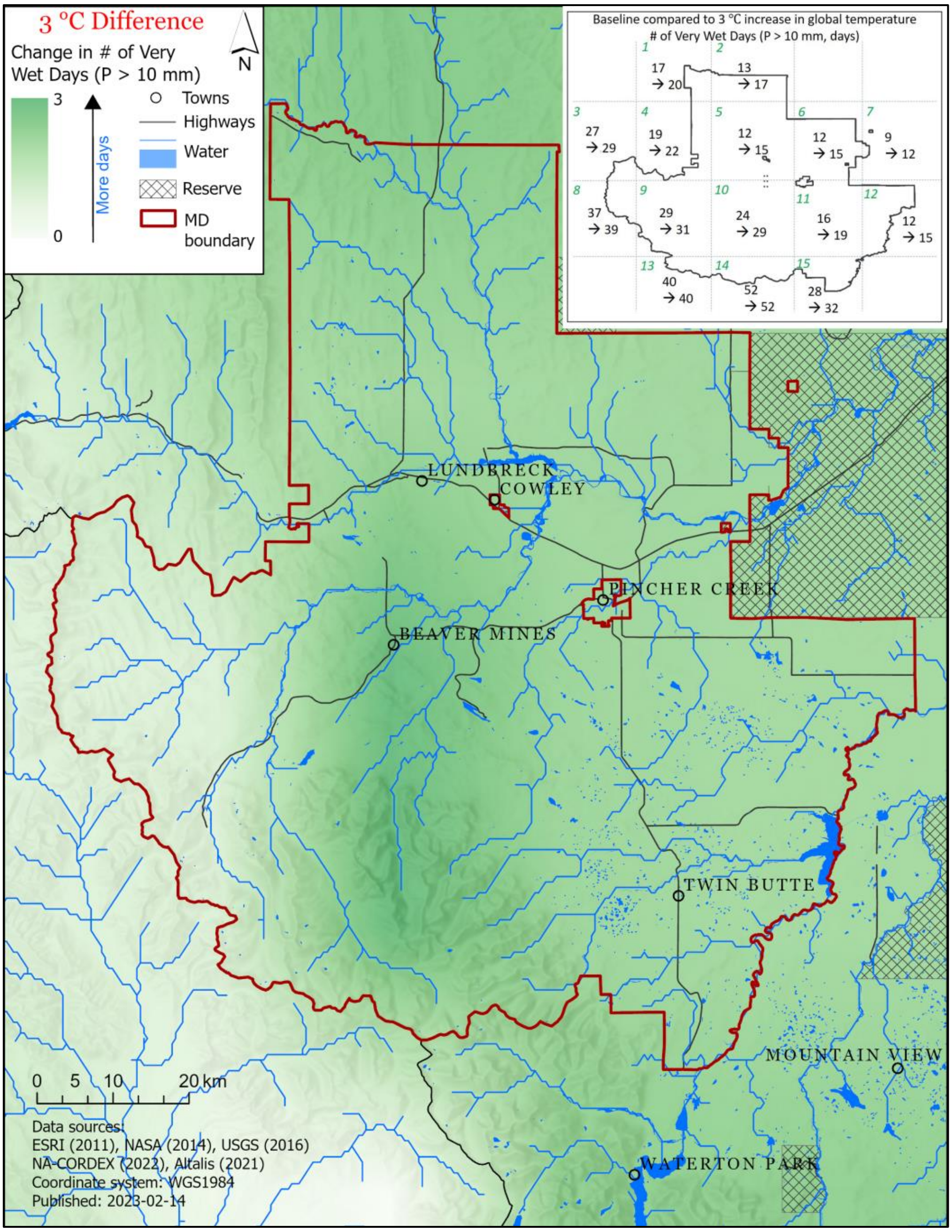

Figure 32: A map of the projected changes in the Number of Very Wet Days (P > 10 mm) under a 3 °C global warming scenario. Across the region, a small amount of change (up to 3 days) or no change in the Number of Very Wet Days is projected. As a result, more intense precipitation events may be expected.

5 References

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6 Appendix - Mean and Absolute Values Tables

Table 7: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 1 under baseline and 3 °C global warming scenario.

Grid 1							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	665.47	689.47	709.02	667.3	750.6	833.42	61.13
Annual T (mm)	2.15	2.29	2.43	5.27	6.05	6.57	3.76
Cold Days (T < - 15° C)	39.6	41.32	43	16.16	20.95	26.1	-20.38
Dry Days (P < 1 mm)	251.3	255.42	259.47	249.77	256.18	264.52	0.76
Fall Max T (° C)	1.98	2.23	2.62	5.1	5.88	6.38	3.65
Fall Min T (° C)	-7.63	-7.29	-7.08	-4.21	-3.02	-2.41	4.26
Fall P (mm)	127.25	136.16	143.29	134.39	145.27	159.3	9.11
# Frost Days	211.8	214.57	217.57	138.84	151.29	163.87	-63.28
Length Frost Free Season	147.43	150.43	153.2	201.13	213.71	226.16	63.28
GDD Base 10	86.27	89.2	91.93	125.94	136.06	147.77	46.86
GDD Base 5	151.23	154.58	156.77	186.61	197.66	204.68	43.08
Hot Days (T > 30° C)	0.2	0.33	0.53	4.06	9.55	18.97	9.22
SPEI runlen12	0.21	0.34	0.49	0.14	0.33	0.58	-0.01
SPEI runlen3	0.33	0.45	0.61	0.29	0.48	0.67	0.03
Spring Max T (° C)	11.23	11.5	11.7	13.12	14.24	15.57	2.75
Spring Min T (° C)	-0.33	-0.06	0.12	2.36	3.47	4.44	3.53
Spring P (mm)	214.01	235.42	251.01	267.61	292.13	321.42	56.71
Summer Max T (° C)	18.37	18.72	19.15	22.13	23.05	25.03	4.33
Summer Min T (° C)	4.76	4.94	5.22	8.29	9.29	10.37	4.35
Summer P (mm)	162.4	178.66	185.84	118.14	166.42	199.88	-12.24
Very Cold Days (T < -30° C)	3.93	4.57	5.93	0.13	0.48	0.77	-4.09
Very Hot Days (T > 35° C)	0	0	0	0	0.32	1.74	0.32
Very Wet Days (P > 10 mm)	16.73	17.26	17.7	17.39	20.62	22.81	3.36
Wet Days (P > 5mm)	46.77	48.5	50.33	45.1	52.03	60.32	3.53
Winter Max T (° C)	-1.69	-1.13	-0.79	0.98	1.92	2.77	3.05
Winter Min T (° C)	-11.49	-11.07	-10.79	-8.14	-7.05	-5.71	4.03
Winter P (mm)	122.25	128.88	134.83	112.72	135.01	153.6	6.13

Table 8: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 2 under baseline and 3 °C global warming scenario.

Grid 2							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	550.59	568.59	589.66	573.4	641.7	694.63	73.1
Annual T (mm)	3.47	3.63	3.77	6.6	7.38	7.92	3.76
Cold Days (T < - 15° C)	35.23	37.2	39	14.45	18.73	23.39	-18.47
Dry Days (P < 1 mm)	272.27	275.12	277.97	268.26	273.35	280.1	-1.77
Fall Max T (° C)	3.81	4.02	4.43	6.95	7.7	8.2	3.68
Fall Min T (° C)	-6.83	-6.57	-6.36	-3.47	-2.28	-1.64	4.28
Fall P (mm)	88.39	95.79	102.36	95	103.32	115.87	7.53
# Frost Days	195.73	197.91	200.87	125.42	138	150.77	-59.9
Length Frost Free Season	164.13	167.09	169.27	214.23	227	239.58	59.9
GDD Base 10	107.33	109.68	112.23	143.42	153.1	162.94	43.42
GDD Base 5	169.77	172.65	174.83	207.61	217.65	223.65	45
Hot Days (T > 30° C)	1.07	1.43	2.23	9.97	16.84	29.29	15.42
SPEI runlen12	0.93	1.11	1.26	0.5	0.78	1.04	-0.33
SPEI runlen3	0.66	0.74	0.83	0.51	0.69	0.81	-0.06
Spring Max T (° C)	13.09	13.37	13.6	14.95	16.02	17.09	2.65
Spring Min T (° C)	0.89	1.14	1.35	3.5	4.62	5.53	3.48
Spring P (mm)	192.09	210.06	226.31	243.27	268.87	295.23	58.8
Summer Max T (° C)	20.08	20.38	20.79	23.74	24.69	26.67	4.31
Summer Min T (° C)	5.97	6.17	6.43	9.55	10.5	11.64	4.33
Summer P (mm)	148.4	158.63	166.23	113.49	152.18	176.42	-6.44
Very Cold Days (T < -30° C)	3.53	4.09	5.43	0.1	0.33	0.74	-3.76
Very Hot Days (T > 35° C)	0	0	0	0.13	1.3	4.29	1.3
Very Wet Days (P > 10 mm)	13.1	13.95	14.73	15	17.7	19.58	3.75
Wet Days (P > 5mm)	37.97	39.24	40.7	37.42	44.16	49.71	4.92
Winter Max T (° C)	-0.24	0.36	0.73	2.44	3.47	4.38	3.1
Winter Min T (° C)	-10.81	-10.36	-10.08	-7.32	-6.24	-4.85	4.12
Winter P (mm)	90.65	95.06	98.79	87.36	106.81	127.87	11.75

Table 9: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 3 under baseline and 3 °C global warming scenario.

Grid 3							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	885.13	915.76	941.6	867.53	949.13	1020.27	33.37
Annual T (mm)	1.48	1.6	1.71	4.58	5.35	5.85	3.75
Cold Days (T < - 15° C)	38.17	39.31	40.4	15.58	20.21	24.84	-19.1
Dry Days (P < 1 mm)	235.93	238.51	242	237.32	240.61	247.42	2.11
Fall Max T (° C)	0.66	0.89	1.27	3.66	4.46	4.94	3.58
Fall Min T (° C)	-7.49	-7.26	-7.07	-4.2	-2.99	-2.43	4.27
Fall P (mm)	220.52	233.52	240.62	211.8	244.92	271.28	11.4
# Frost Days	223.2	226.42	228.93	145.48	157.17	171.39	-69.25
Length Frost Free Season	136.07	138.58	141.8	193.61	207.83	219.52	69.25
GDD Base 10	71.27	74.18	77.3	113.42	124.15	134.06	49.97
GDD Base 5	139.33	142.17	144.47	175.03	186.32	194.97	44.14
Hot Days (T > 30° C)	0.17	0.28	0.37	2.94	6.8	14.84	6.52
SPEI runlen12	-0.11	0.03	0.19	-0.02	0.13	0.41	0.09
SPEI runlen3	0.2	0.29	0.42	0.18	0.33	0.48	0.03
Spring Max T (° C)	10.23	10.48	10.65	12.11	13.26	14.87	2.78
Spring Min T (° C)	-1.01	-0.76	-0.53	1.74	2.83	3.91	3.59
Spring P (mm)	248.56	268.06	283.49	292.46	308.5	338.97	40.44
Summer Max T (° C)	17.52	17.88	18.3	21.13	22.17	24.23	4.29
Summer Min T (° C)	3.99	4.18	4.5	7.46	8.63	9.65	4.45
Summer P (mm)	175.49	194.08	202.99	133.16	182.46	221.61	-11.62
Very Cold Days (T < -30° C)	3.7	4.1	4.87	0.32	0.58	1.13	-3.53
Very Hot Days (T > 35° C)	0	0	0	0	0.19	0.97	0.19
Very Wet Days (P > 10 mm)	26.2	27.96	29.87	26.03	29.46	32.55	1.5
Wet Days (P > 5mm)	65.7	67.77	69.43	60.48	67.48	73.42	-0.29
Winter Max T (° C)	-2.7	-2.18	-1.9	-0.08	0.78	1.65	2.96
Winter Min T (° C)	-11.27	-10.92	-10.61	-8.14	-6.91	-5.69	4
Winter P (mm)	193.06	207.99	218.13	172.91	200.02	222.82	-7.97

Table 10: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 4 under baseline and 3 °C global warming scenario.

Grid 4							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	708.47	728.75	748.75	702.01	782.18	851.83	53.43
Annual T (mm)	2.64	2.79	2.93	5.77	6.56	7.06	3.78
Cold Days (T < - 15° C)	35.47	37.08	38.4	14.26	18.67	23.74	-18.4
Dry Days (P < 1 mm)	253.87	257.16	261.73	254.1	258.57	265.03	1.42
Fall Max T (° C)	2.44	2.65	3.04	5.53	6.28	6.77	3.64
Fall Min T (° C)	-6.75	-6.5	-6.32	-3.4	-2.17	-1.59	4.33
Fall P (mm)	144.48	155.33	161.27	148.06	162.5	178.67	7.17
# Frost Days	203.83	206.51	209.7	127.71	139.18	155.58	-67.33
Length Frost Free Season	155.3	158.49	161.17	209.42	225.82	237.29	67.33
GDD Base 10	92.03	94.55	96.87	130.42	140.42	151.94	45.87
GDD Base 5	156.77	159.82	162.6	192.97	204.81	211.68	44.99
Hot Days (T > 30° C)	0.2	0.53	0.97	5	11.35	22.61	10.82
SPEI runlen12	0.12	0.25	0.43	0.09	0.28	0.51	0.04
SPEI runlen3	0.35	0.46	0.63	0.32	0.47	0.67	0.01
Spring Max T (° C)	11.7	11.93	12.11	13.54	14.71	16.15	2.78
Spring Min T (° C)	-0.01	0.28	0.49	2.73	3.87	4.91	3.59
Spring P (mm)	218.02	236.4	252.41	263.72	288.17	317.88	51.78
Summer Max T (° C)	18.89	19.23	19.67	22.44	23.51	25.57	4.27
Summer Min T (° C)	5.02	5.21	5.48	8.53	9.61	10.66	4.4
Summer P (mm)	155.07	172.3	181.11	119.7	162.36	196.68	-9.93
Very Cold Days (T < -30° C)	3.77	4.24	5.27	0.19	0.47	0.97	-3.77
Very Hot Days (T > 35° C)	0	0	0	0.03	0.55	2.13	0.55
Very Wet Days (P > 10 mm)	18.7	19.88	20.5	19.42	22.62	25.77	2.74
Wet Days (P > 5mm)	49.7	51.32	52.47	45.77	53.17	58.71	1.85
Winter Max T (° C)	-1.32	-0.73	-0.38	1.33	2.29	3.18	3.02
Winter Min T (° C)	-10.65	-10.24	-9.94	-7.33	-6.17	-4.88	4.07
Winter P (mm)	144.29	154.3	163.62	136.4	157.49	177.62	3.19

Table 11: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 5 under baseline and 3 °C global warming scenario.

Grid 5							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	528.11	545.82	558.77	540.33	617.6	667.07	71.77
Annual T (mm)	4.6	4.76	4.89	7.73	8.54	9.02	3.78
Cold Days (T < - 15° C)	30.33	31.91	33.67	12.13	15.85	20.61	-16.05
Dry Days (P < 1 mm)	271.9	274.58	279.03	268.58	273.37	282.23	-1.22
Fall Max T (° C)	4.85	5.09	5.49	8.04	8.77	9.27	3.69
Fall Min T (° C)	-5.68	-5.33	-5.1	-2.26	-1.01	-0.33	4.32
Fall P (mm)	92.4	98.91	104.1	98.85	106.45	117.63	7.54
# Frost Days	179.47	182.05	184.87	102.23	117.18	134.23	-64.86
Length Frost Free Season	180.13	182.95	185.53	230.77	247.82	262.77	64.86
GDD Base 10	120.8	124.11	126.97	155.97	166.71	176.9	42.6
GDD Base 5	184.47	187.31	190.17	225.23	236.48	243.1	49.17
Hot Days (T > 30° C)	3.7	4.44	5.37	17	26.49	40.71	22.05
SPEI runlen12	1.34	1.46	1.6	0.65	1.04	1.29	-0.41
SPEI runlen3	0.72	0.84	0.9	0.6	0.76	0.96	-0.08
Spring Max T (° C)	14.55	14.83	15.03	16.42	17.51	18.7	2.68
Spring Min T (° C)	1.73	1.97	2.17	4.33	5.5	6.48	3.53
Spring P (mm)	179.79	196.25	211.02	224.25	252.94	280.37	56.69
Summer Max T (° C)	21.57	21.89	22.26	25.09	26.15	28.13	4.26
Summer Min T (° C)	6.63	6.8	7.07	10.12	11.16	12.28	4.36
Summer P (mm)	131.19	145.16	153.33	103.06	140.22	165.75	-4.93
Very Cold Days (T < -30° C)	2.7	3.27	4.2	0.1	0.24	0.48	-3.04
Very Hot Days (T > 35° C)	0	0	0	0.65	3.56	9.81	3.56
Very Wet Days (P > 10 mm)	12.27	12.79	13.23	13.35	15.82	17	3.03
Wet Days (P > 5mm)	35.17	35.89	36.87	34.94	40.49	45.32	4.6
Winter Max T (° C)	0.84	1.47	1.86	3.5	4.56	5.52	3.1
Winter Min T (° C)	-9.64	-9.13	-8.83	-6.11	-4.95	-3.7	4.18
Winter P (mm)	91.18	97.04	101.29	88.58	108.02	129.57	10.98

Table 12: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 6 under baseline and 3 °C global warming scenario.

Grid 6							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	502.33	517.28	533.66	519.39	596.94	645.38	79.66
Annual T (mm)	4.83	5.03	5.18	8.02	8.81	9.3	3.79
Cold Days (T < - 15° C)	31.3	33.03	34.83	12.48	16.48	21.55	-16.56
Dry Days (P < 1 mm)	279.4	282.51	286	275.71	280.24	287.29	-2.27
Fall Max T (° C)	5.35	5.6	5.93	8.67	9.33	9.8	3.73
Fall Min T (° C)	-5.67	-5.37	-5.18	-2.26	-1.01	-0.29	4.36
Fall P (mm)	75.64	82.96	89.16	79.36	89.5	99.41	6.54
# Frost Days	176.5	178.77	181.17	104.23	117.21	131.97	-61.57
Length Frost Free Season	183.83	186.23	188.5	233.03	247.79	260.77	61.57
GDD Base 10	125.6	129.24	132.13	161.35	171.05	178.87	41.81
GDD Base 5	189.9	192.91	195.47	228.9	240.29	246.94	47.39
Hot Days (T > 30° C)	5	5.82	7.17	20.29	28.48	42.61	22.66
SPEI runlen12	1.42	1.59	1.75	0.74	1.12	1.34	-0.46
SPEI runlen3	0.83	0.93	0.98	0.66	0.84	0.97	-0.1
Spring Max T (° C)	14.93	15.21	15.42	16.81	17.79	18.67	2.59
Spring Min T (° C)	2.04	2.26	2.49	4.6	5.77	6.65	3.51
Spring P (mm)	182.68	199.54	215.89	231	262.01	291.2	62.48
Summer Max T (° C)	21.91	22.23	22.61	25.36	26.47	28.48	4.23
Summer Min T (° C)	7.03	7.22	7.49	10.6	11.62	12.69	4.4
Summer P (mm)	128.14	145.04	154.2	103.51	141.26	167.38	-3.78
Very Cold Days (T < -30° C)	2.97	3.57	4.67	0.1	0.25	0.58	-3.32
Very Hot Days (T > 35° C)	0.03	0.05	0.1	0.74	4.23	10.61	4.18
Very Wet Days (P > 10 mm)	12.13	12.78	13.33	13.13	15.81	17.9	3.03
Wet Days (P > 5mm)	32.47	33.58	34.9	33.32	38.22	42	4.64
Winter Max T (° C)	0.99	1.78	2.23	3.88	4.89	5.86	3.11
Winter Min T (° C)	-9.79	-9.21	-8.82	-6.05	-4.95	-3.67	4.26
Winter P (mm)	77.07	81.45	85.1	77.25	94.2	111.16	12.75

Table 13: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 7 under baseline and 3 °C global warming scenario.

Grid 7							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	424.72	436.29	449.5	437.76	512.24	551.74	75.95
Annual T (mm)	5.51	5.71	5.89	8.75	9.51	10.01	3.8
Cold Days (T < - 15° C)	31.7	33.24	35.13	11.77	16.2	21.19	-17.03
Dry Days (P < 1 mm)	289.43	291.92	295.73	283	288.57	294.61	-3.36
Fall Max T (° C)	6.13	6.38	6.74	9.54	10.15	10.67	3.78
Fall Min T (° C)	-5.52	-5.24	-5.04	-2.04	-0.82	-0.08	4.42
Fall P (mm)	58.19	64.46	70.59	60.74	70.4	76.63	5.94
# Frost Days	169.53	172.63	175.3	101.58	114	126.29	-58.63
Length Frost Free Season	189.7	192.37	195.47	238.71	251	263.42	58.63
GDD Base 10	137.03	140.83	144.53	170.13	180.07	185.9	39.23
GDD Base 5	202.47	204.25	206.2	238.84	249.61	256.45	45.37
Hot Days (T > 30° C)	9.63	10.75	12.77	27.97	37.89	52.68	27.15
SPEI runlen12	1.9	2.06	2.11	1.14	1.74	2.28	-0.31
SPEI runlen3	1.2	1.31	1.41	0.84	1.04	1.16	-0.27
Spring Max T (° C)	16.27	16.55	16.79	18.13	19.1	20	2.55
Spring Min T (° C)	2.66	2.9	3.13	5.24	6.39	7.31	3.49
Spring P (mm)	158.59	175.55	190.21	205.14	233.4	256.02	57.85
Summer Max T (° C)	23.07	23.37	23.77	26.35	27.58	29.6	4.2
Summer Min T (° C)	7.64	7.83	8.02	11.24	12.25	13.27	4.42
Summer P (mm)	110.48	126.23	135.67	90.12	124.96	152.97	-1.27
Very Cold Days (T < -30° C)	2.97	3.45	5.07	0.06	0.24	0.68	-3.21
Very Hot Days (T > 35° C)	0.1	0.19	0.3	2.32	7.65	16.39	7.46
Very Wet Days (P > 10 mm)	9.27	9.89	10.4	10.03	12.98	15.23	3.09
Wet Days (P > 5mm)	25.7	26.42	27.97	26.42	31.62	35.06	5.2
Winter Max T (° C)	1.59	2.46	2.94	4.61	5.59	6.47	3.12
Winter Min T (° C)	-9.71	-9.07	-8.64	-5.78	-4.73	-3.48	4.34
Winter P (mm)	59.49	62.88	65.55	62.11	74.72	90.27	11.85

Table 14: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 8 under baseline and 3 °C global warming scenario.

Grid 8							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	1097.82	1126.32	1164.12	1076.49	1153.88	1216.03	27.56
Annual T (mm)	1.37	1.48	1.59	4.45	5.21	5.72	3.73
Cold Days (T < - 15° C)	32.73	34.61	36.37	12.55	16.14	20.42	-18.47
Dry Days (P < 1 mm)	227	230.32	233.9	229	232.71	235.19	2.39
Fall Max T (° C)	0	0.23	0.58	3.05	3.81	4.26	3.58
Fall Min T (° C)	-7.02	-6.86	-6.67	-3.91	-2.69	-2.17	4.16
Fall P (mm)	283.83	300.92	317.1	258.93	311.38	350.46	10.46
# Frost Days	219.53	222.71	225.9	145.26	155.85	170.68	-66.86
Length Frost Free Season	139.1	142.29	145.47	194.32	209.15	219.74	66.86
GDD Base 10	67.63	70.36	73.53	108.87	119.54	129.77	49.18
GDD Base 5	135.03	137.61	139.93	169.45	180.83	189.52	43.22
Hot Days (T > 30° C)	0	0.05	0.13	0.97	4.68	11.29	4.63
SPEI runlen12	-0.15	0.02	0.23	-0.21	0	0.21	0
SPEI runlen3	0.09	0.17	0.28	0.04	0	0.29	0
Spring Max T (° C)	9.64	9.87	10.07	11.51	12.69	14.48	2.83
Spring Min T (° C)	-0.98	-0.72	-0.5	1.72	2.81	3.77	3.53
Spring P (mm)	305.74	324.99	341.51	341.51	364.43	402.71	39.44
Summer Max T (° C)	16.78	17.16	17.6	20.66	21.58	23.59	4.42
Summer Min T (° C)	4.45	4.64	4.91	8.02	9.06	10.24	4.42
Summer P (mm)	188.2	212.01	225.19	151.85	199.44	237.54	-12.57
Very Cold Days (T < -30° C)	2.03	2.3	3.2	0	0.14	0.26	-2.16
Very Hot Days (T > 35° C)	0	0	0	0	0.08	0.48	0.08
Very Wet Days (P > 10 mm)	36.37	37.95	39.47	34.65	39.22	43.74	1.27
Wet Days (P > 5mm)	81.83	84	85.7	76.29	82.56	88.68	-1.44
Winter Max T (° C)	-3.02	-2.51	-2.24	-0.46	0.39	1.23	2.9
Winter Min T (° C)	-10.8	-10.41	-10.09	-7.78	-6.52	-5.36	3.89
Winter P (mm)	250.23	274.14	288.42	239.46	263.69	291.56	-10.45

Table 15: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 9 under baseline and 3 °C global warming scenario.

Grid 9							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	890.73	920.01	948.91	870.81	959.84	1019.58	39.82
Annual T (mm)	2.48	2.59	2.7	5.55	6.33	6.82	3.74
Cold Days (T < - 15° C)	31.17	32.82	34.23	12.19	16.42	20.26	-16.4
Dry Days (P < 1 mm)	247.43	250.29	253.9	248.58	252.04	256.48	1.76
Fall Max T (° C)	1.72	1.93	2.29	4.82	5.57	6.01	3.64
Fall Min T (° C)	-6.42	-6.17	-5.93	-3.16	-1.94	-1.45	4.23
Fall P (mm)	202.54	216.83	225.58	199.4	222.4	246.87	5.56
# Frost Days	202.8	206.32	208.7	128.97	140.15	155.77	-66.17
Length Frost Free Season	156.3	158.68	162.2	209.23	224.85	236.03	66.17
GDD Base 10	85	87.66	90.03	124.39	135.41	145.68	47.75
GDD Base 5	150.8	154.09	156.57	186.55	198.71	205.42	44.62
Hot Days (T > 30° C)	0.1	0.26	0.53	4.03	9.02	17.71	8.75
SPEI runlen12	-0.1	0.04	0.2	-0.12	0.09	0.32	0.05
SPEI runlen3	0.18	0.28	0.42	0.14	0.3	0.44	0.02
Spring Max T (° C)	11.08	11.32	11.55	12.97	14.14	15.71	2.81
Spring Min T (° C)	-0.12	0.15	0.36	2.56	3.69	4.62	3.54
Spring P (mm)	264.24	284.17	300.62	314.72	334.53	370.29	50.36
Summer Max T (° C)	18.3	18.62	19	22.01	22.98	24.95	4.35
Summer Min T (° C)	5.15	5.34	5.6	8.71	9.73	10.86	4.38
Summer P (mm)	164.43	191.03	202.24	124.75	177.71	213.69	-13.32
Very Cold Days (T < -30° C)	2.53	2.9	3.7	0	0.2	0.45	-2.7
Very Hot Days (T > 35° C)	0	0	0	0	0.28	1.42	0.28
Very Wet Days (P > 10 mm)	28.47	29.86	31.1	26.32	31.22	34.61	1.36
Wet Days (P > 5mm)	66	69.2	70.7	59.87	68.29	72.48	-0.91
Winter Max T (° C)	-1.65	-1.11	-0.79	0.92	1.83	2.79	2.94
Winter Min T (° C)	-10.23	-9.88	-9.61	-7.09	-5.92	-4.71	3.96
Winter P (mm)	201.97	215.7	226.66	186.88	212.08	238.16	-3.62

Table 16: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 10 under baseline and 3 °C global warming scenario.

Grid 10							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	814.03	835.86	857.72	786.12	912.44	998.55	76.59
Annual T (mm)	3.4	3.53	3.66	6.52	7.32	7.81	3.78
Cold Days (T < - 15° C)	31.23	32.37	34.27	12.42	16.49	21.26	-15.88
Dry Days (P < 1 mm)	254.97	258.91	262.37	253.94	259.38	266.16	0.47
Fall Max T (° C)	3.09	3.31	3.68	6.29	7	7.46	3.69
Fall Min T (° C)	-5.86	-5.59	-5.39	-2.57	-1.32	-0.72	4.27
Fall P (mm)	168.61	178.37	187.69	169.71	185.66	205.66	7.29
# Frost Days	189.53	192.69	195.9	116.65	127.34	142.94	-65.35
Length Frost Free Season	169.1	172.31	175.47	222.06	237.66	248.35	65.35
GDD Base 10	101.67	103.75	106.17	137.74	149.29	160.1	45.55
GDD Base 5	166	169.05	171.67	204.03	215.39	221.26	46.34
Hot Days (T > 30° C)	0.47	0.86	1.5	8.35	14.59	26.94	13.72
SPEI runlen12	-0.04	0.09	0.22	0.01	0.18	0.4	0.09
SPEI runlen3	0.24	0.33	0.44	0.25	0.38	0.5	0.05
Spring Max T (° C)	12.31	12.58	12.78	14.24	15.37	16.7	2.79
Spring Min T (° C)	0.74	0.98	1.2	3.39	4.53	5.46	3.56
Spring P (mm)	250.93	273.41	289.22	303.91	341.6	379.59	68.18
Summer Max T (° C)	19.53	19.85	20.23	23.12	24.17	26.13	4.32
Summer Min T (° C)	5.95	6.14	6.39	9.47	10.55	11.76	4.4
Summer P (mm)	166.53	187.53	197.45	113.64	173.83	211.23	-13.7
Very Cold Days (T < -30° C)	2.63	3.39	4.43	0.1	0.28	0.55	-3.11
Very Hot Days (T > 35° C)	0	0	0	0.13	0.91	3.45	0.91
Very Wet Days (P > 10 mm)	23.57	24.62	25.53	24.23	29.04	34.23	4.42
Wet Days (P > 5mm)	61.57	64.02	65.3	56.13	65.94	75.39	1.93
Winter Max T (° C)	-0.62	-0.02	0.33	2	2.99	4	3.01
Winter Min T (° C)	-9.88	-9.44	-9.1	-6.48	-5.35	-4.12	4.09
Winter P (mm)	173.1	184.73	194.7	168.43	198.09	231.69	13.36

Table 17: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 11 under baseline and 3 °C global warming scenario.

Grid 11							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	618.03	629.6	646.33	600.72	713.89	772.47	84.29
Annual T (mm)	4.78	4.96	5.11	7.97	8.76	9.25	3.8
Cold Days (T < - 15° C)	29.7	31.56	33.13	11.48	15.72	20.68	-15.85
Dry Days (P < 1 mm)	265.17	269.02	271.93	262.58	268.84	278	-0.17
Fall Max T (° C)	5.03	5.28	5.63	8.38	9.05	9.56	3.76
Fall Min T (° C)	-5.23	-4.95	-4.75	-1.92	-0.6	0.13	4.34
Fall P (mm)	109.75	118.18	126.32	114.96	125.11	137.13	6.93
# Frost Days	174.37	177.48	179.57	96.52	111.72	127.42	-65.76
Length Frost Free Season	185.43	187.52	190.63	237.58	253.28	268.48	65.76
GDD Base 10	122.43	125.81	128.77	159.19	169.09	176.52	43.28
GDD Base 5	187.13	189.65	192.4	228	239.5	248.03	49.85
Hot Days (T > 30° C)	4	5.08	6.6	19.16	27.54	41.68	22.46
SPEI runlen12	0.72	0.9	0.99	0.43	0.63	0.84	-0.27
SPEI runlen3	0.57	0.65	0.74	0.48	0.64	0.83	-0.01
Spring Max T (° C)	14.51	14.79	15.01	16.39	17.49	18.5	2.7
Spring Min T (° C)	1.86	2.1	2.32	4.49	5.66	6.51	3.56
Spring P (mm)	210.82	226.14	240.18	253.38	293.26	328	67.12
Summer Max T (° C)	21.67	22.01	22.39	25.18	26.28	28.29	4.27
Summer Min T (° C)	6.88	7.09	7.32	10.41	11.5	12.65	4.41
Summer P (mm)	141.76	158.73	166.79	97.34	149.85	181.27	-8.88
Very Cold Days (T < -30° C)	2.7	3.35	4.63	0.1	0.28	0.55	-3.07
Very Hot Days (T > 35° C)	0	0.03	0.1	0.77	3.73	9.84	3.7
Very Wet Days (P > 10 mm)	15.33	16.18	16.97	16.32	19.34	21.03	3.16
Wet Days (P > 5mm)	40.23	41.64	42.83	38.97	46.85	52.45	5.21
Winter Max T (° C)	0.92	1.64	2.06	3.7	4.71	5.74	3.06
Winter Min T (° C)	-9.33	-8.8	-8.38	-5.67	-4.59	-3.26	4.21
Winter P (mm)	110.47	116.84	121.86	109.86	134.68	159.59	17.84

Table 18: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 12 under baseline and 3 °C global warming scenario.

Grid 12							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	499.16	509.01	526.34	497.16	589.68	637.19	80.67
Annual T (mm)	5.46	5.64	5.79	8.68	9.44	9.94	3.81
Cold Days (T < - 15° C)	29.67	31.23	32.97	11.35	15.6	20.45	-15.63
Dry Days (P < 1 mm)	283.2	285.37	288.17	277.48	283.61	290.68	-1.76
Fall Max T (° C)	6.04	6.29	6.66	9.47	10.08	10.58	3.8
Fall Min T (° C)	-5.15	-4.87	-4.7	-1.76	-0.49	0.24	4.38
Fall P (mm)	77.53	84.72	89.93	80.96	90.74	98.22	6.03
# Frost Days	169.27	171.85	173.4	93.87	108.49	122.68	-63.36
Length Frost Free Season	191.6	193.15	195.73	242.32	256.51	271.13	63.36
GDD Base 10	133.4	137.1	140.47	168.84	178.27	183.87	41.17
GDD Base 5	199.53	201.28	203.4	238.1	249.16	256.9	47.88
Hot Days (T > 30° C)	7.9	9.05	10.53	25.81	35.46	49.19	26.41
SPEI runlen12	1.54	1.71	2.03	0.83	1.24	1.55	-0.48
SPEI runlen3	0.95	1.01	1.11	0.68	0.88	1	-0.13
Spring Max T (° C)	15.6	15.93	16.18	17.52	18.55	19.43	2.62
Spring Min T (° C)	2.48	2.73	2.95	5.07	6.25	7.12	3.53
Spring P (mm)	184.04	198.93	214.39	224.99	261.81	292.12	62.88
Summer Max T (° C)	22.75	23.07	23.49	26.1	27.32	29.34	4.25
Summer Min T (° C)	7.47	7.67	7.86	11.02	12.1	13.22	4.43
Summer P (mm)	122.66	136.37	148.17	90.79	130.37	160.99	-5.99
Very Cold Days (T < -30° C)	2.57	3.25	4.7	0.06	0.23	0.55	-3.02
Very Hot Days (T > 35° C)	0.03	0.12	0.2	1.97	6.55	14.84	6.43
Very Wet Days (P > 10 mm)	12.33	12.96	13.7	12.87	15.94	17.84	2.97
Wet Days (P > 5mm)	30.27	31.45	32.77	30.55	36.37	39.94	4.92
Winter Max T (° C)	1.64	2.43	2.87	4.53	5.5	6.46	3.07
Winter Min T (° C)	-9.25	-8.67	-8.2	-5.44	-4.39	-3.11	4.28
Winter P (mm)	76.47	80.86	83.6	79.93	97.21	113.26	16.35

Table 19: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 13 under baseline and 3 °C global warming scenario.

Grid 13							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	1165.1	1200.08	1241.14	1138.55	1223	1279.45	22.92
Annual T (mm)	2.27	2.38	2.47	5.34	6.09	6.59	3.71
Cold Days (T < - 15° C)	29.1	30.42	31.9	10	13.97	18.45	-16.45
Dry Days (P < 1 mm)	206.47	211.21	216	210.26	214.6	216.97	3.4
Fall Max T (° C)	1.18	1.36	1.69	4.23	4.97	5.4	3.61
Fall Min T (° C)	-6.39	-6.18	-6.01	-3.3	-2.04	-1.57	4.13
Fall P (mm)	314.99	332.41	350.81	277.12	338.62	380.03	6.21
# Frost Days	209	211.72	215.27	136.16	146.84	161.35	-64.87
Length Frost Free Season	149.73	153.28	156	203.65	218.16	228.84	64.87
GDD Base 10	79.37	82.71	85.2	118.68	129.39	138.65	46.68
GDD Base 5	146.07	148.77	151.13	180.42	193.19	199.77	44.42
Hot Days (T > 30° C)	0.1	0.27	0.6	4.35	8.86	17.1	8.59
SPEI runlen12	-0.15	0.01	0.22	-0.2	0.01	0.17	0
SPEI runlen3	0.1	0.21	0.31	0.07	0.22	0.39	0.01
Spring Max T (° C)	10.91	11.15	11.35	12.82	13.98	15.68	2.83
Spring Min T (° C)	-0.48	-0.21	-0.01	2.21	3.3	4.25	3.51
Spring P (mm)	311.69	336.94	358.04	357.22	381.62	413.61	44.68
Summer Max T (° C)	18.04	18.41	18.77	21.85	22.86	24.83	4.44
Summer Min T (° C)	4.87	5.09	5.36	8.52	9.47	10.68	4.38
Summer P (mm)	185.57	205.67	219.6	134.74	189.37	224.26	-16.3
Very Cold Days (T < -30° C)	1.37	1.84	2.47	0	0.12	0.26	-1.72
Very Hot Days (T > 35° C)	0	0	0	0	0.21	1.06	0.21
Very Wet Days (P > 10 mm)	38.07	40.14	42.43	35.32	40.79	45.42	0.66
Wet Days (P > 5mm)	85.73	87.98	90.13	81.16	85.88	92.84	-2.09
Winter Max T (° C)	-1.81	-1.26	-0.99	0.77	1.63	2.51	2.89
Winter Min T (° C)	-10.15	-9.82	-9.52	-7.28	-6.01	-4.88	3.81
Winter P (mm)	284.95	310.59	325.73	266.04	298.1	327.98	-12.49

Table 20: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 14 under baseline and 3 °C global warming scenario.

Grid 14							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	1302.93	1348.05	1371.8	1248.34	1377.81	1478.13	29.76
Annual T (mm)	1.27	1.4	1.52	4.44	5.18	5.7	3.77
Cold Days (T < - 15° C)	34.37	35.74	36.73	13.19	17.91	22.32	-17.82
Dry Days (P < 1 mm)	222.23	226.33	230.43	227.77	231.14	236.1	4.8
Fall Max T (° C)	0.02	0.25	0.61	3.22	3.92	4.35	3.68
Fall Min T (° C)	-6.87	-6.57	-6.36	-3.54	-2.35	-1.83	4.22
Fall P (mm)	339.98	360.35	378.58	314.39	363.55	403.39	3.2
# Frost Days	214.4	216.78	220.77	139.94	152.22	165.58	-64.56
Length Frost Free Season	144.23	148.22	150.6	199.42	212.78	225.06	64.56
GDD Base 10	68.4	70.23	73.4	108.48	118.26	128.35	48.03
GDD Base 5	133.47	136.49	138.73	170.03	182.4	190.87	45.91
Hot Days (T > 30° C)	0.03	0.12	0.2	1.74	4.61	10.74	4.49
SPEI runlen12	-0.18	0	0.18	-0.29	0	0.19	0
SPEI runlen3	0.02	0	0.19	-0.03	0	0.17	0
Spring Max T (° C)	9.13	9.39	9.62	11.06	12.23	13.78	2.84
Spring Min T (° C)	-1.2	-0.92	-0.69	1.61	2.64	3.66	3.55
Spring P (mm)	359.49	381.32	401.96	405.77	440.95	486.9	59.64
Summer Max T (° C)	16.24	16.6	17	20.09	21.08	23.05	4.48
Summer Min T (° C)	4.69	4.91	5.19	8.28	9.38	10.56	4.47
Summer P (mm)	216.99	238.56	249.19	152.57	210.14	255.53	-28.43
Very Cold Days (T < -30° C)	3	3.78	5.03	0.1	0.41	0.74	-3.37
Very Hot Days (T > 35° C)	0	0	0	0	0.09	0.39	0.09
Very Wet Days (P > 10 mm)	49.57	52.64	54.13	45.23	52.79	58.16	0.15
Wet Days (P > 5mm)	92.2	95.18	97.7	85.45	91.89	99.97	-3.29
Winter Max T (° C)	-2.99	-2.41	-2.08	-0.42	0.53	1.47	2.94
Winter Min T (° C)	-10.92	-10.49	-10.12	-7.84	-6.56	-5.4	3.93
Winter P (mm)	327.53	351.18	370.52	301.06	346.02	388.66	-5.16

Table 21: Summary of mean and absolute values for climate and agroclimatic variables over grid cell 15 under baseline and 3 °C global warming scenario.

Grid 15							
	Historical Min	Historical Mean	Historical Max	3 °C Min	3 °C Mean	3 °C Max	3 °C DIFF
Annual P (mm)	921.06	948.66	971.67	879.93	1014.18	1110.5	65.51
Annual T (mm)	3.44	3.57	3.7	6.57	7.35	7.85	3.78
Cold Days (T < - 15° C)	30.4	32.18	33.73	12.06	16.27	20.23	-15.91
Dry Days (P < 1 mm)	241.7	245.25	248.5	243.39	247.4	252.48	2.15
Fall Max T (° C)	3.11	3.34	3.65	6.4	7.09	7.55	3.75
Fall Min T (° C)	-5.77	-5.46	-5.26	-2.5	-1.21	-0.63	4.25
Fall P (mm)	219.21	230.82	240.85	215.74	236.83	260.6	6.01
# Frost Days	191.13	193.49	196.23	118	128.96	144.94	-64.52
Length Frost Free Season	168.77	171.51	173.87	220.06	236.04	247	64.52
GDD Base 10	100.07	102.41	104.83	137.52	148.75	159.29	46.34
GDD Base 5	164.83	168.16	170.07	204.23	215.4	221.68	47.24
Hot Days (T > 30° C)	1.03	1.3	1.87	9.55	16.18	28	14.88
SPEI runlen12	-0.14	0.04	0.2	-0.08	0.11	0.33	0.06
SPEI runlen3	0.25	0.31	0.44	0.21	0.34	0.44	0.03
Spring Max T (° C)	12.33	12.62	12.82	14.31	15.47	16.89	2.85
Spring Min T (° C)	0.49	0.76	0.99	3.19	4.28	5.19	3.52
Spring P (mm)	268.75	291.27	309.95	319.61	357.89	407.14	66.62
Summer Max T (° C)	19.67	19.99	20.37	23.36	24.36	26.27	4.36
Summer Min T (° C)	5.84	6.04	6.27	9.4	10.45	11.7	4.41
Summer P (mm)	172.1	190.52	201.36	110.8	171.52	213.05	-19
Very Cold Days (T < -30° C)	3.1	3.49	4.5	0.06	0.35	0.74	-3.14
Very Hot Days (T > 35° C)	0	0	0	0.13	0.95	3.74	0.95
Very Wet Days (P > 10 mm)	27.2	28.95	30.1	25.45	32.37	36.65	3.42
Wet Days (P > 5mm)	67.27	71.4	73.43	62.9	72.33	82.32	0.93
Winter Max T (° C)	-0.46	0.16	0.5	2.11	3.16	4.22	3
Winter Min T (° C)	-9.82	-9.39	-9.07	-6.6	-5.36	-4.1	4.03
Winter P (mm)	211.37	223.28	231.37	200.49	234.26	264.94	10.98