SOUTHEASTERN ALBERTA CLIMATE CHANGE - FACT OR FICTION?

SEAWA Watershed Report 2010-12

SEAWA Web-based State of the Watershed Report

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Southeastern Alberta Climate Change: Fact or Fiction?

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Abstract

Using Environment Canada's National Climate Data and Information Archive we began on a quest to investigate the controversy surrounding global warming. Through detailed records, we uncovered one hundred twenty years of precipitation and temperature records for Medicine Hat. Other varying time periods were studied for additional Southeastern Alberta areas. We converted our data into graphs spanning yearly and decadal periods. From the analysis of these graphs, we evaluated periods of fluctuation, confirming our hypothesis of recent climate change. On the large scale, we observed a much more rapid and dramatic increase in the most recent temperature cycles. In contrast, declining measurements appeared in average peak precipitation levels. All of our observations showed natural trends of high and low temperature and precipitation cycles. However, these cycles progressively became more frequent and extreme. The environment will continue to experience these cycles. Global warming, we infer, will continue to cause these increases in the severity and frequency of climate cycles and weather patterns.

1. Introduction

Climate change has become a very controversial topic in recent times. Everybody has their own personal opinions on the matter. Differing sides are providing evidence and arguments that appeal to and recruit others to their beliefs. Some support the theory of climate change as a continuous natural process while others believe we are contributing to our weather patterns through human interference.

Those in support of natural variation in global temperature explain their viewpoint through use of proxy records, most notably of which include tree rings, ice cores, pollen and lake sediments. The regular fluctuation of precipitation can be exemplified in Dave Sauchyn's (Senior Research Scientist at the Prairie Adaptation Research Collaborative), tree ring analysis linked to water supply and stream flow in the Southeast Alberta region over several hundred years (Figure 5.4).

In contrast, other climate change advocates defend the theory that our world has, in recent times, undergone a rapid warming when compared to the pattern of slow cooling previous to World War Two. The popular "Hockey Stick Graph" (Figure 5.1) shows our biosphere has drastically warmed over the past several decades because of human activities. Although there is evidence that some warming is occurring there is the possibility that these claims could be exaggerated. Climate patterns are never symmetrical and although regions have specific climate cycles, these patterns usually fluctuate within given ranges. For instance, over the course of history, climate has undergone many varying changes; changes that can be considered natural cycles of heating and cooling. Look at Southern Alberta's varied climates; ranging from once a tropical rainforest, to a land covered in miles of ice sheets, and now a semi-arid desert. For the present, the hockey stick graph mind set appears to be too extreme, however, despite these natural occurring climate variations; global carbon dioxide levels are

increasing at a faster rate than ever before (Figure 5.2). As a result of these increasing carbon dioxide emissions, some climate scientists believe that average global temperatures are showing an overall increase. Based on this theory, it only makes sense that through human interference, we are contributing to climate change.

As well, intertwined with temperature change we find significant issues surrounding water. With the demand for water steadily increasing, combined with an increase in temperature, available fresh water could eventually not meet pressing demands. Southeastern Albertan's water source comes from the South Saskatchewan River and now there are no more water licenses being issued as current licenses exceed the entire river flow. Although we have always had an abundant supply of water, this may not be the case in the future. Unfortunately, society abuses their privilege of having this availability of water by being wasteful and careless in their consumption. Water should be considered a precious resource.

We studied Southeastern Alberta's geographical area in order to compare some of the theories of others to factual evidence in historical weather records.

2. Methods

- ✓ Study
- ✓ Collect
- ✓ Produce

2.1. Study Alberta's Climate

To begin, we studied the classic characteristics of Alberta's Climate, specific to the Southeastern region. In general, Alberta's climate is categorized as continental because it is a province that is relatively detached from any major bodies of water. Water holds heat longer and heats up much more slowly than land, which results in its moderating effect on climate. Without the moderating effect from water Alberta's climate undergoes constant variation in temperature and precipitation from summer to winter. Albertans expect, to some degree, weather inconsistency from year to year. Also, it is recognizable that some years experience more severe storms while other years remain relatively placid. Temperature and precipitation are considered to be components of climate. Therefore, when graphing the averages of temperature and precipitation it is evident that the trends of climate travel in cyclical patterns with fluctuation.

2.2. Collect Historical Weather Records

Using Environment Canada's National Climate Data and Information Archive we uncovered historical weather records for Southeastern Alberta cities and surrounding areas. From the recordings, we plotted onto spreadsheets the yearly data for precipitation and temperature for the maximum number of years available.

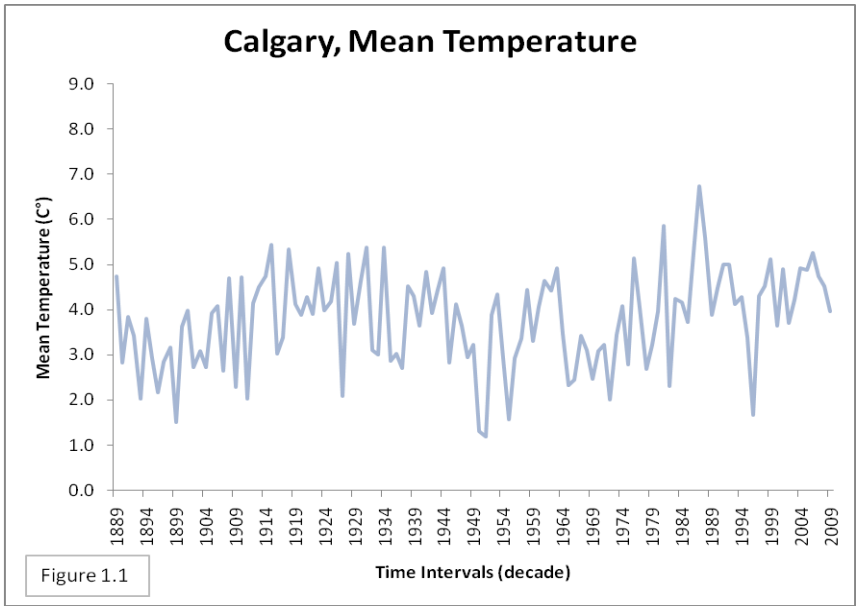
2.3. Produced Yearly and Decadal Averages for Analyses

Then, after organizing our spreadsheets into decade averages for temperature and precipitation, we produced numerous yearly and decadal graphs.

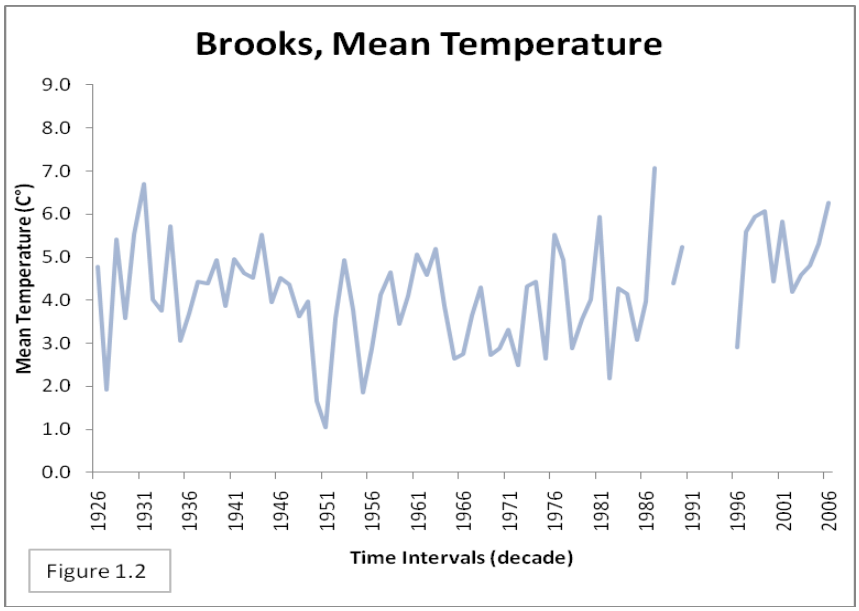
3. Results

3.1. Yearly and Decadal Mean Temperatures

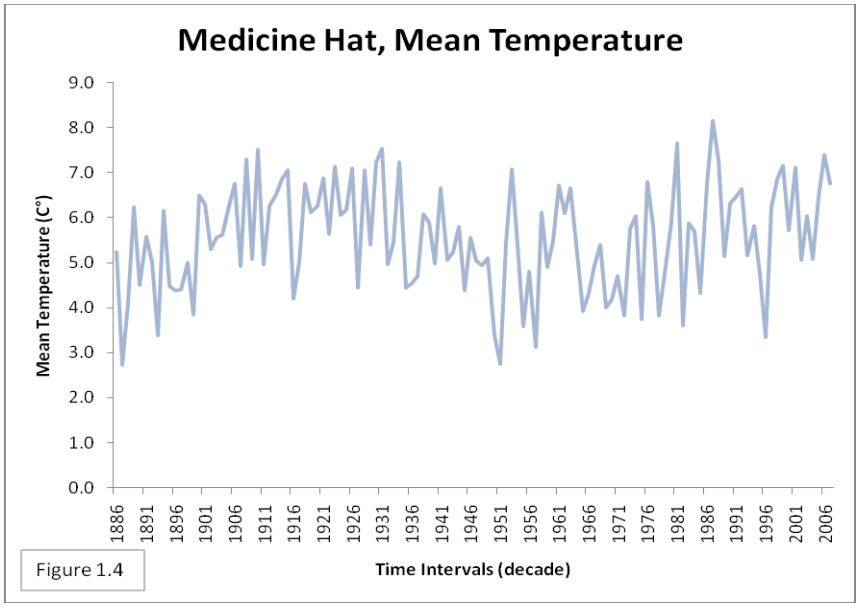
To begin with, yearly temperature averages were recorded. In some cases, faint cycles and trends were apparent. On the other hand, there were also various cases with no noticeable patterns.



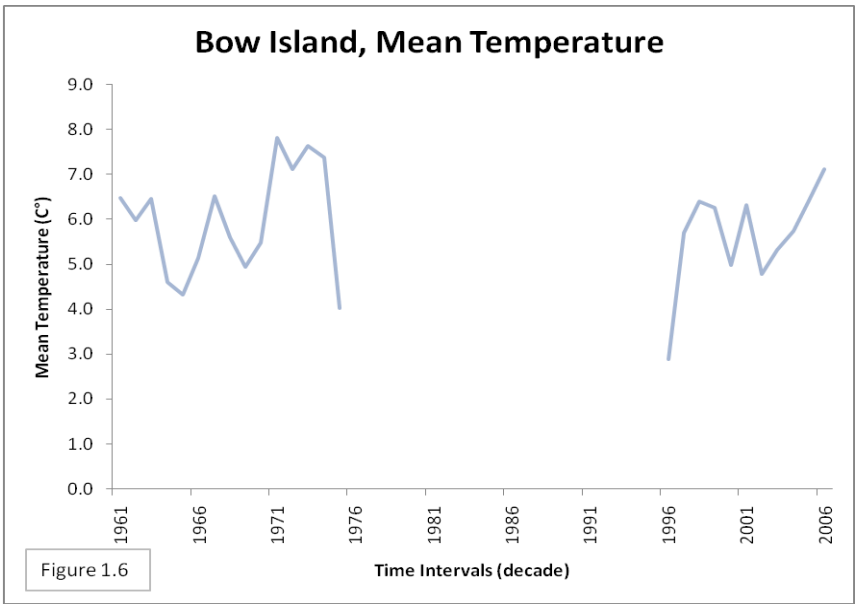
Calgary (Figure 1.1) – Mean temperature shows an increase since 1964. It is possible that currently there is an upward cycle occurring, though it is hard to tell whether or not this cycle has peaked. Another possibility is that there may not be a distinct peak, rather just small temperature fluctuations steadily increasing overall.



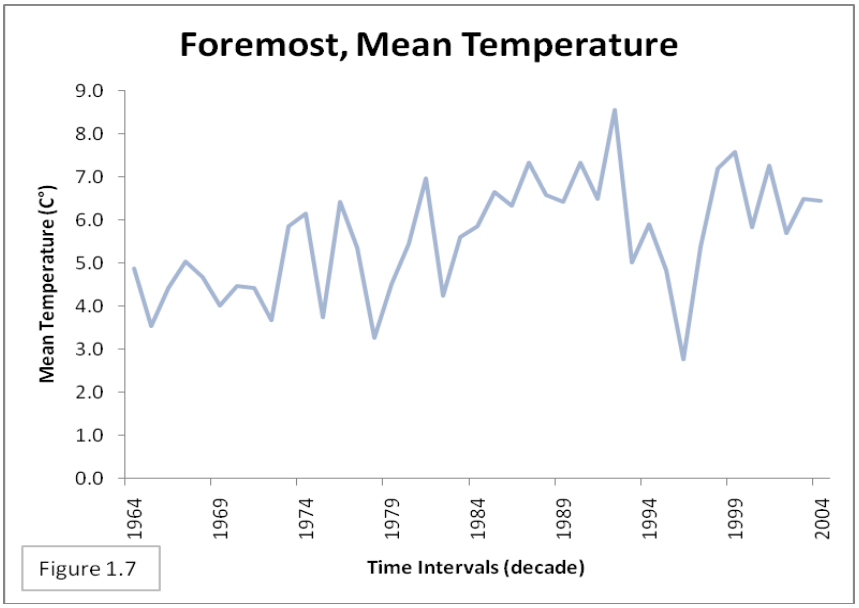
Brooks (Figure 1.2) - Mean temperature is increasing though no distinct cycles are apparent.



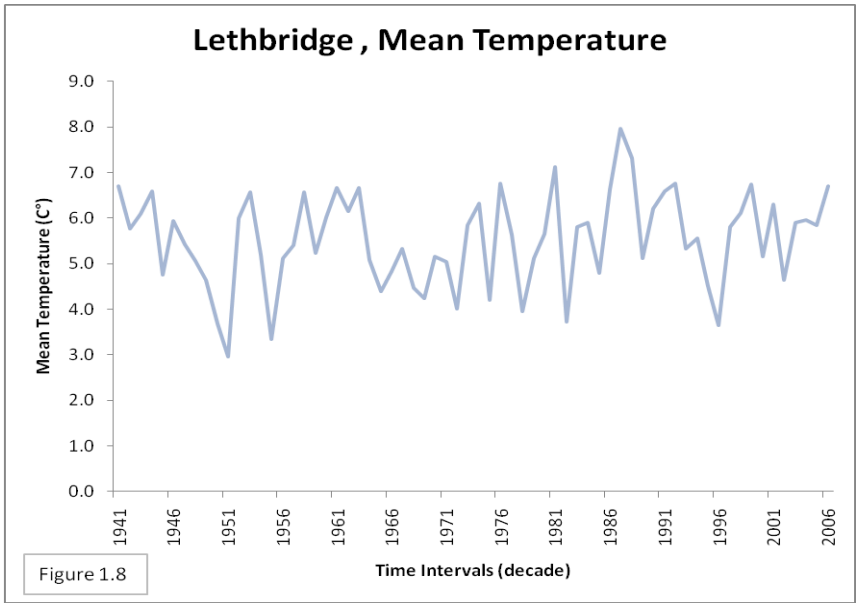
Medicine Hat (Figure 1.4) – Cycles are evident. It appears that temperature has entered into a new cycle and is increasing to its peak.



Bow Island (Figure 1.6) – Over the past few years, temperature has entered into an upward trend.

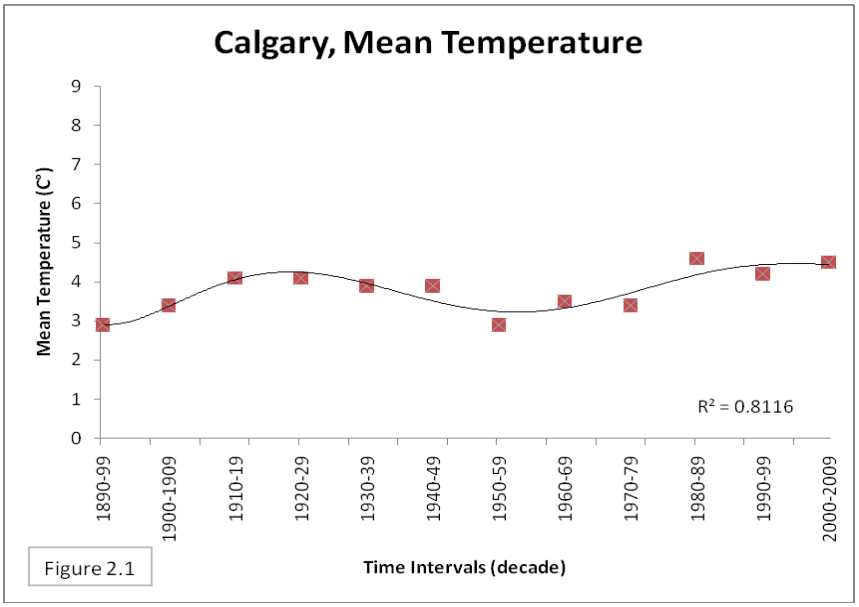


Foremost (Figure 1.7) – There are no clear cycles or patterns visible.

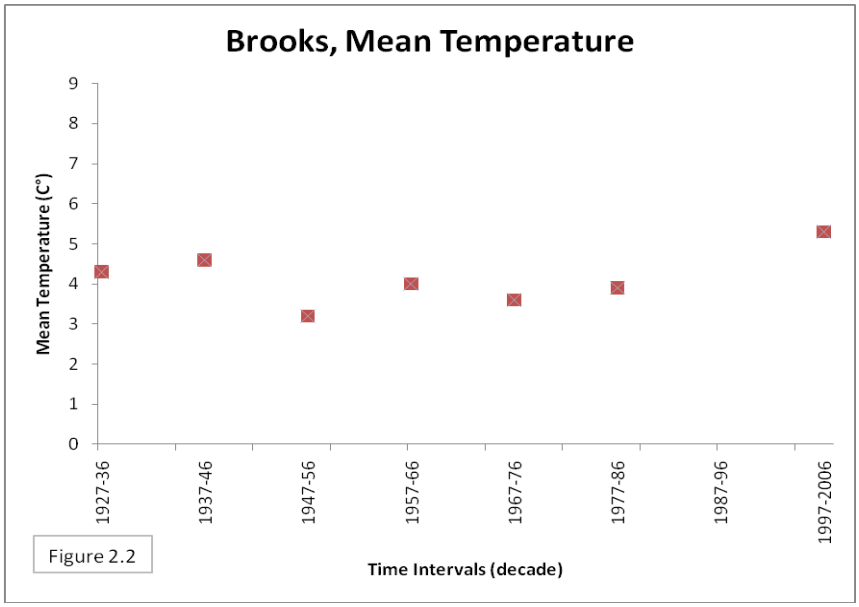


Lethbridge (Figure 1.8) – There are no visible patterns or cycles observed throughout the 65year period. The values have remained similar, with no dramatic differences.

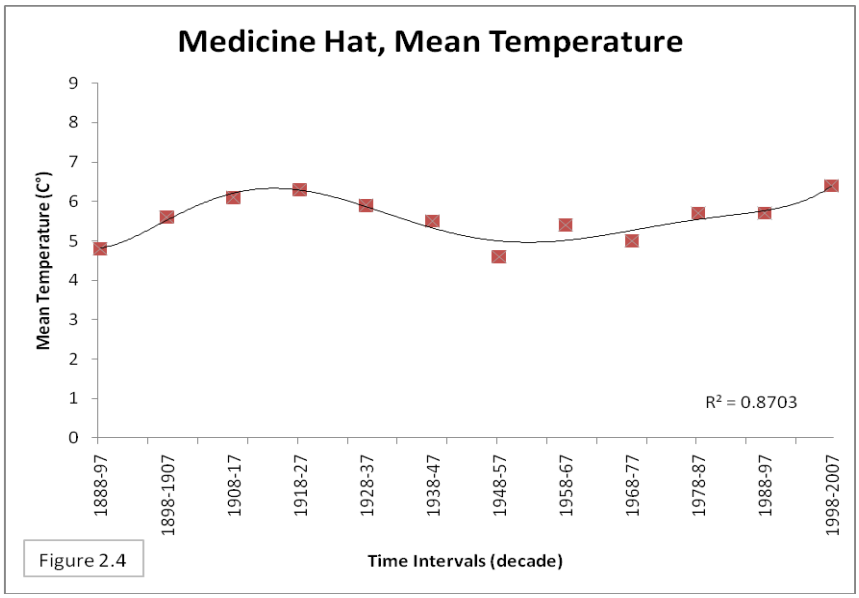
Decadal Mean Temperatures for Southeastern Alberta regions showed more distinct trends and cycles.



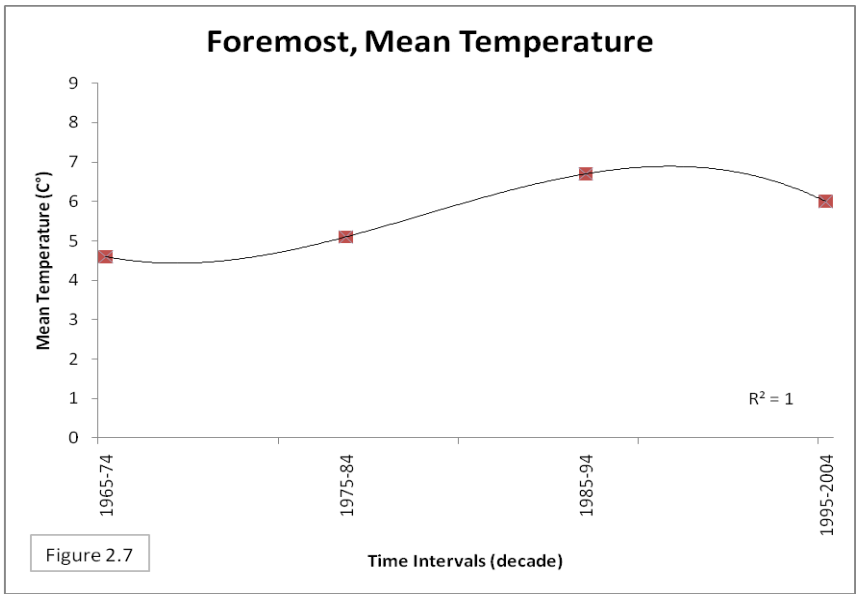
Calgary – First cycle was very gradual occurring over seventy years. It appears that a new cycle began fifty years ago. It is difficult to draw the conclusion as to whether or not this cycle has reached its peak yet.



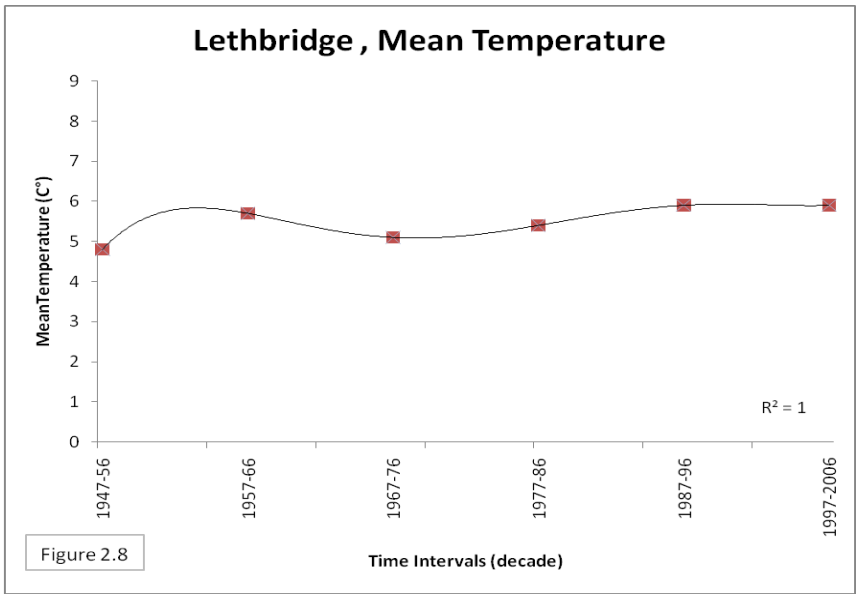
Brooks- Temperature has drastically increased in the past decade when compared to the previous decade values; being 0.8°C warmer than the other highest decade value.



Medicine Hat – The graph begins with one gradual cycle over the course of seventy years. The most recent cycle, which began fifty years ago, has been increasing at a steady rate. The most recent decade (1998-2007) is the warmest average in the history of one hundred and twenty years.



Foremost – This four-decade cycle has fluctuated within a 2.1°C range and appears to be coming out of the cycle in a downward trend



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Lethbridge – For the past two decades temperature averages have remained equal at 5.9°C. These values are 0.2°C warmer than the next greatest value, which occurred in the decade (1957-1966). Although there are no distinct patterns or cycles it seems as though there is a slight upward trend.

It is also important to note that Calgary, Medicine Hat, Brooks, and Lethbridge all experienced a drop in mean temperature around 1996, as well as prior, in 1951. In addition, it is evident again that these four cities all experienced a dramatic spike (peak) in mean temperature around 1986.

3.2 Yearly and Decadal Total Precipitation Means

In our yearly total precipitation means we noticed a general downward trend for most cities in recent years.

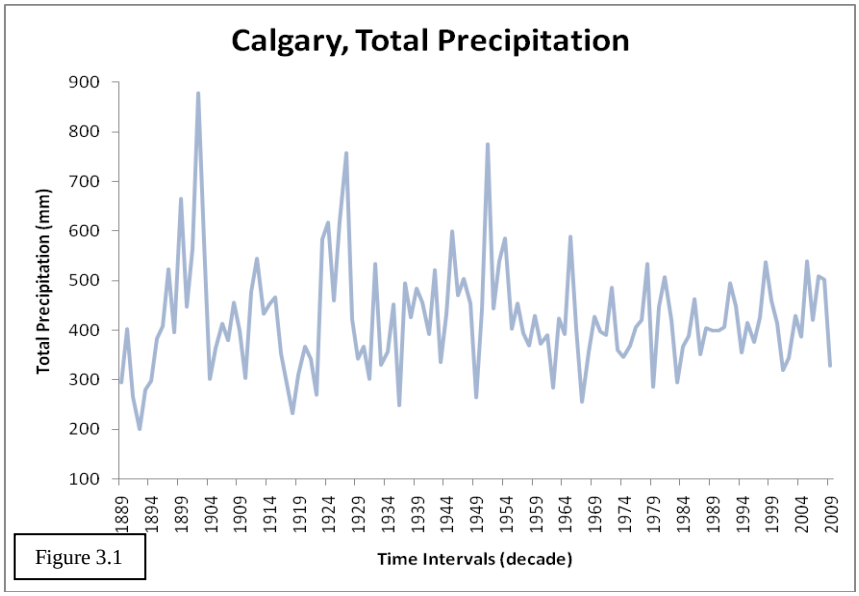


Figure 3.1

Calgary – Previous to 1955 peak precipitation values would spike dramatically within cycles. Currently, total precipitation is clearly showing a decrease with no evident cycles or large fluctuations.

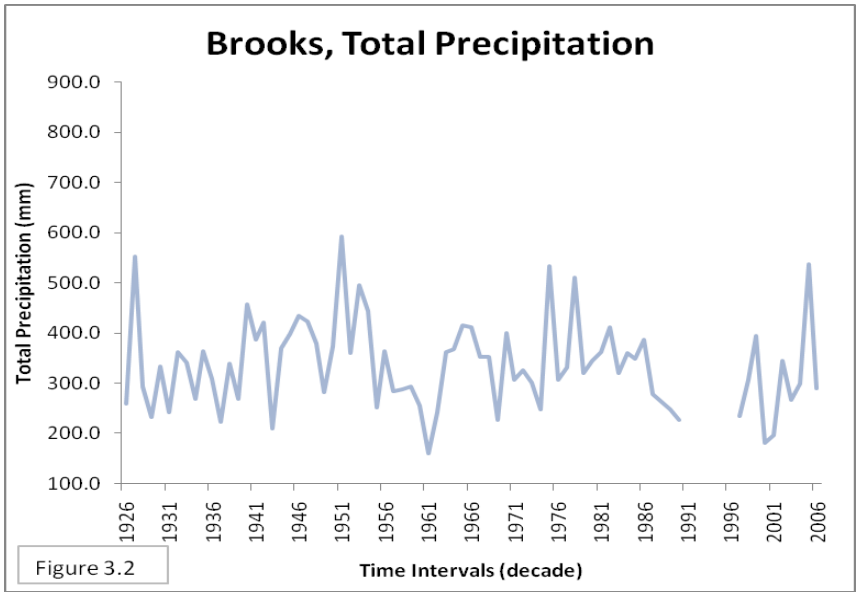


Figure 3.2

Brooks- No obvious patterns have appeared. Rather, moderate fluctuations can be seen over the course of eighty years.

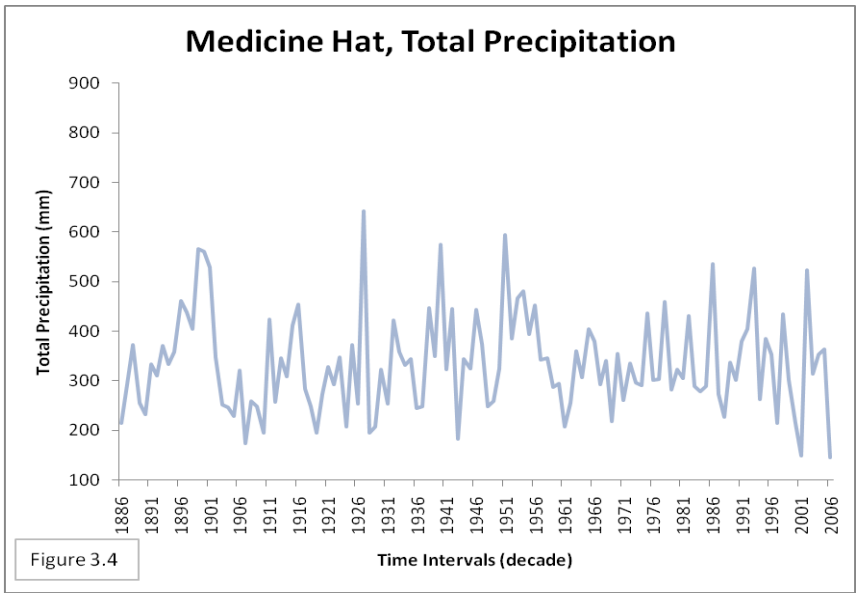


Figure 3.4

Medicine Hat – Precipitation values prior to the early 2000's appear as a range of variously plotted points, not following any cyclical pattern. Now however, precipitation values have decreased over the past few years.

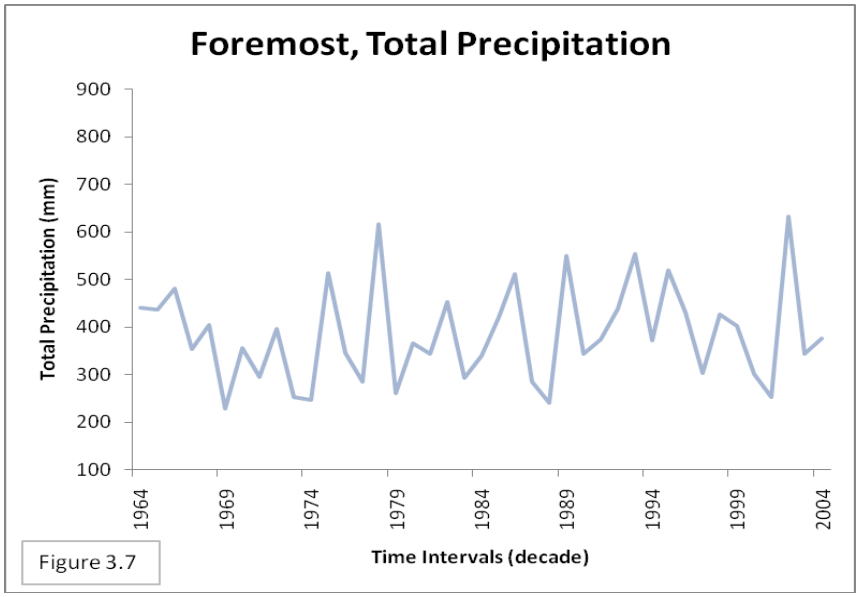


Figure 3.7

Foremost – Cycles and patterns are not visible for precipitation over the history of the one hundred twenty years.

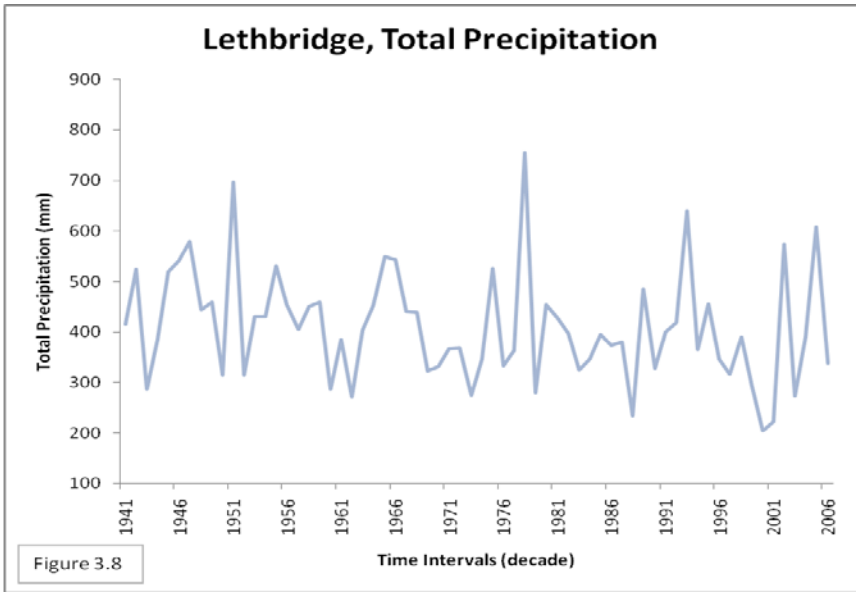


Figure 3.8

Lethbridge – No dramatic differences are visible amongst the values throughout the sixty-five year period. Instead, the values have remained relatively equal.

For our Decadal Total Precipitation Averages we noticed the appearance of cycles in various cases.

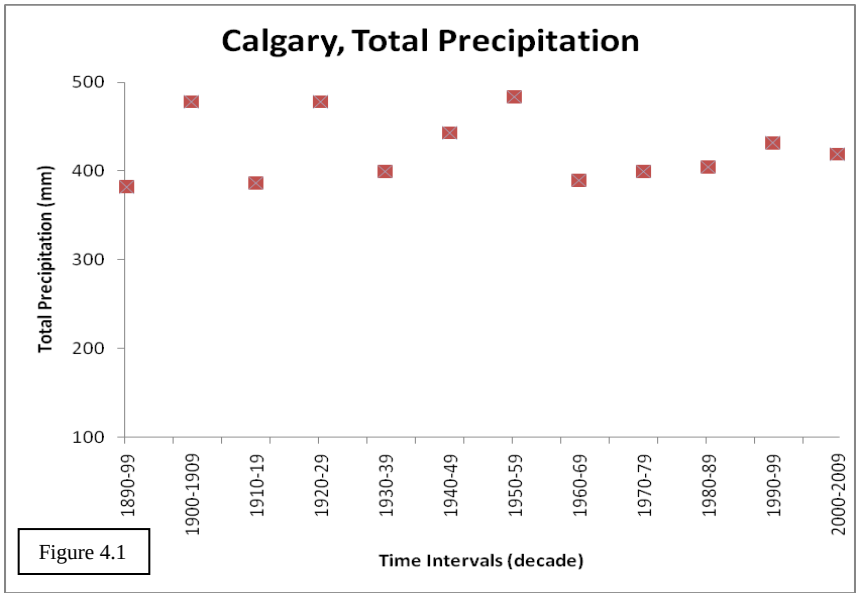
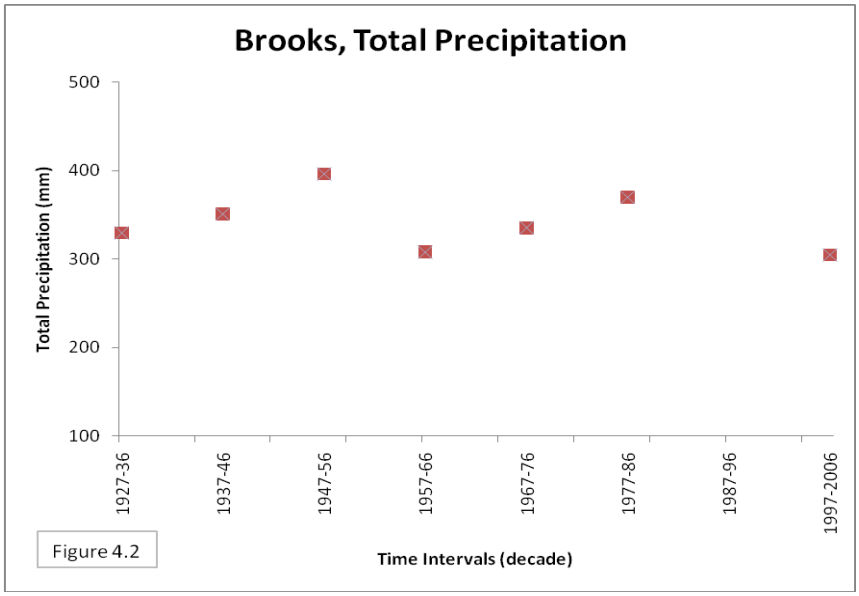
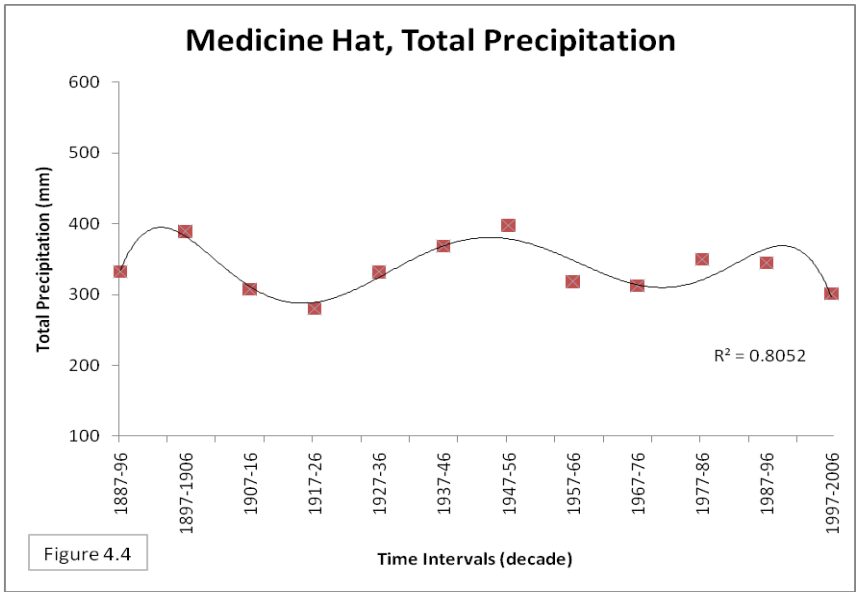


Figure 4.1

Calgary – Previous to the 60's precipitation values did not follow any cyclical patterns, being that individual decades were noticeably wetter or dryer. After the 60's precipitation levels dropped 100mm and continue to remain low.



Brooks- The most recent decade was the lowest value in the course of eighty years. The temperature difference between the highest and lowest value was 91.3mm.



Medicine Hat – Precipitation has experienced three complete cycles. The first two cycle's peaks are noticeably higher than the most recent cycle's peak.

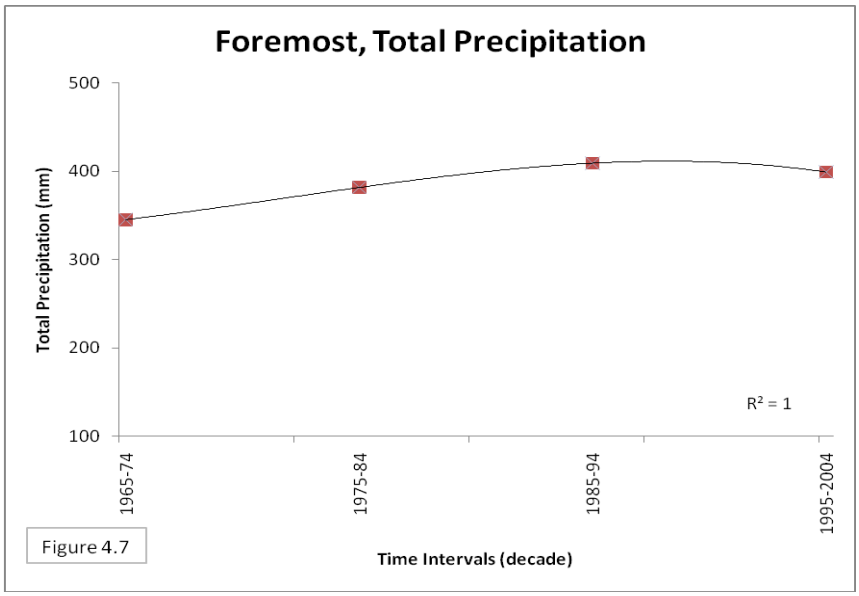


Figure 4.7

Foremost – Precipitation seems to be experiencing one gradual cycle.

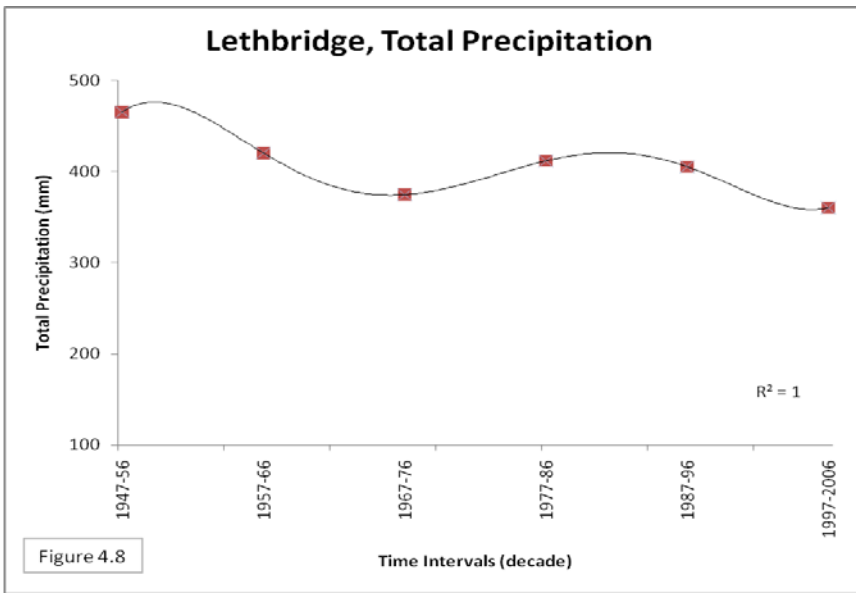


Figure 4.8

Lethbridge – Precipitation has dramatically dropped from 465.4mm to 365.5mm over the course of sixty years.

Once again, it is notable that Calgary, Medicine Hat, Lethbridge, and Brooks all experienced wetter years around 1951, with a spike in regular fluctuation patterns. As well, Medicine Hat, Calgary and Brooks showed a spike in total precipitation in 1926.

4. Discussion

4.1. Weather Vs. Climate

David Phillips from Environment Canada once exclaimed publicly, "We do not look out our window and see climate. Rather, we look out and see weather." Climate encompasses the statistics of temperature, humidity, atmospheric pressure, wind, and rainfall elements in a given region over periods of time. In differentiation, weather is a set of all the phenomena occurring in a given atmosphere at a given specific time. Keeping this in mind, snow and cold in normally warm climates, as well as other extreme weather like hurricanes, tornados, flooding and drought result from changes in weather brought about from human interference; emotionally referred to as Global Warming or Climate Change. Thus, climate change is any long-term significant weather pattern of an area; changes that may be brought about by processes internal to the earth, external forces, or more recently, human activities.

4.2. Natural Variation in Global Temperature

The variability of our environment has been shaped by natural phenomena since the beginning of time. There are many natural processes and components of nature that contribute to Climate Change. The phenomena El Nino and La Nina demonstrate the link between circulation patterns in the atmosphere and those in the earth's oceans. Typical El Niño effects include warmer-than-average temperatures over western and central Canada. La Nina, on the other hand, results in winter temperatures which are cooler than normal in the Northwest. The occurrence of solar flares and cycles as well as volcanic eruptions are said to have significant effects on the conditions of our climate. Changes in solar energy output are understood to occur every 11 years. As the sun goes through a cycle, there is an increase in radiation above normal levels; during this time the number of sunspots on its surface gradually rises until reaching its maximum total. Volcanic eruptions are also considered to impact climate patterns. For example, some scientists believe that cases of variability such as cooling periods were influenced by two major volcanic eruptions, Mount Pinatubo and El Chichon. In addition, measurements recorded and obtained by proxy records have illustrated the occurrence of natural cycles over longer periods of time.

The vast, diverse Pacific Ocean experiences change as well. One specific region off the Pacific coast, the Oregon Dead Zone, normally sustains a rich, abundance of marine life. However, scientists and locals have confirmed that oxygen levels are plummeting every summer. Through studies conducted on the zone, the ocean's bottom can be seen as a graveyard of dead and rotting organisms. These zones do not remain dead; however, conditions are bad for a few months in summer until oxygen returns. These low oxygen zones were once periodic occurrences but now, they are becoming regular, annual summer events. This may or may not be a natural occurrence. They are getting worse and scientists believe that climate change could be the cause behind the worsening of this mysterious phenomenon. Climate change may be altering the winds and raising water temperatures, thus changing the currents.

4.3. Human Impact

Climate change is an important issue; scientists throughout the world have spent years of careful research to collect the data necessary to study climate trends. What is apparent from their research is that our earth has experienced an obvious warming over the past century. According to temperature records, our average global temperature has risen approximately 0.6°C since the beginning of the post-industrial period. Many scientists are supporting the theory that this increase in temperature has come about from the overuse of greenhouse gasses in recent times. Before the industrial revolution, emissions measured from Antarctic ice cores show that atmospheric CO_2 levels were about 280 parts per million by volume. Since then, carbon dioxide concentrations in the atmosphere have gone up by approximately 35 percent, rising from 280 parts per million by volume to 387 parts per million in 2009.

According to statistics, the world population has increased by the billions over the past 50 years (Figure 5.3). Revolutionary change coupled with dramatic population growth introduced new agricultural and industrial practices; altering the global atmospheric environment. Before that time, human activity didn't release many greenhouse gases, but population growth, deforestation, factory farming, and the widespread use of fossil fuels have created an excess of greenhouse gasses in the atmosphere that may contribute to global warming.

4.4. Effects and Future Implications of Climate Change

In the future as climate change continues we can expect further global warming, a rise in sea level, and a likely increase in the frequency of some extreme weather events. In addition to these worldly effects, scientists also predict issues like decreases in biodiversity, drought and the further melting of the polar ice caps. Global warming accelerates the contraction of the Arctic ice caps. Mark Serreze, Director of the Nation Snow and Ice Data Centre at the University of Colorado explains that, "Current climate trends mean that the seasonal Arctic ice could melt in twenty years or less." When snow and ice cover melts, the albedo (how strongly a substance reflects light) decreases and the earth and the ocean absorb more sunlight, thus getting warmer. Ice reflects 80% of the sun's energy, where as the exposed ocean absorbs 80%. Land based glacial melting contributes to rising sea levels, threatening areas around the globe with beach erosion, and coastal flooding.

People are not hearing nor understanding the message that is coming from the powerful and compelling evidence around us. Our earth is changing. In previous and future years, we have undergone and are expected to continue to experience strange and erratic weather. We believe that this may be a "side" effect of global warming. For instance, the snowfall this previous winter in Korea might leave people puzzled; leading them to question the validity of global warming. They are confusing global climate change with the occurrences of unusual or extreme weather. It is important to understand that global warming and climate change can lead to episodes of these weather patterns. In spring of 2010 Medicine Hat experienced uncharacteristically heavy rainfall and

flooding, while later in the summer of 2010, British Columbia wrestled with severe wildfires.

All and all, climate change has always existed and will always continue to occur. Nevertheless, what is alarming is the rate and severity at which this change is happening currently.

4.5. What we can do to help

Dr. David Suzuki took a gentle dig at his own species, stating human beings are not a very impressive animal but we have one great advantage however; our brain. The human brain, according to the Canadian environmentalist, along with the predictive ability of computers and the skills of the scientific community, gives us a great chance to do something about climate change.

It is obvious that everyone must reduce the burning of fossil fuels as fast as possible. This is completely possible with the present technology available to us: solar energy, wind energy harnessed by windmills, and fuels like alcohol and methane from fermentation. On the global level, wind and solar energy are the fastest-growing sectors in the energy industry. Oil companies such as British Petroleum and Shell have even realized the need for change. They have teamed up with major investors in alternative energy projects.

As individuals, each of us can take steps to reduce our carbon footprint and fight global warming by recycling, conserving water, picking energy efficient products, and driving smart. The above are all simple tasks effective in reducing nationwide carbon emissions. Smaller amounts of energy used means less dependence on the fossil fuels that create greenhouse gases and contribute to global warming. When you make an effort to lessen energy consumption, you not only minimize your carbon footprint but also save money.

5. Conclusion

It is evident in our area of Southeastern Alberta that climate change is occurring. Moreover, in agreement with the findings of David Phillips, a leading Environment Canada climatologist, we may draw the conclusion that, were our graphs to be further projected, our region would be continuing to face a period of increasing temperature and decreasing precipitation overall. According to his results, this year Canada has experienced the warmest and driest winter on record for sixty-three years. Despite overall warming, temperature, in order to complete a cycle, must continue to experience downward patterns which indicate cooling. Thereafter, a new cycle can begin.

We believe that our most recently experienced temperature increase can be linked at least partly to human activities, for as it appears; there is an upward trend in temperature with time. As major populations continue to increase, coupled with notably higher combustion of fossil fuels and deforestation a massive release of carbon dioxide gas emissions will continue to disrupt the natural cycles of climate and weather.

Next, we observed through our graphs that precipitation has been partly affected by global warming, resulting in an overall decline in precipitation over the last several

decades. At this stage we cannot state that the temperature has caused a decrease in precipitation. Rather, it is evident there is a link between the two for it appears that when temperature increases, precipitation decreases. Although our results yield convincing evidence for a connection between the two components of climate, precipitation patterns are more complex as they vary by region and are difficult to model. In addition, to further verify our results, we looked to Dave Sauchyn, PhD for his study and analysis of tree rings linked to water supply and stream flow in our region. What we noticed was a great similarity between his stream flow graph and our total precipitation graphs, showing similar decreasing patterns several hundred years, confirming our results.

On the whole, we discovered what seems to suggest a slight increase in cycle's peak mean temperatures, with ever diminishing cycles in regard to precipitation levels, yielding warmer and dryer weather in recent times. When examining our results, both total precipitation and average temperature seem to travel in cycles of varying extremes. This suggests that climate elements do change naturally with gradual and extreme fluxes. However, it is noticeable that these patterns or cycles, which weather undergoes, are becoming more numerous and dramatic. Most likely, the environment will continue to experience these cycles, while global warming, we infer, may continue to cause an increase in the severity and frequency of them.

Extra Graphs

The following graphs were referred to throughout our report. By using these graphs we were able to defend and support our topic and theories.

"The Hockey Stick Graph"

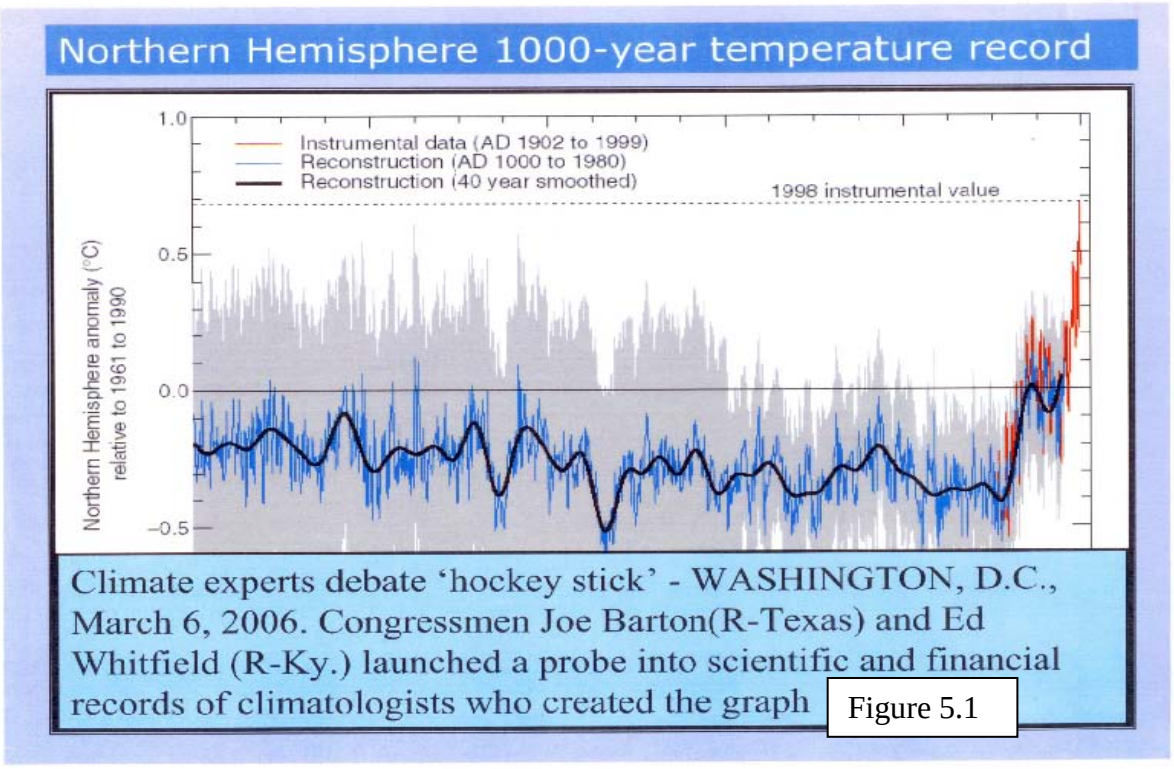


Figure 5.1

"Global Fossil Fuel Emissions"

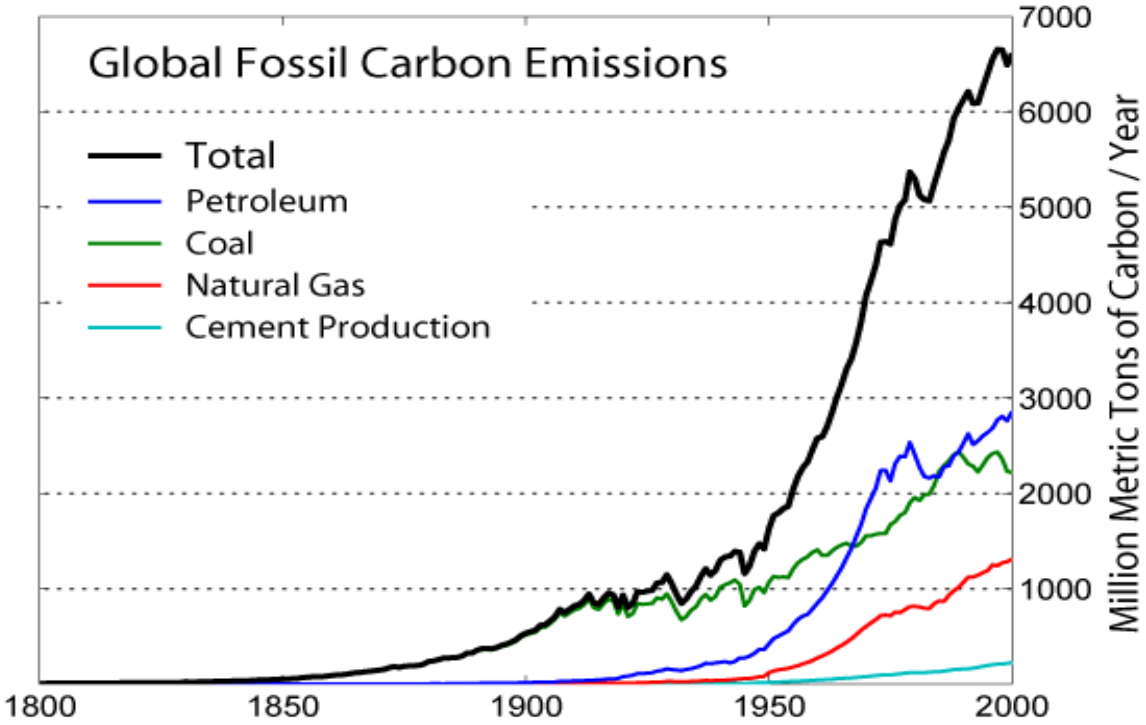


Figure 5.2

"World Population Growth"

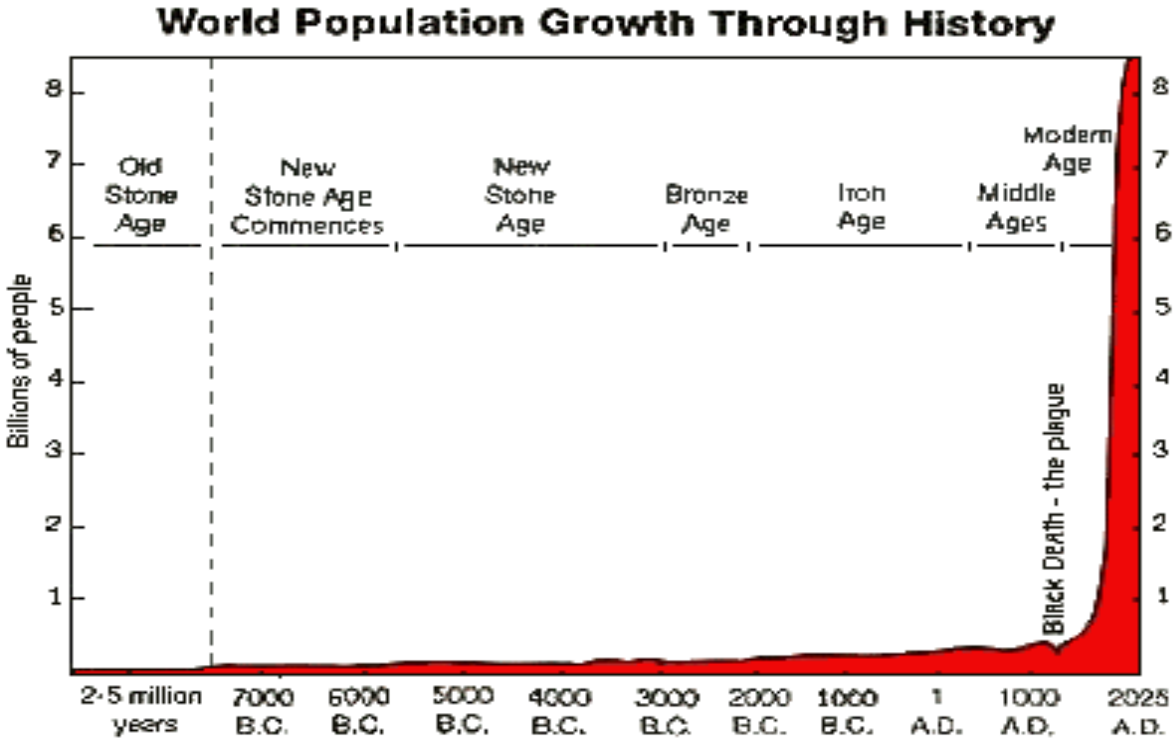


Figure 5.3

"Water Supply and Stream Flow"

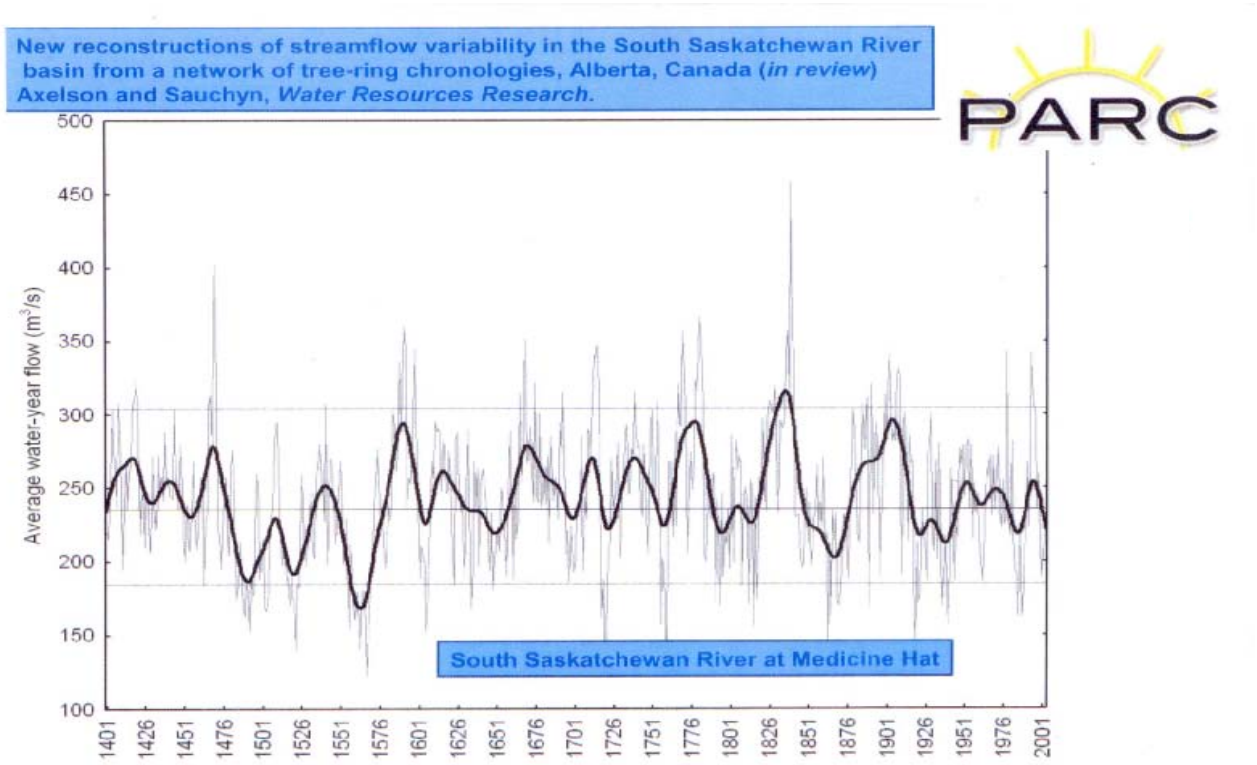


Figure 5.4

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The **South East Alberta Watershed Alliance (SEAWA)** was formed in 2007, incorporated as a non-profit society in 2008, and designated as the WPAC (Watershed Policy and Advisory Council) for the South Saskatchewan River sub-basin.

SEAWA Vision: *A healthy watershed that provides balance between social, environmental and economic benefits.*

SEAWA Mission: *South East Alberta Watershed Alliance brings together diverse partners to plan and facilitate the sustainable use of the South Saskatchewan River Watershed for present and future needs.*

SEAWA Members include interested individuals throughout the watershed along with our communities, ranchers, farmers, industries, companies, governments, conservation groups and educational institutions. We are proud to include the following among our founding members:

Government Sector: Alberta Government, City of Medicine Hat, Government of Canada, Cypress County, Palliser Health Region, Town of Redcliff, Town of Bow Island, and Special Areas Board.

Land Resource - Industry and Agriculture Sectors: St Mary River Irrigation District, Murray Lake Ranching, GG Bruins Farms, Short Grass Ranches, Canadian Fertilizers Limited, Redcliff Technology Enterprise Centre, Box Springs Business Park, and Canadian Centre for Unmanned Vehicles.

Academic, Research and Non-Governmental Organizations Sectors: Medicine Hat College, Alberta Research Institute, Red Deer River Watershed Alliance, and Hyperion Research.

Tourism and Conservation Sectors: Grasslands Naturalists, Canadian Badlands, and Medicine Hat Interpretive Program.

SEAWA Web-based State of the Watershed Report is managed by the *SEAWA State of the Watershed Committee (2010 members)*:

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Gary Bierback, SEAWA Vice-Chair, *St Mary River Irrigation District*
Grayson Mauch, *City of Medicine Hat* Water and Wastewater
Herb Scott, *Cypress County*
Stuart Murray, *Murray Lake Ranching*
Mike Maxwell, *Métis* member
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Russ Golonowski, *Canadian Fertilizers Limited*
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