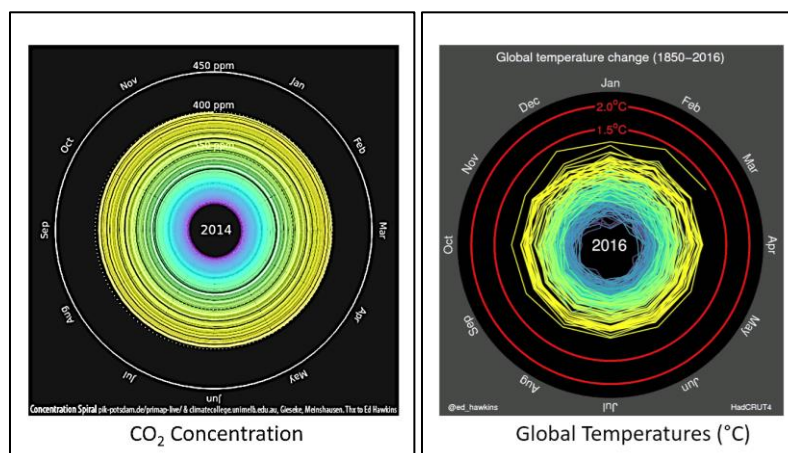




Title slide for talk given at “WNY Climate Conversations”, February 9, 2019, at Burchfield Penney Art Center. Organized by wnyyouthclimatesummit.org.

Thank you for the introduction, and good afternoon all. I want to thank the organizers of this event (WNY Teachers of the Master Teacher Program), and you, the participants, for being a part of this conversation. And I want to stress that what I say today are my own thoughts.

Let me start by stating something that most of you already know: our climate is changing, and it is changing due to the anthropogenic emissions of greenhouse gases. Whatever you might think of climate change, the workings of the greenhouse effect cannot be disputed. It is the greenhouse effect that traps heat which keeps our planet livable. It has been around for about 3 billion years and was “discovered” as early as 1824.



In fact, a 1965 White House report by the Johnson administration, wrote “By the year 2000 the increase in atmospheric CO₂ ... may be sufficient to produce measurable and perhaps marked changes in climate.” It is now 2019!

The obvious problem is that adding more greenhouse gases (referred to as the enhanced greenhouse effect) will only trap more heat – a warming world is the outcome, with all its connected consequences.

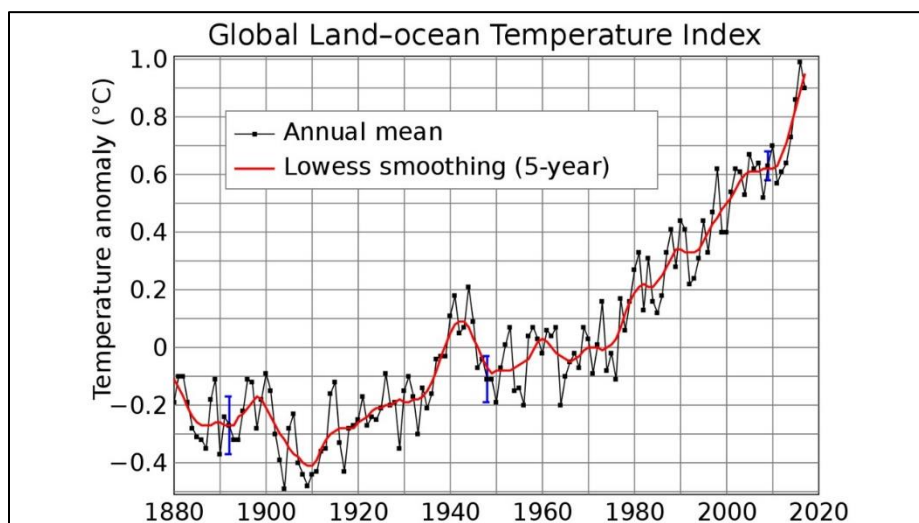
Shifting blame to some other cause would require two lines of evidence: implicating another mechanism to account for the current warming; AND providing an explanation as to why CO₂ and other greenhouse gases would not be culpable (deserving blame). Oh, attempts to do this have been made. All have fallen short.



It is no secret that our past climate has changed but this fact should not distract from the urgency of the current warming. These past changes can be attributed to a variety of mechanisms: changes in Earth's orbital characteristics, changes in solar output, and continental drift, to name a few. Clearly the culprit today is the enhanced greenhouse effect – something we are responsible for and something that is within our control to prevent. Some scientists have referred to our current geological age as the

“Anthropocene” – a period when human activity is the dominant influence of Earth's environment. If that is the case, and I believe it is, there is hope. We are not at the mercy of some uncontrollable natural force. It is us, and it is more important than ever for “us” to be good stewards of our planet.

The evidence of a changing climate is all around us and it has been within sight for many decades. I once served as the Assistant Director of The Climate Change Program for the State of Illinois. Even back in the late 1980's, I thought the evidence was indisputable. Now, 30 years later, the supporting evidence has only compounded. How long do we talk ourselves into circles, how much convincing is needed, before we act decisively?



The first 18 years of the 21st Century all have been warmer (except 1998) than any year in the 20th Century. The year 2018 ranks as the 4th warmest (2016 being the warmest). At its time, the warmest decade was 1980-89, warmer still was the next decade (1990-

99); warmer still was the decade that followed: 2000-2009. And 2010-2019 is on track to be the warmest decade on record. The trend is clearly obvious.

Recent news headlines over the past few weeks only reinforce the need to act: “The Greenland ice sheet is melting at astonishing rate”, “Antarctica ice melt has accelerated by 280% in the last 4 decades”, and “Australia has hottest month ever as polar vortex freezes North America” – the latter headline speaking to the increasing weather variability attributed to a warming planet.

Earlier I said, “within our control to prevent”. To be honest, climate change is already happening, and so are its consequences. Thus, it cannot be prevented. What can be prevented are the even greater consequences. We know of these as: rising sea levels, acidification of oceans, melting glaciers and ice pack, the growing intensity of rain events, the greater frequency of flooding, strengthening hurricanes, more frequent and strengthening droughts and heat waves, and more intense wild fires, to name but a few. It is for this reason the world community, at all levels, has called for a mitigation strategy – limiting the increases in the concentration of greenhouse gases. This is what the 2016 Paris Climate Agreement, and all earlier agreements, is about.

How are we doing? We have far exceeded the earlier maximum 350 ppm ceiling for atmospheric CO₂. Our new goal – as prescribed in the Paris Climate Agreement – is to keep a global temperature rise this century to well below 2 degrees Celsius. Let me just say this about that – given our slow pace in limiting carbon releases, achieving this goal will be a challenge.

Our Local Effort

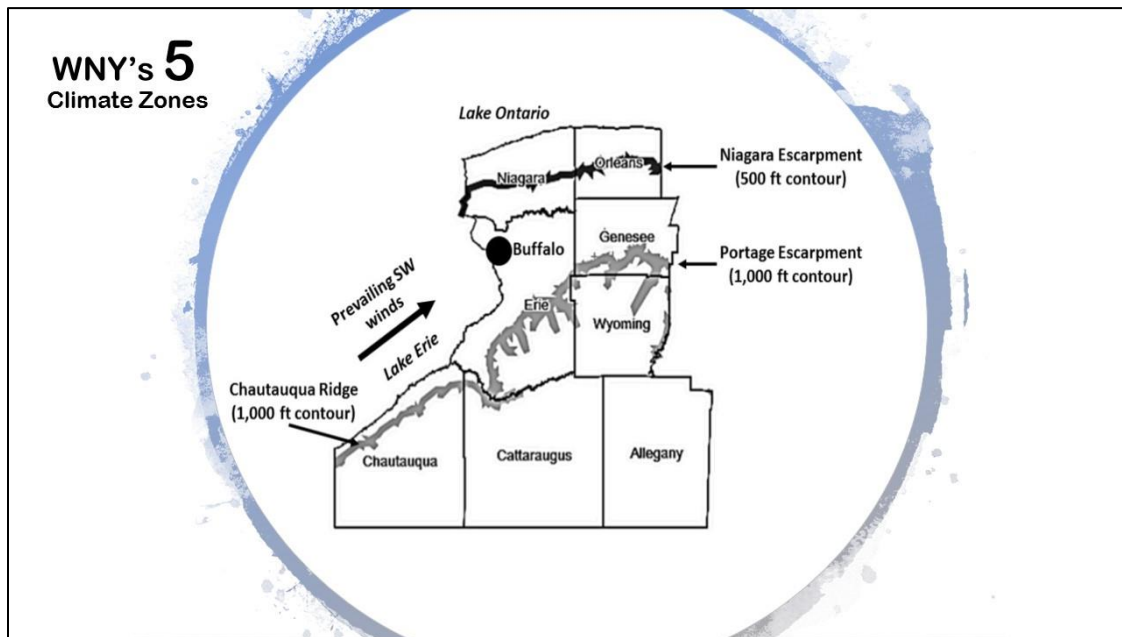
Let me speak about local efforts, specifically about a role which I have undertaken.

Currently, the U.S. has more extreme weather-related events, and variety of events, than any other country in the world. These events will likely increase in number and intensity as the consequence of a warming world. This has led some to question whether places in this country will be inhospitable – outright miserable to live in. Consider the rising sea levels submerging our coastal areas, the increasing strength of hurricanes along the east- and Gulf of Mexico coasts (and inland), the increased frequency of severe thunderstorms and tornado outbreaks and increased flooding in the Midwest, the growing severity of droughts and wildfires in the West, and the South being baked by longer and more intense heat waves. This country, including WNY, will certainly be reshaped by climate change.

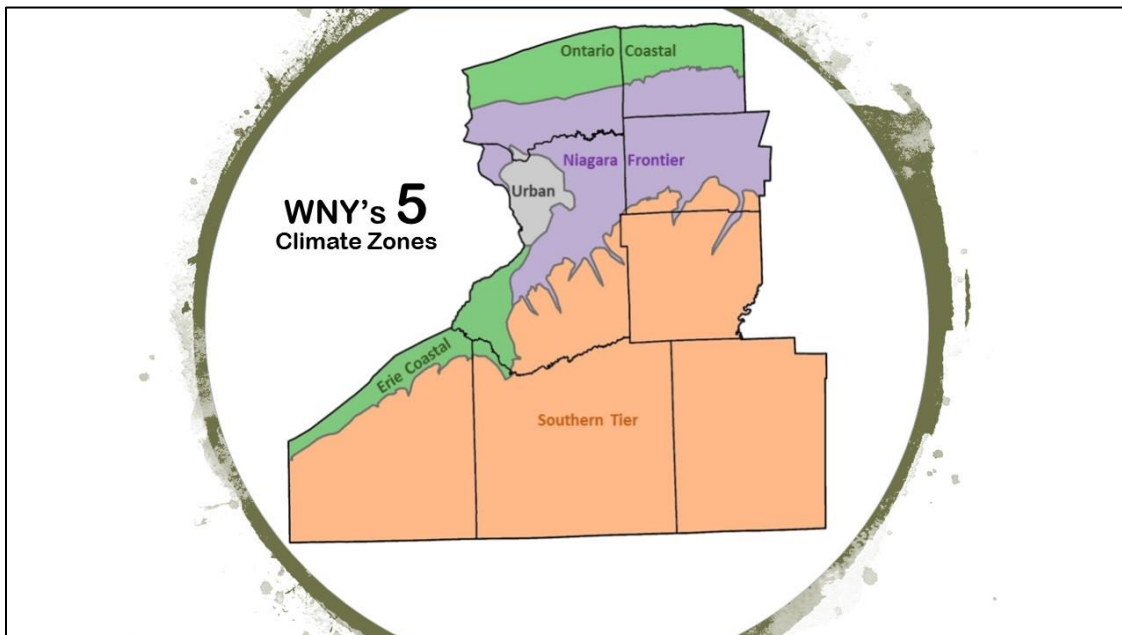
‘Designing to Live Sustainably’ is a local community group. They initially contacted me with their interest in preparing Buffalo and WNY for the effects of climate change. What does the WNY climate record tell us about future local effects?

My first step in answering this question was to define WNY’s current climate. Western New York (WNY) is defined here collectively as the eight westernmost counties of New York State (NYS): Niagara, Erie, Chautauqua, Cattaraugus, Allegany, Wyoming, Genesee, and Orleans.

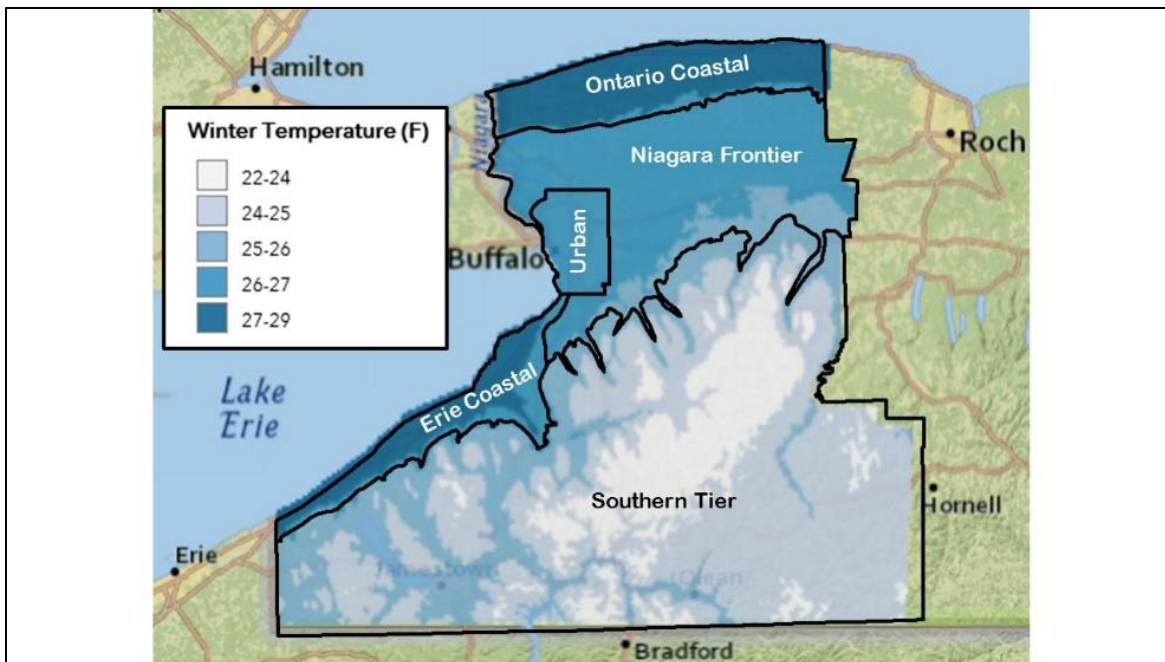
Let us now ignore these political borders just described. Just as water resources are not defined by political boundaries – but rather by watersheds – climate is best described by climate zones defined by several interacting forces driven by atmospheric processes. I have identified five (5) climate zones for WNY. This is the lens through which we should view climate and climate change in WNY.



Discussed climate controls (proximity to Lakes Erie and Ontario, elevation, prevailing winds and the urban heat island) which are used to establish WNY's climate zones.



WNY's 5 climate zones.



Winter temperatures (1980-2010 30-year average) overlaid on WNY's climate zones. Shown here as an example.

With this lens comes the realization that it should not be taken as a matter of course that regions will respond to global warming equally or with similar intensity. Whether we are looking at WNY in comparison to the rest of the country, or to climate zones within WNY, simply adding a projected temperature increase to a given location may not be correct – too simple. The local atmospheric processes must be considered.

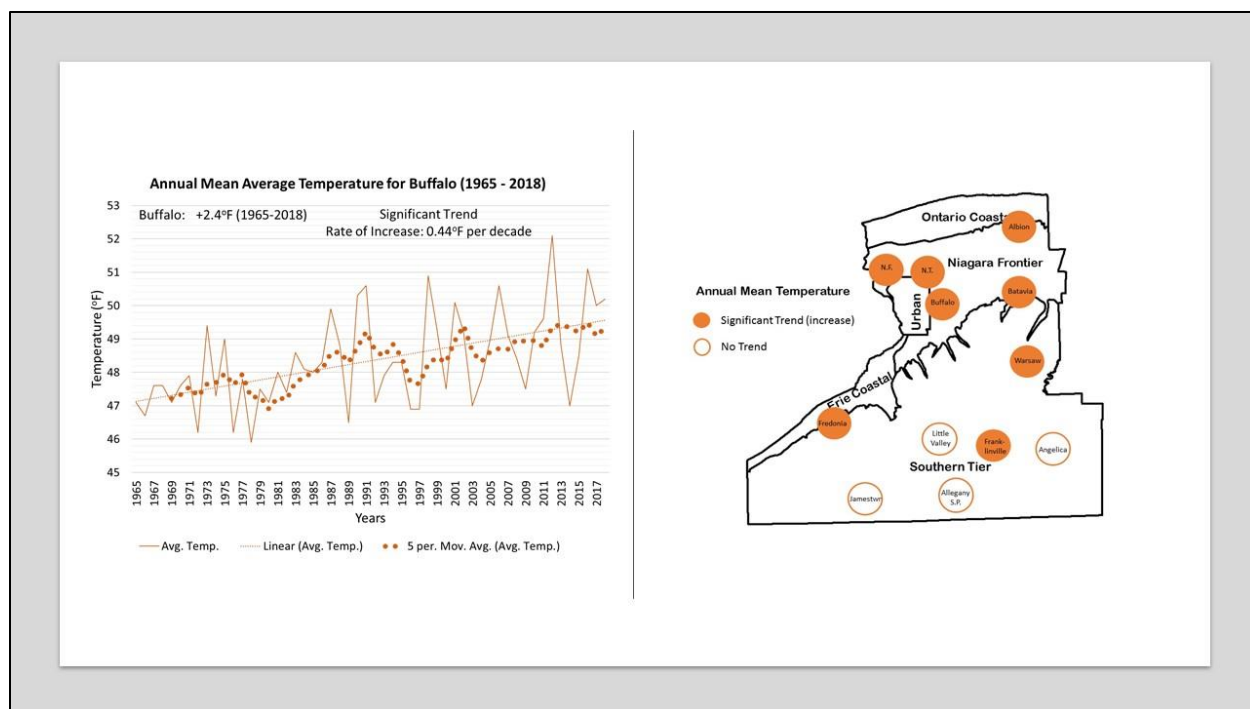
My second step was to search for the existence of trends in the existing climate record.

As I have already noted, climate change/global warming is not something that will be suddenly triggered in 2100, but rather is occurring today, and has been occurring for decades.

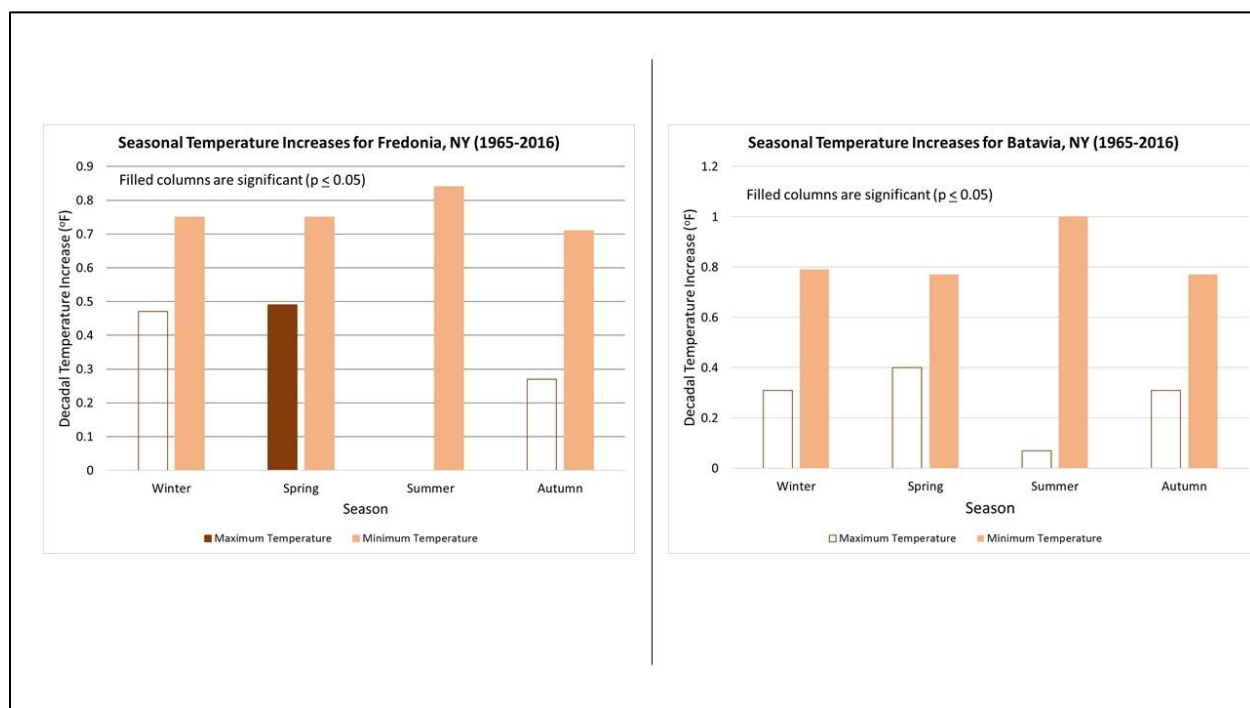
So, modeled climate projections, whether they be warming temperatures or increases in the intensity of precipitation, are usually reflected in the existing climate record.

Given the interest of 'Designing to Live Sustainably' in exploring climate-change related adaptation strategies, I analyzed the climate record for WNY using a trend analysis (starting in 1965). I looked at the data to identify significant statistical trends. I thank Zachary Neudeck, a Buffalo State geography student I hired one summer, for helping to crunch the numbers.

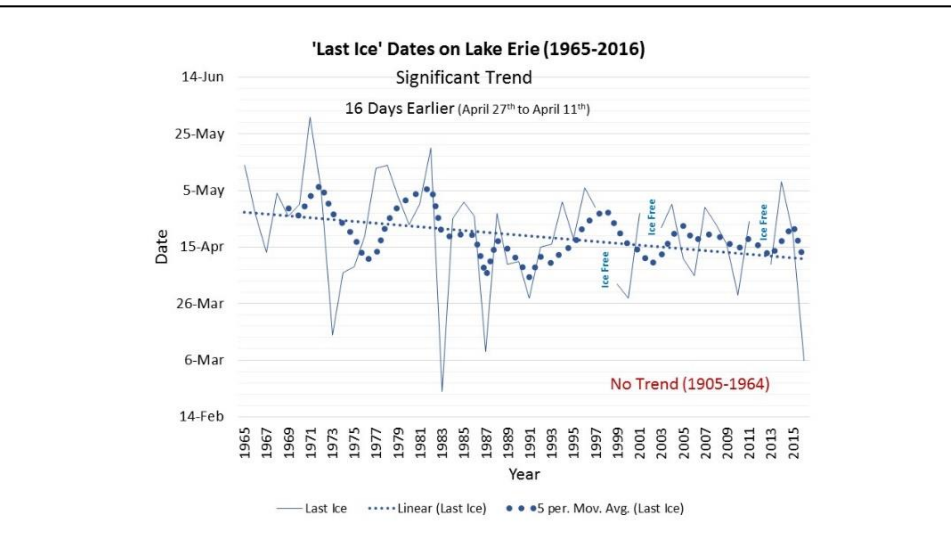
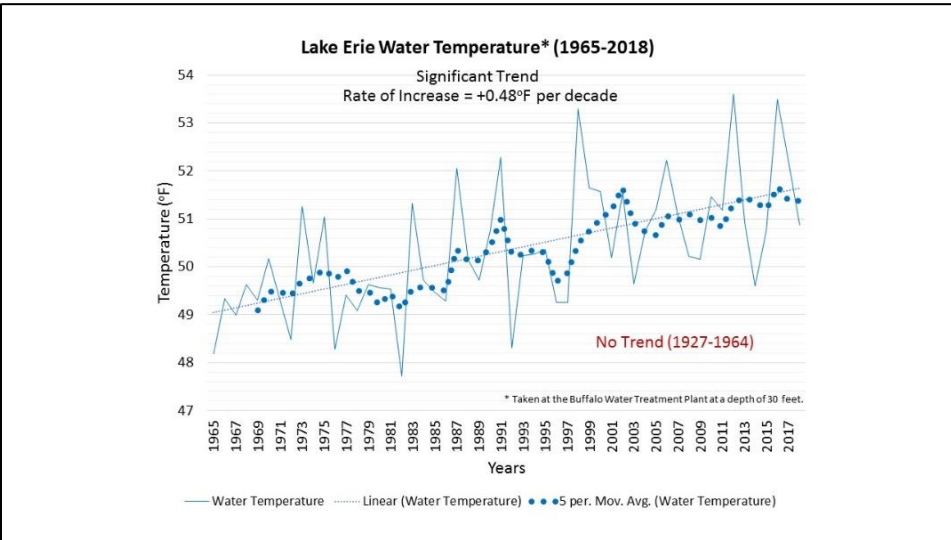
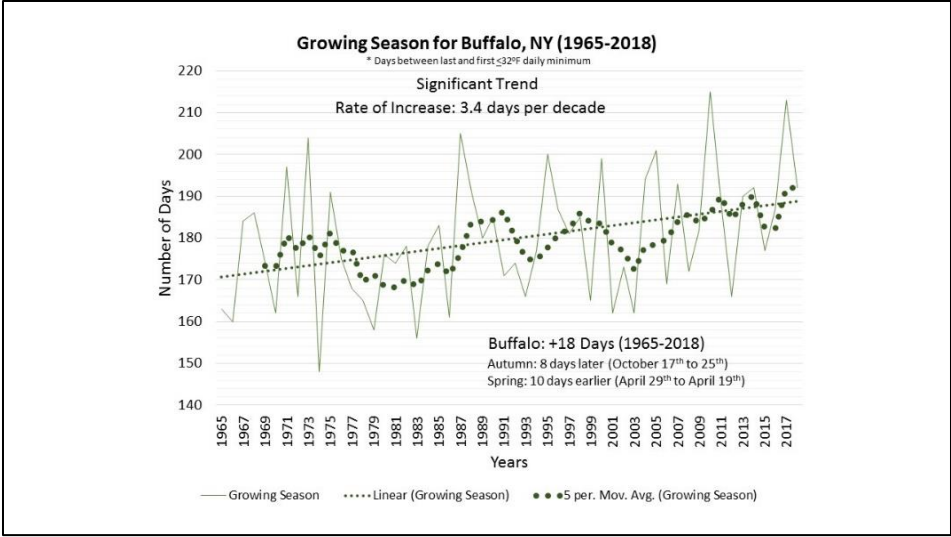
What I found was that on matters related to temperature, Buffalo and WNY is certainly experiencing a warming, at a rate consistent with the U.S. average. Parameters related to temperature all reinforce what would be expected in a warming world: our daily average, minimum, and maximum temperatures are increasing, there is a lengthening of our growing season, the need to heat less in the winter and cool more in the summer, and the warming of Lake Erie's waters, and less ice coverage on the lake, to name a few.



Increasing daily average temperatures for Buffalo, NY and much of WNY. Noted that several stations in the Southern Tier do not show a significant warming.



Increases in daily minimum temperatures appear to dominant at many stations, over that of daily maximum temperatures.



Average Annual Wind Speed for Buffalo, NY (1965-2018)

Significant Trend
Rate of decrease = - 0.38 mph per decade

Wind Speed (mph)

Years

— Average Wind Speed Linear (Average Wind Speed) ● 5 per. Mov. Avg. (Average Wind Speed)

Mean Total Precipitation (1965-2018)

No Significant Trend

Precipitation (inches)

Years

Legend:

- Precipitation
- Linear (Precipitation)
- +5 per. Mov. Avg. (Precipitation)

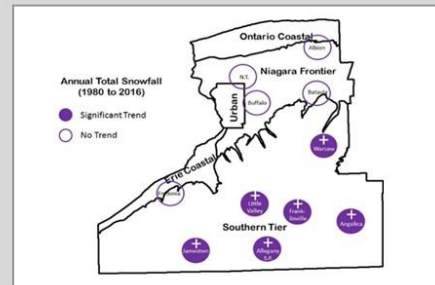
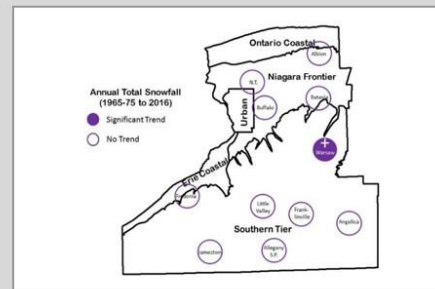
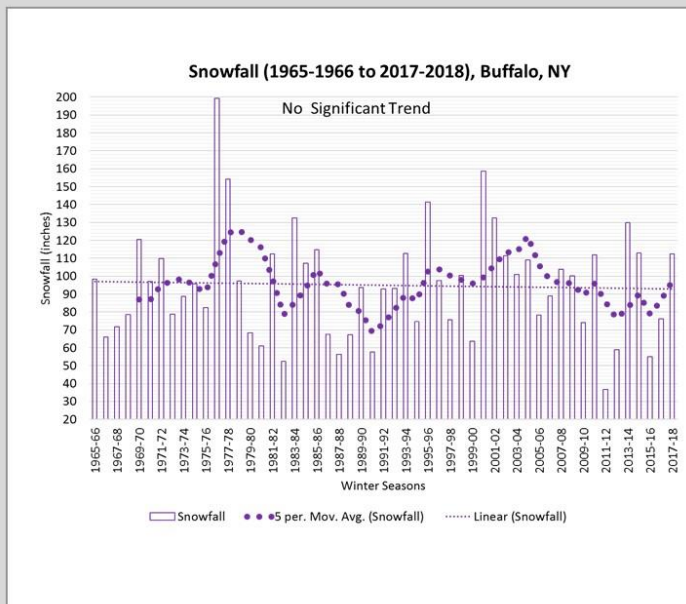
Annual Total Precipitation

Legend:

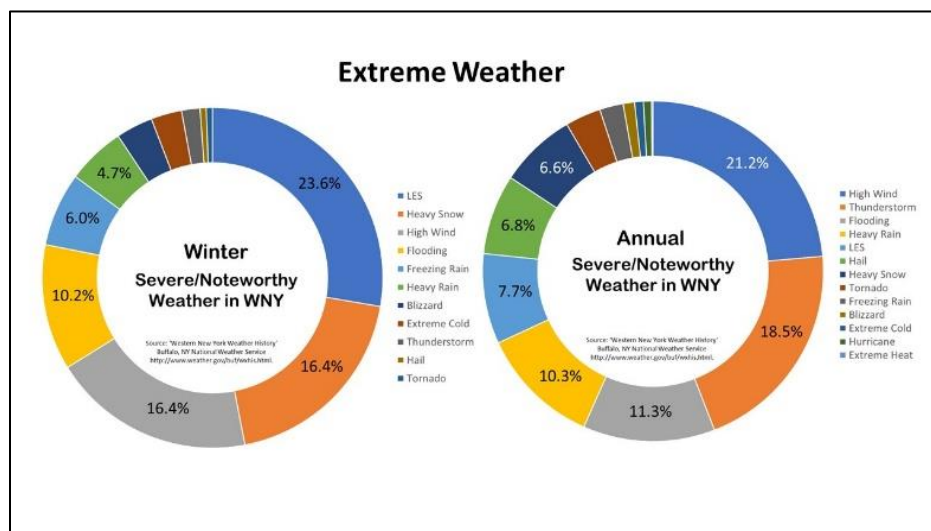
- Significant Trend
- No Trend

Map Labels:

- Ontario Coastal
- Niagara Frontier
- Erie Coastal
- Southern Tier
- Albion
- Urban
- Buffalo
- Barabara
- Warsaw
- Knoxville
- Franklinville
- Angelicus
- Allegheny S.P.
- Cathedral



Average yearly snowfall does not show a significant trend for Buffalo, NY, nor at most other stations across WNY. However, an examination of trends from 1980 to 2016, appears to show a significant increase in snowfall for the Southern Tier.



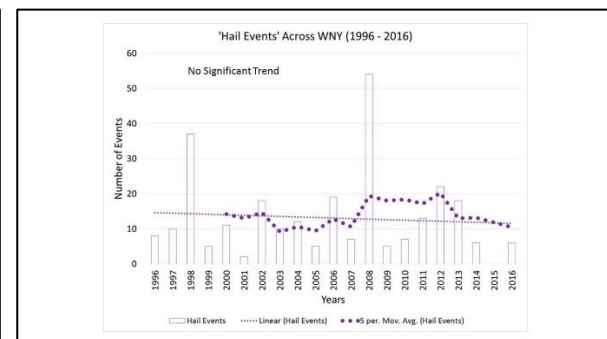
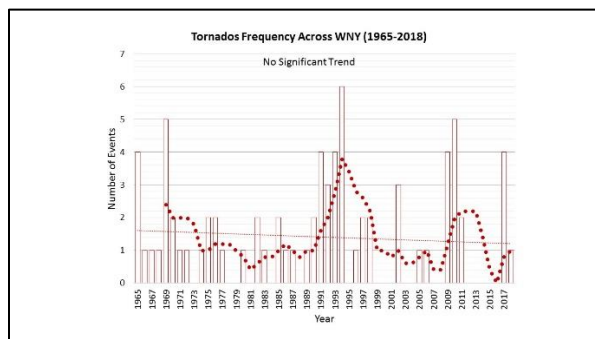
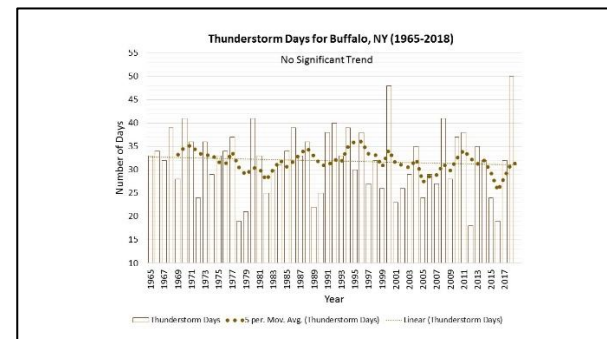
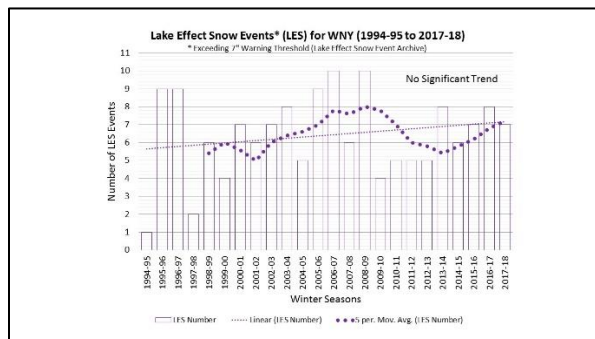
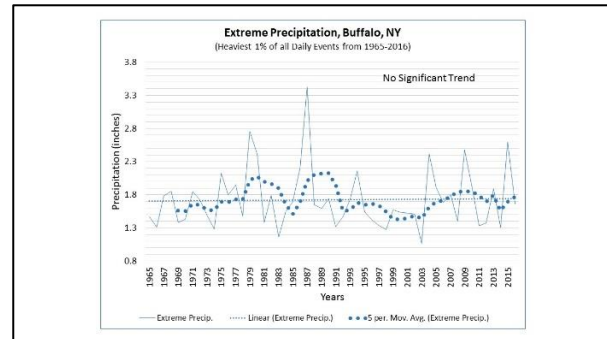
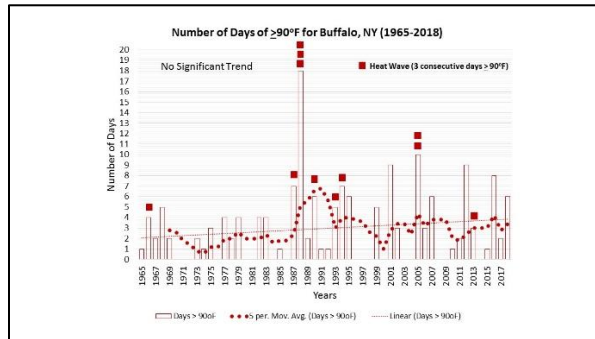
Now, let us look at what makes up extreme weather in WNY. I had my students ‘mine’ words from notable weather events over the years, as taken from the NWS “Western New York Weather History” – a date-by-date notation of notable weather.

As we are currently in winter let us look at severe weather during our winter months. The top five severe weather events in winter are lake effect snow (LES), heavy snow, high winds, flooding, and freezing rain. We just came off a week where we experienced all these events.

For the year, the top five types of severe weather events are high wind, thunderstorms, flooding, heavy rain, and lake effect snow.

How does WNY extreme weather trend over the past 50+ years?

Measures of severe weather-types including days $\geq 90^\circ\text{F}$, heat waves, drought, intense precipitation events, the frequency of thunderstorms, hail, as well as the number and frequency of tornadoes, do not show a significant statistical change.



Adaptation

Let me now speak on adaptation strategies.

The question of “What location will fare better?” is already on people’s radar. Companies grow concerned about the risks of climate change. I recently participated in a workshop titled “Preparing for Climate Change Impacts on Supply Chains” sponsored by the Western NY Sustainable Roundtable and co-sponsored by ‘Designing to Live Sustainably’. Companies study climate risks and consult with customers to reduce those risks. The New York Times reported about a venture capital company which provides mapping data at the city block level, allowing

customers to make business decisions, including location choices, based on the predicted effects of climate change.

The WNY group “Designing to Live Sustainably” has long advocated a local adaptation strategy, recently branded under the banner “Weathering Change in WNY”. Their strategy first involves obtaining a better understanding of what changes may be expected in WNY and outside of our region – as WNY cannot be considered an island – and engaging our community to explore adaptation strategies. An adaptation strategy not only prepares us for the physical effects of a changing climate but also the economic consequences, as well as the consequences to the human condition, including issues addressing climate justice.



Initially I was apologetic that I could not identify expected trends in many climate parameters, other than basic temperature trends. Additional to helping ‘Designing to Live Sustainably’, and by extension WNY, fine-tune possible coping strategies, the data took us to a new place. There was also the realization that this lack of trends (unchanging parameters) suggested that Buffalo and WNY may be better suited to survive climate change than other parts of the country. Is it possible that we can both: adapt and thrive?

The first part of this message (adapt) has met with some local resistance. In WNY we correctly focus on a mitigation strategy and Erie County is to be applauded for their efforts, as described in the “Erie County Commits to Paris Report”. However, we have, for the most part, overlooked an adaptation (coping or resiliency) strategy. It has been argued that we can’t do both. I believe the thinking goes something like: “an adaptation strategy is an admission of defeat”. I disagree. As I said; climate change is already happening, and we need to prepare for it – we certainly can chew gum and walk at the same time. What I mean is that mitigation and adaptation can be pursued together. This dual approach is gaining traction, as demonstrated by the recent recommendation of the Erie County Environmental Management Council to the Erie County Government.

The second part of this message (thrive) has met with greater resistance; that is until the Guardian newspaper recently interviewed Harvard climate adaptation specialist, Jesse Keen, who indicated that he liked the chances of Buffalo and WNY in a warming world. The story of Buffalo thriving in a changing climate was picked up by the Buffalo News, and most recently was the topic of an interview I had with NBC News.

Keen referred to our region’s relatively cooler temperatures, fewer extreme weather events, access to plenty of freshwater, inexpensive land prices, and a well-educated and skilled labor force, among other advantages.

This finding likely was made independent of the climate trend analysis that I have just spoken of. The coming together of these two threads, however, suggests that there may be something to this. As one of the ‘Designing to Live Sustainably’ board members recently put it: “It is unthinkable until someone else does it (or in this case “says it”), and then we may find that it was inevitable” – the “it” here referring to “thrive”.

Will WNY be a location that will fare better, and thus attract positive attention? How will WNY prepare for the consequences of climate change? How will WNY consider vulnerable populations? How will WNY prepared to deal with climate migrants? How will we position our economy to grow? How will WNY prepare to deal with agri-business buying up farmland? There are innumerable social, policy, and planning issues that need to be considered if Buffalo and WNY is to cope. These are compounded by an order of magnitude if we plan to thrive.

Regarding future climate research in WNY: much more work still needs to be done in defining our climate zones and understanding climate trends across all five (5) zones. And we are pushing for local (down-scaled) climate modeling (taking into consideration local climate controls) to provide yet another approach to better understand how WNY and individual climate zones within WNY might respond to a warming world.

Conclusion

Without doubt, Buffalo and WNY will be, and is currently being, stung by climate change. The point of this presentation is that the pain of this sting can be lessened if we start now to identify how WNY will respond to a warming world and consider well-thought-out adaptation strategies that will allow us to weather the change. And, also, how we, as a region, might position ourselves to not only cope but, I dare say, benefit from the change or, as ‘Designing to Live Sustainably’ would say – “to adapt and thrive.”

My charge to you is twofold. First, along with advocating for mitigation strategies, advocate for adaptation strategies that may best prepare WNY to cope with (adapt to) the changes ahead. Second, additionally consider how WNY may take advantage of its better position (to thrive) in comparison to other parts of the country.