Introduction

As I have lived in Indiana for my entire life, and I live in a heavily wooded area that is often affected by storms, I have noticed an extreme increase in severe storms over the last three or four years. I was interested in whether this was because it is more recent in my memory or if it was because of an actual increase. Then when I was at the Earth Day march in my town, Mayor Sakbun said that we had had multiple once in a century storms in the last five years. I thought this would make an interesting science fair project. My hypothesis is that there is going to be a noticeable increase in severe storms in the recent years.

Figure 1: View of tree on my house June 25, 2024
Photo Credit: Karla-Hansen Speer

Figure 3: View of the street down from my house June 25, 2024
Photo Credit: Karla-Hansen Speer

Methods

I was a bit stumped on how to measure a bad storm because there are pros and cons to everything. I considered several options including the property damage that each storm caused, the wind speed, and the rainfall. I decided that the rainfall would not be a good measurement because the amount of rain is not necessarily an indicator of a strong storm. That leaves the damage and wind speed; because of inflation everything costs more and so the property damage would be skewed data. However, I was able to solve this by finding a website that had inflation adjusted property damage, meaning that it will adjust the amount of money so that it is the same in all the years. Wind speed is also a good measure because strong wind can be the most damaging part of storms, knocking over trees, blowing furniture and everything else around. Now that I have my method for how to measure how severe a storm is, I can start looking at storm databases. The National Oceanic and Atmospheric Administration (NOAA) storm database was the one that I finally ended up using the most. It is a very reliable source that also has the wind speed and insurance adjusted property damage (IAPD). I went through each year back to 1977 and picked out the worst storm from each year. I examined the data for changes in the number and severity of storms. Once I found the worst storm for each year, I ran it through NOAA's National Centers for Environmental Prediction (NCEP) reanalysis, which makes a map with the geopotential heights so that you can see the storm fronts as they come through. This gives me a good graphic to see which years caused the most damage. I also used a graphic from NOAA that showed the number of severe weather events (although I am mainly looking at the severe storms part, Figure 5). Using this data, I entered the values onto an excel spreadsheet and ran a t-Test assuming unequal variance. Although not part of my analysis, I did look at the temperatures for 1950 through 2023 to see if there was any discernable increase.

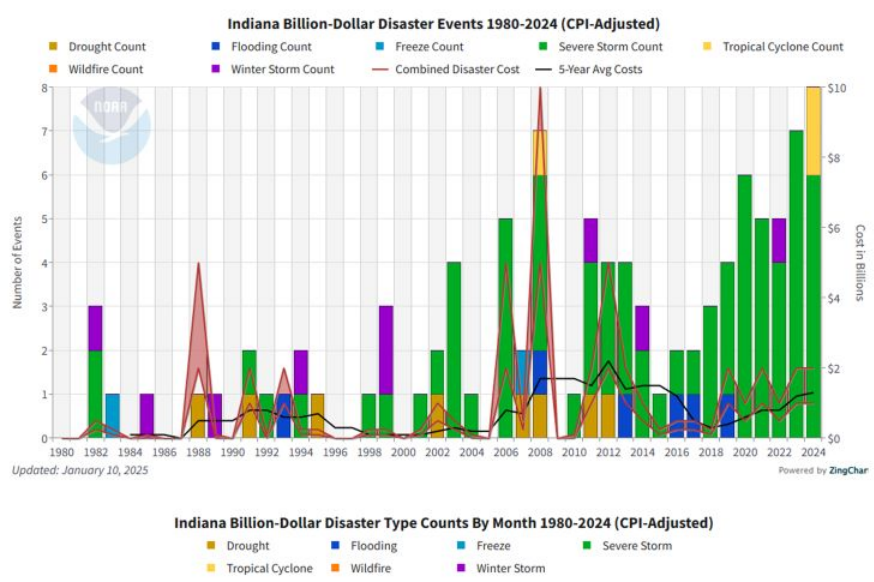

Figure 5: NOAA graph that shows billion-dollar disasters in Indiana

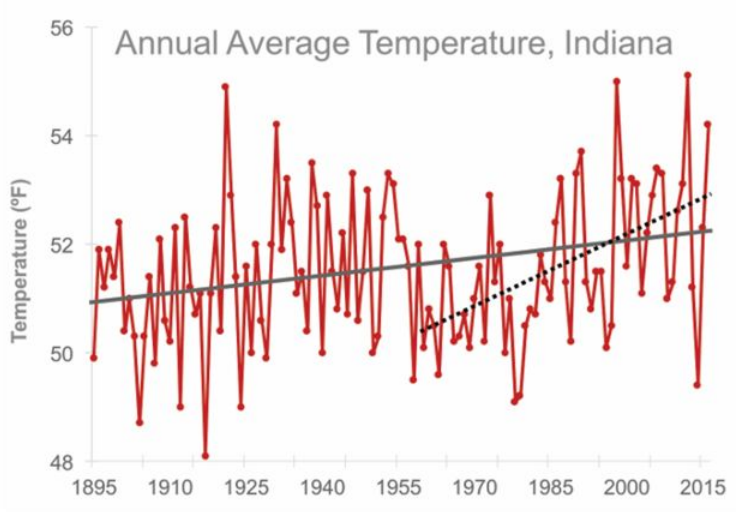

Figure 7: Indiana average temperatures

Results

In figures 4 and 6, you can see the air masses as they moved through the region, highlighting the extreme low-pressure zones that caused such damaging storms. These are two storms in the past five years that have caused over two million dollars in damages each, when the data shows there have been zero others going all the way back to 1977. I can also see from the t-Test (figure 3) that the average mean in storms between 1980 and 2002 is about 0.4 severe storms per year. Meanwhile the mean between 2003-2024 is 2.8 severe storm per year, showing a definite increase in the amount per year. I can see from my p stat that $p<0.001$, meaning that I am 99.9% sure that this did not occur by random chance. In figure 5 you can see that there is a definite increase in the number of storms in the last decade with many years having five or more disasters. In figures 9 and 10, I interpreted the graphs to mean that the average temperatures are higher, with the gray bars showing the temperatures for each year. The graphic in figure 7 also shows the increase in temperatures in Indiana, and how the average temperature increases even more in recent years.

t-Test: Two-Sample Assuming Unequal Variances

The later years are going to have more severe storms than the earlier ones.

	Severe Storms 1980-2002	*Severe Storms 2003-2024*
Mean	**0.391**	**2.864**
Variance	0.340	4.409
Observations	23	22
Hypothesized Mean Difference	0	
df	24	
t Stat	**-5.330**	
P(T<=t) one-tail	**9.04E-06**	
t Critical one-tail	**1.711**	
P(T<=t) two-tail	1.81E-05	
t Critical two-tail	2.064	

Figure 8: T-Test for severe storms assuming unequal variance

Discussion

After analyzing all the data that I have collected, I have concluded that there has been a definite increase in the number and severity of the storms that we have had, supporting my hypothesis. This points to factors such as climate change increasing severe weather, which is very important whenever discussing this topic. Once the main cause of these abnormal weather patterns is isolated, we can take the correct measures to try and reduce the impact, thus saving not only money, but possibly lives in the process. Another possible detail that should considered is the increase in average temperatures in recent years, which is another driver of climate change. This leads me to believe that climate change is having very harmful effects on the severe weather and that if we continue at this rate, the storms with millions to billions of damages will become less the outlier and more the norm. This is why it is of the upmost importance that we figure out exactly how to stop this kind of disaster from happening. The graphic in figure 7 also shows the increase in air temperatures in Indiana and based on this trend, the temperatures are projected to rise.

References

- Noaa.gov. (2011). *NOAA/NWS Storm Prediction Center*. [online] Available at: https://www.spc.noaa.gov/.
- NCEI.Monitoring.Info@noaa.gov (2025). *Billion-Dollar Weather and Climate Disasters | National Centers for Environmental Information (NCEI)*. [online] Noaa.gov. Available at: https://www.ncei.noaa.gov/access/billions/state-summary/IN.
- Team, P.W. (2025). *6-hourly NCEP/NCAR Reanalysis Composites: NOAA Physical Sciences Laboratory*. [online] Noaa.gov. Available at: https://psl.noaa.gov/data/composites/hour/.
- NCEI (2025). *Storm Events Database | National Centers for Environmental Information*. [online] Noaa.gov. Available at: https://www.ncei.noaa.gov/stormevents/.
- Weatherspark.com. (2025). *Terre Haute 2025 Past Weather (Indiana, United States) - Weather Spark*. [online] Available at: https://weatherspark.com/h/y/14045/2025/Historical-Weather-during-2025-in-Terre-Haute-Indiana-United-States#Figures-Summary [Accessed 29 Jan. 2026].
- Indiana's Past & Future Climate: A Report from the Indiana Climate Change Impacts Assessment. (n.d.). Available at: https://goshenindiana.org/wp-content/uploads/2024/12/8271_Indiana-s-Past-Future-Climate-A-Report-from-the-Indiana-Climate-Change-Impacts-Assessment.pdf.

Acknowledgments

I would like to thank my family for all the help on putting my project together, especially on getting started. I would like to thank my brother for help on my citations, my dad for help on helping put my board together and my mom for the pictures that she took of the storms. Mayor Sakbun's speech at the climate march on Earth Day was the inspiration of my project. I would also like to thank my friends for their support and their help to stop me procrastinating and Dr. Greg Bierly, professor of climatology at ISU, for the introduction to the NOAA storm database and reanalysis.