Analyzing Legislative Impacts of Climate Change: A Case Study of Charleston, WV and Ithaca, NY

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Introduction

The Environmental Protection Agency (EPA) characterizes **climate change** as "any significant change in the measures of climate lasting for an extended period of time." This can be seen through rising sea levels, extreme weather trends, and higher temperatures in the present day. Upon realizing the effects of climate change, legislators are attempting to affect positive change. To mitigate the effects of climate change, major pieces of legislation have been passed. This includes the Clean Air Act (1970), which gives the federal government the authority to regulate emittance of a number of harmful pollutants. Though acts like this have been important milestones in environmental protection, climate change is still rapidly progressing.

Research Question:
How effective has legislation been in mitigating CO_2 emissions and the impacts of climate change?

Hypothesis:
Ithaca has not been as affected by climate change as Charleston, WV, due to a more effective implementation of policy to meet EPA air quality standards. Thus, Ithaca, NY, will show less change in temperature & CO_2 emissions.

Background

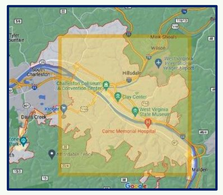
Areas in this case study were Ithaca, NY and Charleston, WV (both in Appalachia). They were chosen because although they are similar in population and land characteristics, their states have highly differing environmental regulations.

Policy Summary

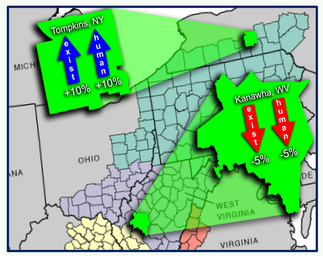
Ithaca, New York	*Charleston, West Virginia*
• Historically, NY has been willing to comply with the EPA's National Ambient Air Quality Standards through implementing regulatory legislation. • NY has implemented Motor Vehicle Inspection & Maintenance (I/M) Programs and Vehicle Inspection Programs (NYVIP).	• Did not meet the EPA's National Ambient Air Quality Standards from 1978-2020. • According to historical performance, West Virginia has not implemented the necessary policy to maintain emissions within the EPA's standards in the past.

By statistically examining the extent of changes in decadal temperature and carbon emission, we can identify the effects climate-targeted policies have had.

Ithaca, New York
Area: ~4.5 square miles



Charleston, West Virginia
Area: ~18 square miles



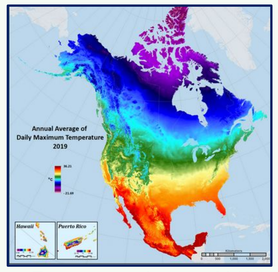
County wide opinions on the existence and sourcing of climate change relative to national average: Yale Climate Studies

Sources, Materials, and Methods

Data Sources

To collect precise data for different regions, ORNL Distributed Active Archive Center (DAAC) was utilized in the analysis. DAAC is a database that includes a scientifically validated range of information related to climate change.

Other sources include:
- National Centers for Environmental Information
- Northeast Regional Climate Center at Cornell



Temperature Average 2019
Source: DAAC

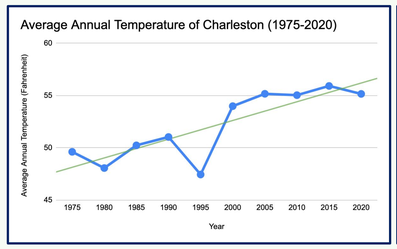
Materials
- Excel statistical and analysis tools
- Google Earth images

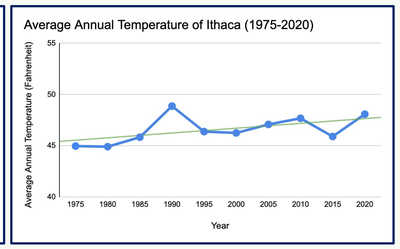
Methods
- Identify policy differences between WV and NY
- Subset data using Spatial Data Access tools
- Calculate rate of change in temperature and CO_2 emissions in each case study region between 1975 and present day
- Compare rate of change of each variable
- Conclude if implemented policy in the two states affected the rate of climate change

Sequence of Analysis

Organize Data (DAAC, NOAA) → Subset data on local basis → Calculate changes in variable patterns → Compare extents of changes

Results (Temperature)





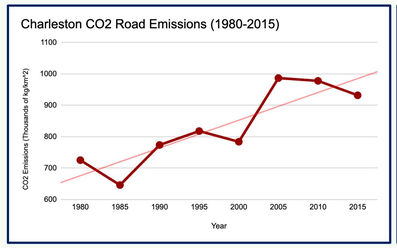
Note: Temperature axis values vary due to regional differences in weather patterns.

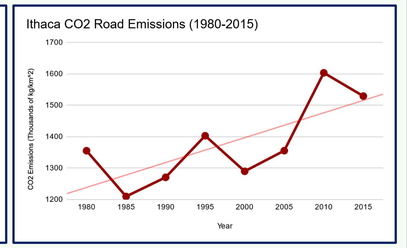
Location	Rate of Change (temp./time)	r^2 value	Maximum Change (Overall)	1975 - 2020 Change
Charleston, WV	+0.894 °F/yr	0.703	8.47 °F	5.54 °F
Ithaca, NY	+0.234 °F/yr	0.292	3.96 °F	3.11 °F

Key Takeaways

- Charleston has a much more statistically **significant increase in temperature** ($r^2 = 0.703$). Charleston is also **warming at a much faster rate** than Ithaca, though Ithaca is also not without temperature increases.
- Temperature differences displayed **greater variability** in Charleston.
- This result aligns with the extent of environmental regulations in each state.

Results (CO_2 Emissions)





Note: On-road emission data was used as a proxy for total emission data due to a limitation of data access.

Location	Rate of Change	r^2 value	Maximum % Increase	1980 - 2015 % Increase
Charleston	44,174 kg/km^2/yr	0.766	52.7%	28.5%
Ithaca	39,608 kg/km^2/yr	0.536	32.5%	12.8%

Key Takeaways

- Charleston demonstrates a statistically **stronger positive emission trend** than Ithaca. The rate of change is also **higher** in Charleston.
- The percent increase of emissions is greater in Charleston than in Ithaca; in fact, the total timeline increase of carbon emissions in Charleston is **more than double** that of Ithaca's.
- Hence, the CO_2 patterns of Charleston and Ithaca align with the hypothesis.

Conclusions

- Notable correlations exist between the implementation of environmental regulations and the extent of change of temperature and carbon emissions. Hence, legislation *can* effectively mitigate climate change.
- Limitations of this research include:
  - Unavailability of land type distribution of case study areas
  - Mismatch between date stamps of data
- Future work includes applying this framework of analysis to other areas to further explore the relationship between policy and climate change.
  - As more legislation is passed and implemented, climate trends will evolve, so these areas could be re-investigated in the future.

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Note: full references available upon request

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Acknowledgements

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