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Methods of Assessing Air Pollution and Economic Development in Colombia

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Publication Date

2023-04-01



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Methods of Assessing Air Pollution and Economic Development in Colombia

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Haorui Zhou*, Harry Hebler*, Kathy Baylis

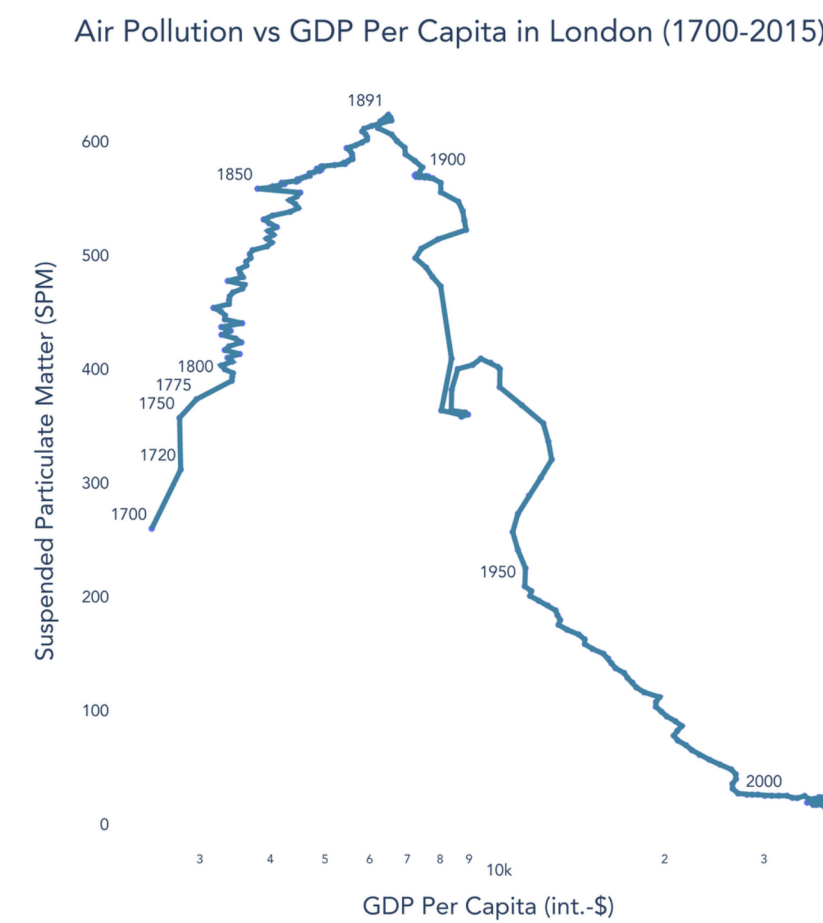
*These authors contributed equally to this work.

INTRODUCTION



Inverted-U Shape
(Environmental
Kuznets Curve) [2]

- In developing countries, pollution can be a major drag on the economy and people's health and ability to work [1].



- London showed an inverted-U shape relationship between air pollution and economic development [3].

QUESTIONS

- Can the same inverted-U shape be observed in developing countries as in London?
- In the United States, air pollution disproportionately affects disadvantaged populations. Do we see the same environmental justice issues in Colombia?

OVERVIEW

- Colombia is a middle-income country with a growing economy. Compared to the rest of the world, Colombia suffers from high levels of air pollution.
- In 2018, the global median PM 2.5 value was 12.8, while the median PM 2.5 value in Colombia was 18. Exposure to air pollutants like PM 2.5 can cause respiratory diseases and have serious health consequences [4].
- Poor air quality can also impact economic activity by reducing worker productivity, increasing healthcare costs, and reducing tourism [5].
- In 2018, Colombia's GDP was \$334.2 billion, making it the fourth-largest economy in South America [6].

DATA

- Annual Mean Surface PM2.5 [$\mu\text{g}/\text{m}^3$] at $0.01^\circ \times 0.01^\circ$ [7]
- Colombia 2018 Census [8]
- Colombia Departmental GDP [9]
- USGS GTOPO30 Elevation [10]

METHODS

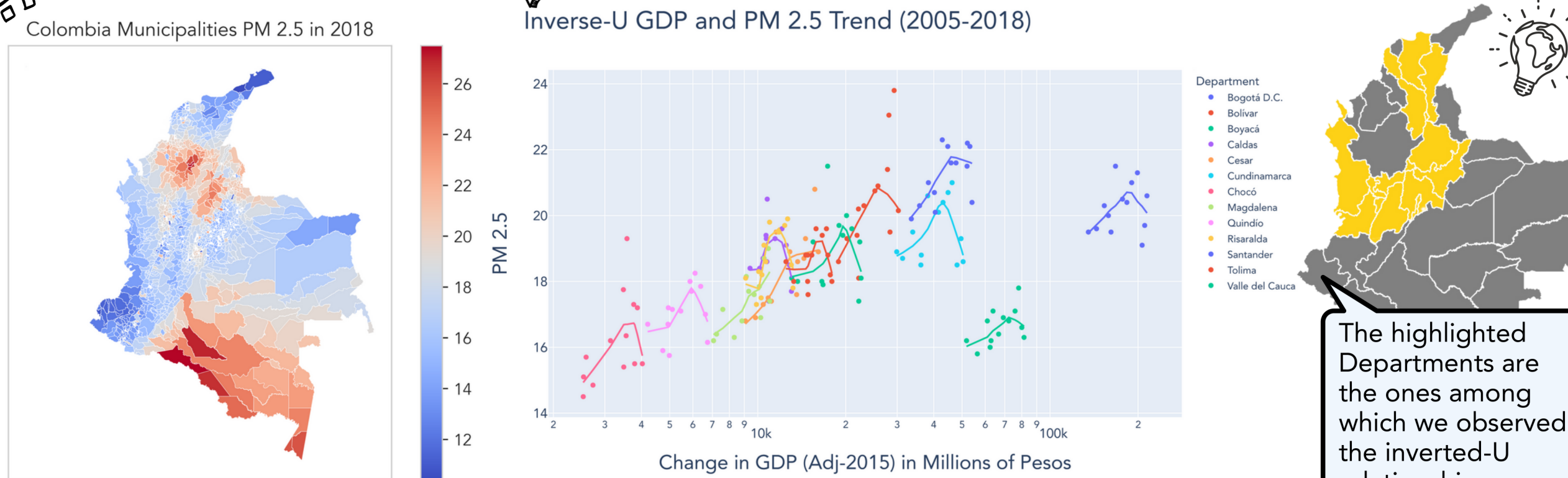
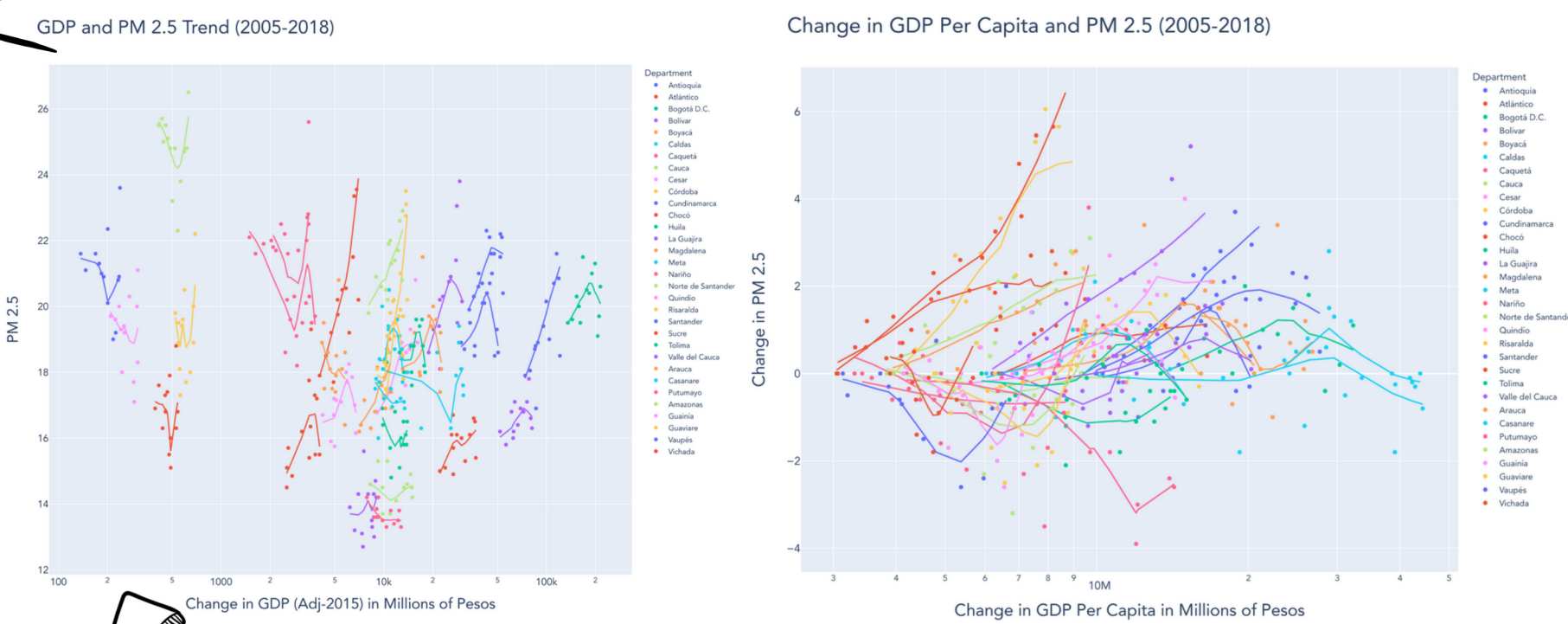
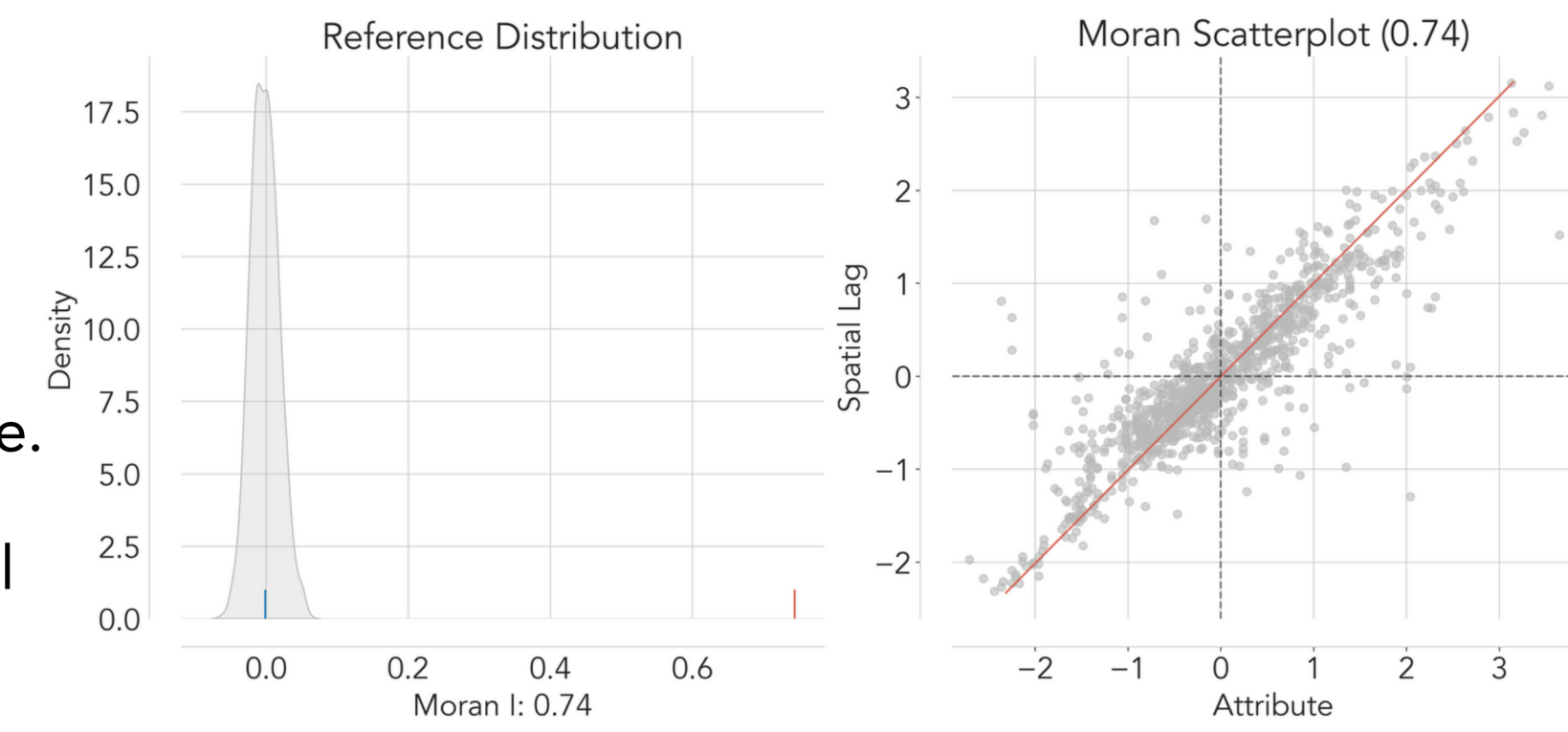
- We conducted a spatial correlation analysis to investigate the relationship between changes in air pollution and GDP over time.
- Air pollution has strong spatial autocorrelation (local Moran's I = 0.74).



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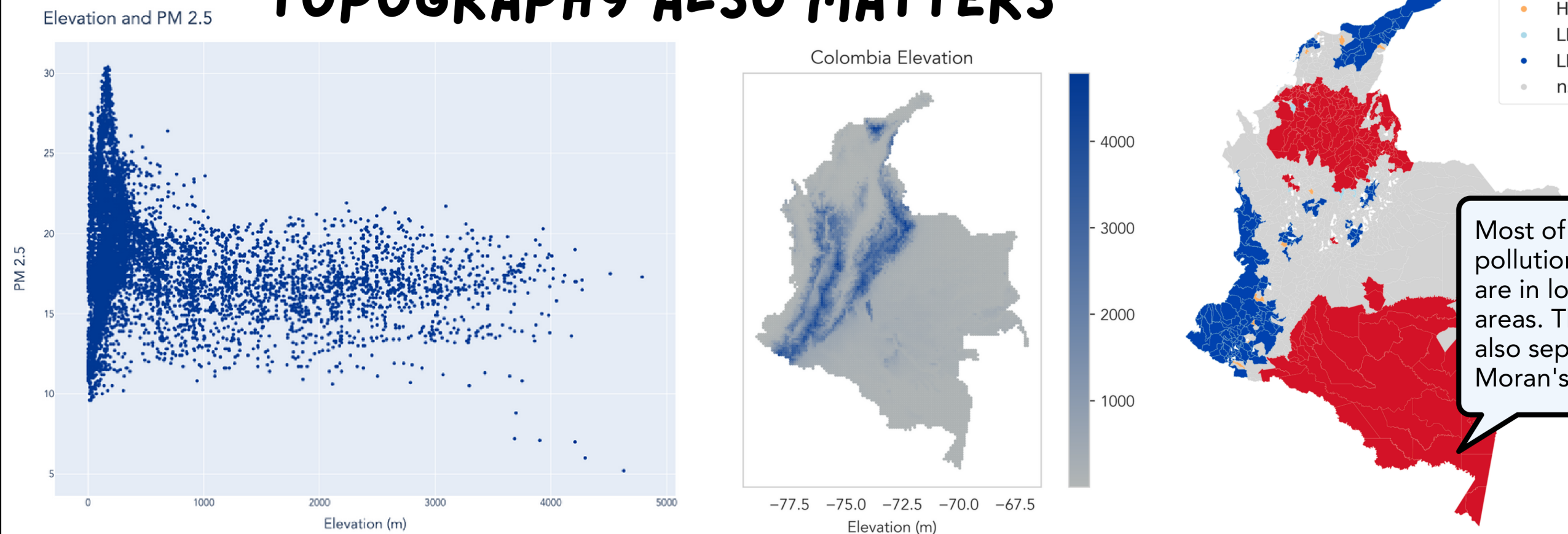
TRENDS

- Some Departments showed an inverted-U shape trend



The highlighted Departments are the ones among which we observed the inverted-U relationship.

TOPOGRAPHY ALSO MATTERS



Most of the high air pollution observation are in low elevation areas. The mountains also separate Local Moran's I zones [11].

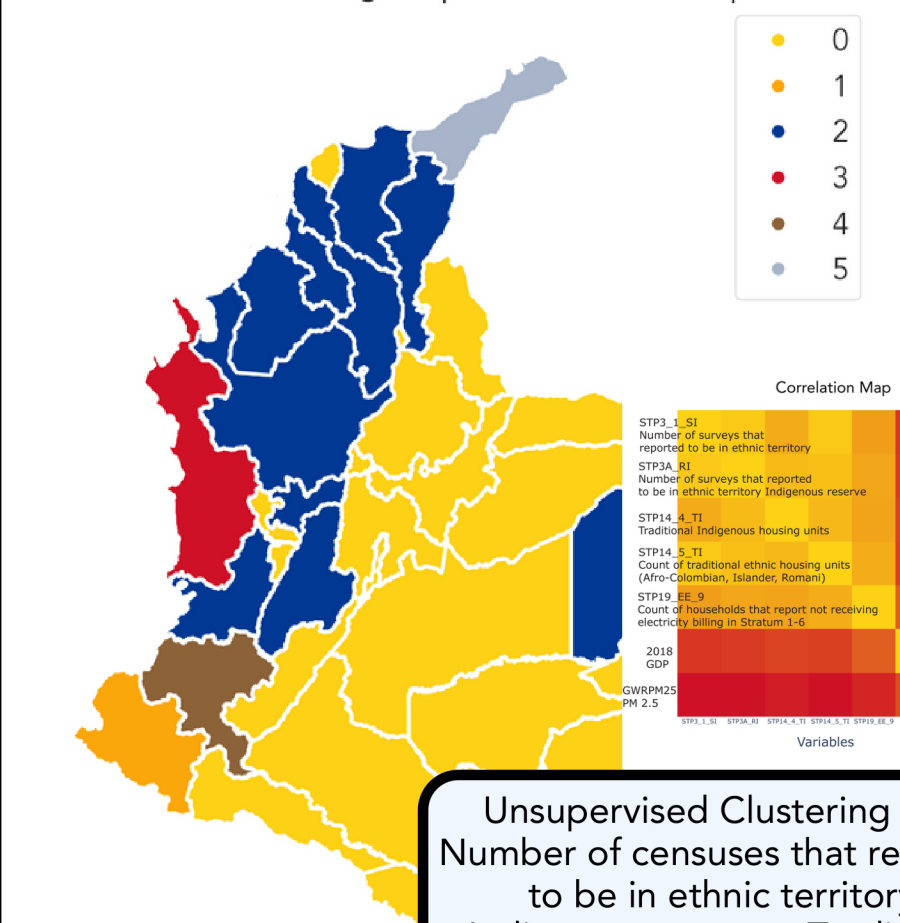
DISCUSSIONS

- We observed preliminary evidence for an inverted-U shape relationship between economic growth and air pollution.
- Air pollution is not significantly higher in disadvantaged communities.
- Clustering analysis and Global Moran's I suggest that air pollution is spatially correlated with certain geographic features [12].

NEXT STEPS

- Connect more census data with air pollution observations.
- Expand the study to other developing and underdeveloped countries that get less attention.
- Introduce population density and weigh air pollution more in a densely populated area.
- GDP per capita is not a bad measure of poverty, but a direct measure is more preferable.

Hierarchical Clustering Map of Colombia Departments



Unsupervised Clustering with Number of censuses that reported to be in ethnic territory, Indigenous reserve, Traditional Indigenous Housing count, Traditional Ethnic Housing count, households not receiving electricity billing in Stratum 1-6

LIMITATION

- Air pollution data is derived from remote sensing data, which can be inaccurate.

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ACKNOWLEDGEMENTS

We would like to acknowledge the generous support provided by UC Santa Barbara's Undergraduate Research & Creative Activities for funding this research project. We would also like to express our sincere appreciation to UCSB Geography Department graduate student Sophia Arabadjis, Katie McMahon, and Pablo Ordonez from Inter-American Development Bank for their invaluable assistance and guidance throughout this research project.

This entry is for Hally Zhou and Harry Hebler, co-authors of the poster.

Reflection

In the beginning, the seeds of our research project were sown when my collaborator, Harry Hebler and I took Professor Kathy Baylis' class on Economic Geography. Professor Baylis presented research on air pollution and population migration; the lecture highlighted the detrimental effects of air pollution on human health and the environment, and its disproportionate impact on less privileged populations. It was during this lecture that we noted the lack of research on developing countries, with most studies focusing on China and India.

We discussed with Professor Baylis and decided on the topic of air pollution and its impact on economic development in Colombia, influenced by the vast body of research highlighting pollution's harmful effects, especially on less privileged populations. We realized that while extensive research existed on developed countries and a few developing ones like China and India, the narrative around middle-income countries like Colombia was relatively unexplored.

Our research process commenced with an in-depth literature review of the economic impacts of air pollution. We relied on the UCSB Library's comprehensive collection of scholarly resources, including research papers, journals, and books. These sources, chosen for their credibility, authority, and scope, were invaluable given that we had not been to Colombia and lacked funding for field research.

The evaluation of our sources was a critical aspect of our research, especially due to the project's technical nature. We scrutinized each source based on the author's expertise, the data quality, and its relevance to our research. This rigorous vetting process allowed us to establish a robust foundation for our study, despite our inability to conduct field research.

Our research is quantitative, using Colombia's Census Data (CNPV 2018), GDP data, digital elevation data, and surface PM 2.5 data from 2005-2017. The data utilized are either from local government officials or peer-reviewed data sets published by other researchers. At the time of conducting this research, Harry and I had not taken any data analytics class, nor any geographic information science class. We struggled with loading and visualizing the large data sets that we were working with and could not make much progress.

A pivotal moment came with the Data Carpentry workshop organized by the Library. This program equipped us with critical skills in Python, R, and geospatial data analysis, forming the cornerstone for our subsequent data analysis endeavors. We ventured into conducting multi-scale spatial analysis and unsupervised machine learning clustering - challenging yet profoundly educational tasks. The knowledge and experience gained through this process not only bolstered our competence but also gave us a significant advantage in our academic coursework this year.

We found the physical space of the library invaluable. It became our workspace, where we analyzed data, conducted research, and created our project's visual component, the poster. The serene environment of the library fostered focus and productivity, essential in navigating our complex topic.

We were fortunate to have the supervision of Professor Kathy Baylis from UCSB Department of Geography. Her guidance was instrumental in our project's successful completion. She challenged our assumptions, refined our research methods, and ensured we maintained a high level of academic integrity.

Reflecting on this journey, I realize that this research process was not just about studying air pollution and economic development in Colombia. It was also about learning how to undertake a complex, data-driven research project, working effectively with a collaborator, and leveraging the resources available to us, like the UCSB Library. It was a process that challenged us, taught us, and allowed us to contribute to a critical global conversation.

In conclusion, this research journey has not only enriched our understanding of air pollution's impact on economic development in countries like Colombia, but it has also equipped us with invaluable skills and insights that we are eager to apply in future research endeavors, contributing to global environmental and economic discourses.

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