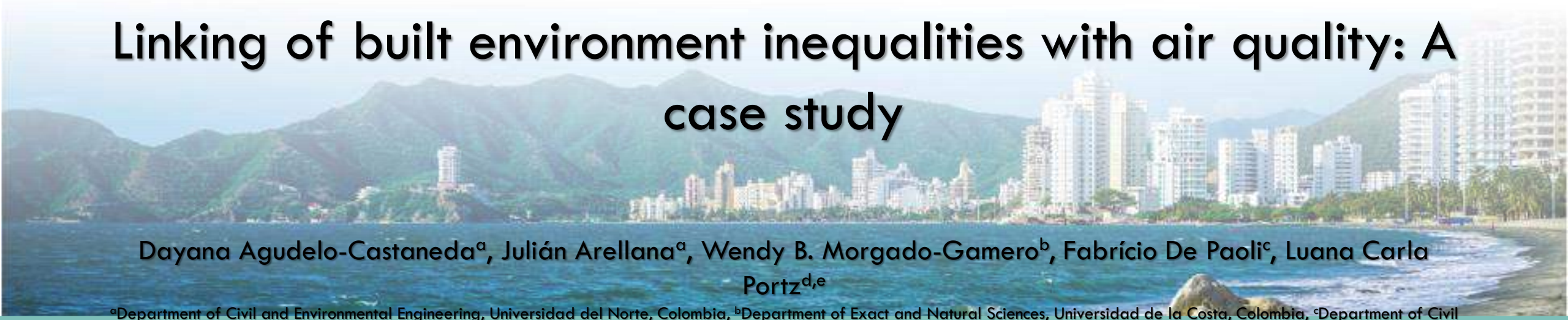
CASAP IX
CONGRESO COLOMBIANO Y CONFERENCIA INTERNACIONAL
DE CALIDAD DE AIRE, CAMBIO CLIMÁTICO Y SALUD PÚBLICA

Linking of built environment inequalities with air quality: A case study



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Presentador: Ing. Fabrício De Paoli, M.Sc.

Why is important?

- Barranquilla, driven by unprecedented economic growth, the explosive increase in urbanization and population, can experience severe NO_2 air pollution problems. .
- Nitrogen emissions management in Latin American countries represents a significant challenge because, in some cities, the air quality monitoring network has poor consistency
- Exposure to air pollution tends to be higher among groups with lower economic and educational resources.
- In Latin America, recent studies suggested that countries of the global South had higher death rates attributable to air pollution than countries of the global North.
- Few studies in Latin America explore the relationship between the built environment inequalities and Land Use Regression (LUR) model.

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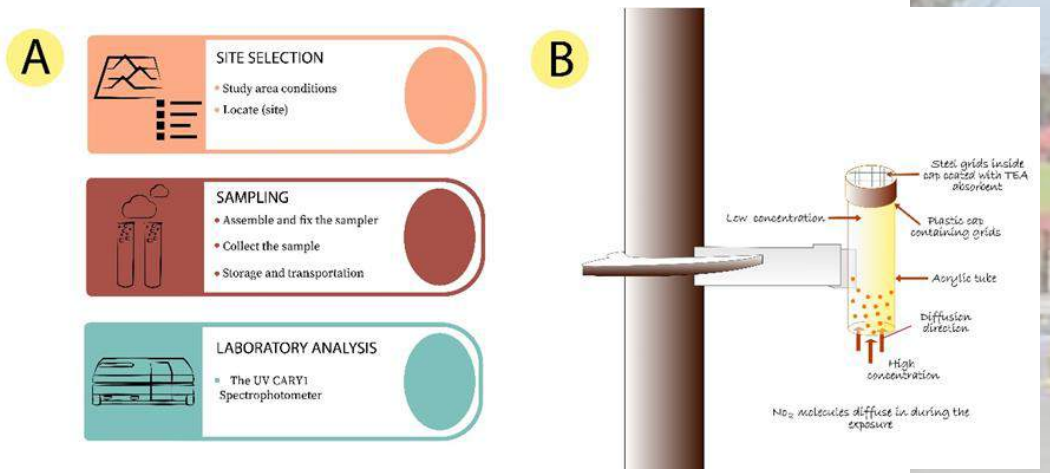
Objectives

- Explore the linking of built environment with air quality by developing a model that allows relating NO2 with transport, land use, socioeconomics, and built environment characteristics.
- Understand the impact of urban planning on the exposure of NO2 in a Caribbean city.

Methods

Passive diffusion tubes

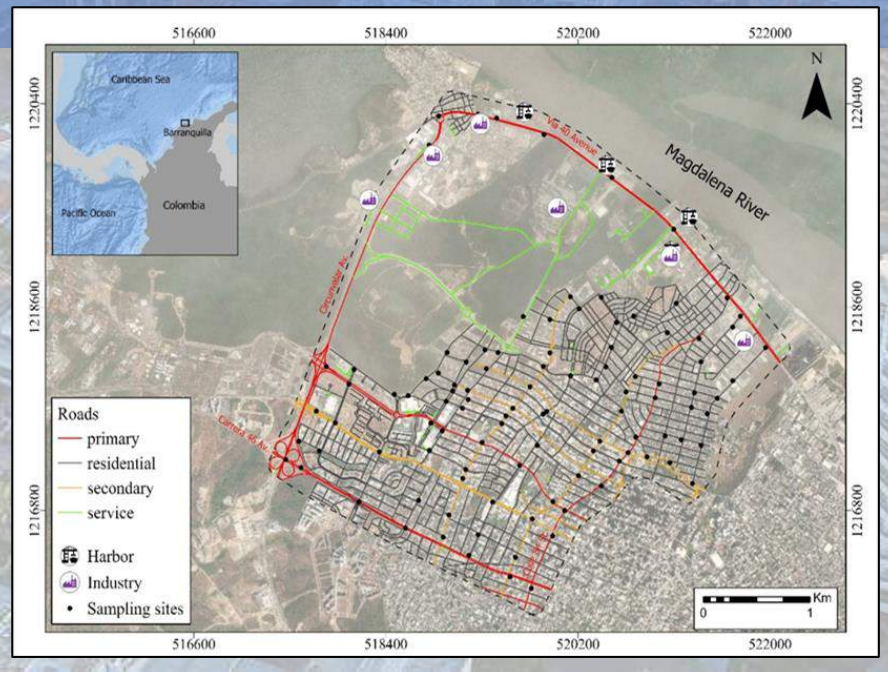
- Passive diffusion tubes to monitor airbone NO2.
- Passive tube samplers were positioned across different sites; on lampposts, street signs, a fence, or other appropriate sites.
- Samples were collected for 337 h on average using passive diffusion tubes (3/16/2019 to 3/30/2019) in 114 points.



Methods

Study area conditions:

- **Barranquilla is one of the main ports and industrial centers of the Caribbean Region of Colombia. It is located on the Magdalena River's western edge, 7.5 km from its mouth in the Caribbean Sea, with 154 km2 of territory and 1.193.952 inhabitants.**
- **The location of study area is in the north of the city, with mixed land use comprised of residential, recreational (e.g. parks), commercial, service, and industrial activities.**



Methods

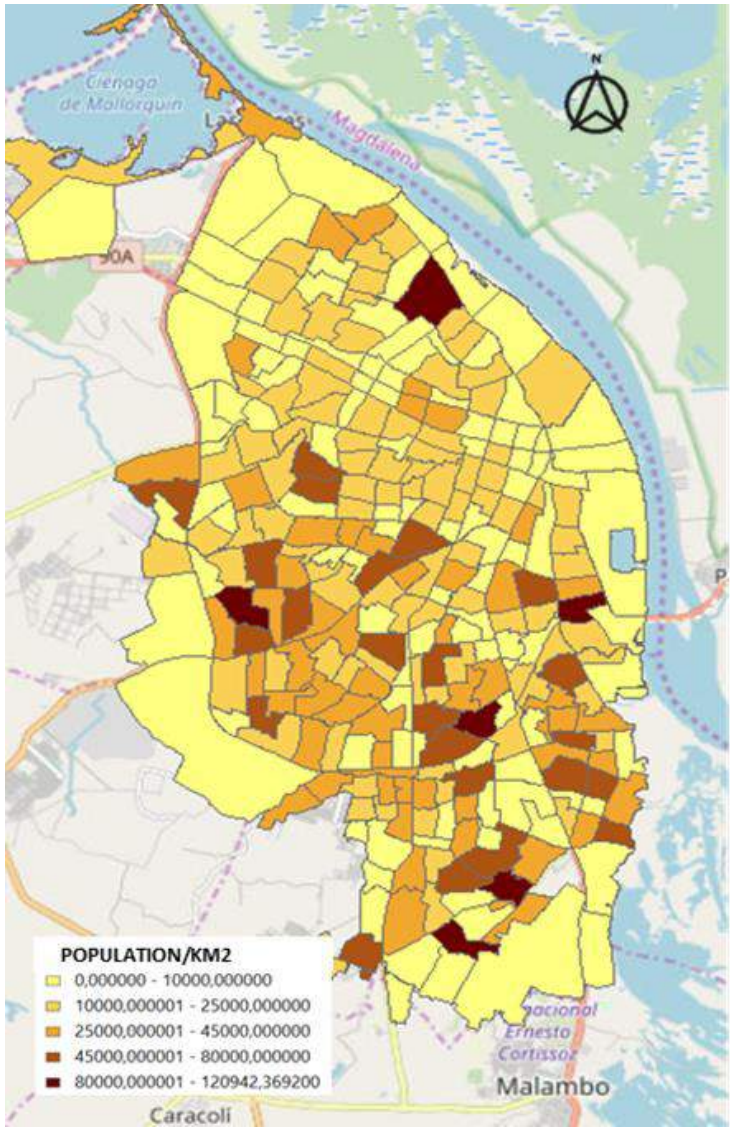
Modelling approach

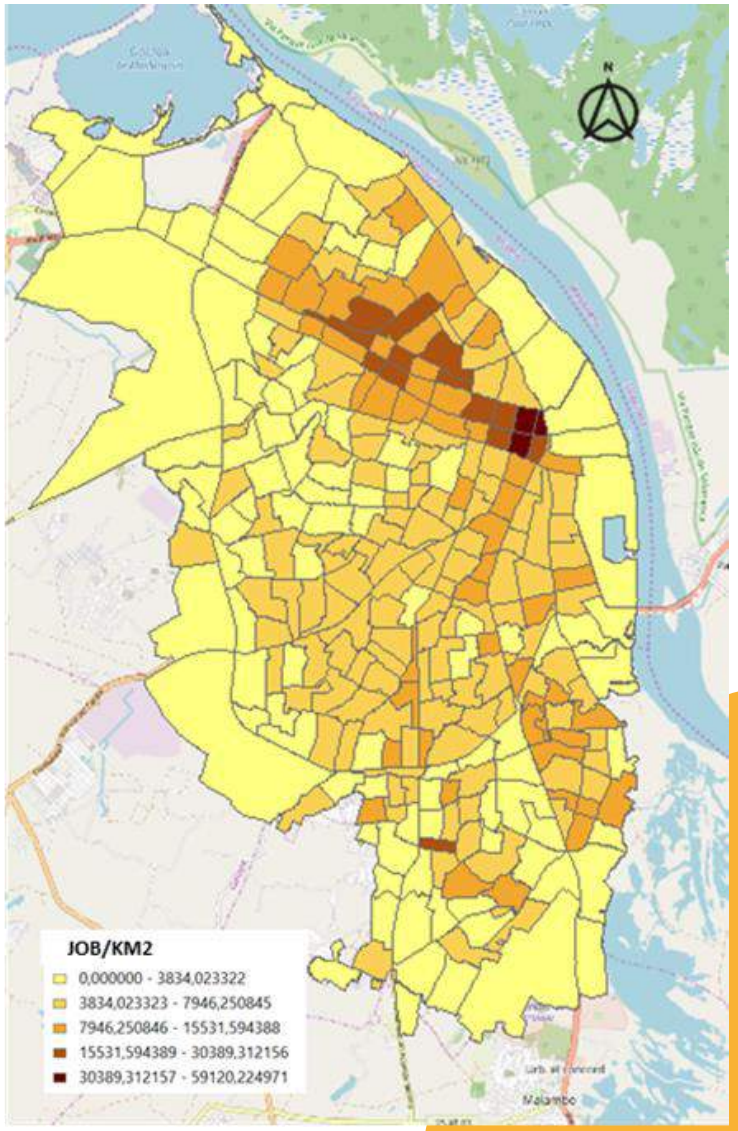
- Analyzing of spatial distribution of real-NO2 measurements in the sample area.
- The transport zone and average diary traffic were assigned on the nearest road to each NO2 sample point by geographical proximity analysis.
- LUR model uses variables associated with socioeconomic status level, built environment (5D criterion approach) and average daily traffic (ADT).
- Verifying the model accuracy in terms of adjusted R-squared.

Methods - 5D criterion approach of built environment

Density

Socioeconomic characteristics, such as population, employment, and study densities are fundamental attributes in urban planning oriented to transport and the environment.





Methods - 5D criterion approach of built environment

Diversity

Relating to land use diversity.

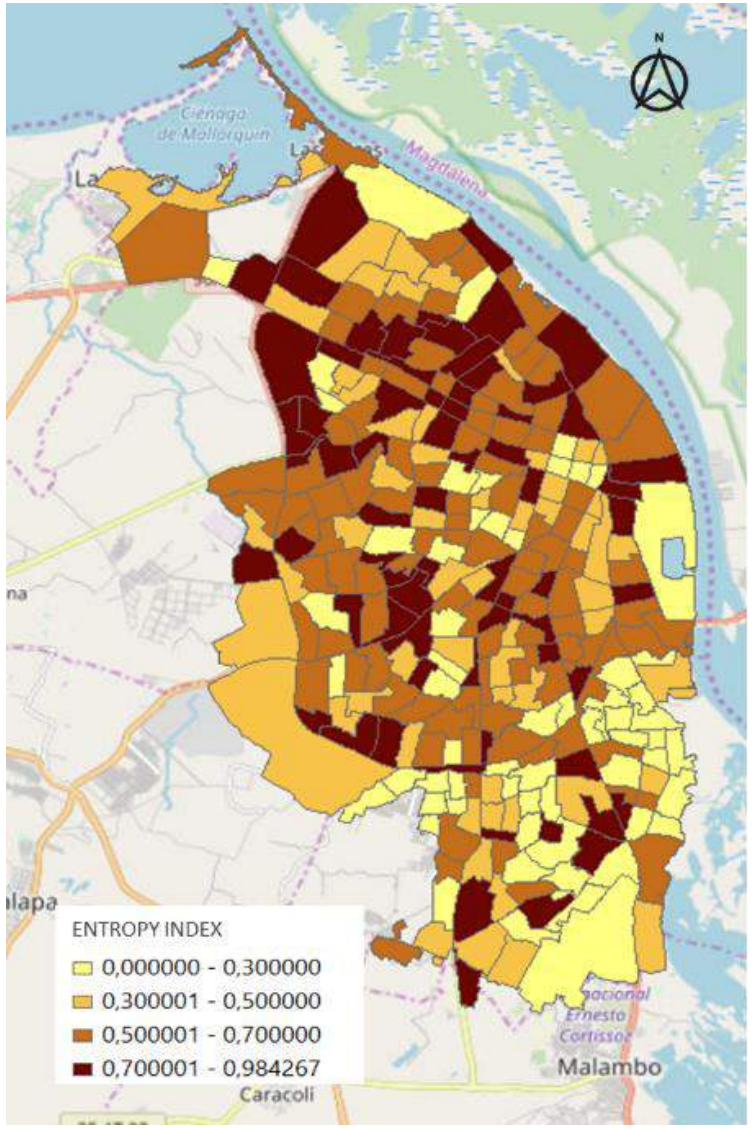
More diverse the land use, the greater number of trips.

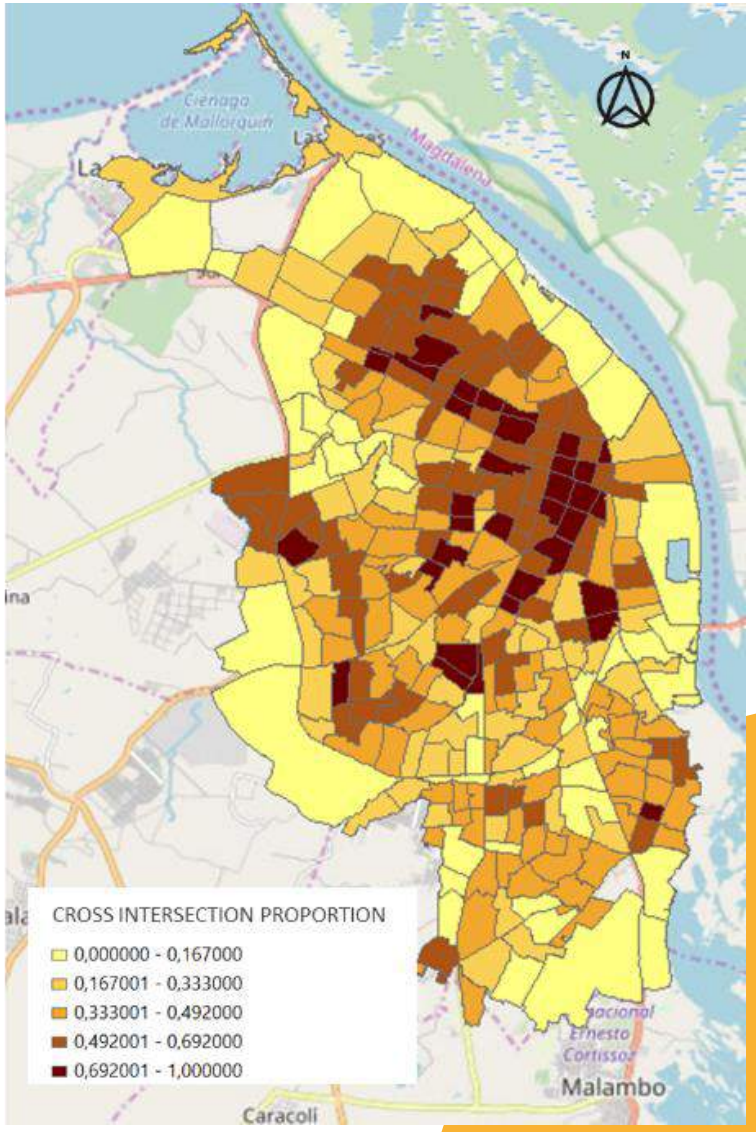
Entropy Index:

$$Entropy\ Index = \sum_j P_j x \frac{\ln(P_j)}{\ln(J)}$$

Design

Referring to the connectivity of road infrastructure (closely related to its configuration and geometry.

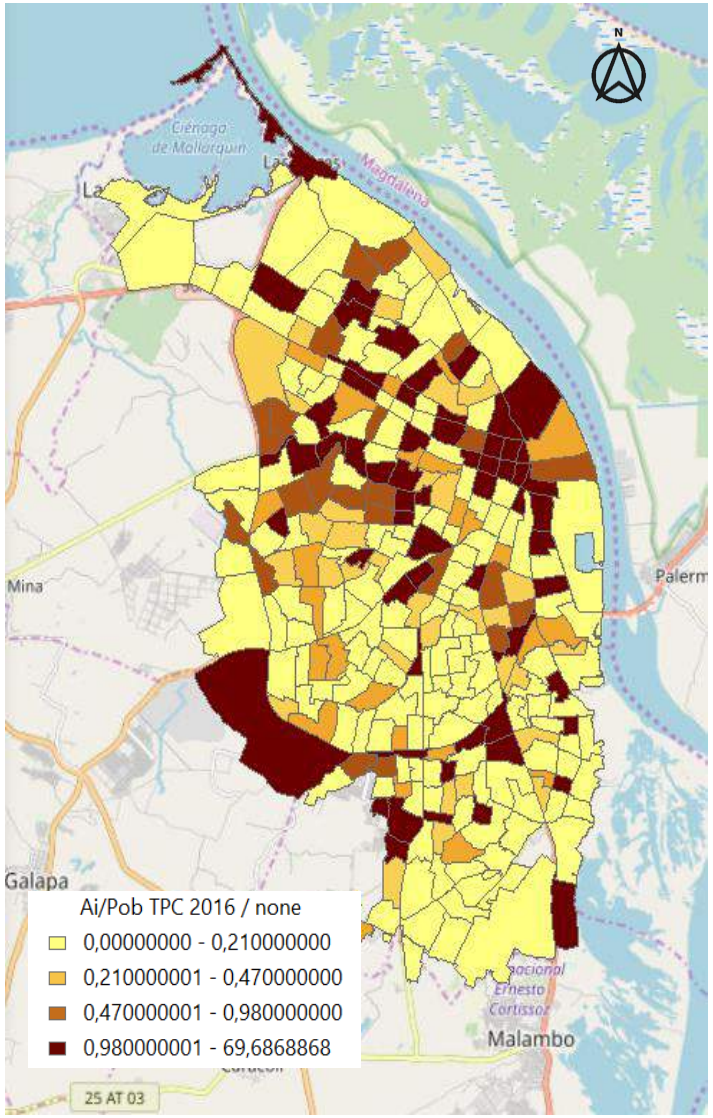


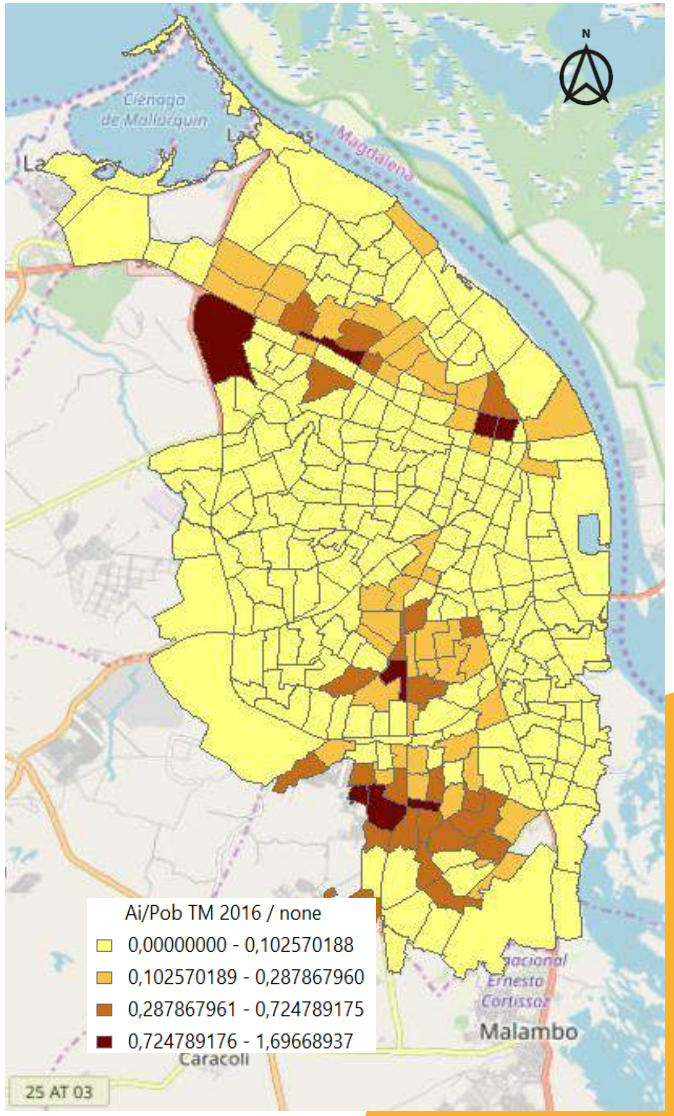


Methods - 5D criterion approach of built environment

Distance

Access distance from an origin point to the nearest public transport station or stop.





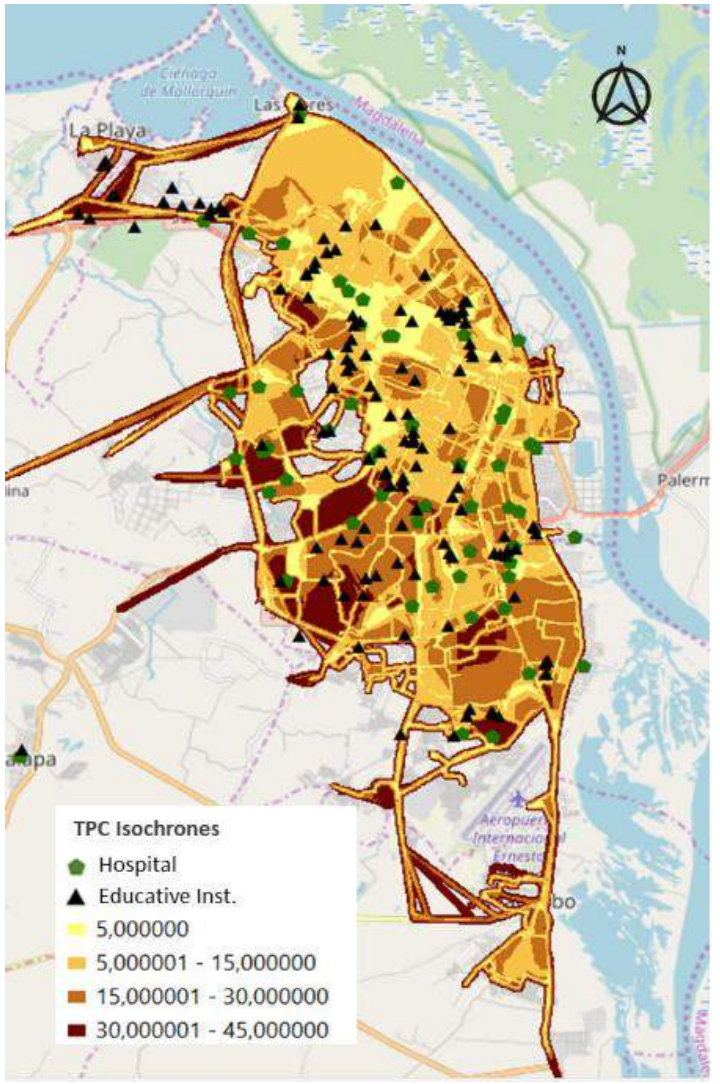
Methods - 5D criterion approach of built environment

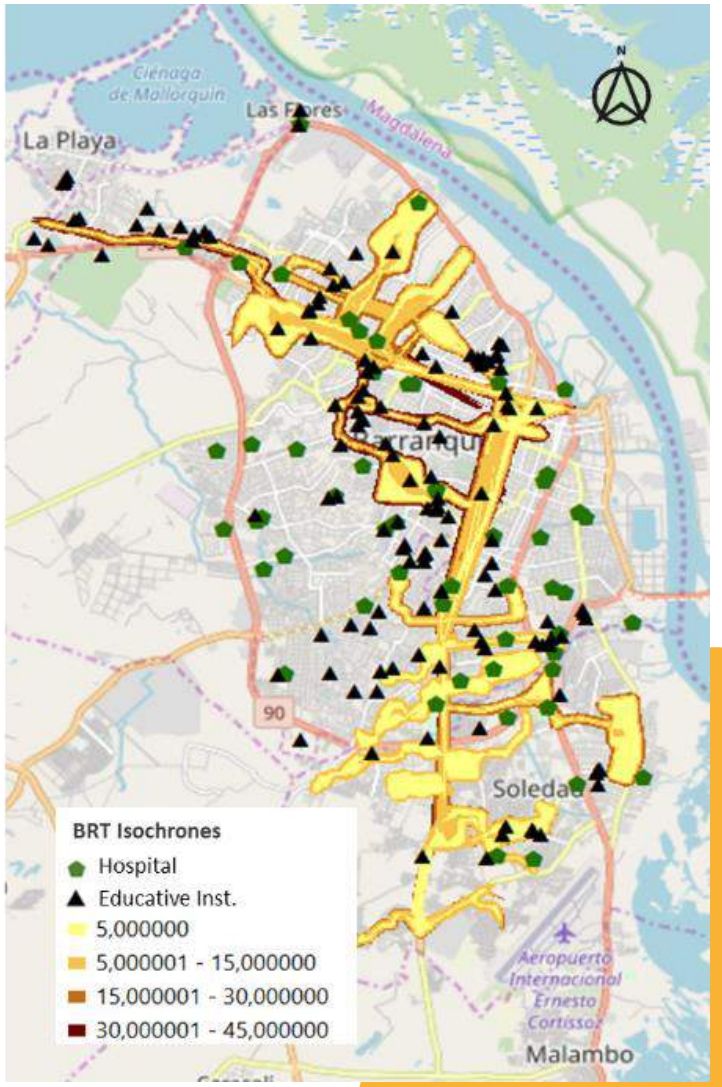
Destination Accessibility

The ease with which people can reach destinations of interest.

Potential accessibility in the zone by transport zone:

$$A_i^m = \sum_{j=1}^{n} O_j e^{\left(-\beta_i^m c_{ij}^m\right)}$$

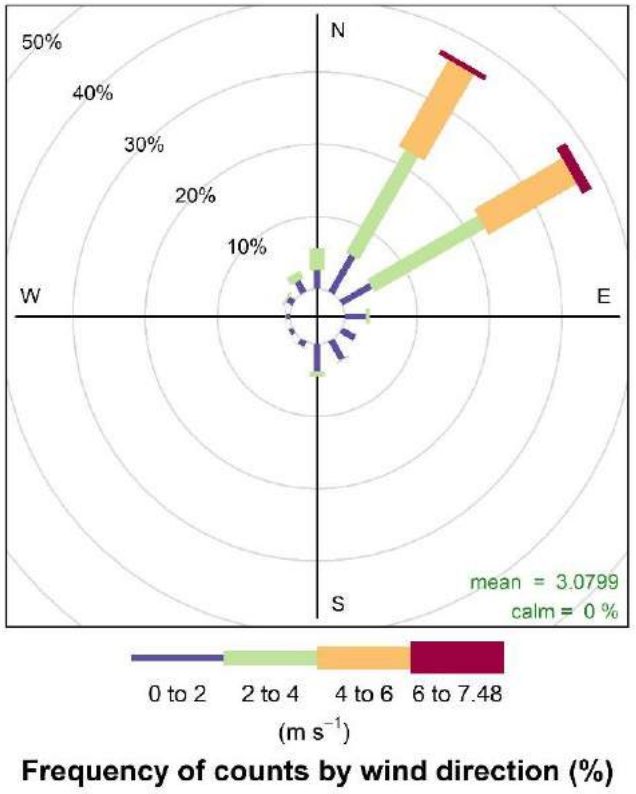




Results

Spatial distribution analysis

- NO2 measured concentration in the study area.



Results

LUR model estimations:

- The regression análisis using 108 NO2 sampling points.
- Population density, commercial áreas and land use diversity influence on activity participation and air quality.

Higher land use diversity (high entropy index) → Higher NO2 concentrations.

Low SES zones show higher NO2 concentrations

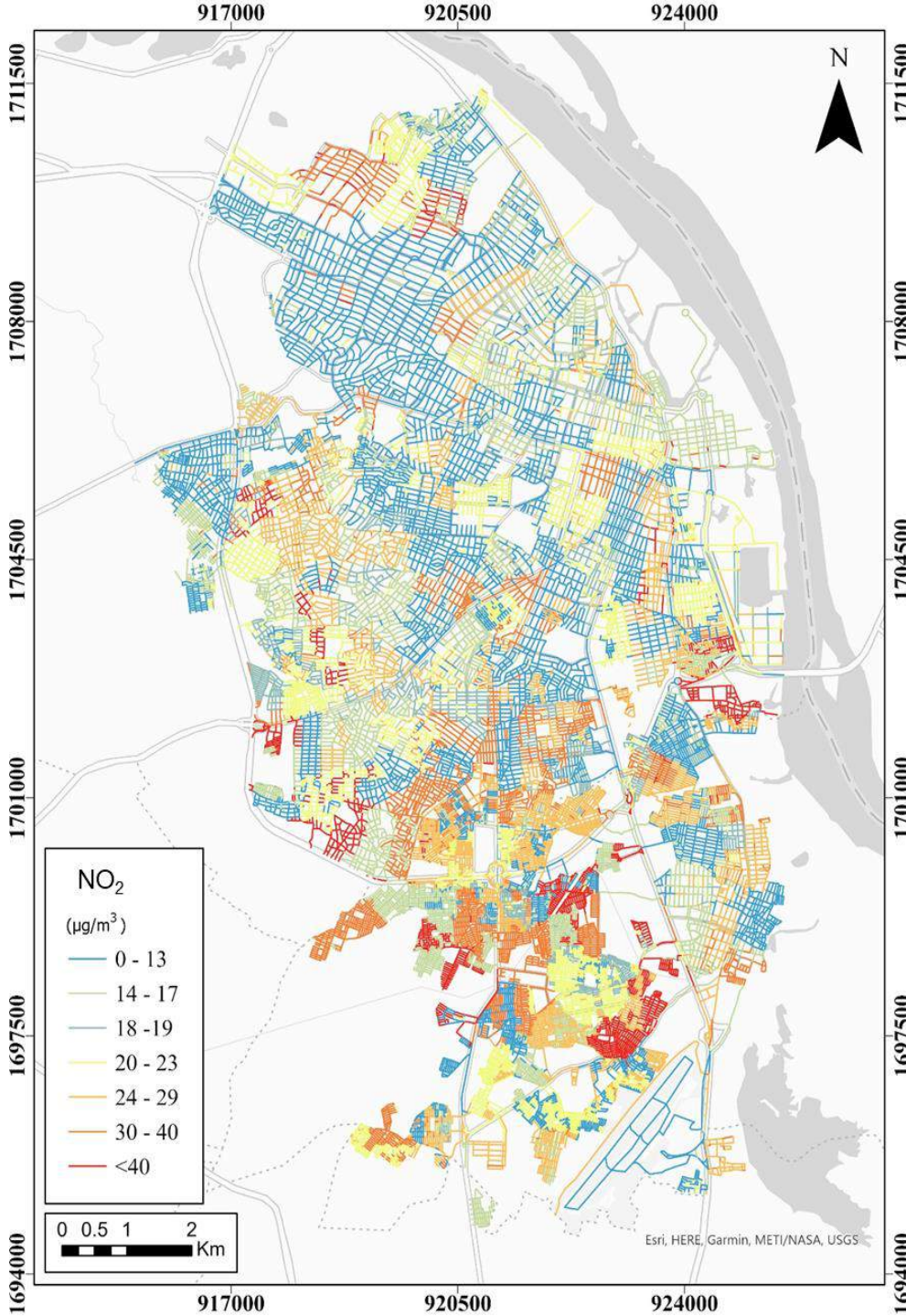
- Areas where people walk more or have building environment conditions that promote walking are observed lower NO2 concentrations.

Results - calibration

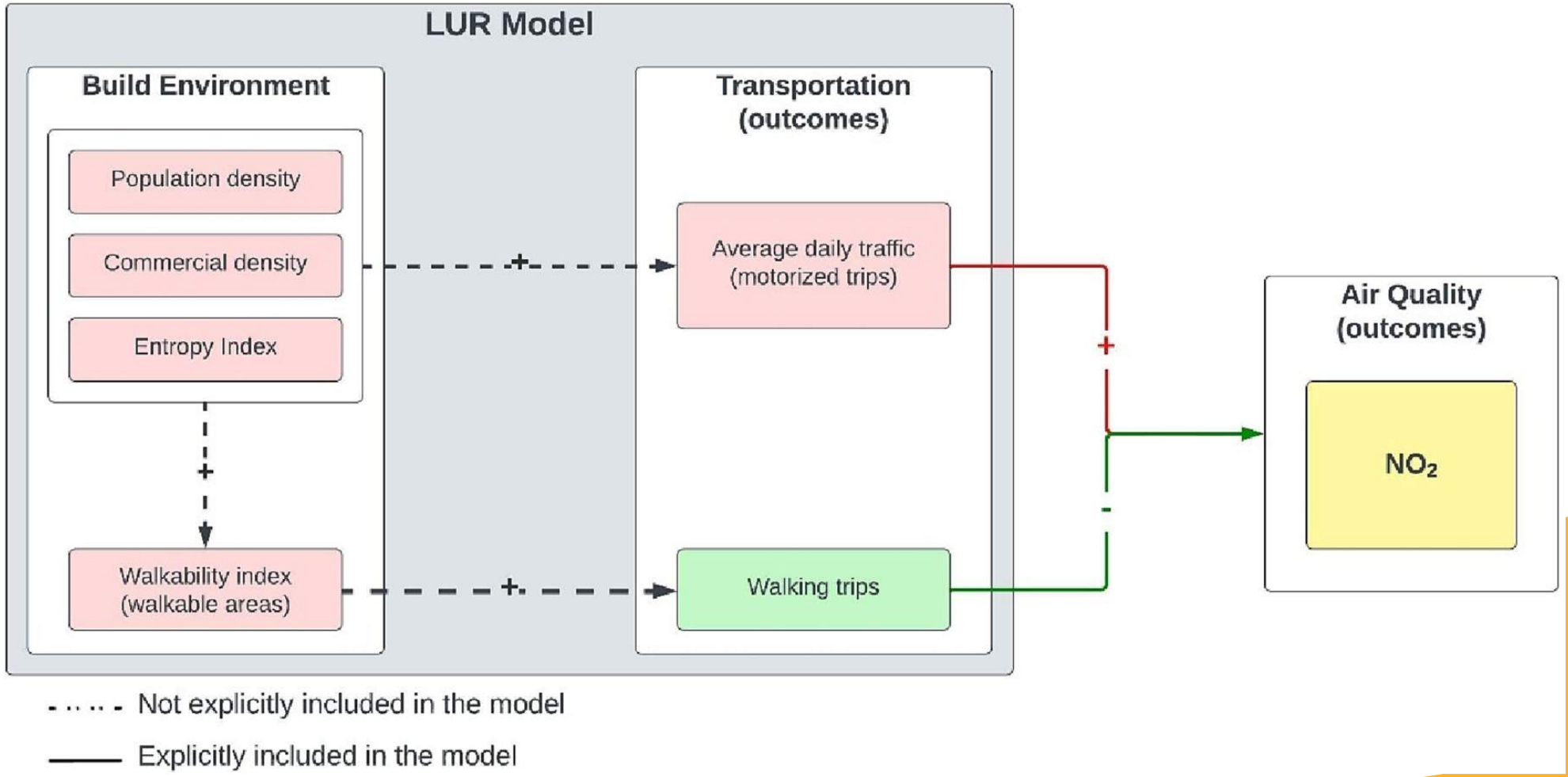
- Areas where people walk more or have building environment conditions that promote walking are observed lower NO2 concentrations.
- Areas with high average daily traffic, population density and commercial density, and entropy index, we observed high NO2 concentrations on the sidewalk.
- High-income zones with high walkability index promote walking.
- The model confirms that the higher the level of traffic, the higher of NO2 pollutants.

Results

- The highest concentrations of the pollutant area are in the south of Barranquilla, where heavy traffic is more frequent, the city is less walkable and low SES households predominate.
- The model suggests that more pedestrian-friendly areas have better
- air quality than others in the study zone.
- Promoting more sustainable transportation (e.g., prioritizing active transport modes such as pedestrians or
- bicycles) will contribute to developing healthier cities with better air quality.



Conceptual model of LUR variables in the modelling



Conclusions

- Exploring the relationship between transport, socioeconomics, land use and built environment characteristics inequity in air quality in Barranquilla.
- Areas with multi-story buildings and heavy vehicular traffic has been observed higher NO2 concentrations.
- Inequity regarding city design (BE and walkability) and greater exposure to air pollution by the lowest SES inhabitants.
- Higher population density, commercial areas and land use diversity (high entropy index) have a relationship with the level of NO2.
- Air quality improved in places that promote walking.
- Cities with lineal development, sustainable mobility is crucial to help in NO2 mitigation.
- Urban infrastructure policies should be conducted to more pedestrian-friendly area, active transport modes and blues spaces to improve the air quality.

CRediT authorship contribution statement

- Dayana Agudelo-Castañeda: Conceptualization, Methodology, Resources, Data curation, Writing – original draft, Writing - review & editing. Supervision.
- Julián Arellana: Formal analysis, Software, Writing – review & editing.
- Wendy B. Morgado-Gamero: Conceptualization, Methodology, Writing – original draft.
- Fabrício De Paoli: Conceptualization, Methodology, Visualization, Writing – review & editing.
- Luana Carla Portz: Formal analysis, Software.

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Thank you!

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