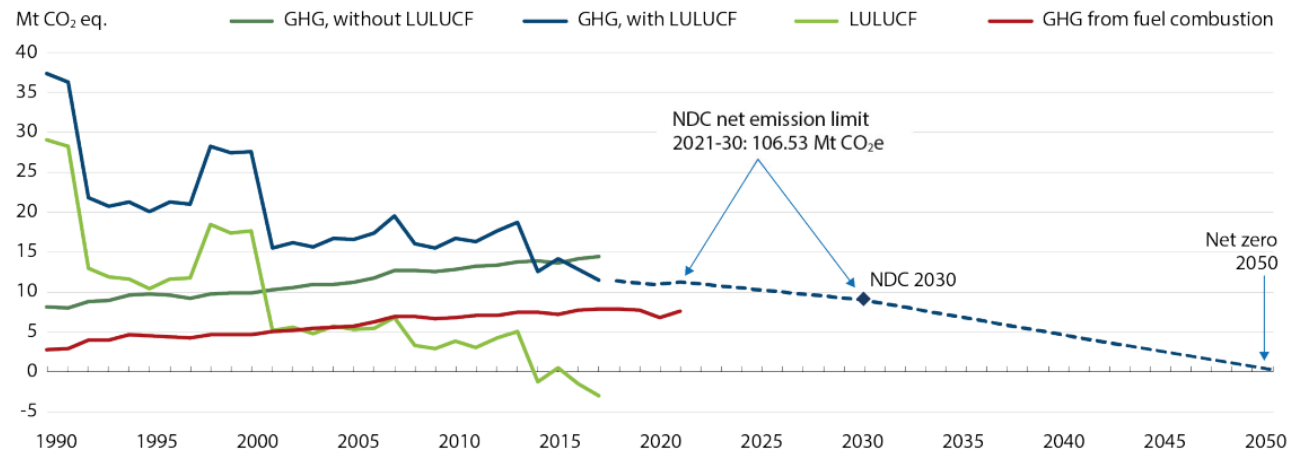# Economic and Environmental Impacts of Modal Shift to Light Rail Transit: A Case Study from San José, Costa Rica

March 25, 2024

Background

Costa Rica aims to be carbon neutral by 2050
Historical and projected GHG emissions, targets and pathways to targets

Mt CO₂ eq.

Legend: GHG, without LULUCF — GHG, with LULUCF — LULUCF — GHG from fuel combustion

NDC net emission limit 2021-30: 106.53 Mt CO₂e

NDC 2030

Net zero 2050

Note: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry; NDC = Nationally Determined Contribution. Net GHG emissions include those from the LULUCF sector.
Sources: OECD (2023), IEA CO2 Emissions from Fuel Combustion Statistics: Greenhouse Gas Emissions from Energy; MINAE (2020), Contribución Nacionalmente Determinada 2020; SINAMECC (2020), Inventario Nacional de Gases de Efecto Invernadero.

Environmental Performance Reviews

OECD

- Costa Rica aims to achieve net-zero emissions by 2050

- Transportation accounts for a significant portion of the country's emissions

- The "Light Rail at the Metropolitan Area Costa Rica" project is a GCF-funded initiative to implement a low-carbon sustainable transport system

Intended Outcomes (source: GCF Funding Proposal FP166)

Increased usage of a sustainable low-emission urban transport system

Increased capacity of stakeholders to replicate NMT and connectivity interventions

Reduced economic costs of mobility and air pollution

Reduced dependency on fossil fuel imports

Unintended Outcomes

Gentrification and displacement of low-income residents in areas surrounding the light rail stations

Increased property values and rental rates near the light rail stations

Potential loss of small businesses and informal economic activities due to changes in land use

Increased traffic congestion during the construction phase

Impacts on cultural heritage sites or historic neighborhoods along the light rail route

Indicators

Transportation Indicators:

- **Traffic Congestion:** traffic flow & congestion in construction.

- **Transit Ridership:** public transport ridership (light rail).

- **Air Quality:** Variation in pollutant levels (e.g., PM2.5, NOx, SO2)

Economic and Housing Indicators:

- **Property Values:** Trends in property prices in proximity to the light rail stations

- **Rental Rates**: Changes in rental costs near the light rail route compared to other areas.

- **Business Activity:** Impact on local businesses, including closures, openings, and economic performance.

- **Displacement Patterns:** Incidence and demographics of displaced residents due to rising costs or redevelopment.

- **Socioeconomic Impacts:** Effects on different socioeconomic groups, including income and employment changes.

Spatial Indicators:

- **Land Use Changes:** Alterations in land use patterns along the light rail corridor.

- **Gentrification Hotspots:** Identification of areas experiencing rapid socio-economic and cultural changes.

- **Connectivity and Accessibility:** Changes in accessibility to services and amenities due to the light rail.

Stakeholder Perspective Indicators:

- **Community Feedback:** Insights from surveys, interviews, or focus groups (e.g. women) on perceived impacts of the project.

- **Stakeholder Viewpoints:** Perspectives of key stakeholders, including local authorities, businesses, and residents, on unintended impacts.

Data Sources

Quantitative :

Travel Surveys

- National Household Travel Survey (ENVIH) - Ministry of Public Works and Transportation

Traffic Counts and Transit Ridership

- Automatic traffic recorder data - CONAVI (national road network)

- Bus and rail ridership data - INCOFER (Rail Institute)

Economic Impact

- House price data (Global Property Guide, Numbeo)

- Business/employment data (Economic Census INEC, World Bank)

Spatial Data

- Satellite imagery (Google Earth, Planet Labs)

- Geographic data (National Geographic Institute - IGNCR)

Qualitative:

Household Surveys
- Living Standards Measurement Surveys (World Bank)
- Population and Housing Census (INEC)

Public Sentiment
- Social media data (Twitter X, Instagram, Tiktok) - Tools like Crimson Hexagon

Stakeholder Perspectives
- Interview/focus group transcripts
- Community outreach by local transportation authorities
- Passenger Survey

Sentiment Analysis - Generative AI

- Collect interview transcripts, social media posts, passenger feedback

- Use large language models like GPT-4, Sonnet, Gemini etc.

- Models can directly classify sentiment (positive/negative/neutral)

- Generate sentiment classifications and summaries

- Extract key themes driving +/- feedback
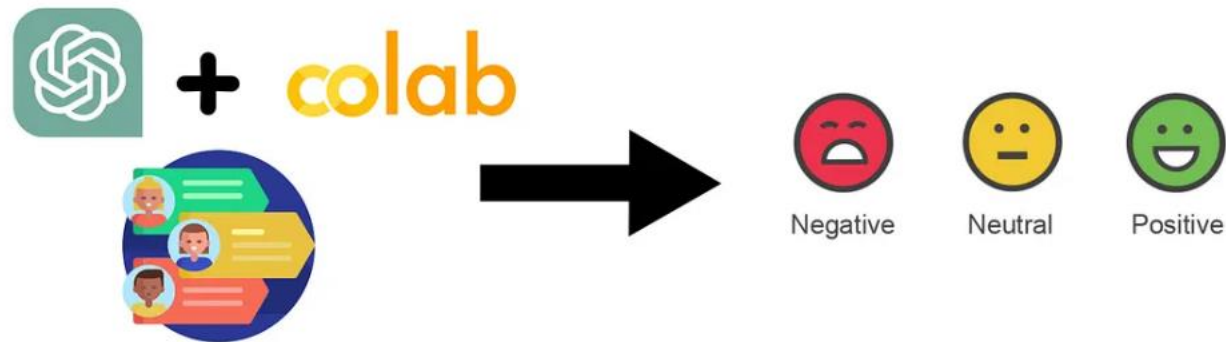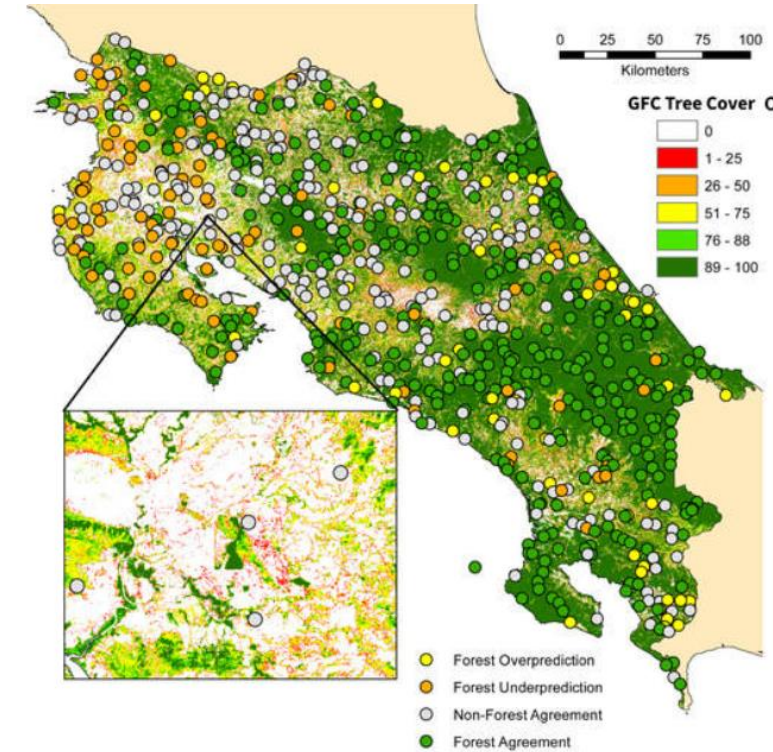
Housing and Gentrification

- Quantile regression models on satellite imagery and census data estimating quantile treatment effects of rail proximity on distributions of house prices, demographics (income, education, race/ethnicity)

- Identify areas with disproportionate house price impacts across quantiles and shifts towards higher/lower quantiles of demographics indicating gentrification/displacement patterns
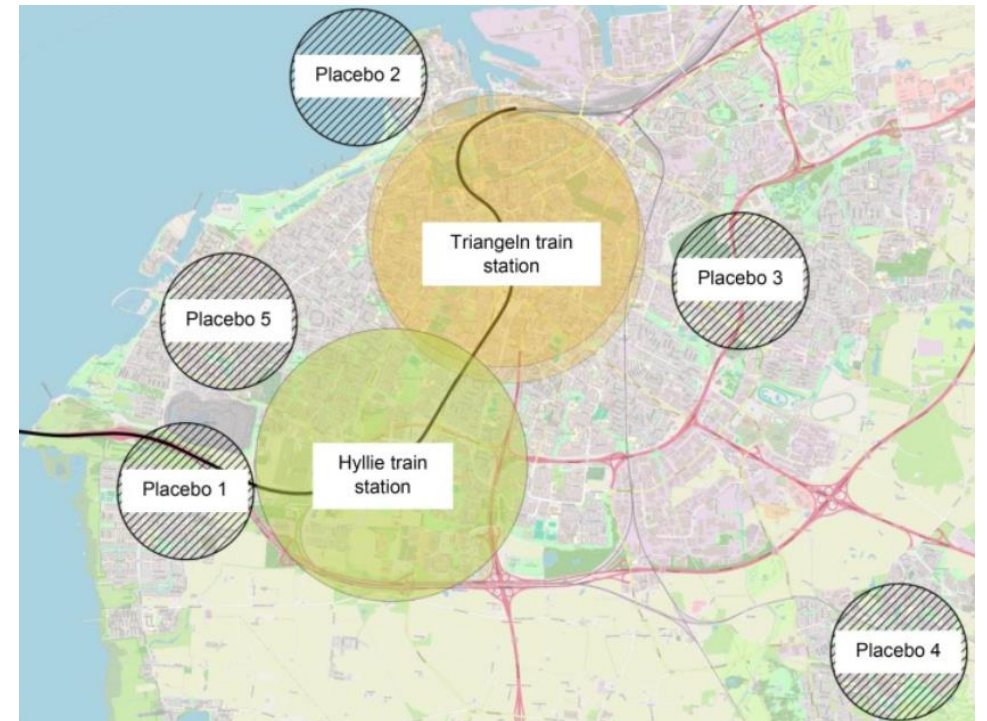
Methodology based on: Sundbyberg, W & Merril, L. (2024). Impact of Commuter Rail on Neighborhood Housing Prices: Evidence from the Stockholm Metropolitan Area. Journal of Transport Geography, 95, 103-124. https://doi.org/10.1016/j.jtrangeo.2024.103184"

Business and Deforestation - Change Detection

- Use high-resolution satellite imagery for areas along rail corridor

- Change detection algorithms to identify new construction, demolitions, deforestation

- Combine with business registration data and heritage site locations

Q&A

Thank you!