Personal Exposure Assessment for Transportation Modes

La Paz, Bolivia

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Introduction

La Paz, Bolivia presented a unique location in its variety of available forms of travel and extremely varied terrain. Accessible by the public were 'micros,' taxis, diesel buses, personal cars, and the recently built Teleférico. Measurements were taken using low-cost, air quality monitoring equipment to assess personal exposure to particulate matter, black carbon and carbon monoxide. Data was collected along typical commuter routes during peak travel times in order to evaluate personal exposure to pollutants.

Equipment

Particulate Matter

Dylos - $425
Reference - $5,000+
Limitations: Only measures bin sizes >0.5 µm and >2.5µm

Carbon Monoxide

Lascar EL USB - $100
Reference - $4,000+
Limitations: 0.5 ppm detection limit, 0-300 ppm range

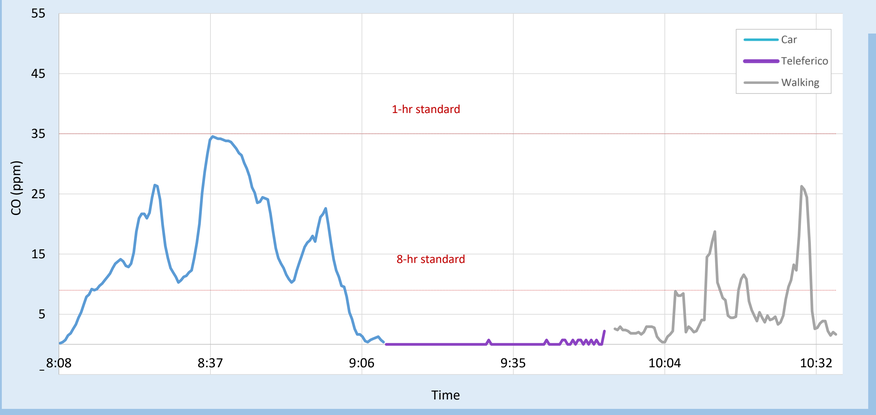
Black Carbon

MicroAeth - $6000
Reference - $20,000+
Limitations: Decrease of sensitivity with particle build up on filter

Standards

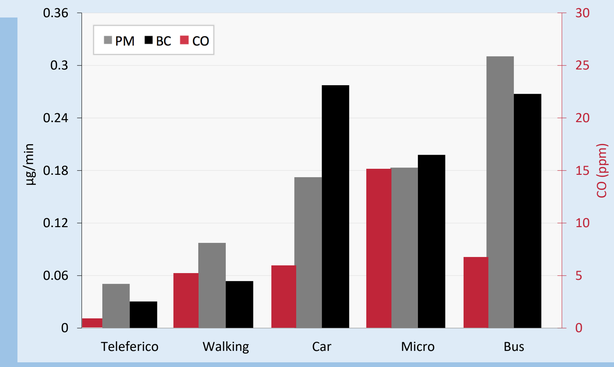
	NAAQS	WHO
PM 2.5 24-hour	35 µg/m^3	25 µg/m^3
PM 2.5 annual	12 µg/m^3	10 µg/m^3
CO 8-hour	9 ppm	--
CO 1-hour	35 ppm	--

Black carbon is a component of particulate matter; there is not a specific black carbon standard



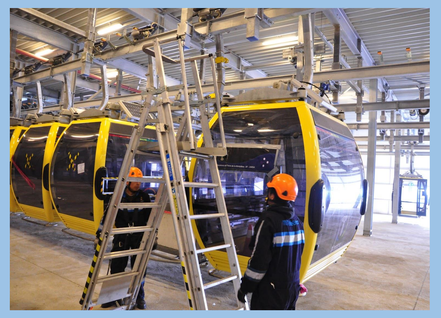
Personal exposure for CO was measured continuously during morning commute hours. First, a car was driven from a downtown residential area (in La Paz) to the Teleférico station in El Alto. After spending 45 minutes monitoring CO at the Teleférico (notice concentrations were essentially negligible), pedestrian exposure was assessed along a route to the central business district in downtown La Paz. We estimate that this route is representative of typical pedestrian exposure. Results imply that Teleférico commuters are exposed to significantly lower pollutant concentrations than commuters using more conventional forms of ground transportation.

Unit pollution exposure for selected transportation modes are provided so that commuters can calculate expected exposure. Average mass of pollution inhaled per minute is shown for $PM_{2.5}$ and BC. Note that CO is in units of ppm since it is a time sensitive pollutant; CO exposure impacts may be estimated according to the 1- and 8-hr NAAQS.



Sustainable Development Goals

- Sustainable Development Goal (SDG) number 3, indicator #33 calls for the tracking of $PM_{2.5}$ in all urban areas with a population greater than 250,000
- Many municipalities in low to middle income countries (LMICs) do not have the resources or training to use scientific air quality measuring equipment
- The equipment used in this project was cheap, easy to use, and required little resources or training to operate
- Although there are vehicle emission regulations, they are not strictly enforced, which leads to pollutant levels often substantially exceeding guidelines.

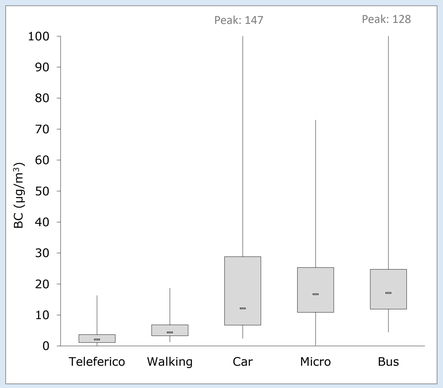


Limitations

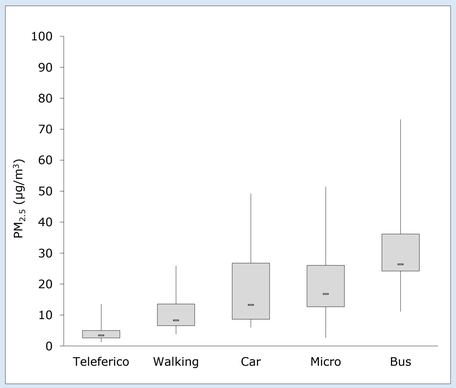
- Time and equipment availability was occasionally limited by in-country partner
- All modes of transportation could not be simultaneously assessed with only two sets of monitoring equipment
- Battery life (ranging from 6 hours to 2 days) limited the length of experimentation

Concentration

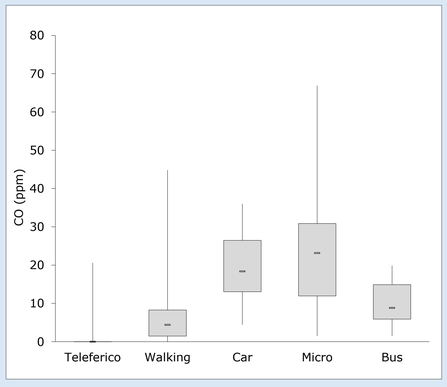
Black Carbon

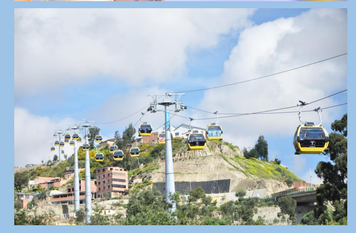


Particulate Matter



Carbon Monoxide





Discussion & Conclusions

- Personal vehicles, microbuses, and diesel buses see similar levels of pollutant exposure.
- Walking allows a commuter to be slightly removed from direct emissions, so personal exposure levels are lower on average. However, walking travel times may be longer in comparison to motorized transportation, allowing the commuter to be exposed to higher amounts of pollution over time.
- PM and black carbon concentrations on the Teleférico were consistently lower than all other forms of transportation. On the Teleférico, CO concentrations seen were negligible

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