Emissions Inventory and Health Risk Assessment of Toxic Air Pollutants for the Canadian Lower Fraser Valley and Vancouver, British Columbia

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for

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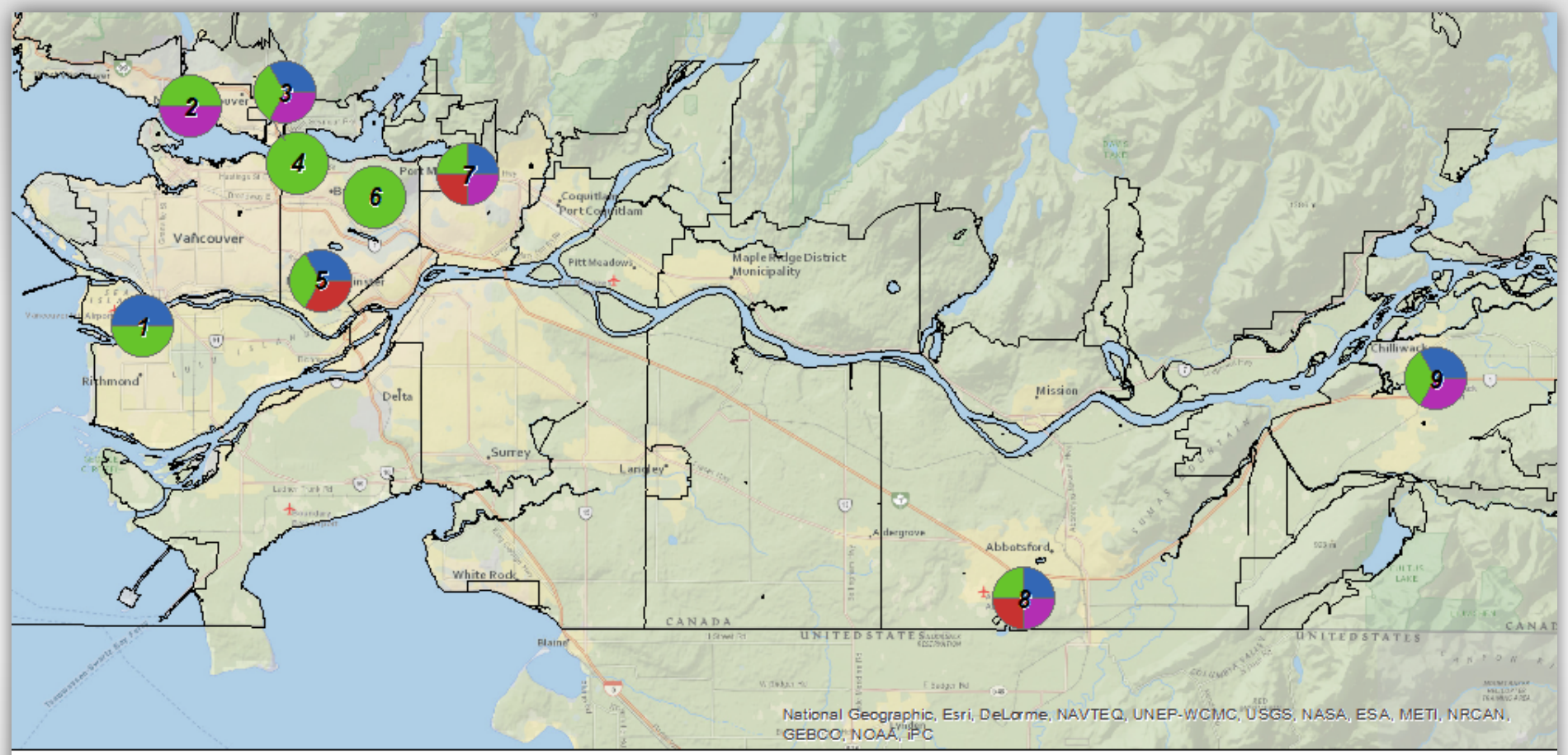
metrovancouver

Study Overview

Study purpose: Develop improved information for use in decision- and policy-making

- **Task 1 –** Health Risk Assessment
  - Evaluate air toxics data collected in the Canadian Lower Fraser Valley (CLFV) and perform a health risk assessment for those pollutants.
- **Task 2 –** Update the Emissions Inventory (EI) of Toxic Air Pollutants (TAPs)
  - Update the air toxics EI with an emphasis on the prioritized pollutants based on cancer and noncancer health risks.

Study Area, Monitoring Sites, and Pollutants



BC
VOC
Metals
PVOC
Lower Fraser Valley boundaries

1. Richmond YVR
2. N. Vancouver BIALAQS S006
3. N. Vancouver 2nd Narrows
4. Burnaby North
5. Burnaby South
6. Burnaby Burmount
7. Port Moody Rocky Pt
8. Abbotsford YXX
9. Chilliwack

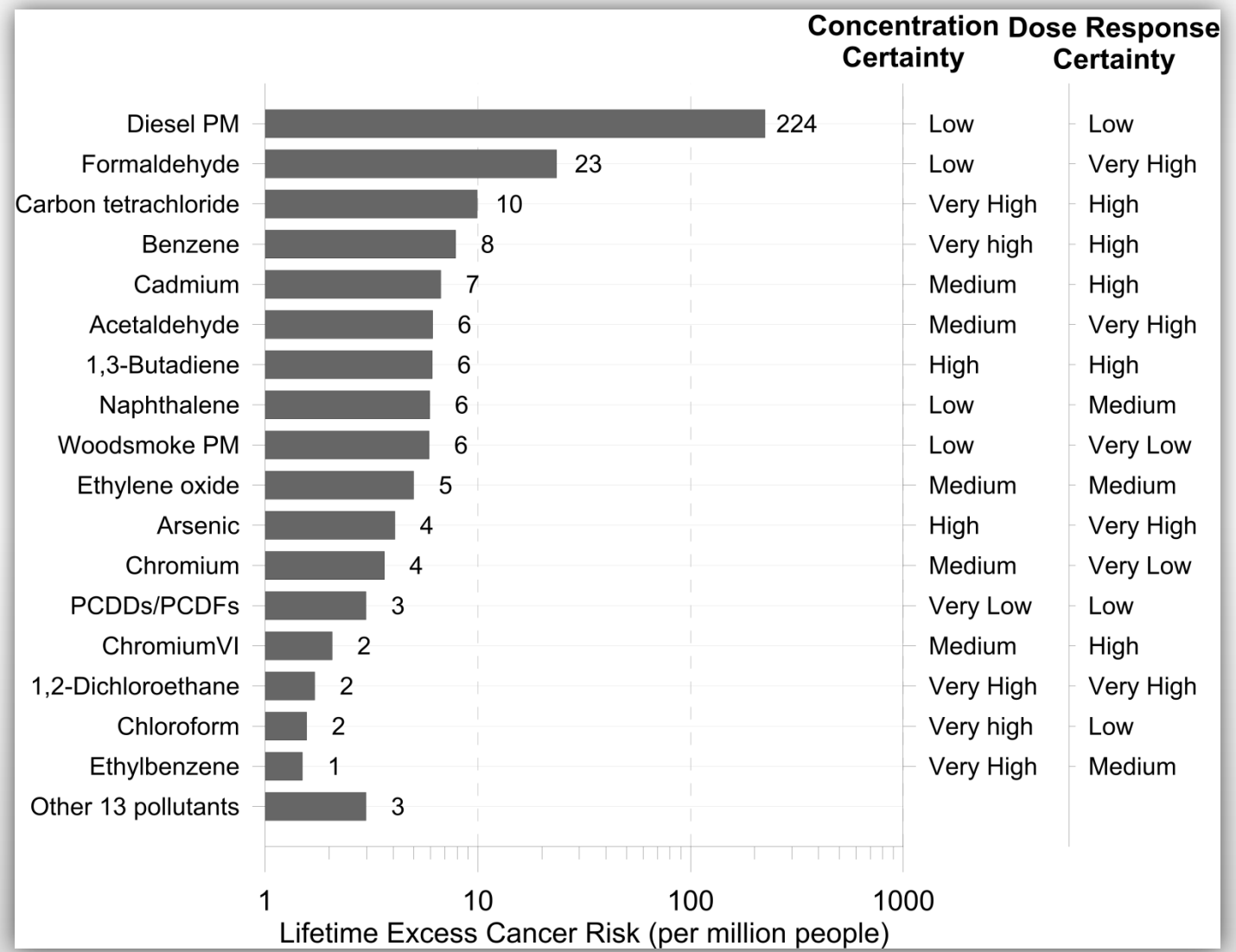
0 5 10 20 Kilometers

N

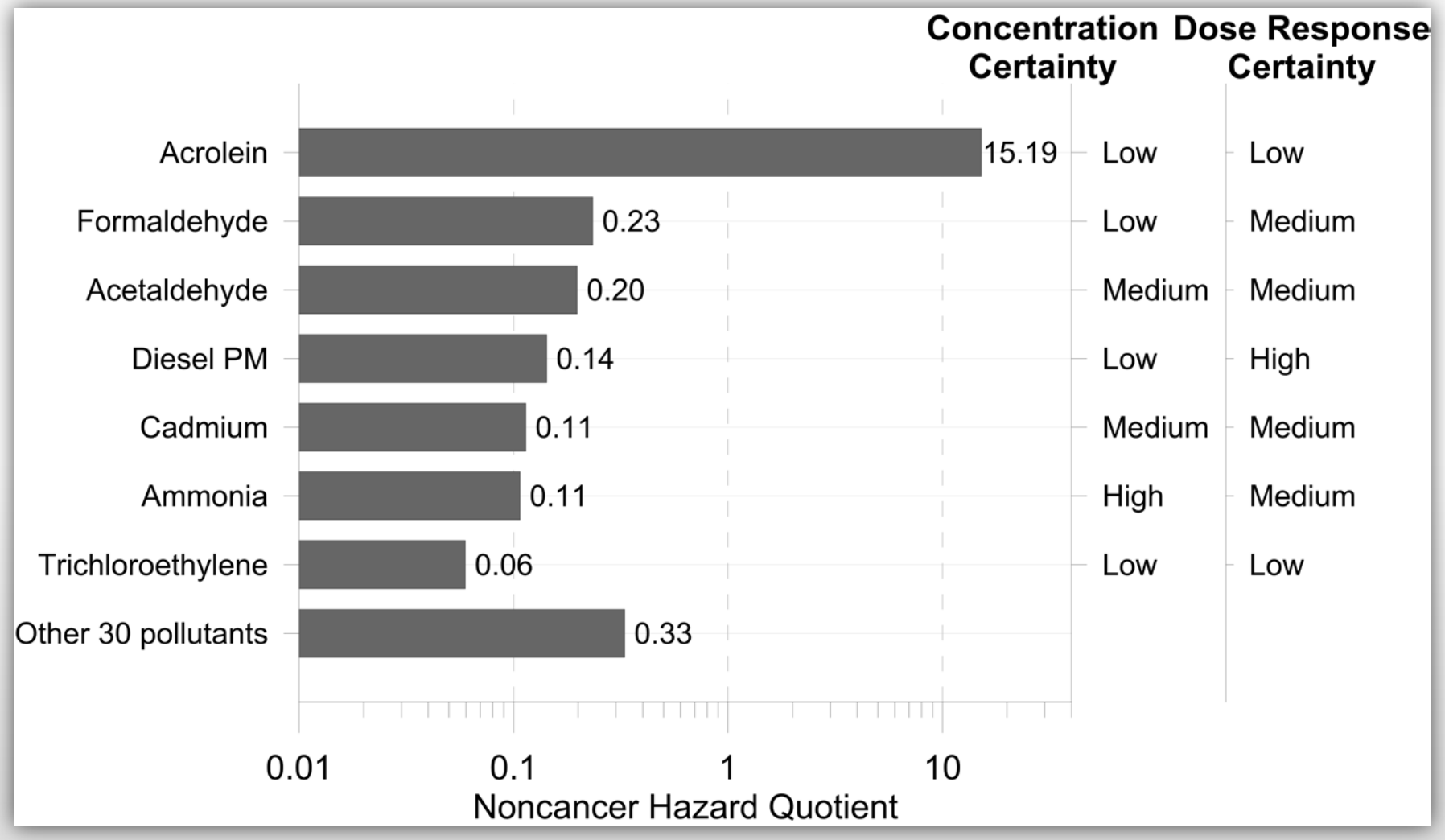
Task 1 – Risk Assessment

- **Hazard Identification** – Determine which pollutants are of concern.
- **Dose-Response Assessment** – Quantify the levels of concern.
- **Exposure Assessment** – Quantify or estimate the concentrations to which people are exposed.
- **Risk Characterization** – Quantify risk and hazard levels.

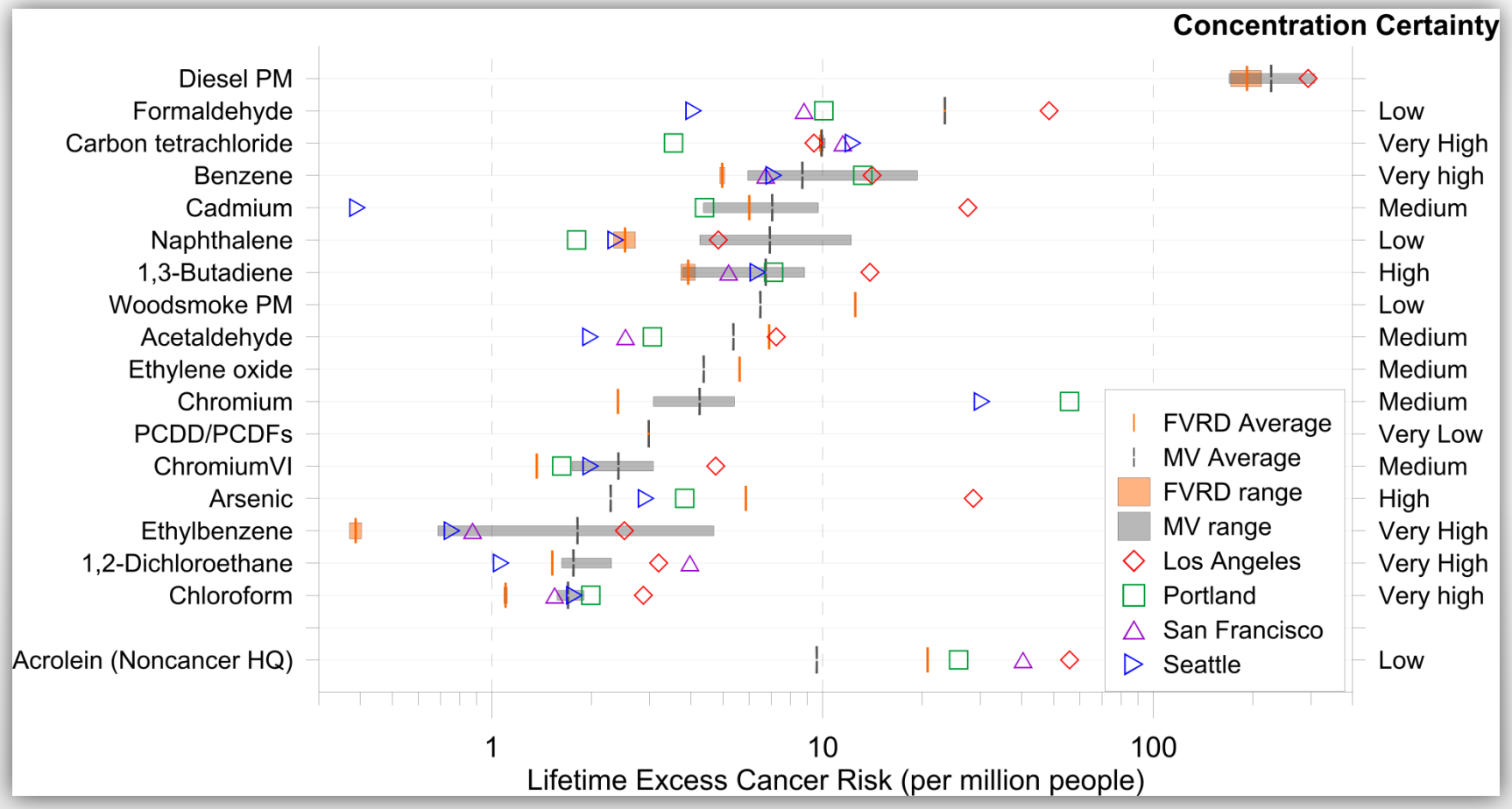
CLFV Average Cancer Risk



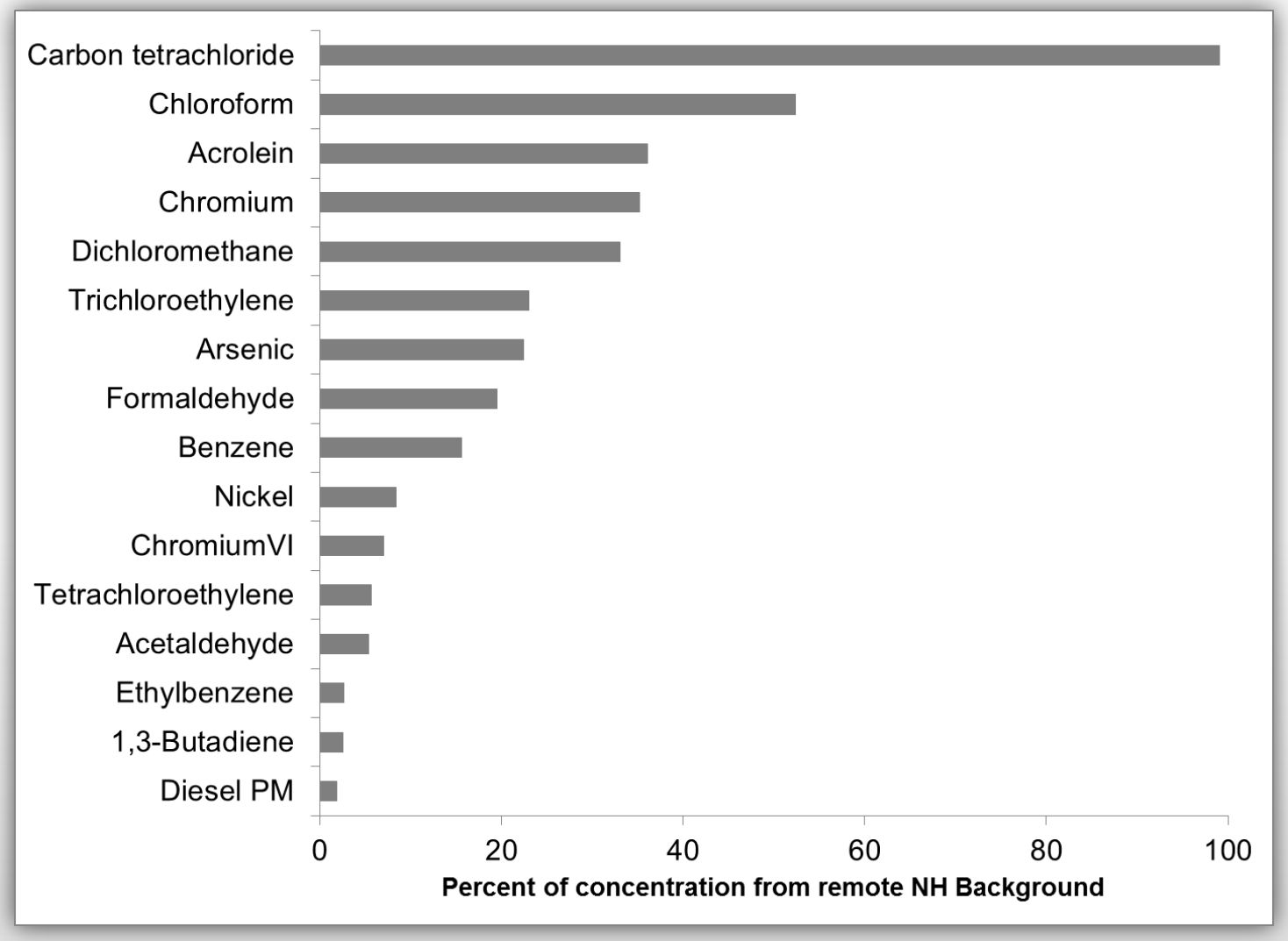
CLFV Average Noncancer Hazard



Comparisons with Other Cities



Background Contributions



Metals values are upper estimates; true contributions are likely less.

NH = northern hemisphere

Task 2 – Update the EI of TAPs

Background and context

- A year-2000 EI of TAPs was previously developed for the CLFV airshed.
- The goal of this task is to develop an updated (2010) EI for priority TAPs in the CLFV airshed.
- The 2010 TAP EI is a tool air quality managers may reference when considering which TAPs and sources to address with mitigation actions.

Methodology (1)

- Screening-level EI
  - Processed point, on-road, non-road, and nonpoint sources separately
  - Data/approach selection hierarchy
    - TAP emissions (e.g., MOVES, NPRI data)
    - Speciation of criteria air pollutant (CAP) emissions
      - Local profiles
      - SPECIATE 4.4

NPRI = National Pollutant Release Inventory
CAP = Criteria air pollutant

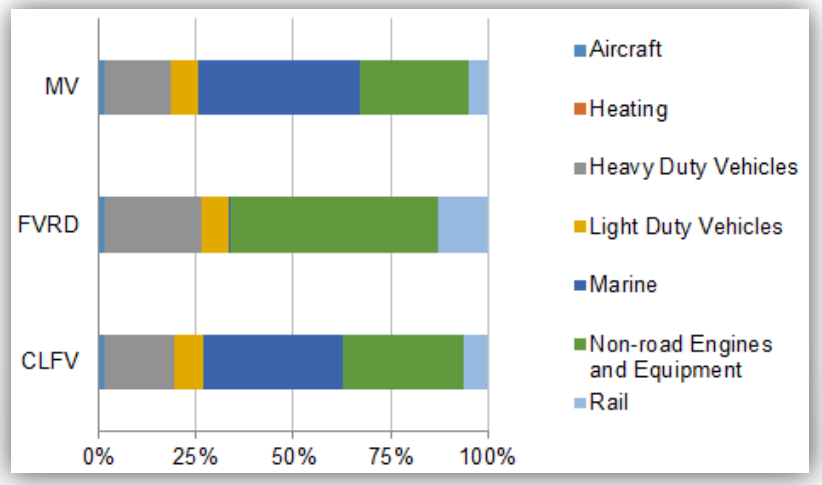
Methodology (2)

- Refined EI
  - Processed point, on-road, non-road, and nonpoint sources separately
  - Data/approach selection hierarchy
    - Adopt TAP emissions (e.g., MOVES, NPRI data)
    - Estimate emissions by applying emission factors (EF)
      - TAP EF × Activity (e.g., aircraft, residential wood combustion)
    - HAP augmentation (i.e., EPA 2011 NEI)
    - Speciation of CAP emissions (i.e., screening-level EI)

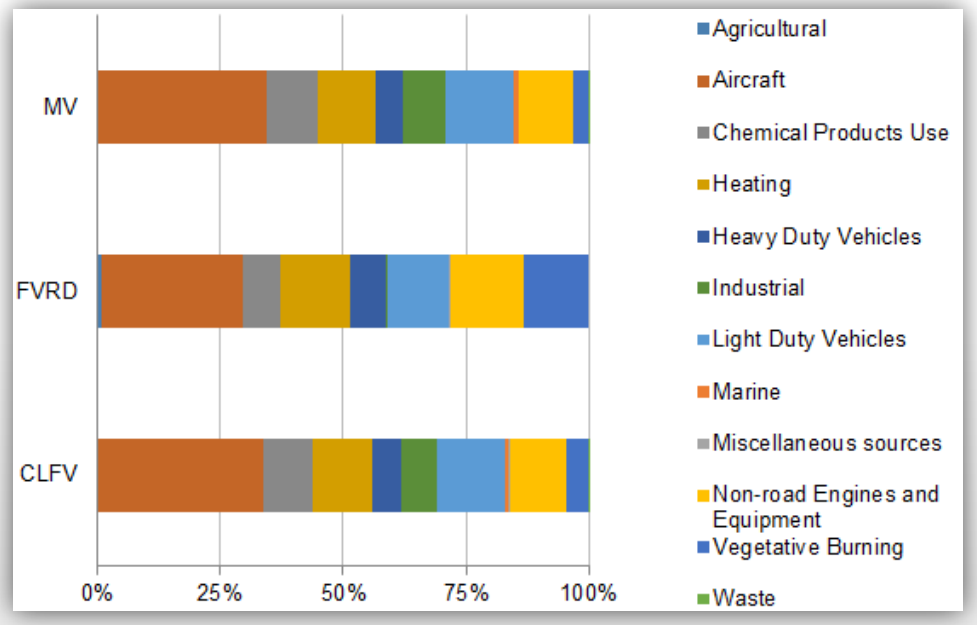
HAP = Hazardous air pollutant
NEI = National emissions inventory

Source Category Contributions by Region

Diesel PM

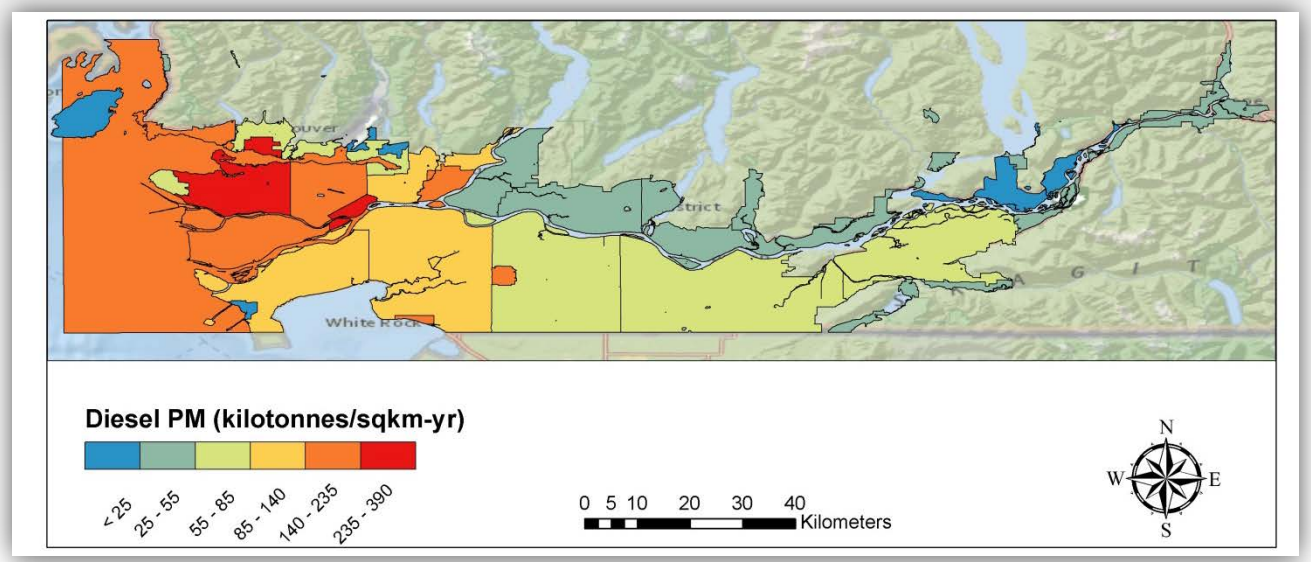


Acrolein

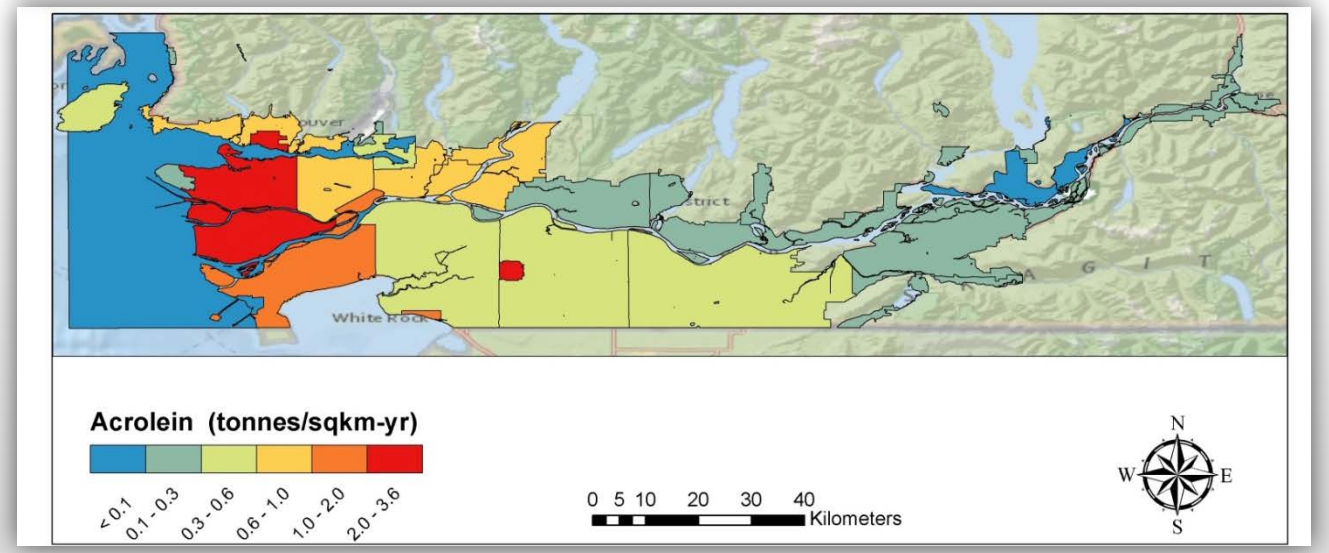


Emissions Spatial Distribution

Diesel PM



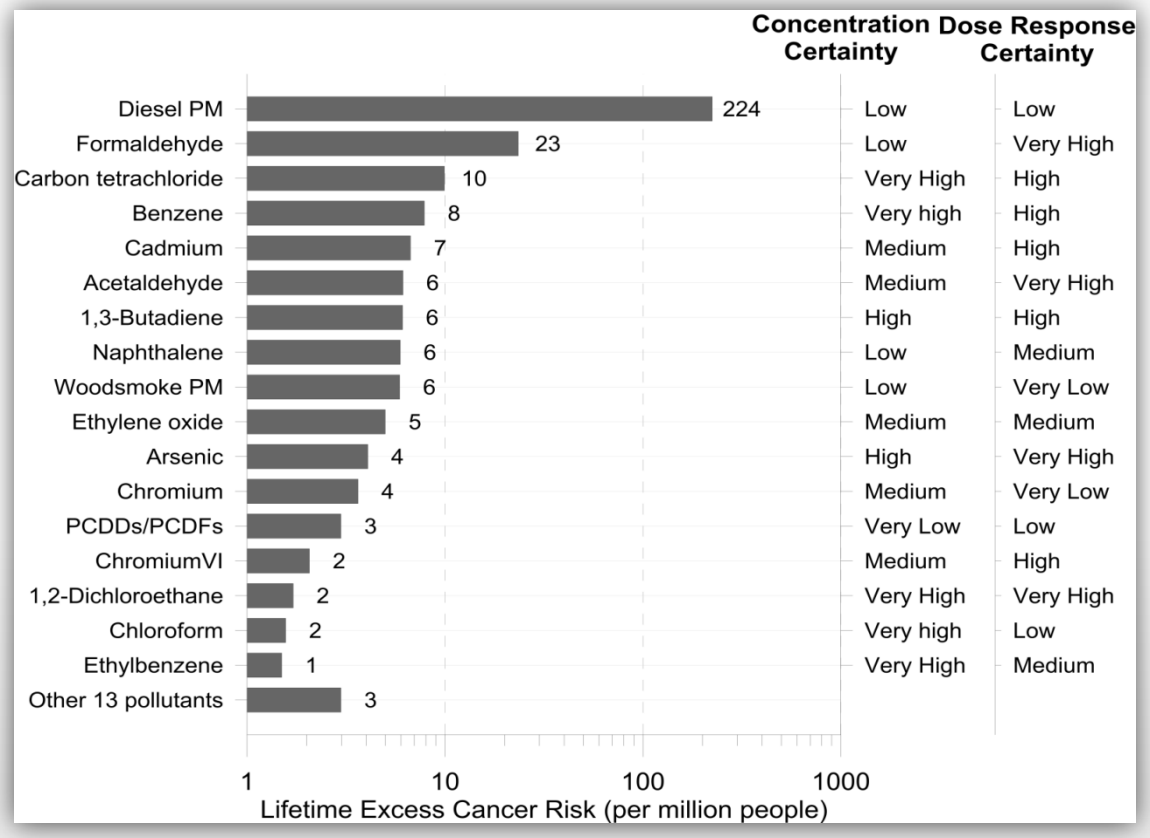
Acrolein



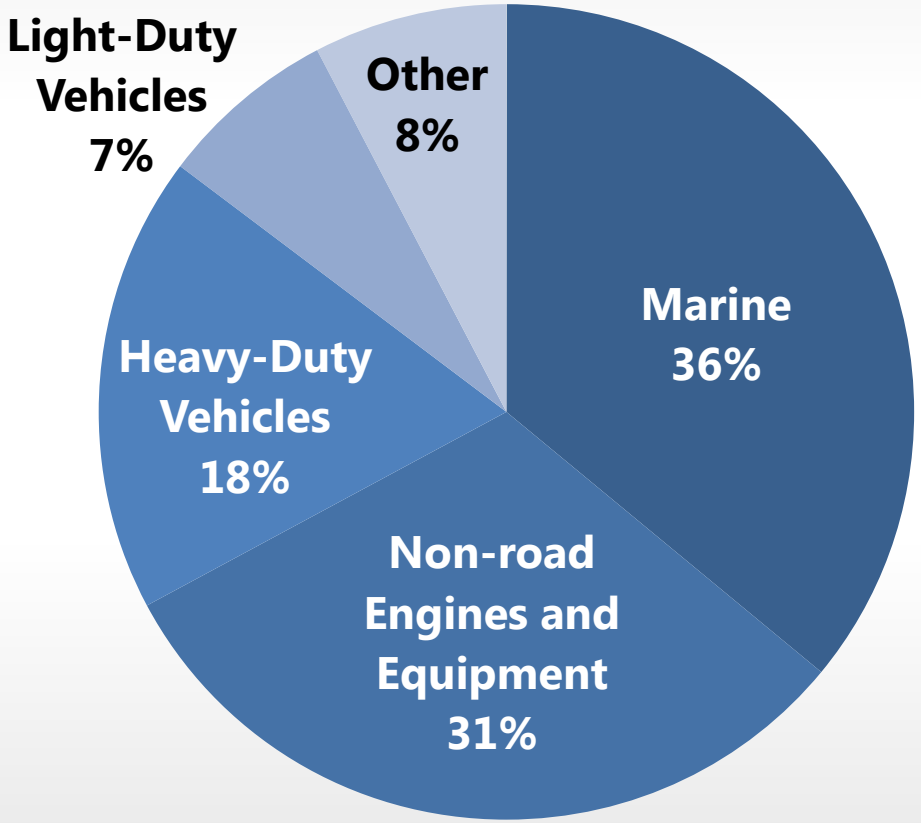
Important TAPs for Cancer Risk

Estimated average excess lifetime cancer risk for the CLFV

- Diesel PM: 224 per million people (with low certainty)
- All other TAPs studied, combined: 98 per million people



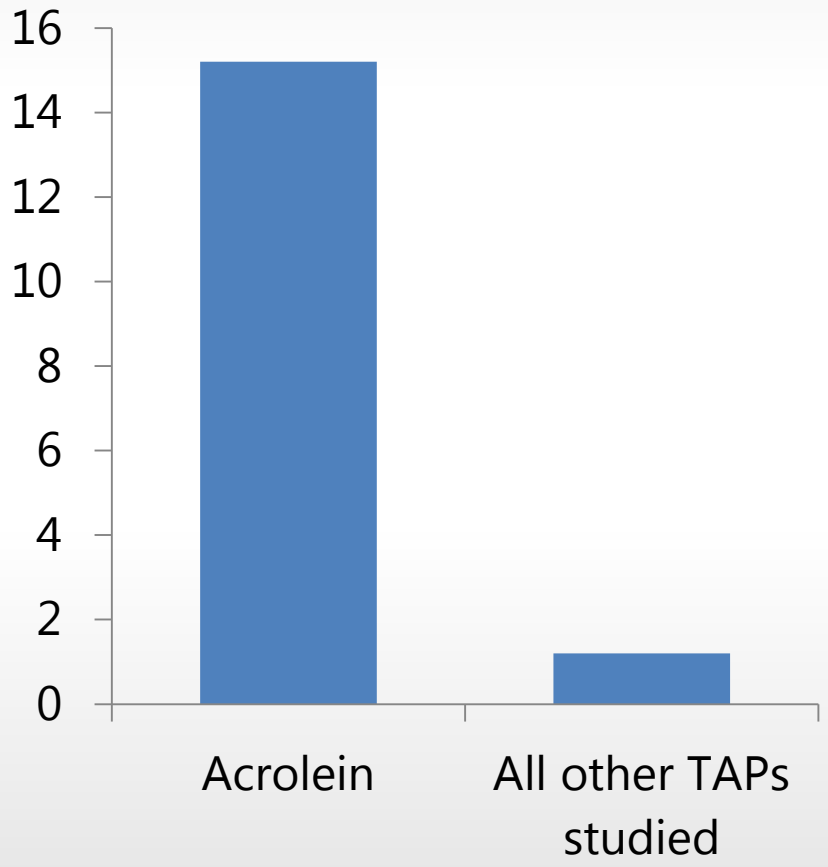
Key Sources of Diesel PM



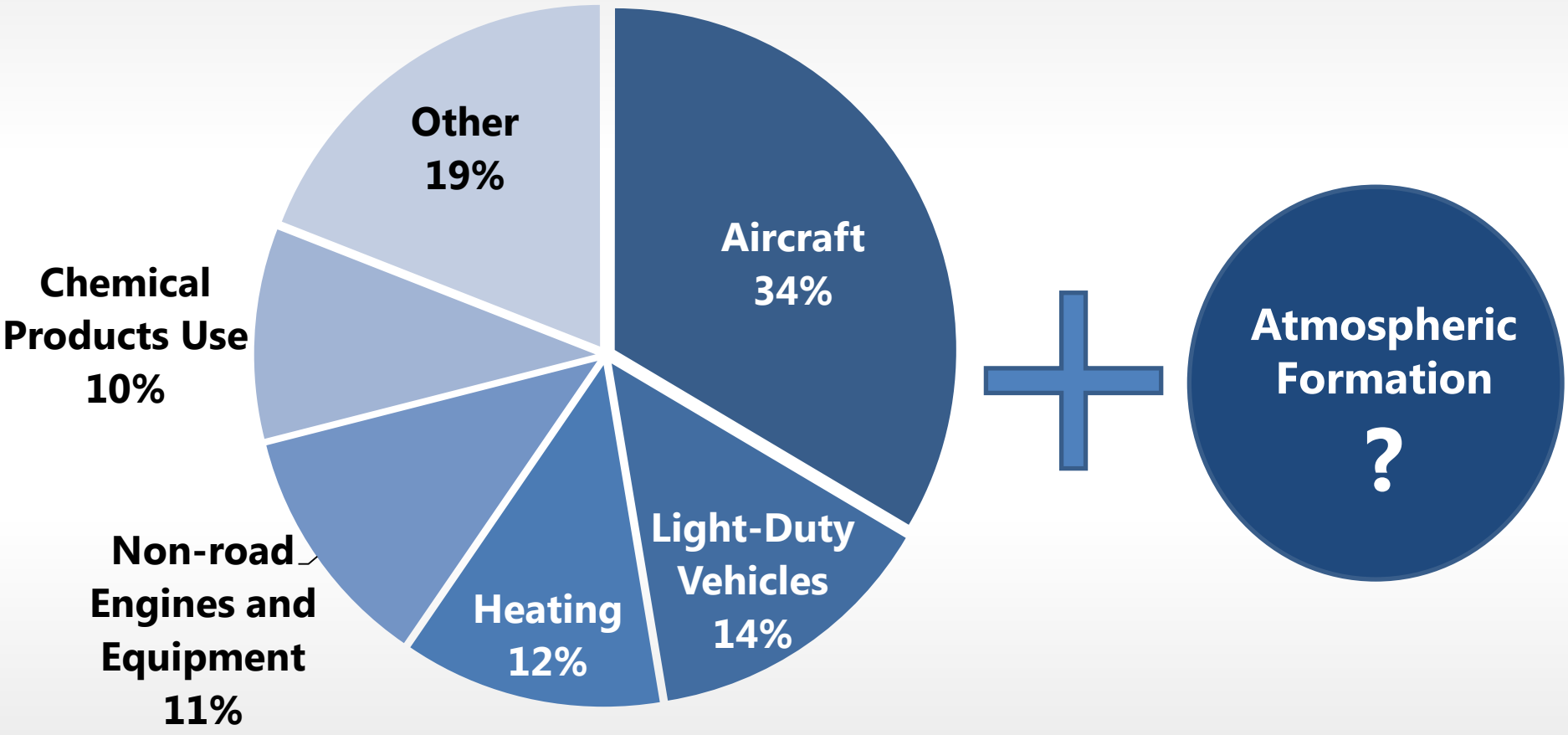
Total CLFV Emissions: 1451 tonnes

Key TAPs for Noncancer Hazard

- Estimated average noncancer hazard quotients for the CLFV
  - Acrolein: 15.2
  - All other TAPs studied, combined: 1.2
  - The second- and third-highest contributors to hazard:
    - Formaldehyde: 0.23
    - Acetaldehyde: 0.20

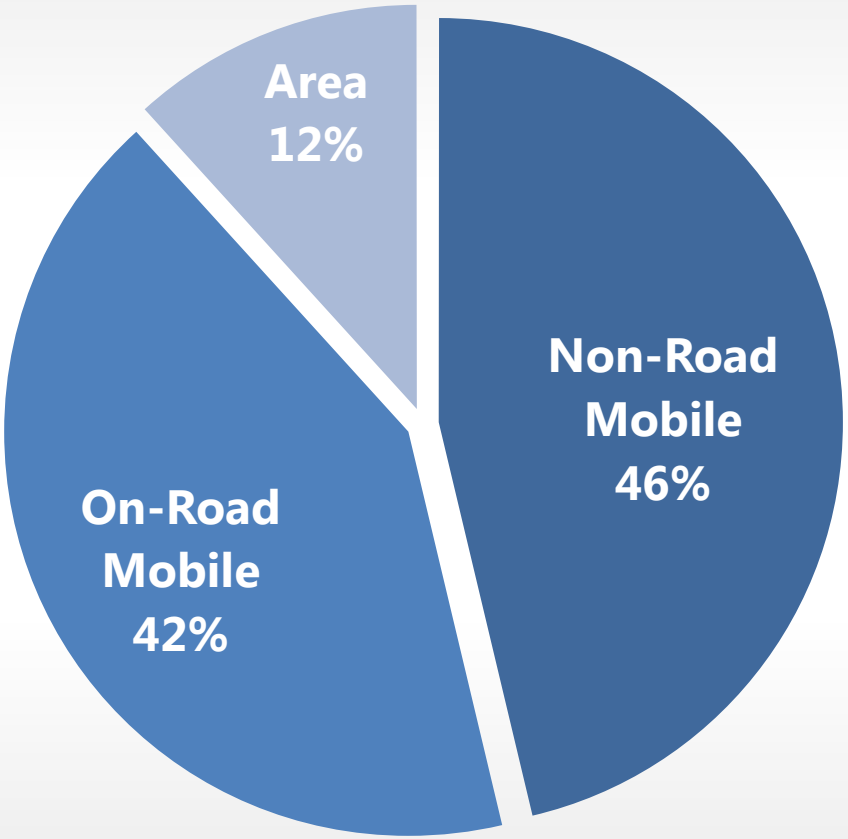


Key Sources of Acrolein



Total CLFV Emissions: 43.5 tonnes

Key Sources of 1,3-Butadiene



Total CLFV Emissions: 104 tonnes

For more information about atmospheric transformations of 1,3-Butadiene that form acrolein, see:
Formation and Reaction of Hydroxycarbonyls from the Reaction of OH Radicals with 1,3-Butadiene and Isoprene
Jillian Baker, Janet Arey, and Roger Atkinson, *Environmental Science & Technology* **2005** *39* (11), 4091-4099.

Metro Vancouver Policy Context

- MV has delegated authority for regional air quality management:
  - 2011 Integrated Greenhouse Gas & Air Quality Management Plan has goals and strategies that include TAPs, particularly diesel PM.
  - Pursuant to our previous TAP Risk Assessment and EI (2007), MV developed a Non-Road Diesel Engine Emission Regulation targeting largest (onshore) regional source of diesel PM.

Metro Vancouver Policy Implications (1)

- Diesel PM remains by far the largest source of cancer risk and risk weighted emissions
  - Continue and potentially enhance Non-Road Diesel Engine Emission Regulation.
  - Investigate measures to reduce diesel PM emissions from on-road heavy diesels.
  - IMO North American Emission Control Area will play vital role in reducing marine diesel PM emissions.

IMO = International Maritime Organization

Metro Vancouver Policy Implications (2)

- On-road and non-road gasoline engines remain key sources of TAPs
  - Termination of the regional AirCare I&M program for on-road LDVs is a concern.
  - New Regional Ground Level Ozone Strategy may motivate VOC reduction policies.

- Residential wood burning is a surprisingly large source of TAPS
  - Development of regulations on residential wood burning currently underway.

Recommendations

- Monitoring
  - Add permanent monitoring of acrolein, formaldehyde, acetaldehyde, and ethylene oxide.
  - Apply optical saturation correction of black carbon measured with aethalometers to improve characterization of wood smoke and diesel PM (following published methods).
  - Monitor PCDDs, PCDFs, and PAHs intermittently (e.g., every 3rd or 5th year) to assess local concentrations.

PCDDs = polychlorinated dibenzodioxins
PCDFs = polychlorinated dibenzofurans
PAHs = polycyclic aromatic hydrocarbons

Recommendations

- Exposure modeling
- Data analyses
  - Analyze spatially resolved emissions and receptor data as a simplified alternative to exposure modeling.
  - Compare results to other Canadian studies when available.
  - Characterize co-benefits of pollutant reductions.
- Policy development
  - Continue existing diesel emissions regulatory programs.
  - Investigate new programs for sources not currently regulated at the regional level: additional diesel PM sources, on-road vehicles, non-road engines, and wood burning.

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