SPHERE: SAN JOAQUIN VALLEY POLLUTION AND HEALTH ENVIRONMENTAL RESEARCH

Ada Chibueze

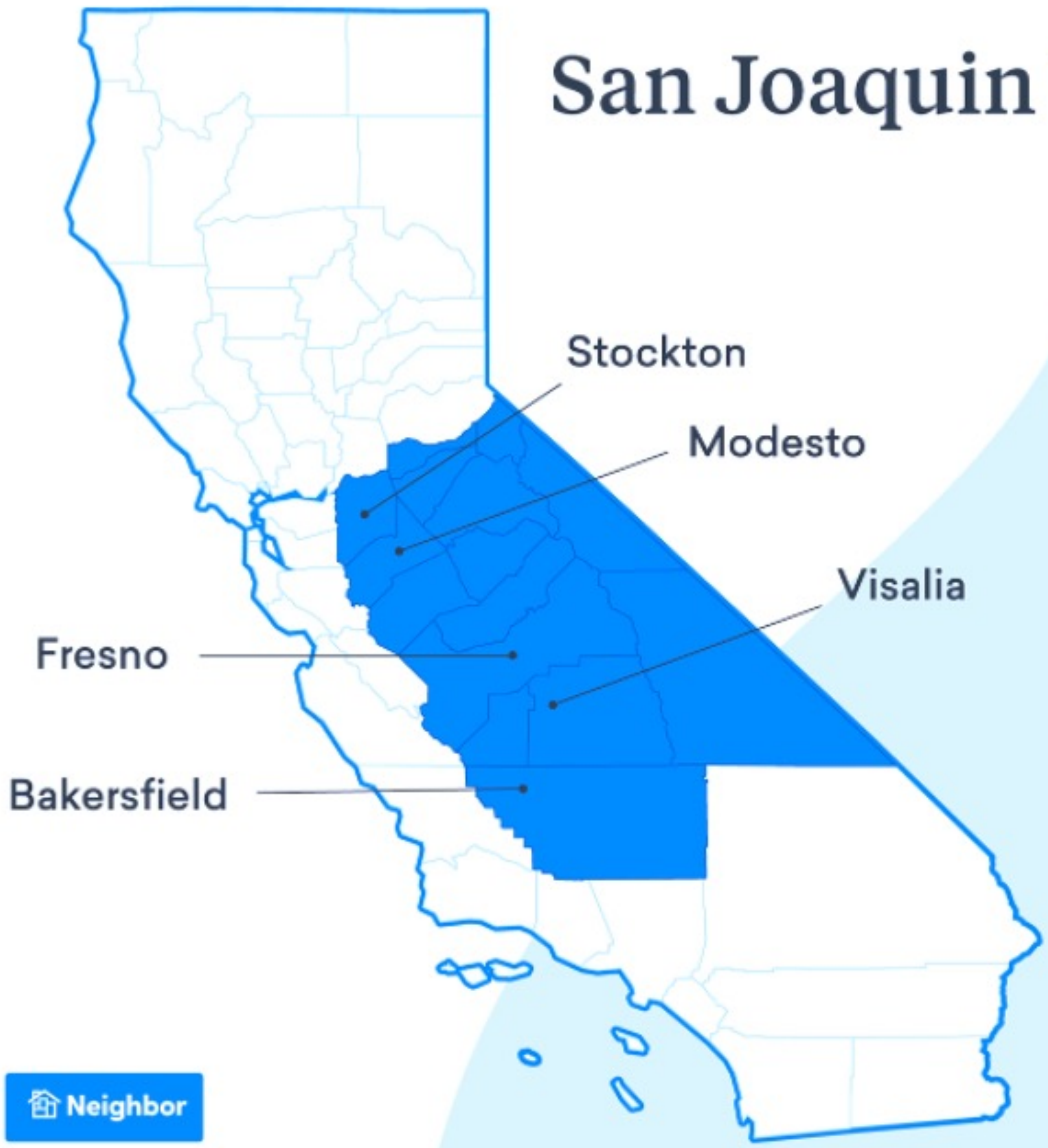
Mentor: Rosemary Castorina

August 11, 2023

STEER SYMPOSIUM

Research Process

San Joaquin Valley



Risk and warnings	Examples	RGB color & dBA
Painful & dangerous: Use hearing protection or avoid	Fireworks, gun shots and stereos (at full volume)	130
Uncomfortable: Dangerous over 30 seconds	Jet planes (during take off)	125 120
Very Loud: Dangerous over 30 minutes	Concerts (any genre of music), car horns and sporting events	115 110 105 100 95 90
Over 85 dB for extended periods can cause permanent hearing loss		85
Loud	Alarm clocks Traffic and vacuums	80 75 70
Moderate	Normal conversation and dishwashers Moderate rainfall	65 60 55 50
Soft	Quiet library Whisper	45 40 35 30

"The traditional definition of noise is unwanted or disturbing sound. Sound becomes unwanted when it either interferes with normal activities such as sleeping, conversation, or disrupts or diminishes one's quality of life."

- Environmental Protection Agency

Soundscape of the San Joaquin Valley

TRANSPORTATION

Cars, trucks, buses, motorcycles, trains, and airplanes

INDUSTRIAL OPERATIONS

Machinery, equipment, fans, and industrial processes

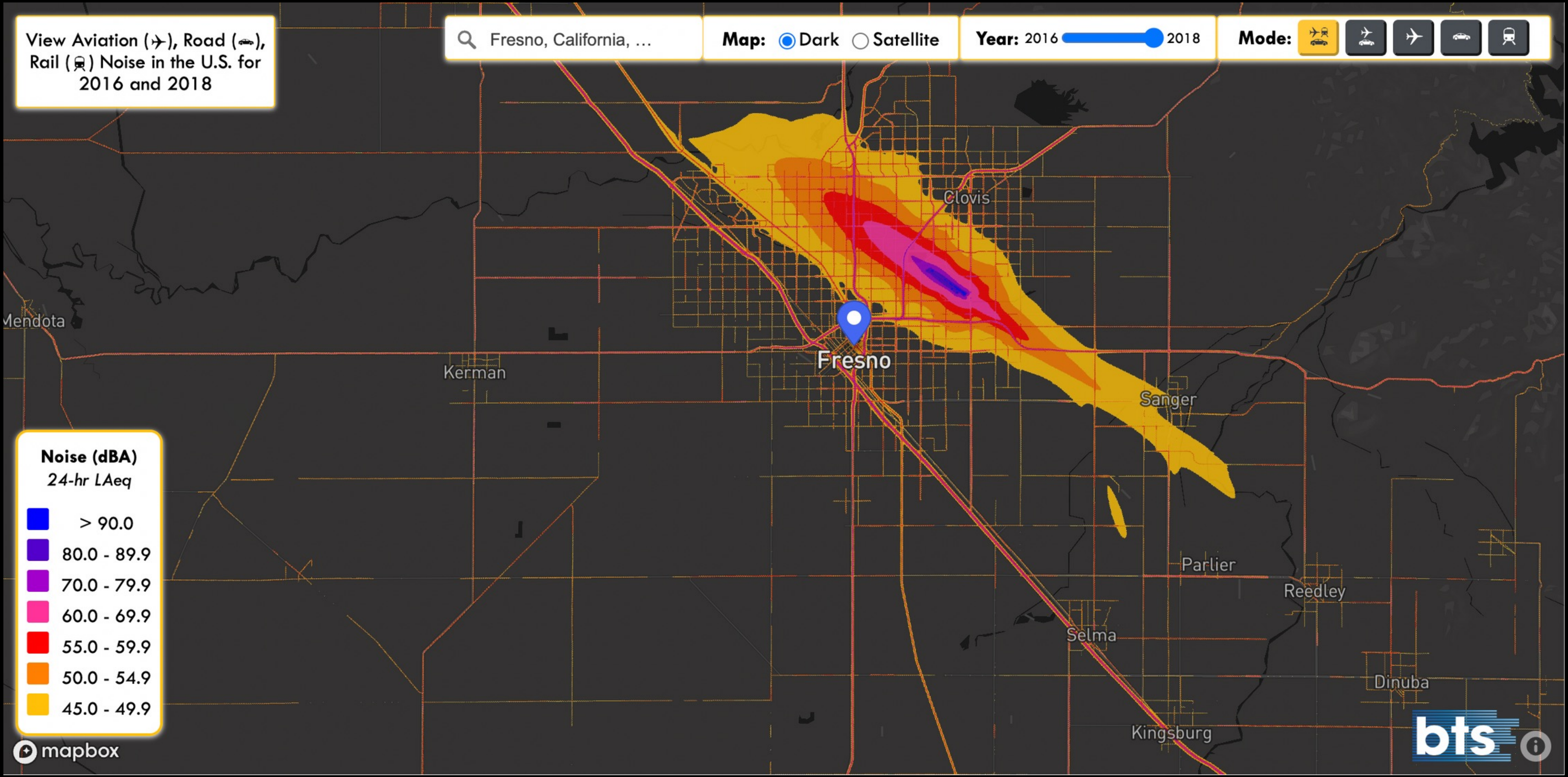
NEIGHBORHOOD NOISE

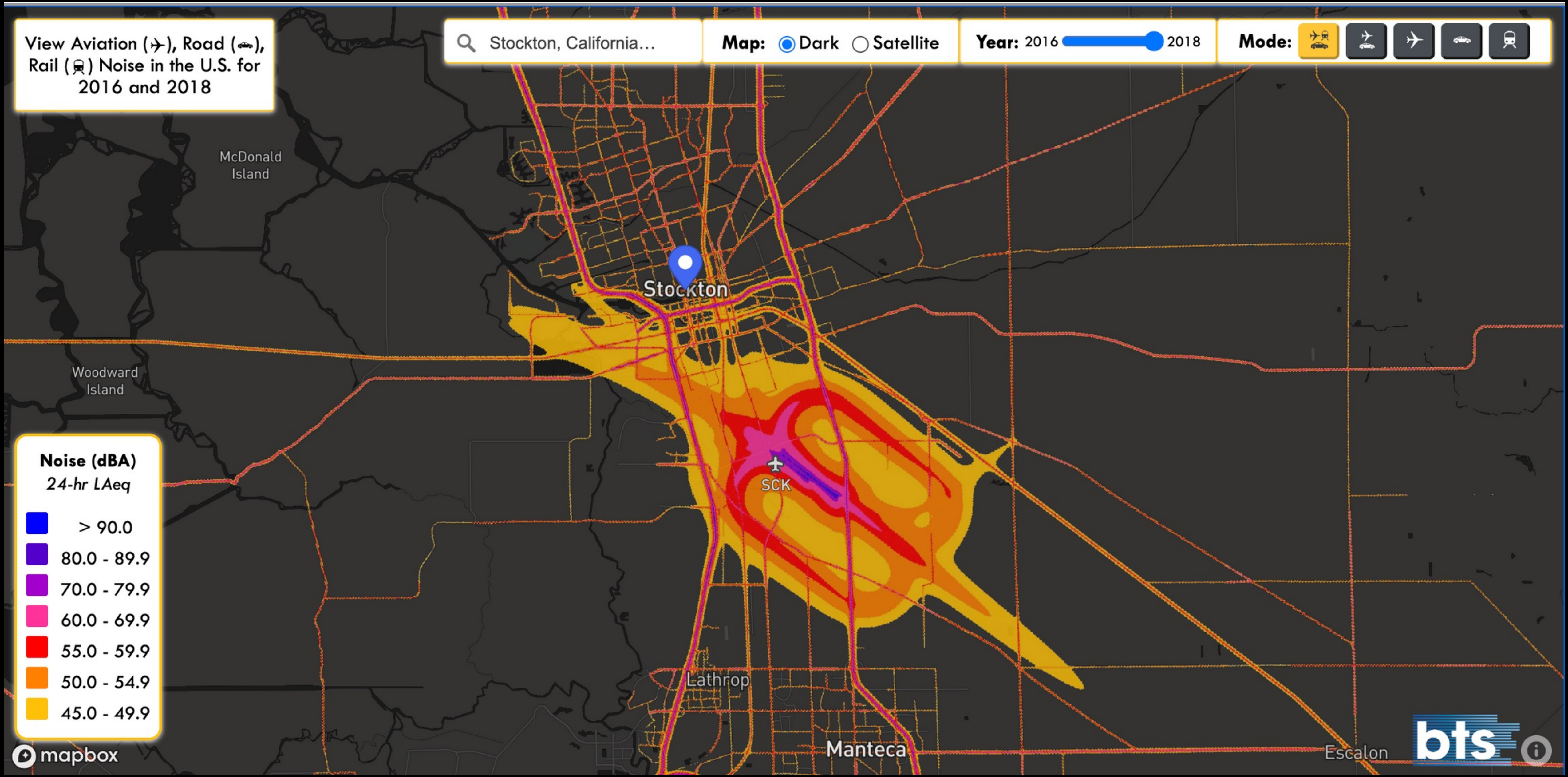
Lawnmowers, leaf blowers, parties, barking dogs

CONSTRUCTION

Jackhammers, generators, pavers

MAJOR SOURCES OF NOISE POLLUTION INCLUDE TRANSPORTATION VEHICLES, INDUSTRIAL MACHINERY, AND SOUNDS FROM RESIDENTIAL NEIGHBORHOODS.


View Aviation (✈), Road (🚗), Rail (🚆) Noise in the U.S. for 2016 and 2018
Fresno, California, ...
Map: Dark Satellite
Year: 2016 2018
Mode:
Clovis
Mendota
Kerman
Fresno
Sanger
Parlier
Reedley
Selma
Dinuba
Kingsburg
Noise (dBA)
24-hr LAeq
> 90.0
80.0 - 89.9
70.0 - 79.9
60.0 - 69.9
55.0 - 59.9
50.0 - 54.9
45.0 - 49.9
mapbox
bts


View Aviation (✈), Road (🚗), Rail (🚆) Noise in the U.S. for 2016 and 2018
Stockton, California...
Map: Dark Satellite
Year: 2016 2018
Mode:
McDonald Island
Woodward Island
Stockton
SCK
Lathrop
Manteca
Escalon
Noise (dBA)
24-hr LAeq
> 90.0
80.0 - 89.9
70.0 - 79.9
60.0 - 69.9
55.0 - 59.9
50.0 - 54.9
45.0 - 49.9
mapbox
bts

Health Implications of Noise Exposure

SLEEP DISTURBANCE

Noise pollution disrupts sleep patterns and decreases sleep time.

HEARING LOSS

Long-term noise exposure damages sensitive structures in the inner ear, causing permanent hearing loss.

CARDIOVASCULAR DISEASE

Noise pollution increases stress hormones and blood pressure, raising risk of hypertension, stroke, and heart attacks.

COGNITIVE IMPAIRMENT

Noise makes it harder to focus and process information, negatively impacting learning and academic performance.

MENTAL HEALTH ISSUES

Noise pollution can worsen anxiety, depression, and other mental health conditions.

Disparities in Noise Exposure

- Casey et al. (2017)
    - Looked at noise level exposure amongst SES of race, income, education level and within segregated communities
- Dale et al. (2015) and Huang et al. (2021)
    - Found that income is also a determining factor of noise exposure

Race/Ethnicity, Socioeconomic Status, Residential Segregation, and Spatial Variation in Noise Exposure in the Contiguous United States

Joan A. Casey,[1] Rachel Morello-Frosch,[2] Daniel J. Mennitt,[3] Kurt Fristrup,[4] Elizabeth L. Ogburn,[5] and Peter James[6]

[1]Robert Wood Johnson Foundation Health & Society Scholars Program, University of California, San Francisco and University of California, Berkeley, California, USA
[2]Department of Environmental Science, Policy, and Management, and the School of Public Health; University of California, Berkeley, California, USA
[3]Department of Electrical & Computer Engineering, Colorado State University, Fort Collins, Colorado, USA
[4]Natural Sounds and Night Skies Division, Natural Resource Stewardship and Science Directorate, National Park Service, Fort Collins, Colorado, USA
[5]Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA
[6]Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Healthcare Institute; Departments of Epidemiology and Environmental Health, Harvard TH Chan School of Public Health; Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital & Harvard Medical School, Boston, Massachusetts, USA

Background: Prior research has reported disparities in environmental exposures in the United States, but, to our knowledge, no nationwide studies have assessed inequality in noise pollution.

Objectives: We aimed to *a*) assess racial/ethnic and socioeconomic inequalities in noise pollution in the contiguous United States; and *b*) consider the modifying role of metropolitan level racial residential segregation.

Methods: We used a geospatial sound model to estimate census block group–level median (L_{50}) nighttime and daytime noise exposure and 90th percentile (L_{10}) daytime noise exposure. Block group variables from the 2006–2010 American Community Survey (ACS) included race/ethnicity, education, income, poverty, unemployment, homeownership, and linguistic isolation. We estimated associations using polynomial terms in spatial error models adjusted for total population and population density. We also evaluated the relationship between race/ethnicity and noise, stratified by levels of metropolitan area racial residential segregation, classified using a multigroup dissimilarity index.

Results: Generally, estimated nighttime and daytime noise levels were higher for census block groups with higher proportions of nonwhite and lower-socioeconomic status (SES) residents. For example, estimated nighttime noise levels in urban block groups with 75% vs. 0% black residents were 46.3 A-weighted decibels (dBA) [interquartile range (IQR): 44.3–47.8 dBA] and 42.3 dBA (IQR: 40.4–45.5 dBA), respectively. In urban block groups with 50% vs. 0% of residents living below poverty, estimated nighttime noise levels were 46.9 dBA (IQR: 44.7–48.5 dBA) and 44.0 dBA (IQR: 42.2–45.5 dBA), respectively. Block groups with the highest metropolitan area segregation had the highest estimated noise exposures, regardless of racial composition. Results were generally consistent between urban and suburban/rural census block groups, and for daytime and nighttime noise and robust to different spatial weight and neighbor definitions.

Conclusions: We found evidence of racial/ethnic and socioeconomic differences in model-based estimates of noise exposure throughout the United States. Additional research is needed to determine if differences in noise exposure may contribute to health disparities in the United States. https://doi.org/10.1289/EHP898

Introduction

A growing body of evidence links environmental noise—a biologic stressor usually generated by mechanized sources: transportation, industry, power generation, power tools, and air-conditioning—to hearing loss and other health outcomes (Basner et al. 2014). The human body initially reacts to noise with activation of the central nervous system, even while asleep. This can result in release of stress hormones and increased blood pressure, heart rate, and cardiac output (Evans et al. 1995; Lercher 1996). While individual noise sensitivities differ, the World Health Organization (WHO) estimated a "no observed effect level" for average outdoor nighttime noise of 30 A-weighted decibels (dBA) based on evidence that sleep is not disturbed by noise below 30 (dBA) (WHO 2009). The Federal Highway Administration noise abatement criteria near hospitals and schools is 70 dBA, a recommendation that balances health, communication, and economic interests (U.S. DOT 2015). Exposure to these noise levels has been associated with impaired cognitive performance (Clark et al. 2012) and behavioral problems in children (Hjortebjerg et al. 2016), as well as hypertension (van Kempen and Babisch 2012), type 2 diabetes (Sørensen et al. 2013), cardiovascular disease (Gan et al. 2012), and reduced birth weight (Gehring et al. 2014). The WHO (2011) has estimated >1 million disability adjusted life years are lost annually in Western Europe due to environmental noise, attributable primarily to annoyance and sleep disturbance. The WHO calculation was based on estimated noise exposures and previous research on associations between noise and health outcomes.

Environmental noise is typically measured as sound pressure level, a logarithmic quantity expressed in decibels (dB); for example, an increase of 3 dB is a doubling of sound energy. With every 5.5-dB increase, the proportion of individuals highly annoyed by residential noise exposure appears to double (ANSI 2003). Measurements of sound pressure level are commonly adjusted by A-weighting to reflect how humans perceive sound across frequency, denoted as dBA (Murphy and King 2014). Because sound levels vary over time, metrics describing the statistical behavior of the variation are utilized. The energy average, or equivalent, indicator is abbreviated L_{eq}. Multiple exceedance levels are used to characterize magnitude, rate of occurrence, and duration of environmental noise. The L_{50} is the noise level exceeded half of the time, whereas the L_{10} is the level exceeded 10% of the time.

Address correspondence to J.A. Casey, University of California, Berkeley, 13B University Hall, Berkeley, CA 94610 USA. Telephone: 541-760-8477; Email: joanacasey@berkeley.edu

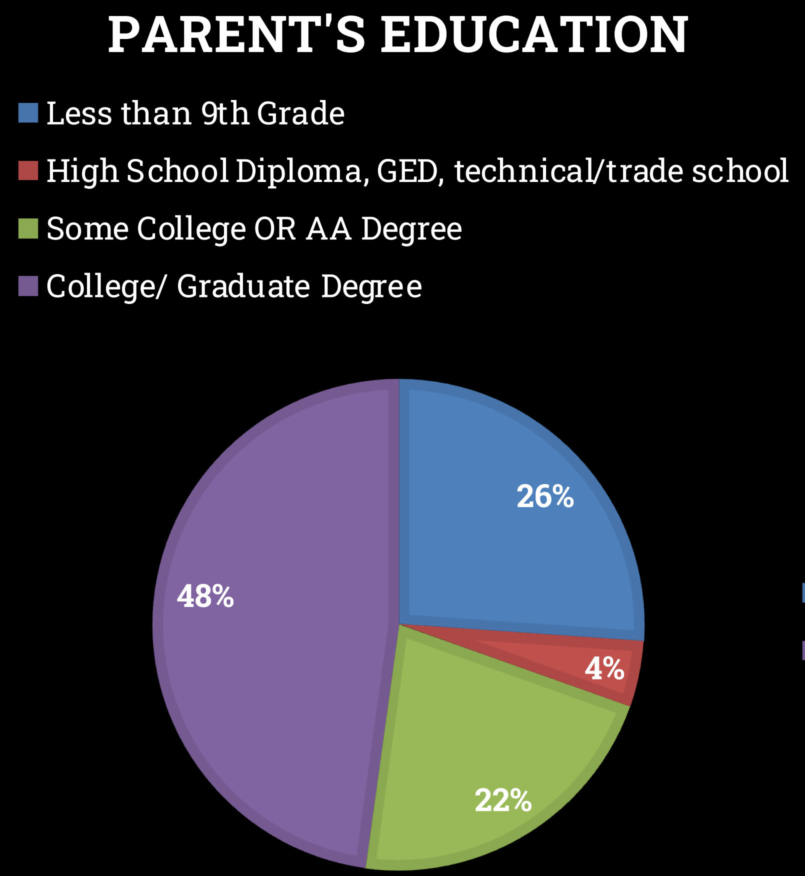
Supplemental Material is available online (https://doi.org/10.1289/EHP898).

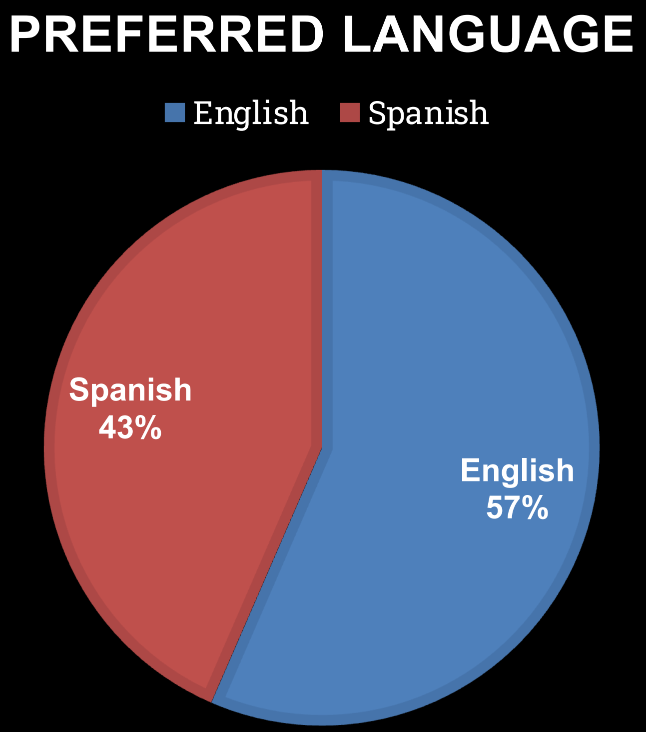
The authors declare they have no actual or potential competing financial interests.

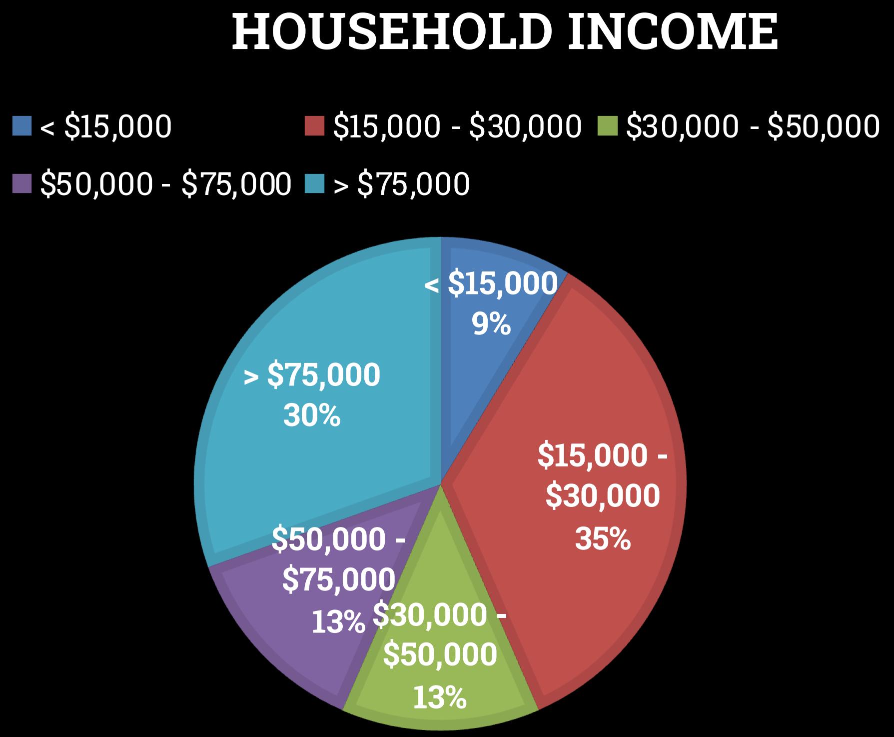
Received 1 August 2016; Revised 6 February 2017; Accepted 6 February 2017; Published 25 July 2017.

Note to readers with disabilities: *EHP* strives to ensure that all journal content is accessible to all readers. However, some figures and Supplemental Material published in *EHP* articles may not conform to 508 standards due to the complexity of the information being presented. If you need assistance accessing journal content, please contact ehponline@niehs.nih.gov. Our staff will work with you to assess and meet your accessibility needs within 3 working days.

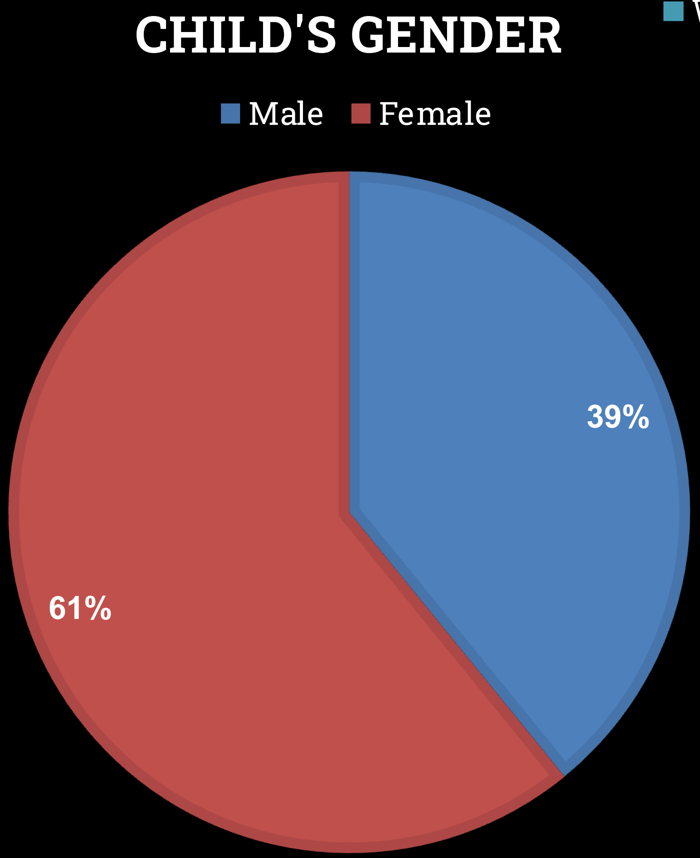
Population Demographic – Parents (n=23)

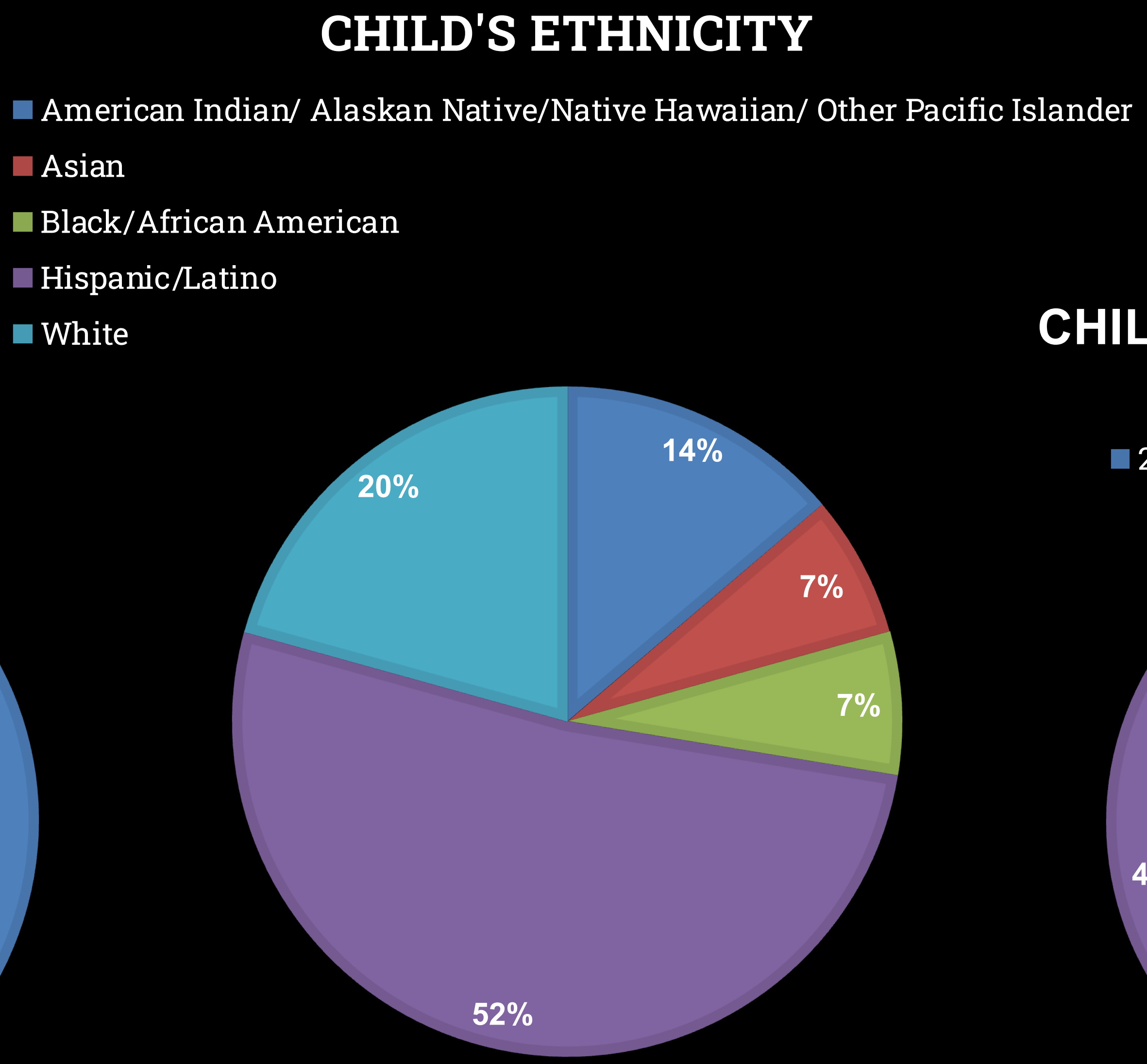


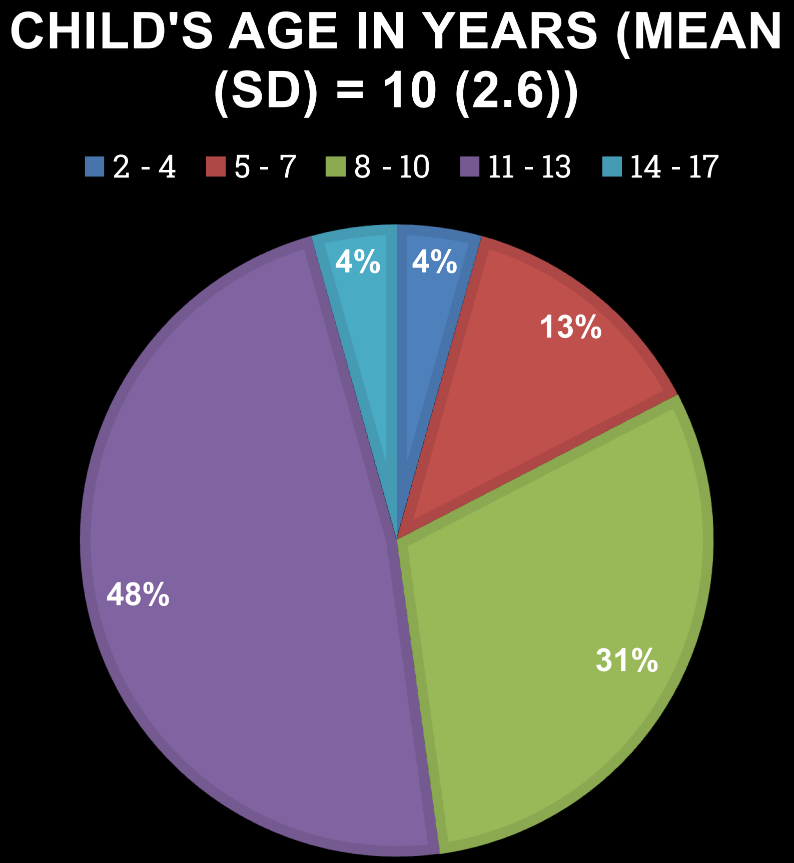




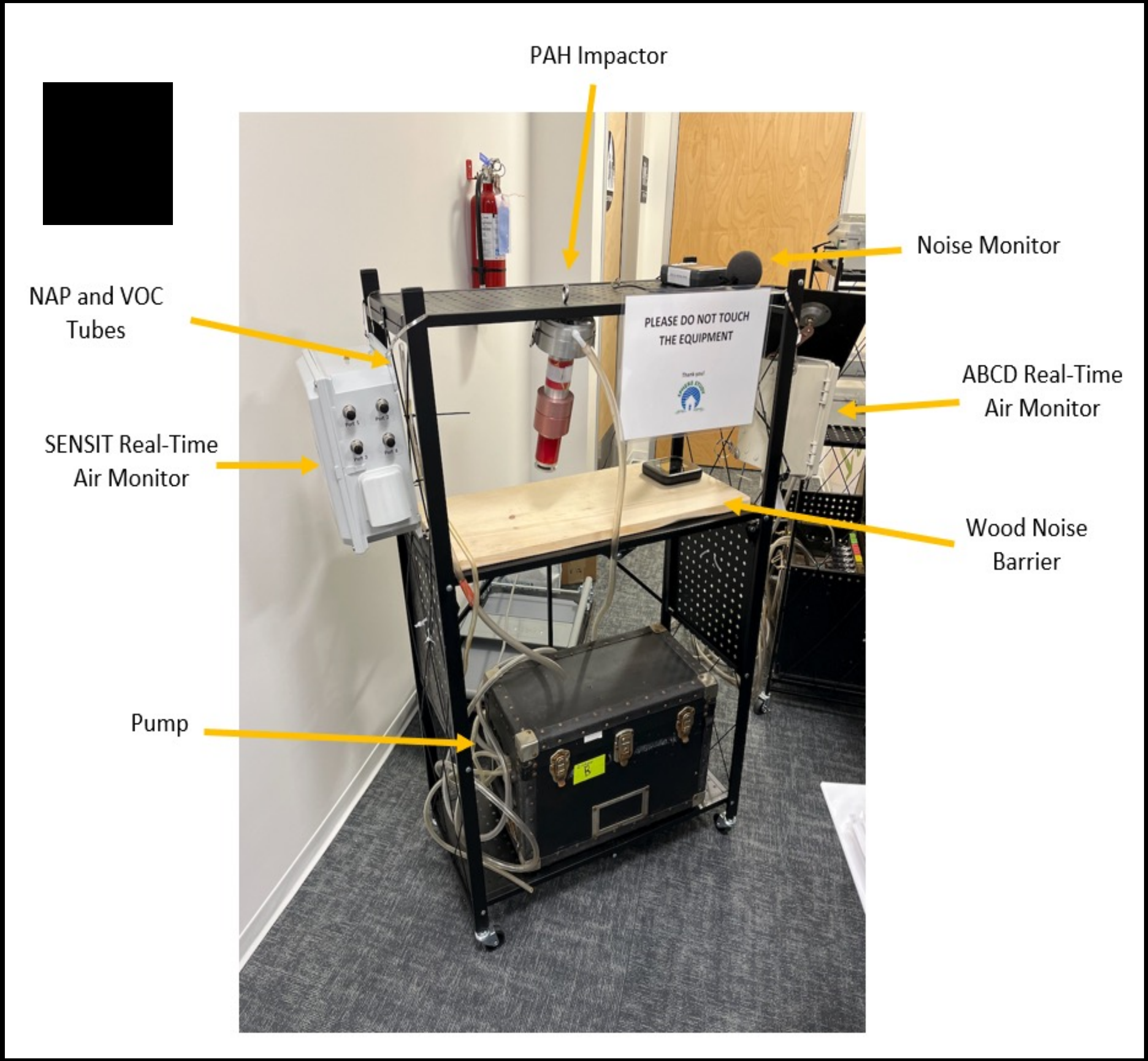
Population Demographics – Children (n = 23)







Data Collection and Methods



Data Cleaning and Quality Checks

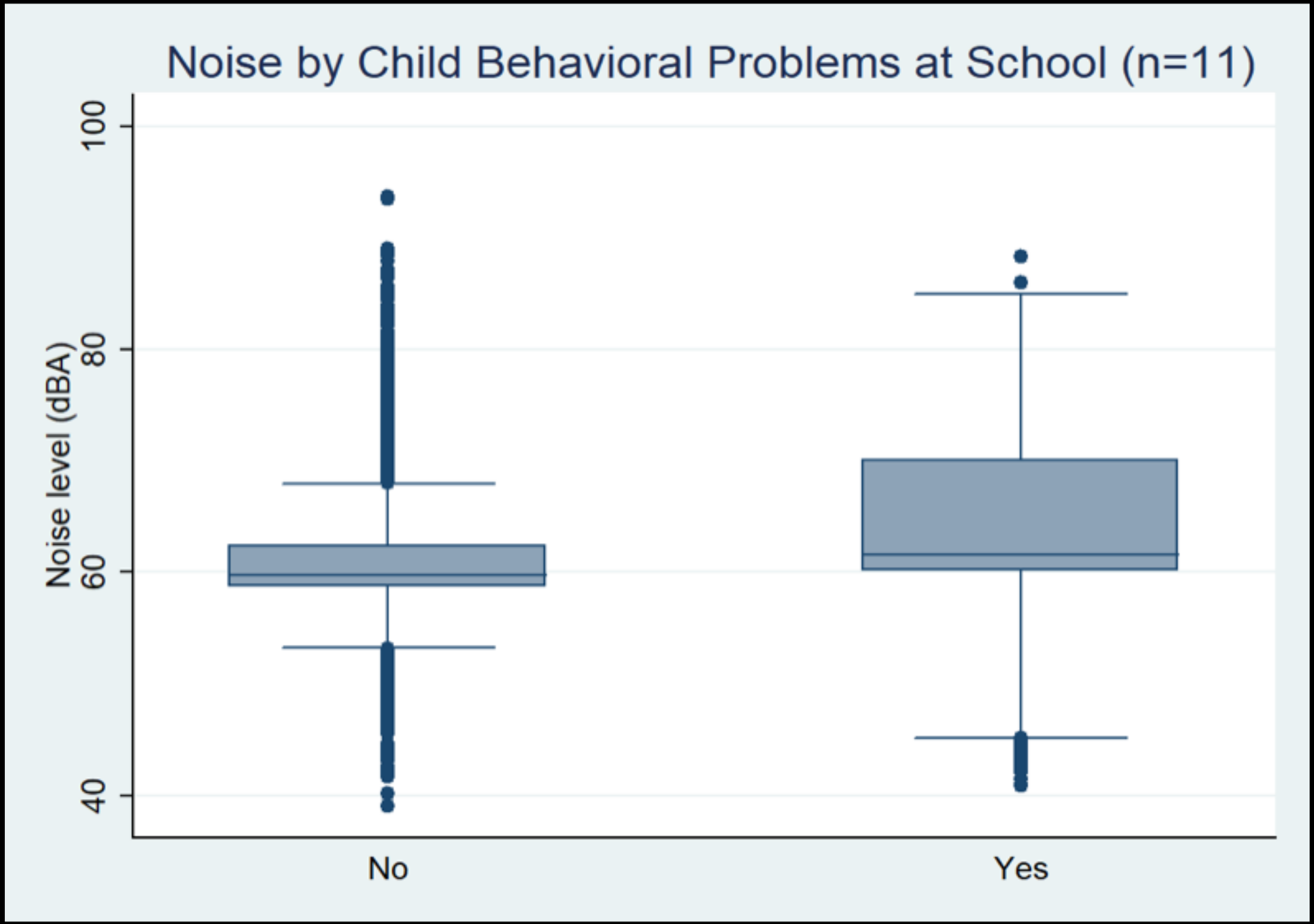
Ensuring data is viable and in preparation of data analysis

- Cross reference data Sets with Monitoring Dates
- Check for duplicate data sets spanning across multiple days
- Keep track of error occurrence and percentages

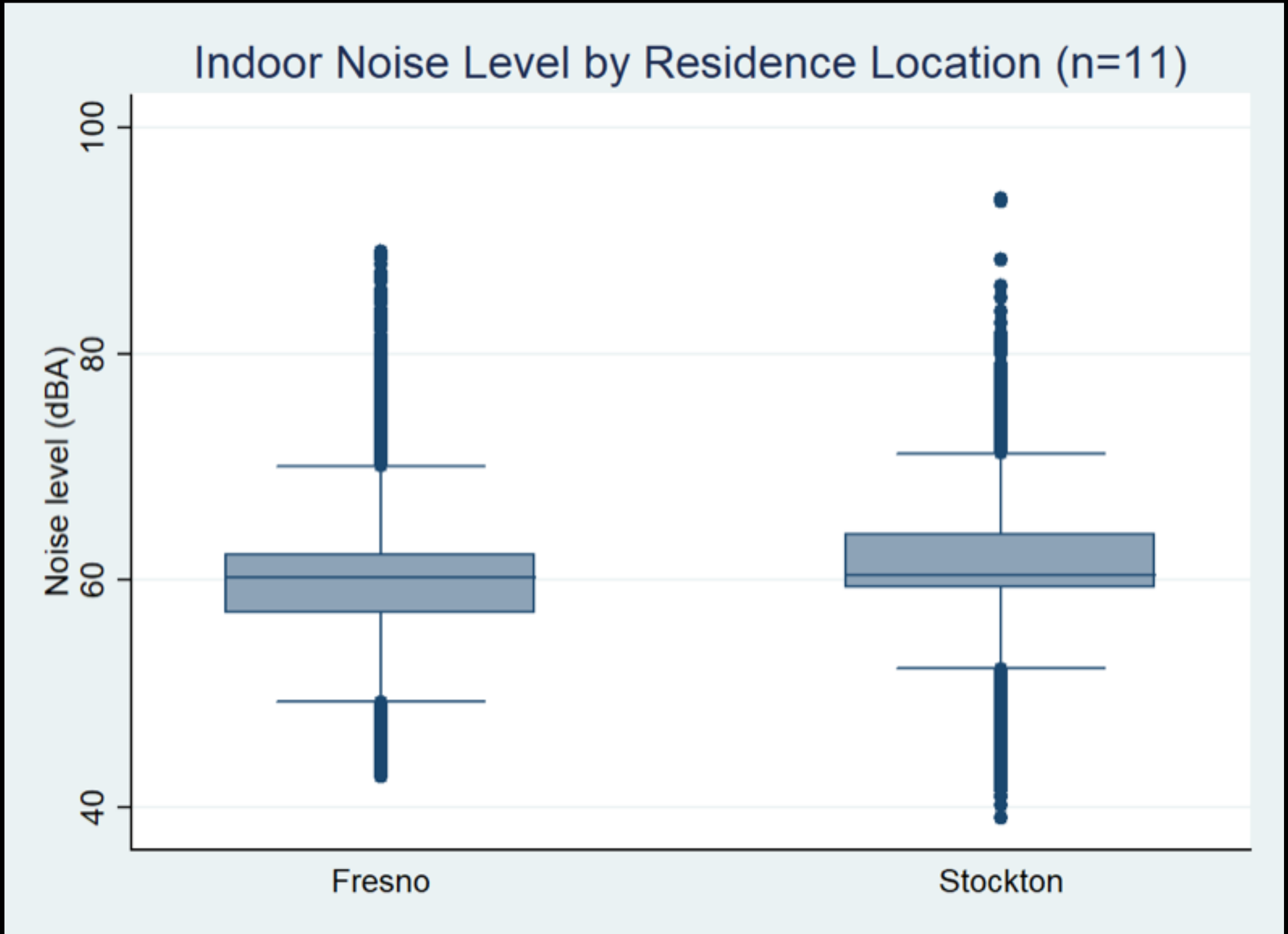
Summary Statistics

	Indoor (n=11)	Personal (n=5)	Outdoor (n=6)
Average	61.3	52.3	59.1
Standard Deviation	6.3	9.2	2.8
Median	60.3	50.4	59.3
Range	39.1, 93.7	33.9, 91.3	41.1, 93.6

Variable of Interest – Child Behavior



Variable of Interest – Location



LIMITATIONS AND FUTURE OBJECTIVES OF SPHERE

- Limitations
  - Outdoor and Indoor Sampling may not be truly representative of ambient noise levels
  - Participant error of equipment leaves some room for misreporting to happen
  - Current data analysis is working within a small sample size with little variability within SES factors
- Future
  - Continue collecting noise monitoring samples in Fresno and Stockton region to expand sample size
  - Geo-code houses via GIS to access nearby sources of expsoure

Thank you!

STEER Cohort, Sadie Costello, Carissa Harris

Jesus Alfraro, Norma Firestone, Gina Grayson

LittleManila RISING

CCAC
Central California Asthma Collaborative

Berkeley
University of California

University of California
Merced

California
Air Resources Board

BEAR Lab
Berkeley Exposure Assessment Research Lab

cerch
Center for Environmental Research & Children's Health