EPA
United States
Environmental Protection
Agency

EPA Tools and Resources Webinar: Environmental Quality Index

January 18, 2017

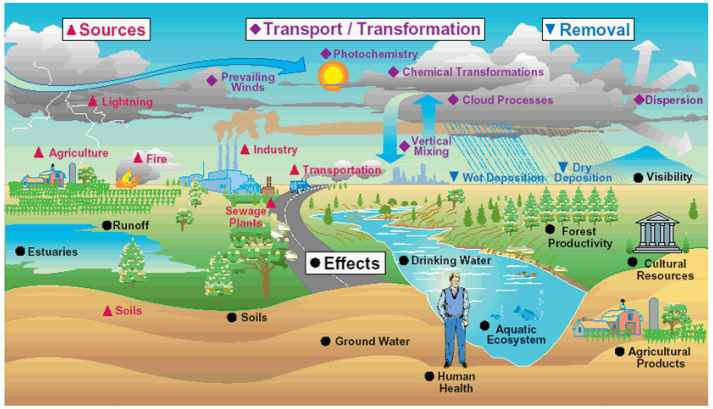
Danielle T. Lobdell, PhD, MS

Office of Research and Development

EPA United States Environmental Protection Agency

Multiple Environments

Multiple Environmental Hazards



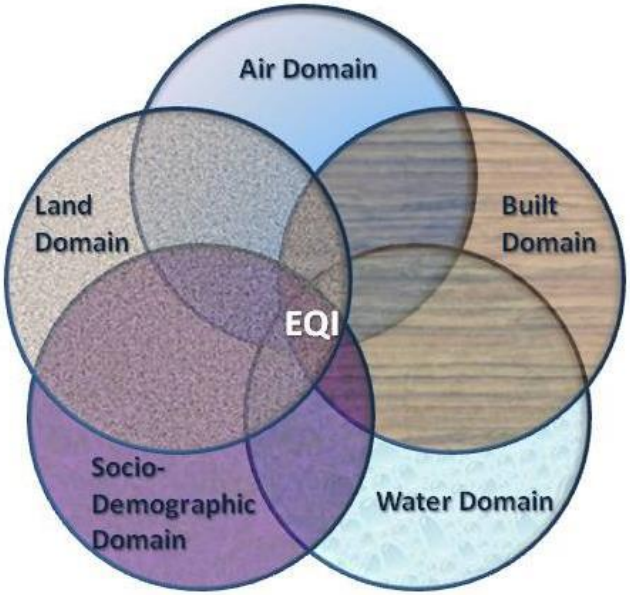
Problem:

- Human health and disease - a complex process
- Exposures to harmful and benign substances occurring simultaneously
  - Environmental exposures tend to cluster
- No single exposure can be held responsible for good or poor health

How we addressed this problem:

- Construct an environmental quality index (EQI) for all counties in the U.S.

Environmental Quality Index (EQI)



Multiple domains that influence exposure and health

- Five domains: air, water, land, built environment, and socio-demographic

Incorporates data representing the chemical, natural and built environment

EQI – Data Sources

Air Domain

87 variables representing criteria and hazardous air pollutants

- EPA Air Quality System (AQS)
- National Air Toxics Assessments (NATA)

Water Domain

80 variables representing overall water quality, general water contamination, recreational water quality, drinking water quality, atmospheric deposition, drought, and chemical contamination

- Watershed Assessment, Tracking & Environmental Results Database (WATERS)
- National Contaminant Occurrence Database (NCOD)
- National Atmospheric Deposition Program (NADP)
- Water Use Estimates
- Drought Monitor Data

Land Domain

26 variables representing agriculture, pesticides, contaminants, facilities, and radon

- 2002 Census of Agriculture Full Report (Ag Census)
- National Priority List (NPL)
- National Geochemical Survey

Sociodemographic Domain

12 variables representing socioeconomics and crime

- 2000 U.S. Census
- Uniform crime reports

Built Environment Domain

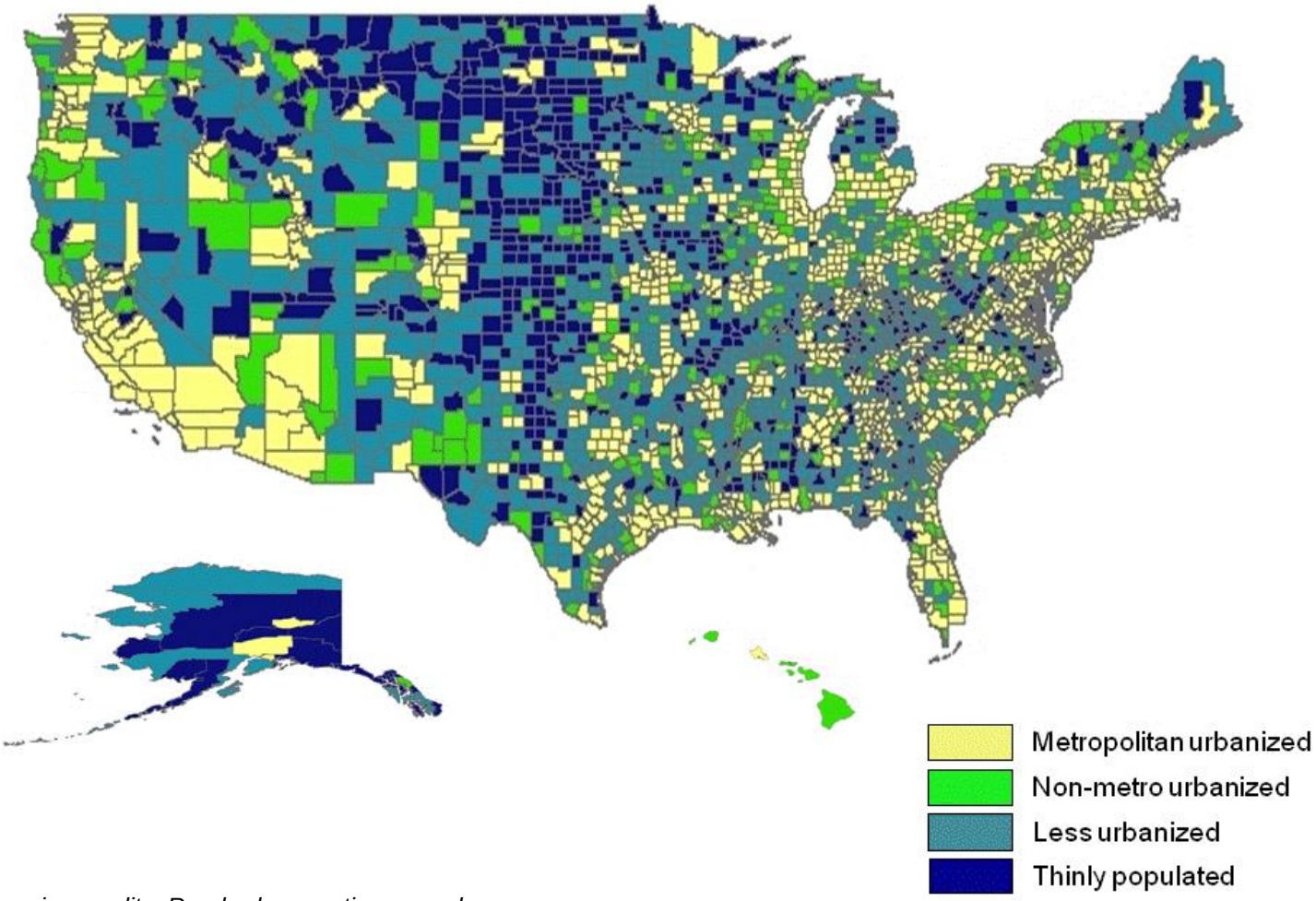
14 variables representing roads, highway/road safety, public transit behavior, business environment, and subsidized housing environment

- Duns and Bradstreet North American Industry Classification System (NAICS) Codes
- Topologically Integrated Geographic Encoding and Referencing (TIGER) Data and NAVTEQ streets
- Fatality Annual Reporting System
- Housing and Urban Development

Lobdell DT, et al., AJPH 2011

EPA United States Environmental Protection Agency

Rural-urban continuum code (RUCC) stratification for all counties in the U.S.



Source: USDA, *Measuring rurality: Rural-urban continuum codes.*

Domain-Specific and Overall EQI Construction - Conceptually

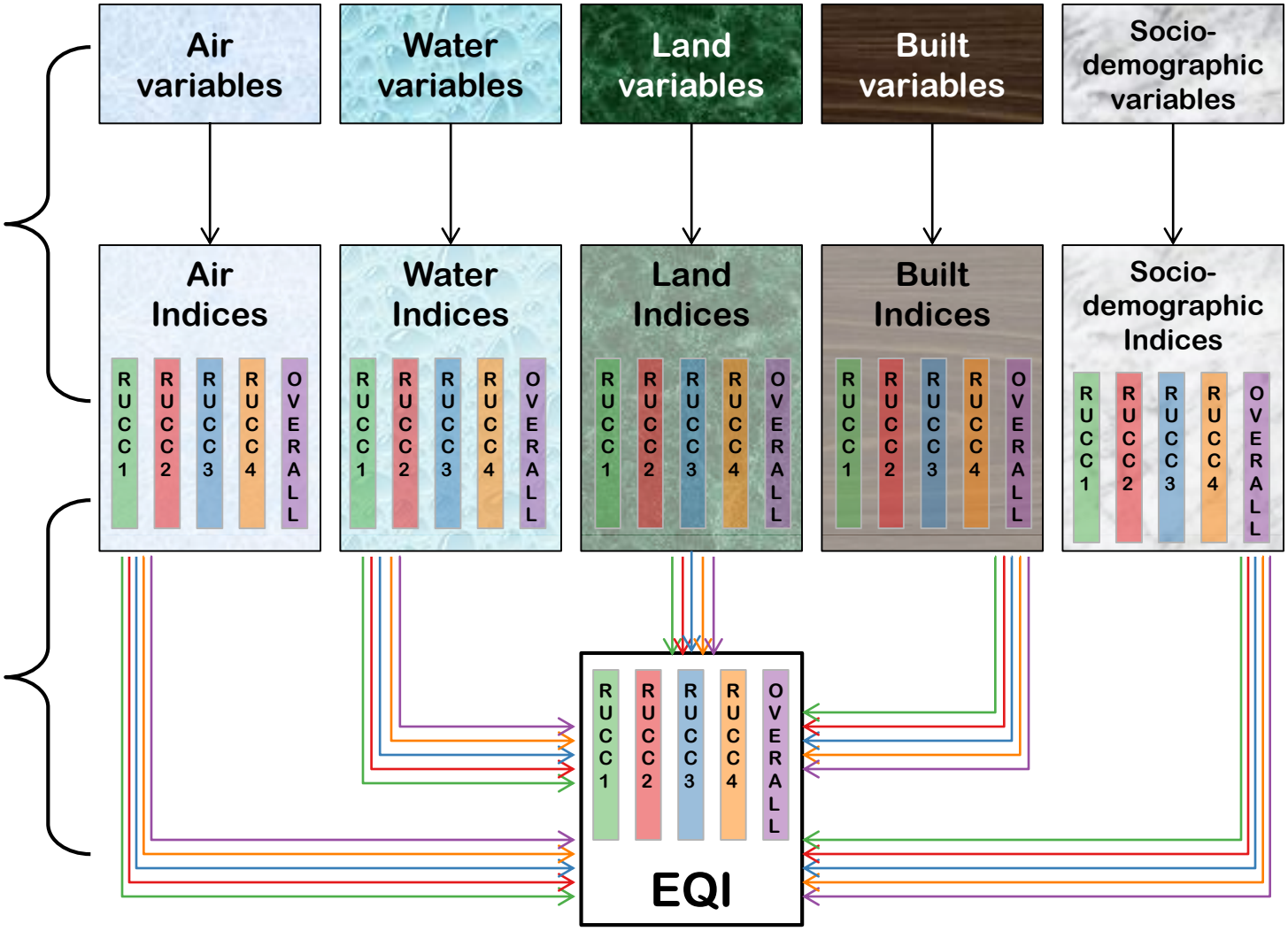
United States Environmental Protection Agency

Principal components analysis (PCA) reduced multiple variables into domain specific indices, for each rural-urban continuum code (RUCC) strata and overall

Legend:

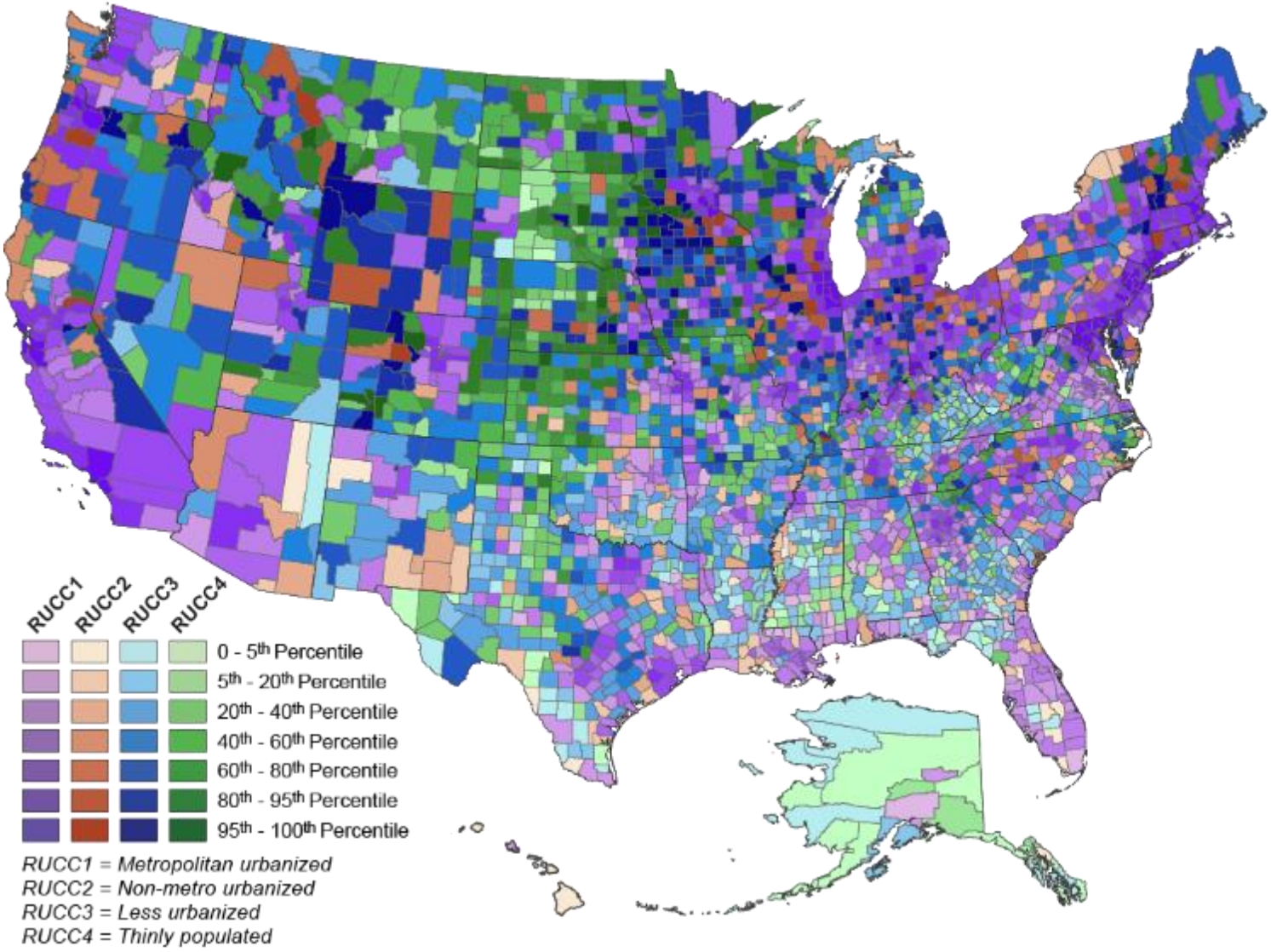
- RUCC1 = metropolitan urbanized
- RUCC2 =non-metropolitan urbanized
- RUCC3 =less urbanized
- RUCC4 =rural
- OVERALL

Domain specific indices combined using PCA to create EQI, for each RUCC strata and overall



Messer LC et al., Environmental Health 2014

Overall EQI Stratified by RUCC by County 2000-2005

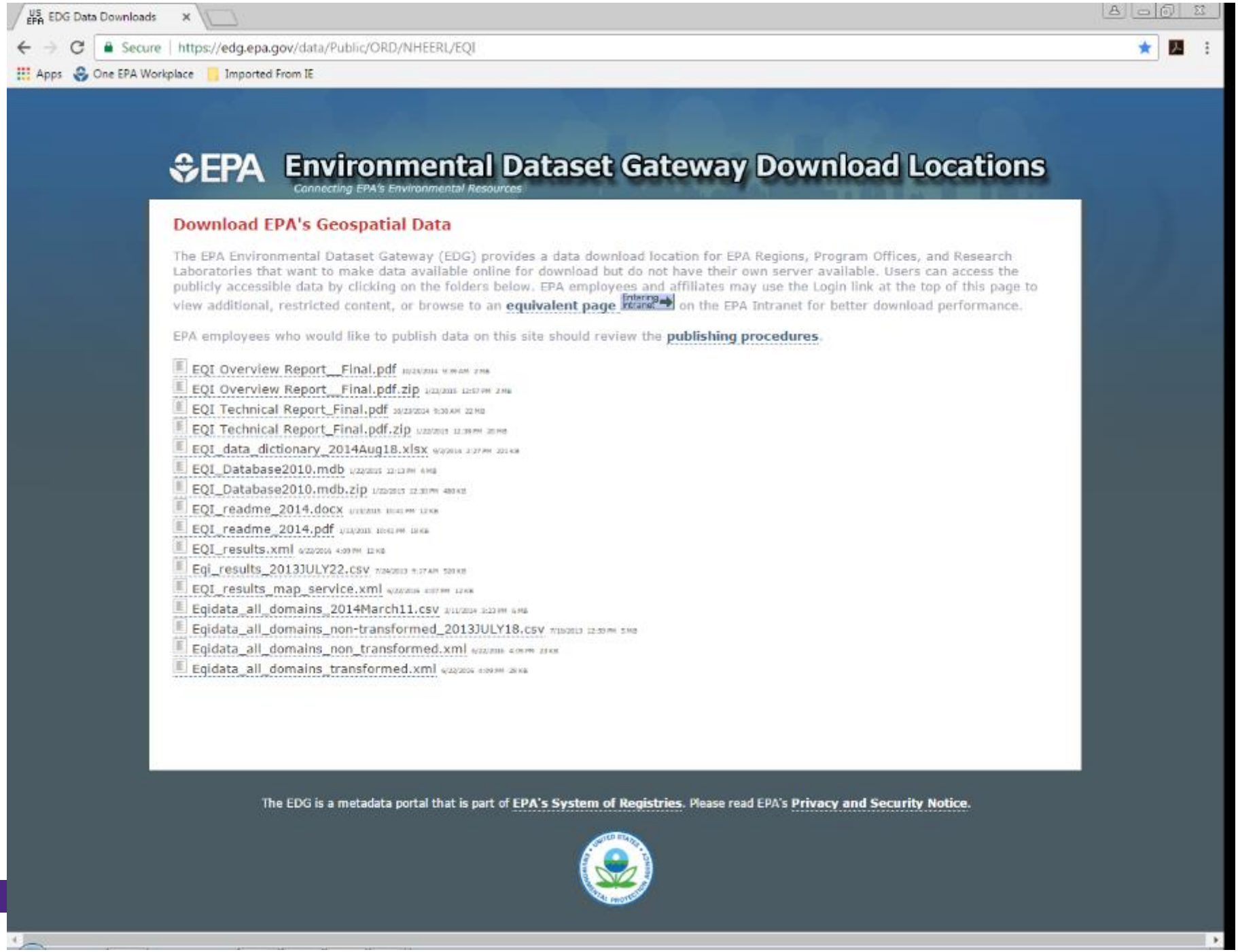


EPA
United States
Environmental Protection
Agency

Public Access To EQI

http://epa.maps.arcgis.com/home/item.html?id=90ab3f8d668c4a4e88144d586ea34141

https://edg.epa.gov/data/Public/ORD/NHEERL/EQI


US EPA EDG Data Downloads
Secure https://edg.epa.gov/data/Public/ORD/NHEERL/EQI
Apps One EPA Workplace Imported From IE
EPA Environmental Dataset Gateway Download Locations
Connecting EPA's Environmental Resources
Download EPA's Geospatial Data
The EPA Environmental Dataset Gateway (EDG) provides a data download location for EPA Regions, Program Offices, and Research Laboratories that want to make data available online for download but do not have their own server available. Users can access the publicly accessible data by clicking on the folders below. EPA employees and affiliates may use the Login link at the top of this page to view additional, restricted content, or browse to an equivalent page on the EPA Intranet for better download performance.
EPA employees who would like to publish data on this site should review the publishing procedures.
EQI Overview Report__Final.pdf
EQI Overview Report__Final.pdf.zip
EQI Technical Report_Final.pdf
EQI Technical Report_Final.pdf.zip
EQI_data_dictionary_2014Aug18.xlsx
EQI_Database2010.mdb
EQI_Database2010.mdb.zip
EQI_readme_2014.docx
EQI_readme_2014.pdf
EQI_results.xml
Eqi_results_2013JULY22.csv
EQI_results_map_service.xml
Eqidata_all_domains_2014March11.csv
Eqidata_all_domains_non-transformed_2013JULY18.csv
Eqidata_all_domains_non_transformed.xml
Eqidata_all_domains_transformed.xml
The EDG is a metadata portal that is part of EPA's System of Registries. Please read EPA's Privacy and Security Notice.

EQI – Strengths and Limitations

United States Environmental Protection Agency

Strengths

- First attempt to model the multifactorial nature of environmental exposures
- Coverage for all counties including AK and HI
- Able to capture domain specific exposures
  - Able to incorporate multiple variables representing multiple domains
- Appropriate urban-rural distinctions in variable loadings

Limitations

- Data scarcity – spatial and temporal coverage
  - Urban areas better represented with available data
- Construction at county level
  - Not all data sources could be used because not available for all counties in U.S.
  - Lower geographic aggregations may be more suitable for exposure
- Focus is on ambient environment

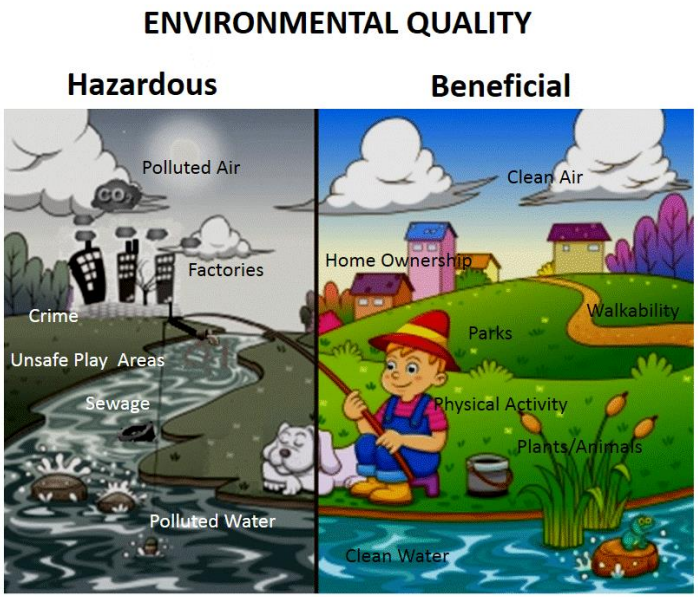
On-Going Activities

- Development of county EQI for 2006-2010
- Different spatial resolutions
  - City
  - Neighborhood
  - **Census tract**
- EQI in relation to health outcomes

EQI Health Outcomes Studies

- **Preterm birth (birth certificate records)**
- **Mortality (death certificate records)**
- **Control variable: birth outcomes related to hurricane exposure (birth certificate records)**
- **Cancer (SEER)**
- Race/Ethnicity interaction and Mortality (death certificate records)
- Asthma (Truven MarketScan)
- Disparities in birth outcomes (birth certificate records)
- Infant mortality (linked infant mortality/birth certificate records)
- Childhood cancer (SEER)
- Obesity and physical inactivity (NHIS)
- Cancer survivorship (SEER)
- Birth defects (NBDN)

Impact of EQI



- Developed to explore:
  - Associations with adverse health effects
  - How various environmental factors contribute in concert to health disparities in low-income, underrepresented minority and vulnerable populations
- Results from studies could be used for hypothesis generating studies to explore cumulative exposures in communities
  - Help communities prioritize interventions
- Characterizing environmental quality across U.S.

United States Environmental Protection Agency

Contact information

Danelle T. Lobdell, PhD, MS
lobdell.danelle@epa.gov

Publications to date

- Lobdell DT, Jagai JS, Rappazzo K, Messer LC. (2011) Data sources for environmental assessment: determining availability, quality and utility, American Journal of Public Health Suppl 1:S277-85
- Jagai JS, Rosenbaum BJ, Pierson SM, Messer LC, Rappazzo K, Naumova EN, Lobdell DT. (2013) Putting Regulatory Data to Work at the Service of Public Health: Utilizing Data Collected Under the Clean Water Act. Water Quality, Exposure and Health 5:117-125
- EPA Report # EPA/600/R-14/304 (2014) Creating an Overall Environmental Quality Index – Technical Report
- Messer LC, Jagai JS, Rappazzo KM, Lobdell DT. (2014) Construction of an environmental quality index for public health research. Environmental Health 13:39 doi: 10.1186/1476-069X-13-39
- Grabich, S. C., Horney, J., Konrad, C., & Lobdell, D. T. (2015). Measuring the Storm: Methods of Quantifying Hurricane Exposure with Pregnancy Outcomes. Natural Hazards Review, doi: 10.1061/(ASCE)NH.1527-6996.0000204
- Rappazzo KM, Messer LC, Jagai JS, Gray CL, Grabich SC, Lobdell DT. (2015) The association between environmental quality and preterm birth in the United States, 2000-2005: a cross-sectional analysis. Environmental Health 14:50 doi:10.1186/s12940-015-0038-3
- Grabich, Rappazzo, Gray, Jagai, Jian, Messer, Lobdell. (2016) Additive interaction between heterogeneous environmental quality domains (air, water, land, sociodemographic and built environment) on preterm birth. Frontiers in Public Health http://dx.doi.org/10.3389/fpubh.2016.00232
- Jian Y, Messer LC, Jagai JS, Rappazzo KM, Gray CL, Grabich SC, Lobdell DT. (2016) The associations between environmental quality and mortality in the contiguous United States 2000-2005. In press. Environmental Health Perspectives

Acknowledgements

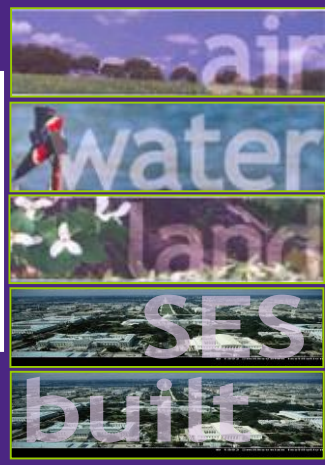
- Study team
  - Danelle Lobdell (EPA/NHEERL)
  - Kristen Rappazzo (EPA/NHEERL)
  - Stephanie DeFlorio-Barker (EPA/NHEERL)
  - Lynne Messer (Portland State University)
  - Jyotsna Jagai (University of Illinois at Chicago)
  - Christine Gray (ORISE)
  - Yun Jian (former ORISE post doc)
  - Shannon Grabich (former ORISE student)
- Student Contractors
  - Achal Patel
  - Monica Jimenez
  - Kyle Messier
  - Genee Smith
- GIS contractors
  - Mark K Murphy
  - Suzanne Pierson
  - Barbara Rosenbaum

EPA
United States
Environmental Protection
Agency

Questions?

EPA
United States
Environmental Protection
Agency

Health studies as follows…



Preterm Birth (PTB)

- Assessed relationships between county-level EQI and domain- specific indices and county- and individual-level preterm birth (<37 completed weeks of gestation) prevalence
- Live birth records from the National Center for Health Statistics for all United States, 2000-2005 (n=24,483,348)
- Individual-level: fixed slope, random intercept multi-level linear regression models to estimate effects of EQI quintiles on preterm birth, adjusting for county-clustering, maternal age, education, and race
- County-level: Births aggregated to county-level PTB/live births (n=3141), logistic regression used to estimate effects for increasing quintiles of EQI and domain indices, adjusting for percent non-minority
- Results are reported as prevalence rate difference or odds ratio (95% confidence interval) where lowest/best environmental quality used as reference

Rappazzo *et al. Environmental Health* (2015) 14:50
DOI 10.1186/s12940-015-0038-3

ENVIRONMENTAL HEALTH

RESEARCH Open Access

The associations between environmental quality and preterm birth in the United States, 2000–2005: a cross-sectional analysis

Kristen M. Rappazzo[1*], Lynne C. Messer[2], Jyotsna S. Jagai[3], Christine L. Gray[4,5], Shannon C. Grabich[4,5] and Danelle T. Lobdell[6]

Abstract

Background: Many environmental factors have been independently associated with preterm birth (PTB). However, exposure is not isolated to a single environmental factor, but rather to many positive and negative factors that co-occur. The environmental quality index (EQI), a measure of cumulative environmental exposure across all US counties from 2000—2005, was used to investigate associations between ambient environment and PTB.

Methods: With 2000–2005 birth data from the National Center for Health Statistics for the United States ($n = 24,483,348$), we estimated the association between increasing quintiles of the EQI and county-level and individual-level PTB; we also considered environmental domain-specific (air, water, land, sociodemographic and built environment) and urban–rural stratifications.

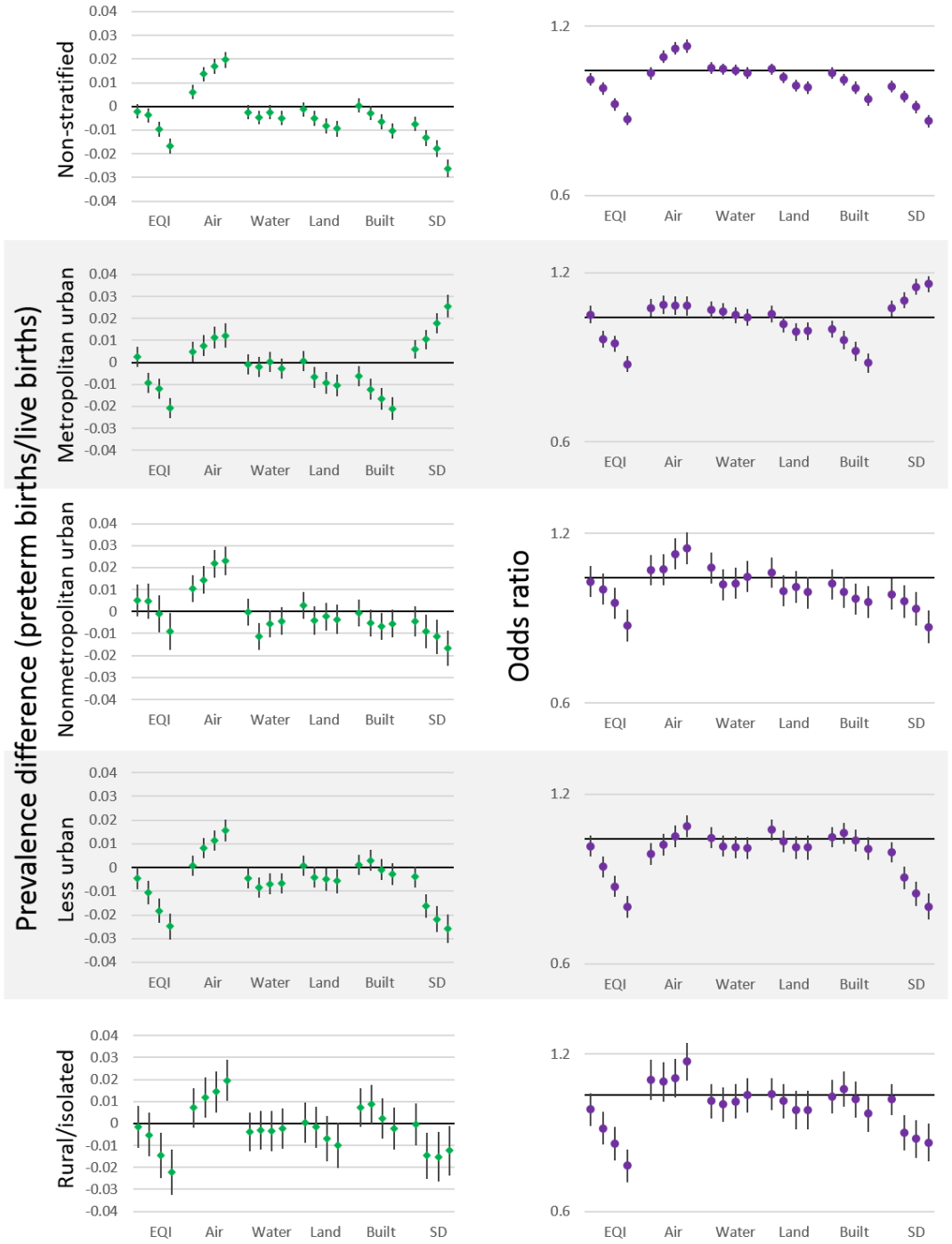
Results: Effect estimates for the relationship between environmental quality and PTB varied by domain and by urban–rural strata but were consistent across county- and individual-level analyses. The county-level prevalence difference (PD (95 % confidence interval) for the non-stratified EQI comparing the highest quintile (poorest environmental quality) to the lowest quintile (best environmental quality) was −0.0166 (−0.0198, −0.0134). The air and sociodemographic domains had the strongest associations with PTB; PDs were 0.0196 (0.0162, 0.0229) and −0.0262 (−0.0300, −0.0224) for the air and sociodemographic domain indices, respectively. Within the most urban strata, the PD for the sociodemographic domain index was 0.0256 (0.0205, 0.0307). Odds ratios (OR) for the individual-level analysis were congruent with PDs.

Conclusion: We observed both strong positive and negative associations between measures of broad environmental quality and preterm birth. Associations differed by rural–urban stratum and by the five environmental domains. Our study demonstrates the use of a large scale composite environment exposure metric with preterm birth, an important indicator of population health and shows potential for future research.

Keywords: Environmental quality, Air quality, Water quality, Land quality, Built environment, Sociodemographic, preterm birth

United States Environmental Protection Agency

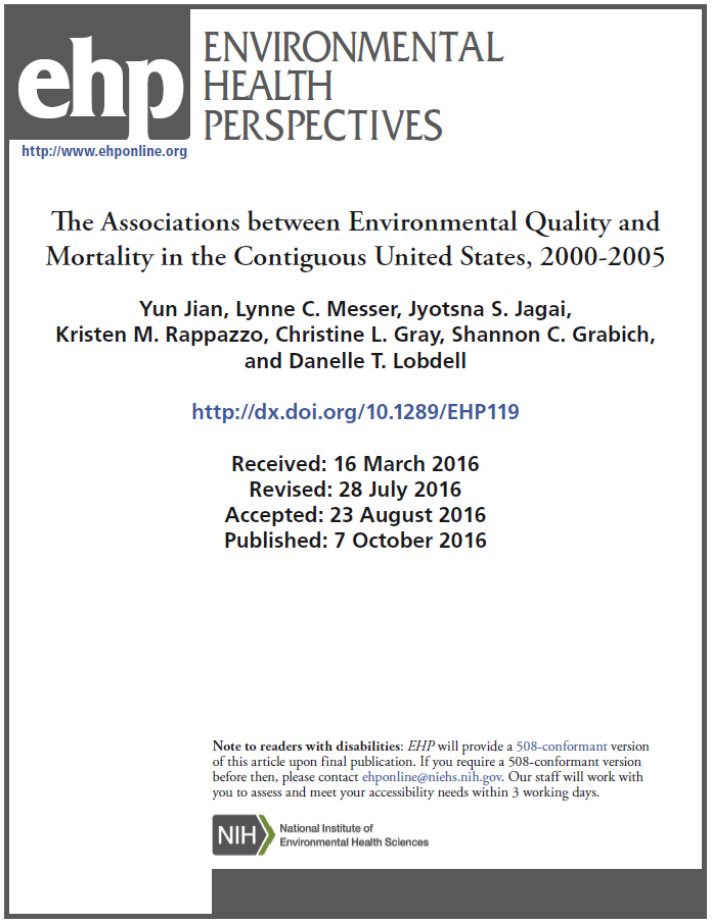
- Effect estimates for the relationship between environmental quality and PTB varied by domain and by urban-rural strata but were consistent across county- and individual-level analyses.
- Worsening air index consistently associated with increased PTB
- Sociodemographic domain associated with increasing PTB in most urban strata, but had inverse/negative associations in suburban and rural strata



Rappazzo et al., Environmental Health 2015

Mortality

- County-level age-adjusted mortality rates for the contiguous U.S.(n=3109 counties) from 2000-2005
  - All-cause mortality, and mortality due to the three leading causes (heart disease, cancer and stroke)
- Assessed associations between death rates and overall EQI as well as domain- specific EQI indices.
  - Used random intercept, random slope multi-level models, adjusting for percent white, population density, smoking and alcohol consumption.
  - Regression slopes and intercept were allowed to vary for counties clustered by a combination of RUCC and Koppen climate regions
- Results are reported as percent change in death rate for 1 standard deviation increase in EQI.



ehp ENVIRONMENTAL HEALTH PERSPECTIVES

http://www.ehponline.org

The Associations between Environmental Quality and Mortality in the Contiguous United States, 2000-2005

Yun Jian, Lynne C. Messer, Jyotsna S. Jagai, Kristen M. Rappazzo, Christine L. Gray, Shannon C. Grabich, and Danelle T. Lobdell

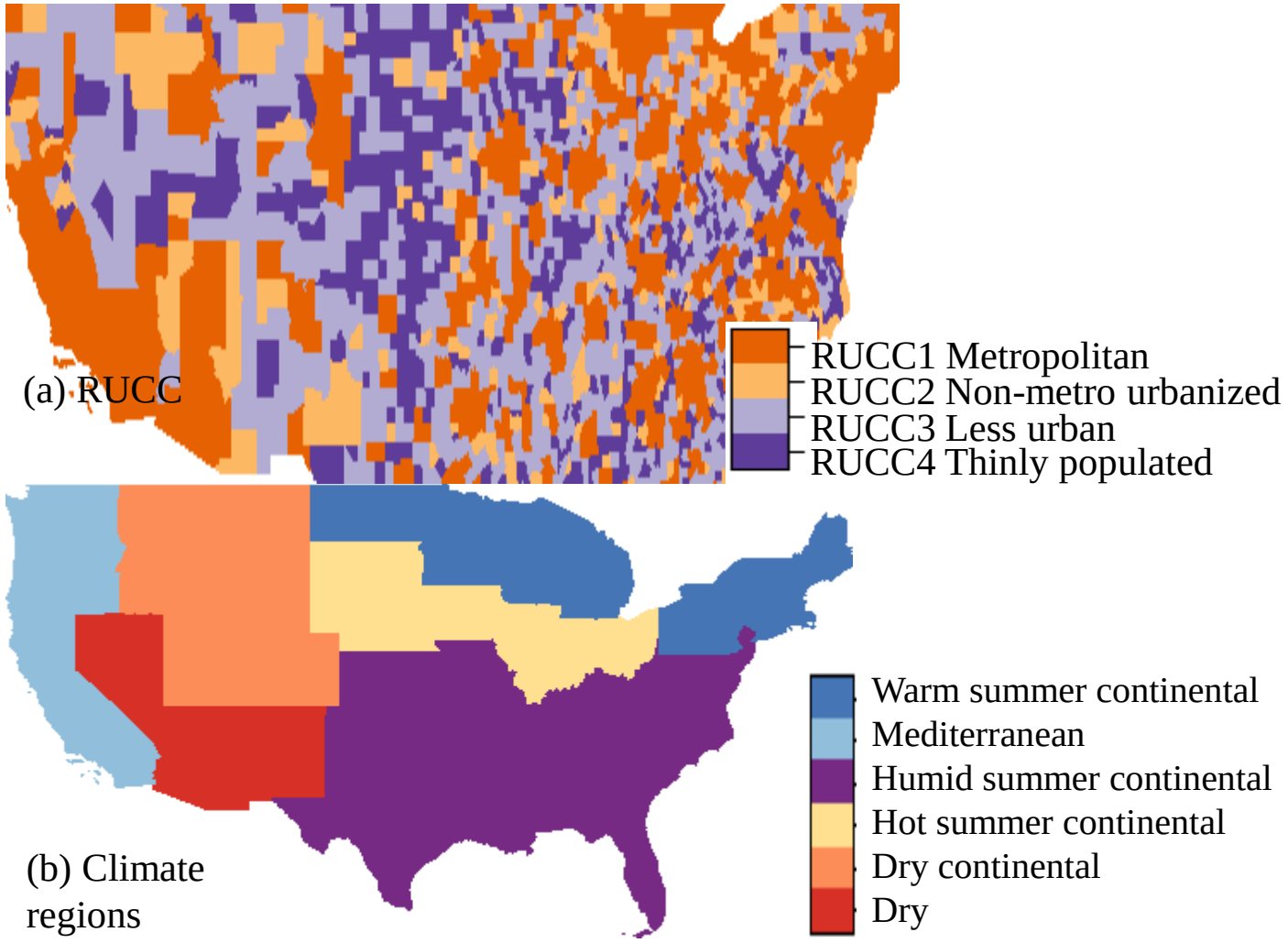
http://dx.doi.org/10.1289/EHP119

Received: 16 March 2016
Revised: 28 July 2016
Accepted: 23 August 2016
Published: 7 October 2016

Note to readers with disabilities: *EHP* will provide a 508-conformant version of this article upon final publication. If you require a 508-conformant version before then, please contact ehponline@niehs.nih.gov. Our staff will work with you to assess and meet your accessibility needs within 3 working days.

NIH National Institute of Environmental Health Sciences

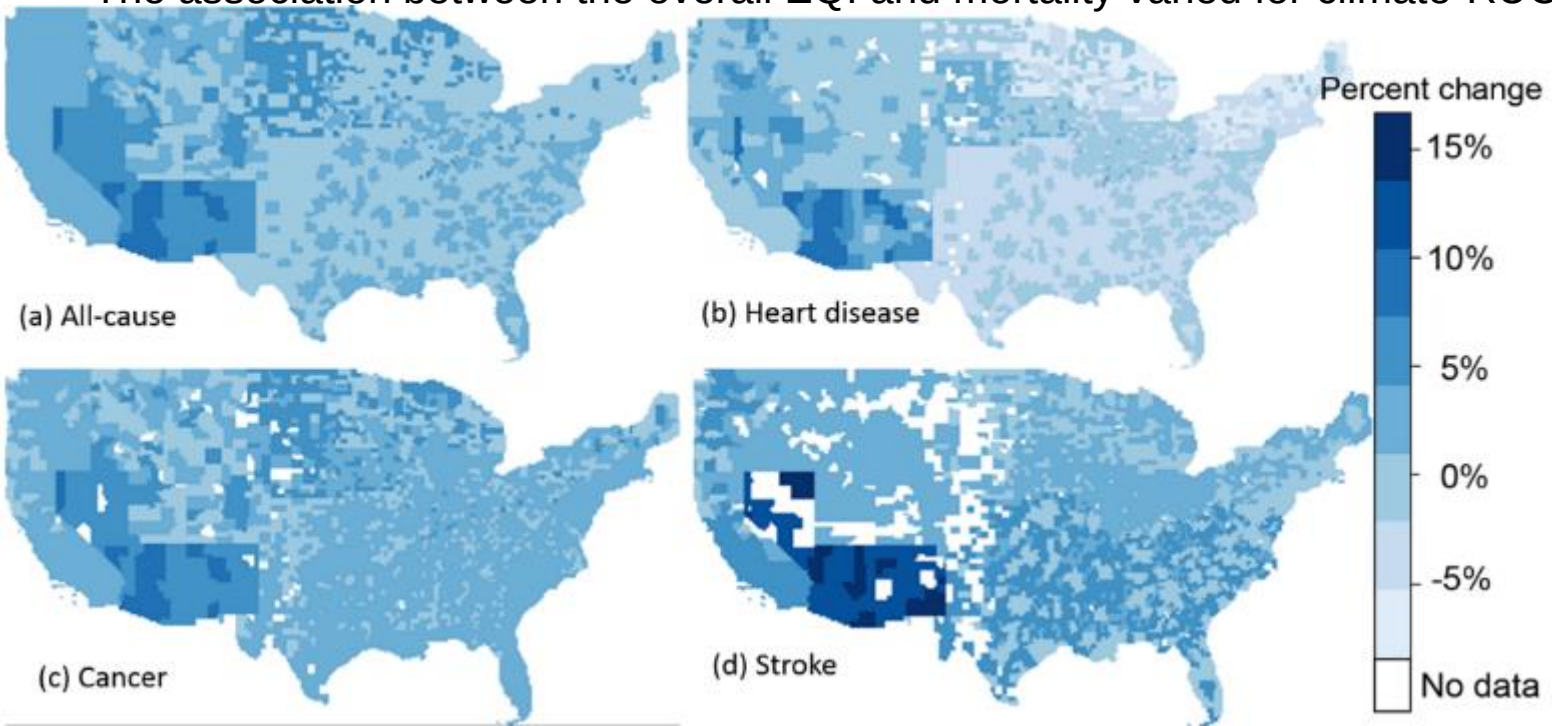
Condensed Koppen Climate Regions and RUCC Map



Mortality

- One standard deviation increase in overall EQI (worse environment) was associated with
  - 3.2% (95% CI: 2.8%, 3.6%) increase in all-cause mortality rate
  - 0.5 % (-0.2%, 1.3%) increase in mortality rate due to heart disease
  - 2.7% (2.2%, 3.2%) increase in mortality rate caused by cancer
  - 2.3% (1.1%,3.4%) increase in mortality rate caused by stroke

- The association between the overall EQI and mortality varied for climate-RUCC groups



Percent change in all-cause, and cause specific mortality rate for 1 standard deviation increase in overall EQI for each RUCC – climate group.

Mortality

United States Environmental Protection Agency

The association between the EQI domain indices and mortality varied for climate-RUCC groups

- The figure shows percent change in all-cause mortality rate per 1 standard change in EQI domain indices
- Air index had the largest association with all-cause mortality