Creating an Environmental Quality Index to Examine Health Outcomes

Danelle T. Lobdell¹, Jyotsna S. Jagai¹, Kristen Rappazzo², Lynne C. Messer³

¹U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory
²University of North Carolina at Chapel Hill, School of Public Health
³Center for Health Policy and Inequalities Research, Duke Global Health Institute

Promoting Healthy Communities
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Multiple Environmental Hazards

http://www.epa.gov/oar/airtrends/2007/graphics/Air_pollution_pathways_textbox.gif
Human health and disease - a complex process

Exposures to harmful and benign substances occurring simultaneously

- Environmental exposures tend to cluster
  - Environmental disamenities such as landfills or industrial plants often located in neighborhoods with high a percent of minority and poor residents
  - Conversely, high income neighborhoods frequently contain amenities conducive to promoting and maintaining optimal health, such as parks

No single exposure can be held responsible for good or poor health

- Not just good quality air or high income that produces health, but probably the combination of these and other various exposures
Goals of EQI

- This research will attempt to construct an environmental quality index (EQI) for all counties in the U.S. taking into account:
  - multiple domains that influence exposure and health
    - five domains: air, water, land, built environment, and SES
  - incorporates data representing the chemical, natural and built environment
Project Aims of EQI

- Collect and standardize data representing broad environmental data for multiple geographies across the U.S.
- Assess counties of greater or lesser environmental quality
- Assess the relationship between “environmental quality” and human health outcomes
  - Assessing predictive utility for disparate reproductive health outcomes (e.g., infant mortality, preterm birth, birth weight)
  - Analyses with non-reproductive outcomes, like asthma, gastrointestinal morbidity
- Develop a measure that can be used as a baseline for communities to use for comparison
- Specific EQI variable loadings will suggest the magnitude of each domain’s contribution to the overall environmental quality
- Used by investigators interested in specific environmental exposures (e.g., air quality researchers) to adjust for the overall environmental quality, to better isolate specific exposure effects.
<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>DATA SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Air Quality System (AQS); National Air Toxics Assessment (NATA)</td>
</tr>
<tr>
<td>Land</td>
<td>County pesticide use estimates; 2002 Census of Agriculture Full Report; Dun and Bradstreet Agriculture Data; Web Feature Service for National Priority List (NPL) Sites; National Geochemical Survey (NGS); Map of Radon Zones</td>
</tr>
<tr>
<td>Water</td>
<td>National Water Information System (NWIS)/STORET; WATERS Program/Reach Address Databases; National Contaminant Occurrence Database (NCOD); Safe Drinking Water Information System (SDWIS); Estimates of Water Use in U.S.; Drought Monitor Data; National Atmospheric Deposition Program; Nutrient Loss Database for Agricultural Fields in U.S.</td>
</tr>
<tr>
<td>Built Environment</td>
<td>Duns and Bradstreet North American Industry Classification System (NAICS) codes; Topologically Integrated Geographic Encoding and Referencing (TIGER); Rural-Urban Commuting Area (RUCA) Codes; Fatality Annual Reporting System; Housing and Urban Development</td>
</tr>
<tr>
<td>Socio-demographic</td>
<td>Uniform crime reports; U.S. Census; Home Mortgage Disclosure Act (HDMA) Data</td>
</tr>
</tbody>
</table>
Proto-EQI Development

• Air Domain
  – Criteria air pollutants: mean annual values of PM10, PM2.5, CO, SO2, NO2, and O3.
    • Monitor data from Air Quality System taken and kriged across the U.S. to obtain values at each county centroid
  – Hazardous air pollutants: annual emissions in tons for 103 pollutants (e.g., toluene, hydrochloric acid, methanol, hexane, etc)
    • Modeled ambient concentration estimates from the National-Scale Air Toxics Assessment (NATA)
• Water Domain

  – WATERS Database: Percent of stream length impaired in county, number of discharge permits in county, number of days a beach is closed for advisories
  – Estimates of Water Use (USGS): percent of population using ground water, surface water for domestic use
  – National Atmospheric Deposition Program: Precipitation weighted mean deposition of elements
    • Ca, Mg, K, Na, NH4, NO3, Cl, SO4, Hg
    • Measured data kriged across the country to obtain county level values
  – Drought Monitor Data: Percent of county in extreme drought conditions
  – National Contaminant Occurrence Database: Average of measured values for contaminants (i.e., arsenic, dioxin, atrazine, uranium)
Proto-EQI Development

• Land domain
  – NGS data (means of soil samples taken from stream beds for various minerals (n=14), including arsenic, lead, copper, sodium, iron)
  – Radon zones (3 category variable)
  – Agriculture data (number of farms, irrigated acres and harvested acres in 2002, acres in crops (e.g., wheat, corn, soybean, tobacco) and insecticide-treatment)

• Sociodemographic domain
  – Census data (housing characteristics, poverty, language, unemployment)
  – Crime rates (violent, murder, rape, robbery, aggravated assault, property, burglary, larceny, vehicular)
Proto-EQI Development

• Built domain
  – Road-way data (density of highways, secondary roads, streets)
  – Three transportation-related census variables (percent taking public transportation, mean commute time, percent working outside county of residence)
  – Transportation-related fatalities (density of fatal accidents)
  – Public housing (Section-8 and low-rent housing density)
Proto-EQI

Legend
- min - <20%
- 20 - <40%
- 40 - <60%
- 60 - 80%
- 80% - max

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Danelle T. Lobdell, Ph.D.
Rural-Urban Continuum Code (RUCC)

- Will Stratify by RUCC
  - 9-item categorization code of proximity to / influence of major metropolitan areas on counties
    - RUCC1 (metropolitan urbanized = codes 1+2+3)
    - RUCC2 (non-metro urbanized = 4+5)
    - RUCC3 (less urbanized = 6+7)
    - RUCC4 (thinly populated = 8+9)
Timeline
FY 09 – Exploring sources of data
FY 10 – Obtain, clean and prepare data
FY 11 – Produce draft indices
FY 11 – Revise data based on initial analyses and indices development
FY 11 – Finalize indices and analyze data
FY 11/12 – Produce manuscripts
FY 12 – Apply methods to other health outcomes

Keep updated with progress of project through our website at:
http://www.epa.gov/nheerl/eqi/
Ongoing Related Projects

• Utilizing impairment data collected under the Clean Water Act for public health analysis
  • Linear random effects model at county level
  • Limited data availability but associations seen with gastrointestinal infections and recreational water impairment

• Multiple Environmental Contexts and Preterm Birth Outcomes
  • Linear regression for county level risk of preterm birth with proto-EQI
  • Variety of effects found across urban/rural and racial strata
    • E.g., air domain associated with increased prevalence of preterm birth in urban counties, decreased in rural counties.

• NC MEDI-EQI – Birth Outcomes
  • Multilevel model of various birth outcomes (low birth weight, small for gestational age, preterm birth) in NC associated with MEDI –EQI
  • No significant associations demonstrated, but may need to stratify analysis by rural / urban areas
Questions?