A Preliminary Screening Method to Estimate Cumulative Environmental Impact

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Strengthening Environmental Justice Research
and Decision Making Symposium

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Summary of Literature Review and Research on Cumulative Assessment Methods

Research Sources: Articles, Guidance Documents, Tools and Reports
"If Cumulative Risk Assessment Is the Answer, What is the Question?" Callahan & Sexton
Community Evaluation Tool (COMET) California EPA Air Resources Board (ARB)
"Framework for Cumulative Risk Assessment" EPA Report
"Guidelines for Conducting Environmental Justice Analyses". Environmental Load Profile EPA Region 2
Region 6 GIS Screening Tool (GISST) Cumulative Risk Index Analysis EPA
"Smart Enforcement Assessment Tool." EJ SEAT - EPA
"Toolkit for Assessing Potential Allegations of Environmental Injustice". EPA
"Unequal Exposure to Ecological Hazards: Environmental Injustices in the Commonwealth of Massachusetts." Faber & Krieg
"Cumulative Risk and a Call for Action in Environmental Justice Communities." Hynes & Lopez
Community Profile Tool Maryland State Commission on Environmental Justice and Sustainable Communities (CEJSC)
"A Phased Approach for Assessing Combined Effects from Multiple Stressors" Menzie, MacDonell, & Mumtaz
"The Air is Always Cleaner on the Other Side: Race, Space and Ambient Air Toxics Exposures in California." Pastor Jr., Manuel., Rachel Morello-Frosch, James L. Sadd.
Healthy Development Measurement Tool (HDMT) San Francisco Department of Public Health, Program on Health, Equity and Sustainability

Outline of Approach

Identify separate "indicators"

Quantify indicators separately at small geographic scale using GIS

Assess options for combining, weighing or aggregating indicators

"Scale Up" to larger geographic areas

Analyze/correlate with other variables
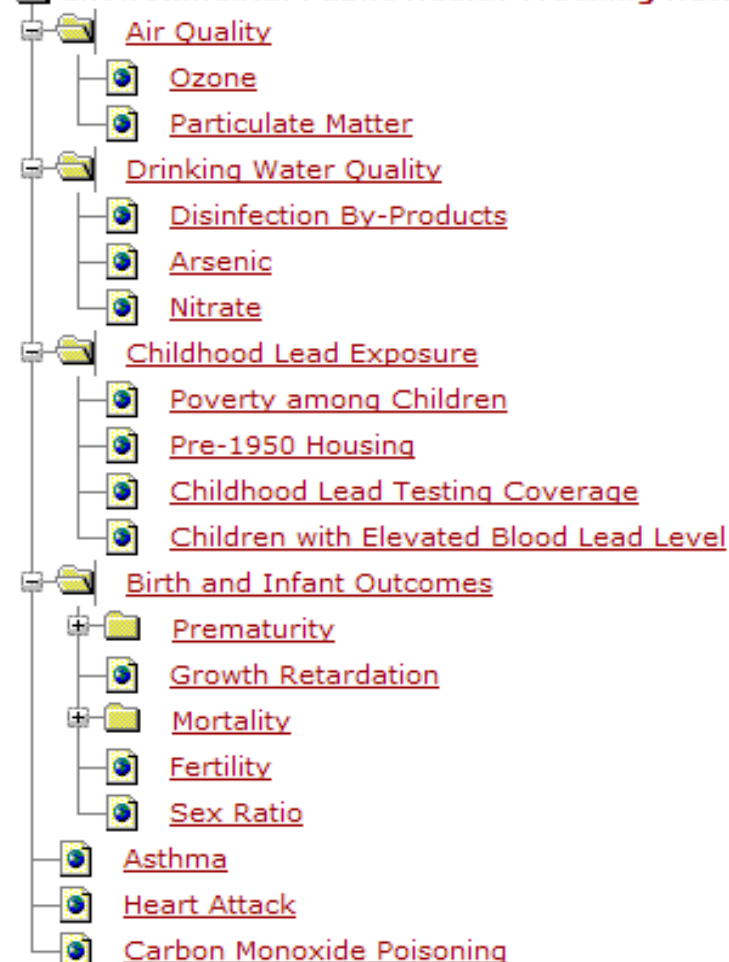
Data Needs for Statewide Indicators

- Available Statewide

- Accurate (and consistent)

- Accessible electronically

- Compatible electronically

- Consistent GIS information (spatial)

- Consistent time information (temporal)

Current Indicators

Indicator	Data source	Original Geographic Scale	Original Units
NATA cancer risk (1999)	EPA data	Census tract	Risk per million
NATA diesel (1999)	EPA data	Census tract	Ug/m3
NJDEP Benzene estimate	DEP emission inventory	100 meter grid	Ug/m3
Traffic All	Congestion Management System	1000 foot buffer	Traffic Counts all vehicles
Traffic trucks	Congestion Management System	1000 foot buffer	Traffic Counts heavy trucks
Density of Major Regulated sites	DEP NJEMS data	100 meter grid	Sites per acre
Density of Known Contaminated	DEP SRP data	100 meter grid	Sites per acre
Density of Dry Cleaners	DEP GIS data	100 meter grid	Sites per acre
Density of Junkyards	DEP NJEMS data	100 meter grid	Sites per acre

Indicators from NJ DHSS now Public

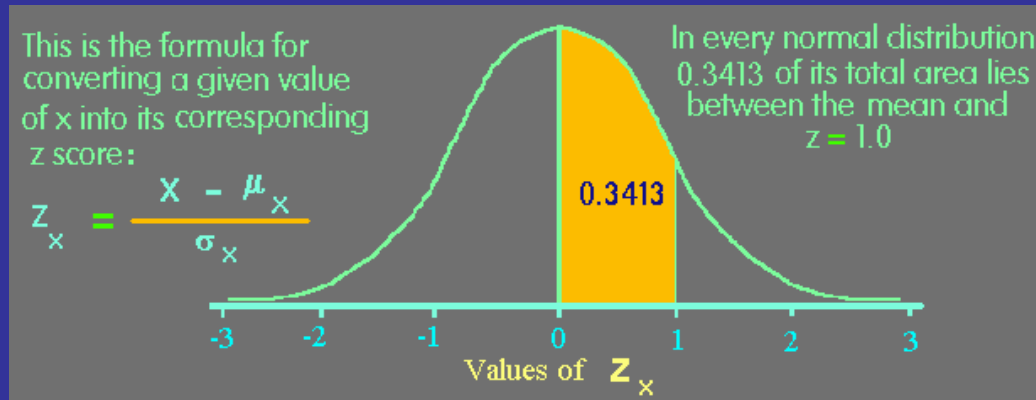**Environmental Public Health Tracking Network Categorized Index**

- Air Quality
  - Ozone
  - Particulate Matter
- Drinking Water Quality
  - Disinfection By-Products
  - Arsenic
  - Nitrate
- Childhood Lead Exposure
  - Poverty among Children
  - Pre-1950 Housing
  - Childhood Lead Testing Coverage
  - Children with Elevated Blood Lead Level
- Birth and Infant Outcomes
  - Prematurity
  - Growth Retardation
  - Mortality
  - Fertility
  - Sex Ratio
- Asthma
- Heart Attack
- Carbon Monoxide Poisoning

Center for Health Statistics, New Jersey Department of Health and Senior Services, PO Box 360, Trenton, NJ 08625-0360, Phone: 609-984-6703, Fax: 609-984-7633, e-mail: chs@doh.state.nj.us, Web: www.nj.gov/health/chs

6

Options to quantify indicators

- Matrix approach (NEJAC)
- Weighting (Faber)

Type of Hazardous Facility or Site	Points for Rating Severity of Each Facility or Site
EPA National Priority List Site	25
DEP TIER 1A Site 10	10
DEP TIER 1B 8	8
DEP TIER 1D	8
DEP TIER 1C 6	6
DEP TIER 2 4	4
DEP Other Sites 1	1

- Scaled Composite Score (EJ SEAT)

- Percentile/quartile distribution
- Z-score methodology (Hynes & Lopez)
  - Z score = (value-mean)/standard deviation
  - Normalizes the data to a mean = 0 and standard deviation = 1

This is the formula for converting a given value of x into its corresponding z score:

$$z_x = \frac{x - \mu_x}{\sigma_x}$$

In every normal distribution 0.3413 of its total area lies between the mean and $z = 1.0$

0.3413

Values of z_x

Options for Geographic Analysis

- Use Administrative/political boundaries
  - Ex. Faber used municipalities or counties
  - Count per square mile

- Grided spatial analysis (Rasters in GIS)
  - Create grid for each indicator at small geographic scale
  - Use consistent statewide grid


Sqrt([Inlayer1])
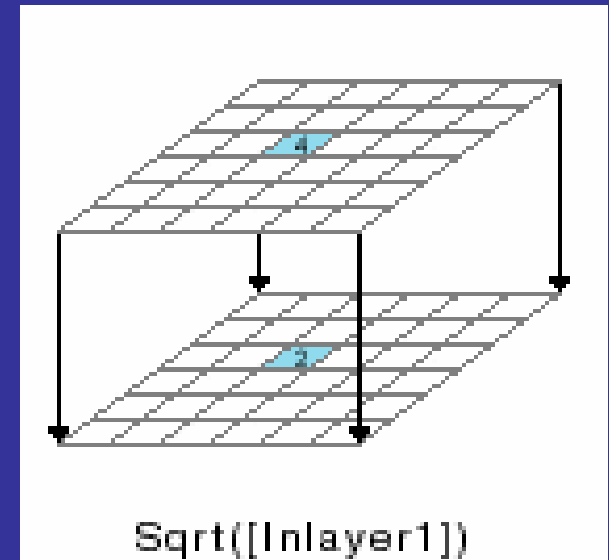
Methods to Calculate and Combine Indicators

- Calculate z-score for each indicator in each grid
  - Statewide grid just over 2 million grids

- Eliminate outliers, z-score >3 are assigned a score of 3
  - This impacts less than 0.5% of grids

- Two options used to combine indicators:

  - Option 1: **Sum** all z-scores in each grid
    - Maximum score of 27 (9 indicators) * (3 max z score)
    - Quantifies how all indicators impact one area
    - One or two high indicators can drive results

  - Option 2: **Count** each grid with a z score greater than 1
    - Maximum score of 9 (9 indicators) * (1 count if z >1)
    - Focuses more on higher scores
    - Highlights areas with multiple high indicators

Presentation of DRAFT Results

- Some caveats on presentation of draft results……

- To display data, particularly on maps, we need to make certain decisions on methods and parameters (cut points)

- For example…
  - How many cut points or groups to present
  - **Equal Interval method:** (separate by range in data, highlights changes in the extremes)
  - **Quantile method:** (separate by number of records, highlights changes in the middle values of the distribution)
  - **Natural break method**: (a balance between equal interval and quantile)

- **Decisions made to present results may NOT be the policy decisions needed to identify communities of concern**

10

DRAFT Results Option 1: Summation of all scores

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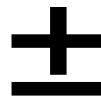
Legend

Counties

Grid Impact Summation Method
<VALUE>
- -6.1 - -2.1
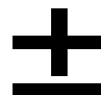- -2 - -0.7
- -0.6 - 0.9
- 1 - 2.8
- 2.9 - 4.9
- 5 - 7.6
- 7.7 - 10.5
- 10.6 - 13.6
- 13.7 - 17
- 17.1 - 24.9

0   105,000   210,000   420,000 Feet

For Illustration Purposes Only

Legend

Counties

Grid Impact Count Method

VALUE

0

1 - 9

0   105,000   210,000   420,000 Feet

13

DRAFT Results Option 2: Count of all scores >1

For Illustration Purposes Only

Legend

Counties

Grid Impact Count Method
VALUE

0
1
2
3
4
5
6
7
8
9

| 0 | 105,000 | 210,000 | | 420,000 Feet |

Estimating impacts in larger areas

- Grid-level data provides useful information at local level and ability to "aggregate up" to larger levels

- Impact estimates at larger areas useful to link to other information, such as socio/economic information

- Scale up to "block group" estimates
  - Smallest area with Census data on income/poverty
  - There are ~ 6,500 block groups in New Jersey
  - Average area of ~ 800 acres
  - Average population of ~ 1,300

- Methods
  - Zonal Statistics tool in Spatial Analyst
  - Determine **Maximum** grid in block group
  - Weighted **Average** of all grids in block group

Estimating impacts in larger areas

- Calculated for both Summation and Count methods
- Final Block Group data has four impact scores:

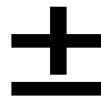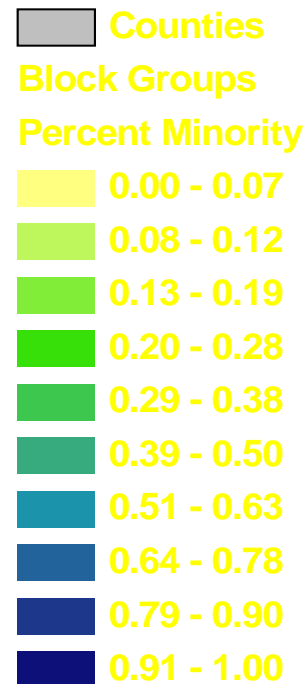| Summation Method	Count Method
(1) Max Grid	(3) Max Grid
(2) Mean of all grids	(4) Mean of all grids

NJ Census Data for Socio/Economic Status Percent Minority

- Several States identify communities based on minority and income criteria
  - Pennsylvania, New York, Massachusetts, Indiana, Minnesota

- Northern New Jersey Metropolitan Transportation Planning Authority also identifies communities based on race and income

- DEP has not identified areas base on race and income

- Other screening methods add race, income and other "vulnerability" indictors as part of combined scoring

- DEP is currently using race and income data as separate independent indicators to understand relationship with impact scores

17

NJ Census Data for Percent Minority
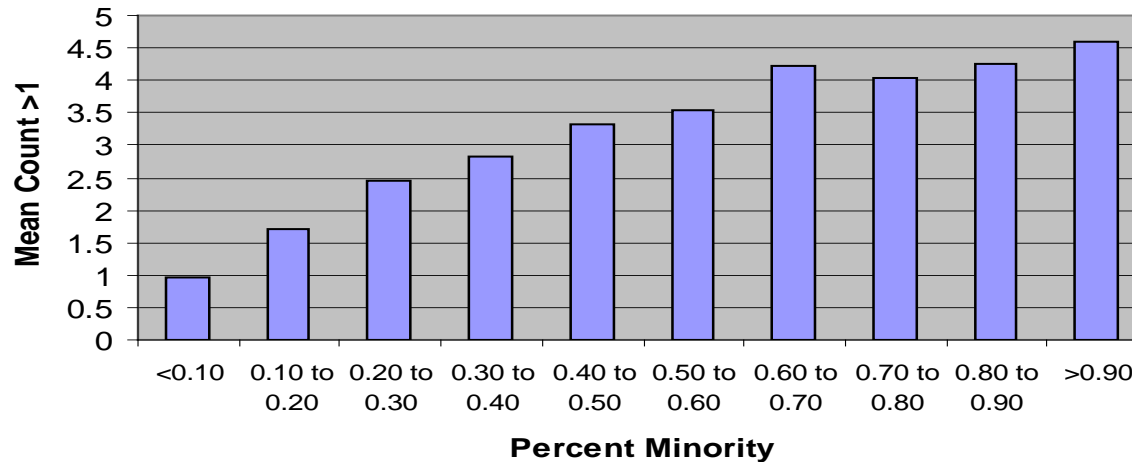
For Illustration Purposes Only

Legend

Counties

Block Groups

Percent Minority

- 0.00 - 0.07
- 0.08 - 0.12
- 0.13 - 0.19
- 0.20 - 0.28
- 0.29 - 0.38
- 0.39 - 0.50
- 0.51 - 0.63
- 0.64 - 0.78
- 0.79 - 0.90
- 0.91 - 1.00

0   105,000   210,000   420,000 Feet

Figure 1: Relationship Between Cumulative Impact and Percent Minority

Figure 2: Relationship Between Cumulative Impact and Poverty

- Grouped all block groups based on percent minority and poverty

- Calculated average cumulative impact score for combined groups

- Cumulative impact scores increase steadily with increasing percent minority and poverty

19
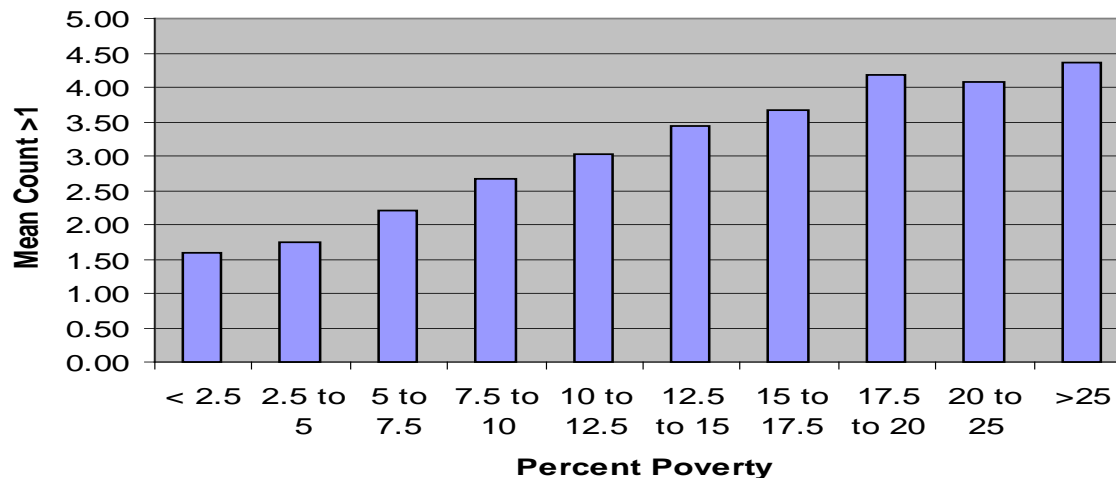
Next Steps on Finalizing Methods

- Updates/improvements to existing indicators
    - NATA 2002 results
    - KCS list for 2009

- Potential new indicators
    - Drinking Water
        - Community water systems
        - Private Well Testing Act
    - Ground Water and Soil data
    - Air quality data for Ozone and PM2.5
        - Hierarchical Bayesian data combining monitoring and modeling (CMAQ)

- Comments:
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