Rural Environmental and Health Disparity Measures: Are rural areas inaccurately portrayed and under represented by current indices?

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ABSTRACT

Though 20% of the US population resides in rural areas, little research has been done to systematically understand rural environmental and health disparities. Cumulative impact models investigate population characteristics and environmental stressors comparing urban and rural areas using percentile ranking systems. However, model metrics are derived from urban studies, thus, indicating higher cumulative impact in urban areas may be biased. Compared to urban areas, rural areas in Illinois have lower per-capita income, higher poverty rates, and equivalent unemployment, and educational attainment. The twelve southernmost rural counties in Illinois rank last (102 total) for health factors and health outcomes. There is reason to suspect that current models do not accurately reflect rural exposures. Our study examines rural environmental and health disparities in Illinois based on current indices which show rural areas are misrepresented with this approach and that the development of separate criteria will better reflect disparate conditions in rural areas.

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BACKGROUND

Environmental and Cumulative Exposure Methods in Health Disparities Health disparities exist among racial, ethnic, geographic, and socioeconomic groups with inequalities spanning a wide range of illness, individual behavioral risk factors, environmental exposures, social determinants of health, and access to medical care. Environmental disparities studies look to see if everyone, regardless of race, color, national origin or income, experiences the same degree of protection from environmental and health hazards with equal access to the decision-making process to provide a healthy environment to live, work and play (USEPA, 2016). Recently, environmental and health disparity research is moving beyond the chemical-by-chemical or facility-by-facility analysis toward a cumulative exposure approach that can account for exposure realities of diverse populations incorporating concepts of social vulnerability into assessments of community susceptibility to environmental pollutants (Morello-Frosch, Pastor Jr, Porras, & Sadd, 2002). It is known that disparities in exposures to environmental hazards are important in understanding the complex and persistent patterns of negative health status, yet, these exposures are often times poorly understood (Morello-Frosch et al., 2002). Cumulative framework methodology incorporates both environmental and sociodemographic variables to identify geographic areas that have increased environmental exposures and social vulnerability. This may include multiple pollution sources and socioeconomic status in relation to health outcomes, such as cancer (Osiecki, Kim, Chukwudozie, & Calhoun, 2013).

The SVI and EJSCREEN The Centers for Disease Control and Prevention (CDC) Agency for Toxic Substances and Disease Registry (ATSDR) has created the Social Vulnerability Index (SVI) Mapping Dashboard using Census Bureau data to determine SVI for each census tract (CDC, 2014). SVI includes fourteen social factors which are grouped into four themes: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. Each census tract is ranked within each theme, as well as an overall score for the entire United States. In addition, the United States Environmental Protection Agency (EPA) has developed the Environmental Justice Screening and Mapping Tool (EJSCREEN) which uses percentile rankings to create a supplementary demographic index based on American Community Survey(ACS) data at the block level which includes: a) six vulnerability indicators, b) the percentile ranking of over 150 socioeconomic variables, and c) twelve environmental indicators (such as National Scale Air Toxic Assessment data, proximity to national priorities list sites, major direct water dischargers and lead paint indicator (USEPA, 2016). Such measures may not be adequate for whole-state assessments, as due to highly concentrated disadvantage census tracts in urban areas, the EPA and CDC percentile ranking systems, by design, we believe will systematically categorize most rural census tracts in the lower percentiles.

Are Urban-Derived and -Validated Measures Accurate in Rural Areas? The indicators used in these models are commonly derived from past environmental and health disparity research that has its roots in major cities. These are then expanded to examine an entire state, looking at both

rural and urban areas, with an underlying assumption that such measures are valid in less population dense areas. Thus, analyses using percentile ranking systems by a geographic unit such as a county or census tract perhaps unsurprisingly show significantly increased levels of burden and vulnerability in the highly populated areas while rural communities appear to face less risk. But, given that urban-derived measures have not been validated in less populated areas, does this mean that rural areas are indeed less affected? Little research has been done to understand what defines vulnerability or environmental exposures in rural areas which may possess unique sociodemographic characteristics and environmental hazards unrelated to urban areas.

Rural-Urban Disparities in Illinois Health disparities in Illinois are well-documented, especially in the city of Chicago and the surrounding metropolitan area (Orsi, Margellos-Anast, & Whitman, 2010). However, racial disparities do not tell the entire tale of inequality. In fact, the disparities faced by rural Illinois residents are comparable in both scale and degree to urban racial disparities. **Table 1**, for example, compares key socioeconomic factors in Illinois that are common social vulnerability indicators for both rural and urban areas (CDC, 2014). Rural areas in Illinois have seen lower per-capita income, higher poverty rates, and equivalent unemployment and educational attainment in comparison to Illinois urban areas.

Table 1. Socioeconomic factors by Rural, Urban and State

Illinois·	Rural	Urban	Total
Population (millions)	1.5	11.4	12.9
Per-capita income (2014 dollars)	37,236	49,012	47,643
Per-capita income percent change	-3.1%	1.3%	0.9%
Percent poverty*	14.7%	14.4%	14%
Percent without high school diploma	12.3%	12.4%	12.4%
Percent unemployment rate	7.1%	7.0%	7.1%

* Data from the 2010- 2014 American Community Survey

Not only might rural areas be different than urban, there is frequently variation amongst otherwise seemingly-similar rural areas. A study comparing northern, central and southern rural areas in Illinois found that southern Illinois counties experienced greater socioeconomic deprivation and had higher rates of obesity, smoking and lung cancer compared to the other rural regions (all also in excess of urban areas; (Zahnd, 2016).The sixteen southernmost counties of Illinois are part of the Mississippi River Delta Region, a multi-state region along the lower half of the Mississippi river, which is among the most socioeconomically disadvantaged areas in the United States (Gennuso, Jovaag, Catlin, Rodock, & Park, 2016). These counties have poorer health status compared to non-Delta counties due to worsening health factors and health outcomes (Gennuso et al., 2016).

The County Health Rankings for 2016 present the rankings for the 102 counties in Illinois. Figure 1 and Figure 2 show health factors (health behaviors, clinical care, social & economic factors, and physical environment) and health outcomes (length and quality of life) for the entire state. The twelve counties that rank last in Illinois are located in southern Illinois in comparison to Cook County that includes the City of Chicago which is ranked 62nd.

Figure 1. Overall Rankings in Health Factors; 2016

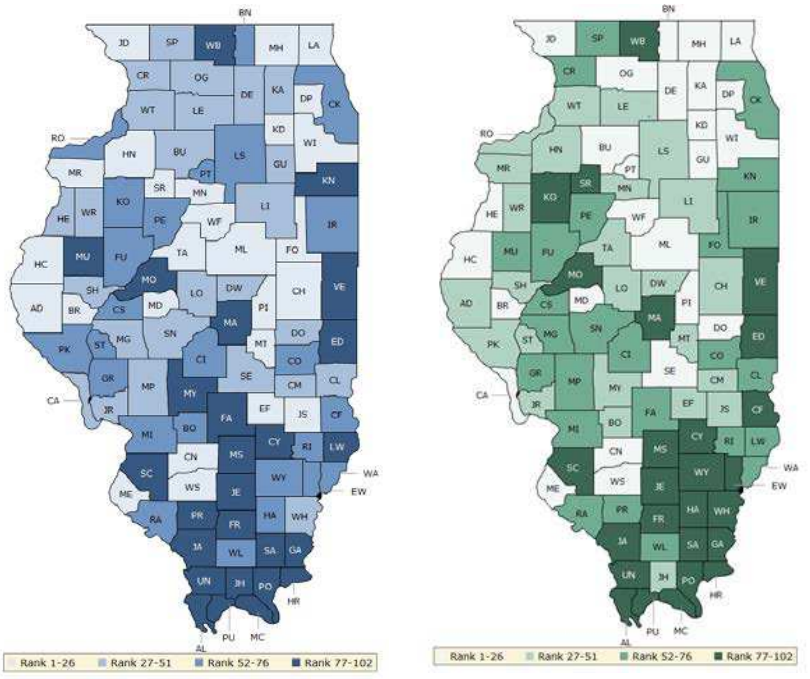
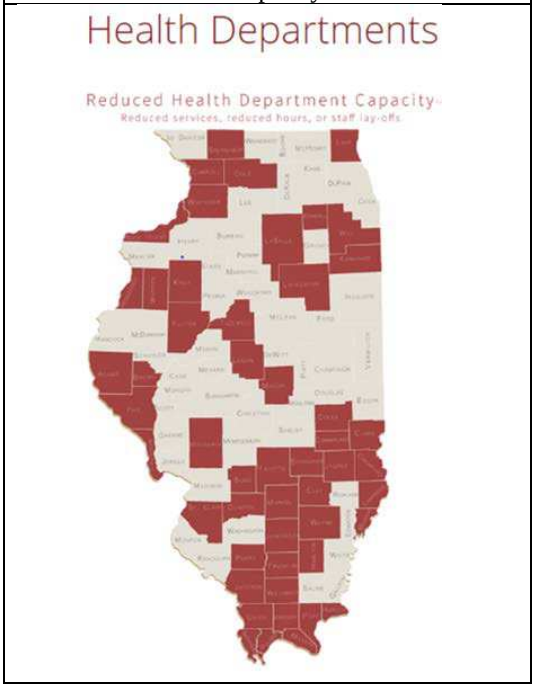


Figure 2. Overall Rankings in Health Outcomes; 2016

90	Edwards (EW)
91	Vermilion (VE)
92	Gallatin (GA)
93	St. Clair (SC)
94	Massac (MC)
95	Jackson (JA)
96	Franklin (FR)
97	Pope (PO)
98	Mason (MO)
99	Saline (SA)
100	Alexander (AL)
101	Pulaski (PU)
102	Hardin (HR)

Since the beginning of FY16, Illinois has experienced a fiscal crisis causing the inability of state government to pass an annual budget. Stop gaps have provided emergency funding to ensure essential services do not shut down; however, county health departments have not received allocations of this revenue. **Figure 3** shows the counties that have reduced health services due to the budget impasse including numerous counties in southern Illinois (reference).

Figure 3. Illinois County Health Departments with reduced health capacity 2015 - 2016



RATIONALE

Rural environmental justice studies have long been present, but generally only in the background, and are forgotten as a social, ecological, cultural, economic, and political category that encompasses environmental struggles that are experienced on a daily basis (Pellow, 2016). Several rural environmental and health disparities studies result from a particular incident of injustice on the affected community (Pellow, 2016); however, standardized approaches for rural areas are relegated to urban based indices. There are few studies that look at a point source environmental hazards

such as the elevated risk of multiple cancers in rural Illinois areas such as lung and colorectal associated with exposures to coal mining. Spatial clustering was observed between coal production, incidence and mortality rates (Mueller et al., 2015). Cumulative impact models, have been utilized in state-wide studies (Faber & Krieg, 2002) (Gilbert & Chakraborty, 2011), but contain indicators associated with urban exposures such as air pollution, toxic release inventory sites and brownfields. Rural communities face different threats associated with environmental injustice such as extractivism, mining, pesticide drift, ground water contamination, nuclear power, hydroelectric dams, political and economic marginalization (Pellow, 2016). Furthermore, the potential negative health outcomes associated with these exposures and effects have not been investigated.

METHODS

The specific objectives of the study are:

Objective 1. To evaluate percentile ranking maps produced by the CDC SVI and the EPA EJSCREEN tools to create a baseline of each model comparing urban and rural areas which will be defined with RUCA codes. The models will be run for the state of Illinois which use 2010 census data, 2010 – 2014 ACS for sociodemographic variables and the latest available data (2011 – 2015) for environmental indicators.

Objective 2. To assess Illinois rural areas using the CDC SVI and EPA EJSCREEN raw data to reformulate the data from percentile rankings to rates for each index's variables to develop maps that represent percent outcomes for sociodemographic indicators and concentrations or counts for environmental indicators. Rank these variables by county and compare these results to the county health outcomes and factors from 2011.

Objective 3. To conduct time-space analysis on health outcomes on the Illinois Delta Region to analyze significant spatial changes of health factors and outcomes from 2011 - 2015. Compare outcomes to results produced in objective 2 to see if the timeliness of CDC SVI and EPA EJSCREEN data and if it is reflective of current conditions.

Objective 4. To identify potential sociodemographic and environmental indicators by reviewing current rural health and environmental disparity literature that look at population characteristics and environmental stressors currently not included in the CDC SVI and the EPA EJSCREEN. Collect data for the Illinois Delta region to test a model integrating new variables and those identified in objective 2.

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