KFTC Environmental Justice Analysis Executive Summary

This report provides an Executive Summary of the KFTC Environmental Justice (EJ) Analysis, a project which analyzes the spatial relationships between pollution, health problems, and vulnerable demographics in Kentucky to identify the areas and communities which stand the most to benefit from a clean energy transition. This report can be used by KFTC members, in organizational strategizing and implementation and local organizations and citizens across the state to increase understanding of EJ issues in their community.

What is an Environmental Justice Analysis?

The EPA defines environmental justice (EJ) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Studying and analyzing environmental justice requires a recognition that, across the United States, low income and communities of color have systemically faced the greatest exposure to both air and water pollution that is harmful to health, including heighted risk from hazardous facilities and sites. These communities bear the brunt of energy systems and stand the most to benefit from a clean energy transition.

Often, however, clean energy plans have not included low-income persons and people of color in decision-making conversations, which produces plans which do not direct support to areas that need it the most and, sometimes, alleviate pollution in some areas while increasing exposure in the already-burdened areas.

The purpose of an EJ Analysis is to identify the vulnerable communities in an energy system to more accurately and affectively inform clean energy plans and transitions. Many states and organizations in the U.S. have completed such analysis and the EPA has developed tools and a database for analyzing EJ issues across the country.

Why is it important for Kentucky?

In Kentucky, a shift to cleaner energy sources can generate significant improvements in the health of Kentuckians, including lower rates of premature death, asthma, lung cancer, and COPD (chronic obstructive pulmonary disease). As Kentuckians for the Commonwealth (KFTC) works to develop a clean power plan specific for our state, it is important, now more than ever, to explore and increase understanding of the most vulnerable within Kentucky's energy system. KFTC recognizes that it is not inevitable that benefits from cleaner energy will occur in the most

affected communities and that low-income people and people of color have systemically been negatively impacted by our energy system (living closest to pollution sources, exposure to low water quality, etc.). Therefore, a Kentucky-specific EJ Analysis is necessary to **increase an understanding of the spatiality of environmental justice issues in Kentucky** as well as **inform conversation** about energy policies. Through an EJ Analysis, we can explore questions such as:

- Where are the most polluted areas in Kentucky?
- Where are the highest concentrations of health problems (due in part to pollution) in Kentucky?
- What are the relationships between pollution and low income and communities of color in Kentucky?
- What are the relationships between pollution, health problems, and vulnerable demographics (including race, income, age, and educational attainment)?
- **Essentially, we are asking "where and who are the most vulnerable communities within our current energy system?"** We want to recognize all the characteristics of vulnerability. And then make these areas the focus of a clean energy transition.

What the KFTC EJ Analysis Explores

The benefit of a state-specific EJ Analysis is that it concentrates on pollution sources, health effects, and demographic characteristics that are part of the state's unique story. Drawing upon guidance and resources from EJ analysis research from across the country and at the federal level, the KFTC EJ Analysis focuses on 3 types of vulnerability:

- Cumulative Pollution Exposure
- Concentration of Exposure-Related Health Problems
- Demographic Vulnerability

What do we mean by Cumulative Pollution Exposure?

When we look at Cumulative Pollution Exposure, we are exploring the spatial distributions of multiple pollution sources across our state, both individually as well as how they relate to each other. Our goal has been to include all possible pollution sources to be as comprehensive and relevant to Kentucky as possible. Therefore, we drew upon pollution indicators that EPA uses in their EJ Analysis and supplemented with Kentucky-specific data:

- Count of surface, underground, and abandoned mines
- Proximity to coal ash impoundments
- Proximity to Coal Haul Highway System
- Traffic proximity
- Count of injection wells

- Count of oil and gas wells
- Concentration of ozone
- Concentration of PM2.5 (particulate matter)
- Proximity to National Priorities List (NPL) sites, Risk Management Plan (RMP) facilities, NPDES (major direct water dischargers), and TSDFs (Transfer, Storage, and Disposal Facilities)
- Lead exposure

What do we mean by Concentration of Exposure-Related Health Problems?

When we look at Concentration of Exposure-Related Health Problems, we are exploring the spatial distributions of multiple health problems that research has stated are caused, in part, by pollution. We are exploring where these health problems are concentrated spatially individually, as well as how they are related to each other. We relied on Kentucky-specific research on pollution impact upon health issues. Here's what we're looking at:

- Prevalence of asthma in adults
- Hospitalization due to asthma for children
- Percent of adults with hypertension
- Rate of heart disease deaths
- Premature death rate

What do we mean by Demographic Vulnerability?

Here, we are working to identify the populations and communities which are most highly impacted by the energy system in Kentucky, specifically from pollution exposure and exposure-related health problems. To do this, we must identify multiple characteristics of demographic vulnerability. We have relied upon research from EJ analyses to produce this set of the commonly-used characteristics of demographic vulnerability:

- Percent low income (below poverty level)
- Percent minority (nonwhite)
- Percent with less than high school degree
- Percent under age 5
- Percent over age 64

Methods for Analysis

This project has collected data from multiple sources, creating a Kentucky-specific EJ database. The spatial distributions of each dataset were examined. Indicators for each category were overlaid using geospatial methods to show cumulative concentrations of these indicators across

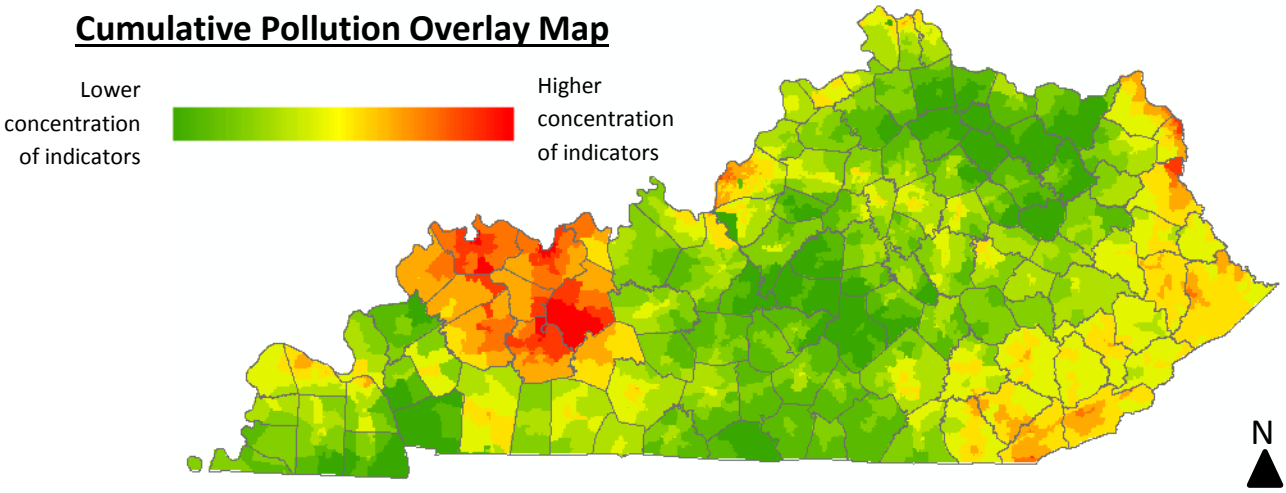
the state. Geospatial statistical analysis (a spatial correlation analysis) was completed to examine the correlations (i.e. strength and direction, positive or negative) between datasets.

Major Findings

Kentuckians across the state are impacted by pollution from many sources and, while pollution from the energy sector is a large part of this map, it is not the whole story.

When all the pollution indicators are overlaid into a single map (shown below), certain areas of Kentucky are highlighted more than others but it is clear that pollution occurs across Kentucky. **When we look at this map, we can ask "What pollution sources cause this area to be highlighted?"**

Cumulative Pollution Overlay Map



First, we notice that **Western Kentucky** is highlighted (area including Daviess, Henderson, Ohio, Muhlenberg Counties and others), i.e. "more vulnerable to cumulative pollution," than the rest of the state. If we take a look at the indicators that went into the Cumulative Pollution Overlay, we see why: power plants, coal ash impoundments, coal mines, oil and gas wells, injection wells, Risk Management Plans (RMPs), and concentrations of ozone and PM2.5 all cumulatively impact this area.

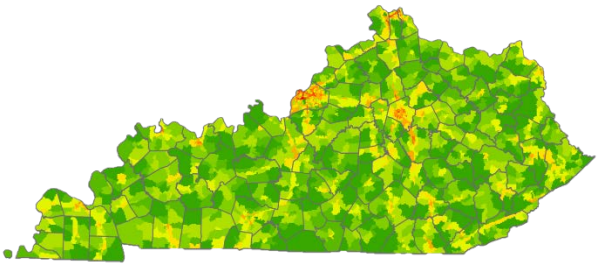
Eastern Kentucky is also a large region that is highlighted, due to cumulative impacts from coal mines, oil and gas wells, injection wells, and the coal haul highway system.

However, pollution from Kentucky's energy sector are not the only pollution sources which appear on this overlay:

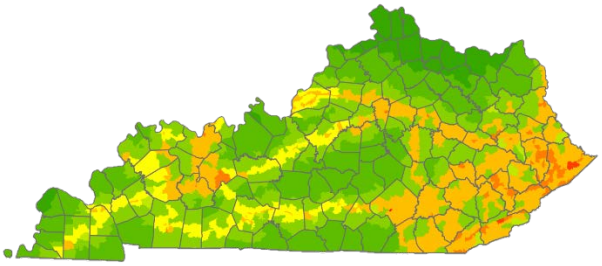
- While **Jefferson County**'s highlight can be attributed in part to cumulative presence of power plants, coal ash impoundments, and concentrations of ozone and particulate matter, the area also hosts RMPs, NPDES, and TSDFs and is high in traffic proximity measurements.
- Likewise, the area of **Northeastern Kentucky** which contains Greenup, Boyd, and Lawrence Counties contain density of oil and gas wells, injection wells, mines, and power plants, as well as RMPs, NPDES, NPL, and TSDFs.

The spatial patterns of pollution sources in Kentucky matter. The Cumulative Pollution Overlay map contains concentrations in Eastern and Western Kentucky but also **highlights across the state**, which can be attributed to the transportation indicators of traffic proximity and proximity to coal haul highway system, as well as the spatial pattern of other proximity indicators, such as RMP, shown as an example below:

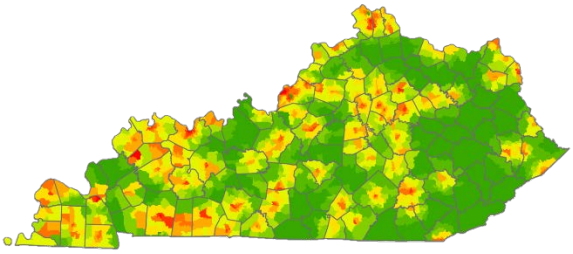
Traffic Proximity



Proximity to Coal Haul Highway System



Proximity to RMPs



Why This Is Significant: To identify the most vulnerable areas and communities in Kentucky regarding the energy landscape and all pollution sources, we must start by examining the spatial patterns of pollution sources. Examining cumulative pollution in this way demonstrates how **all Kentuckians stand to benefit** from a clean energy transition and policies which mitigate pollution.

How We Apply This: Kentuckians can use the maps provided in the EJ Analysis to look at cumulative pollution across the state (using the Cumulative Pollution Overlay map) as well as better understand the spatiality of individual pollution sources by examining the individual maps. **What pollution sources define the "cumulative pollution story" for your county and community?**

Different pollution sources affect low income and minority communities in Kentucky.

Of all the pollution sources included in the EJ Analysis, each was correlated positively with *either* percent poverty *or* percent minority.

Poverty is spatially and positively correlated with:

- coal mine indicators (surface, underground, and abandoned mines), injection wells, oil and gas wells, and the coal haul highway system

Percent minority is spatially and positively correlated with:

- proximity to power plants, lead exposure, proximity to coal ash impoundments, concentration of ozone, and proximity to Transfer, Storage, and Disposal Faculties.

Additionally, results show that percent minority is *statistically significantly* correlated with:

- concentration of PM2.5, proximity to RMP facilities, and traffic proximity to the 95% confidence level*
- There is statistically significant correlation with proximity to NPDES to the 99% confidence level*

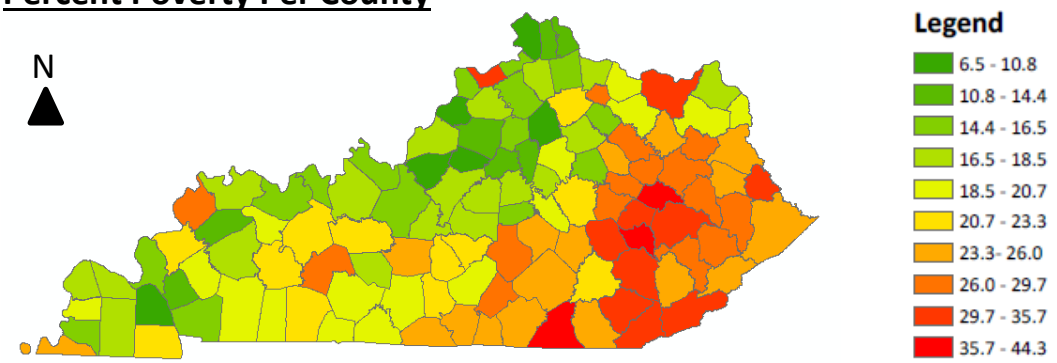
*95 and 99% confidence levels are a common way of presenting results from a statistical analysis. It indicates the confidence of the result. It means that, if we repeated this analysis 100 times, comparing the observed values of poverty and minority with random values, 95 or 99 times out of 100, we would receive the same result of high correlations

Why This is Significant: To understand how pollution is related to and impacts impoverished and minority communities in Kentucky, **we must first understand the demographics of our state and the spatial distribution of our pollution sources**. This analysis assists us in that understanding.

The American Community Survey (ACS) estimates that the 2014 percentage of persons below the poverty level in Kentucky was around 18% (see map below, uses the 2014 data). The spatial pattern displayed in this map reflects the spatial patterns of pollution sources such as coal

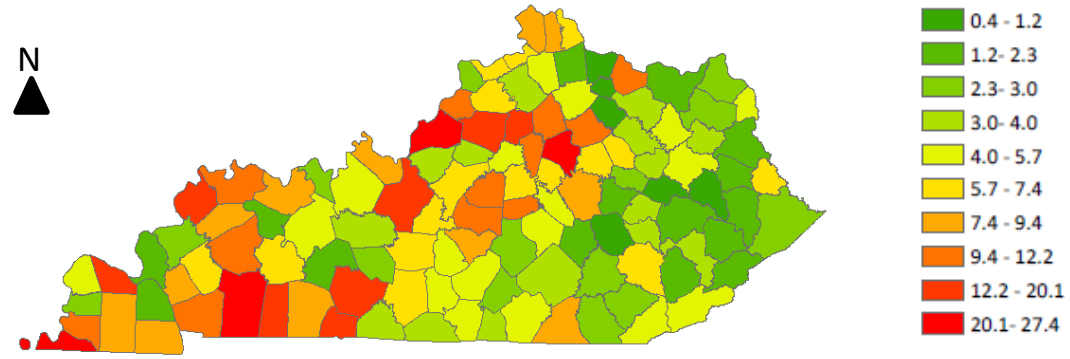
mines, coal haul highway system, injection wells, and oil and gas wells.

Percent Poverty Per County



For comparison, the ACS 2014 estimate for percent minority for Kentucky was about 12.6%. The map below visualizes percent minority data per county (from 2014 data). At the statewide scale, concentrations of low income and minority communities are distinctly different, which reflects the difference in correlations with pollution sources.

Percent Minority Per County



How We Apply This: **First**, we intentionally recognize pollution sources that are not just from the coal landscape or energy sector in Kentucky, specifically recognizing the sources which strongly affect people of color. **Our definition of "vulnerable communities" needs to not just include the coal landscape and poverty, but all pollution sources affecting all people, specifically including people of color. Second**, we check ourselves: are our clean energy policies working to mitigate pollution sources which hit *all* of Kentucky's vulnerable communities the hardest? **Third**, we can support localized efforts which concentrate on areas where these facilities are (example: doing case studies in areas surrounding power plants, RMPs, etc.).

Concentration of exposure-related health problems are strongly correlated with energy extraction in Kentucky.

The statistical analysis found that the **cumulative health score** (an aggregation of all the health indicators examined) **correlated positively** with the following pollution sources:

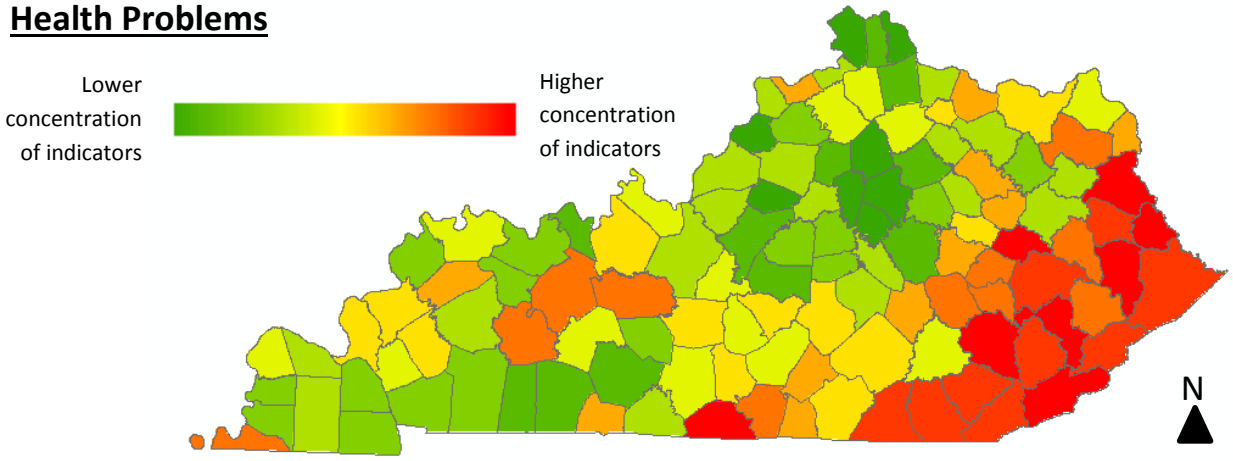
- Coal mines (surface*, underground*, and abandoned)
- Injection wells
- Oil and gas wells
- Proximity to the coal haul highway system

  **the correlations between cumulative health score and surface mines and underground mines was found to be statistically significant, to the 95% confidence level*

Results also indicate that a**pproximately 30% and 22% of the spatial variation and distribution of exposure-related health problems** (represented in the cumulative health score) **can be attributed to the location of surface and underground mines**, respectfully.

Additionally, both the **prevalence of asthma and hypertension** (two specific variables within the cumulative health measure) **are correlated positively with the same pollution sources** listed above.

Concentration of Exposure-Related Health Problems



Why This is Significant: The EJ Analysis is at the statewide scale and statistically shows how **pollution from energy sector sources are directly, strongly, and positively correlated with health problems in Kentucky.** The energy sector includes the extraction and transportation components of the coal landscape, as well as natural gas and oil processes. **However, scale matters.** Examining data at the statewide scale can erase the more localized relationships

between pollution sources and health problems, such as in the immediate vicinity of a power plant.

How We Apply This: This analysis builds upon past and ongoing research of relationships between pollution and health in Kentucky. With the EJ Analysis, we can begin examining the one-to-one relationships between health problems, pollution sources, and demographics. We can also support the examination of health vulnerability at multiple scales, not just statewide.

In Kentucky, there are strong relationships between exposure-related health problems and vulnerable demographics, such as poverty, educational level, and certain age groups.

Both when examined cumulatively (via the cumulative health measure) and individually (examining one-to-one relationships between health problems and demographics), the following results are shown:

- Educational level (percent without a high school degree) is *significantly and positively* correlated with the cumulative health measurement, to the 99% confidence level. Educational level is *significantly and positively* correlated with hypertension, heart disease, and premature death (to the 95% confidence level). **Meaning, the spatial distribution of Kentuckians without a high school degree is highly related to the spatial distributions of exposure-related health problems, specifically hypertension, heart disease, and premature death in our state.**
- Further, the analysis indicates that **upwards of 50% of the spatial distribution of premature deaths in Kentucky can be attributed to educational level** across Kentucky
- Poverty in Kentucky is *significantly and positively correlated* with cumulative health score and, specifically, heart disease, cancer, and premature death to the 95% confidence level. **Meaning, the spatial distribution of low income persons in Kentucky is highly related to the spatial distributions of exposure-related health problems, specifically heart disease, cancer, and premature death.**
- Hypertension, cancer, and premature death are *significantly correlated* with persons over age 64 in Kentucky, to the 95% confidence level. These same health problems, as well as cumulative health score, are also *significantly correlated* with percent under age 5, to the 95% confidence level. **Meaning, the spatial distributions of the oldest and youngest Kentuckians are highly related to the spatial distributions of exposure-related health problems in our state.**

Why This Is Significant: Kentucky's most vulnerable demographics are strongly and positively correlated with health problems that are due, in part, to the energy systems and pollution in

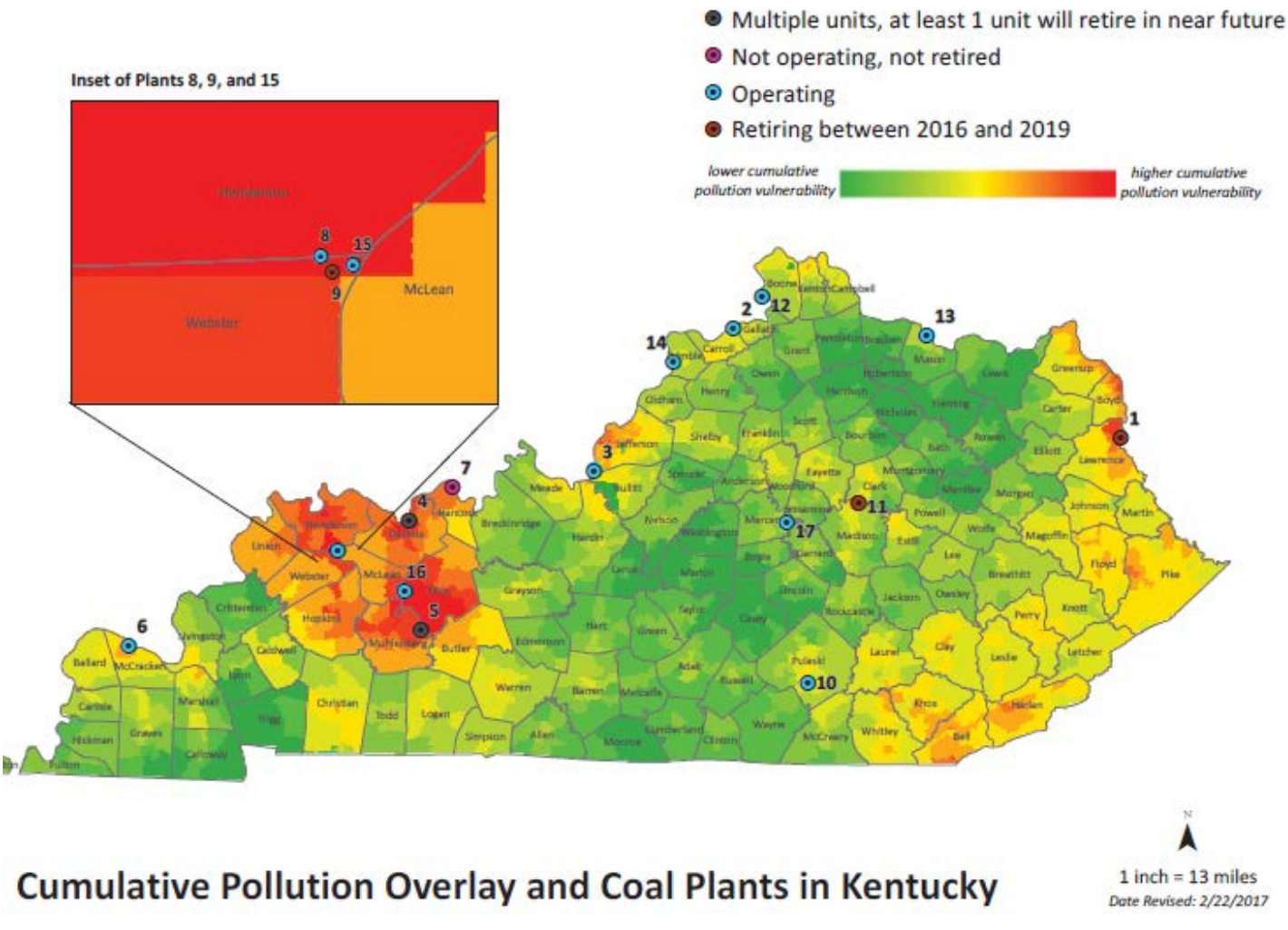
our state. This statistical finding indicates that lack of educational opportunity, systemic poverty, and age are important factors in determining a Kentuckians' health.

How We Apply This: We can continue to examine the one-to-one relationships provided in this analysis between specific health, demographic, and pollution variables and, due to their strong statistical significance, place these topics at the forefront of our conversations, research, and policymaking.

Many of Kentucky's coal-fired power plants are located in areas which exhibit cumulative pollution exposure and/or demographic vulnerability.

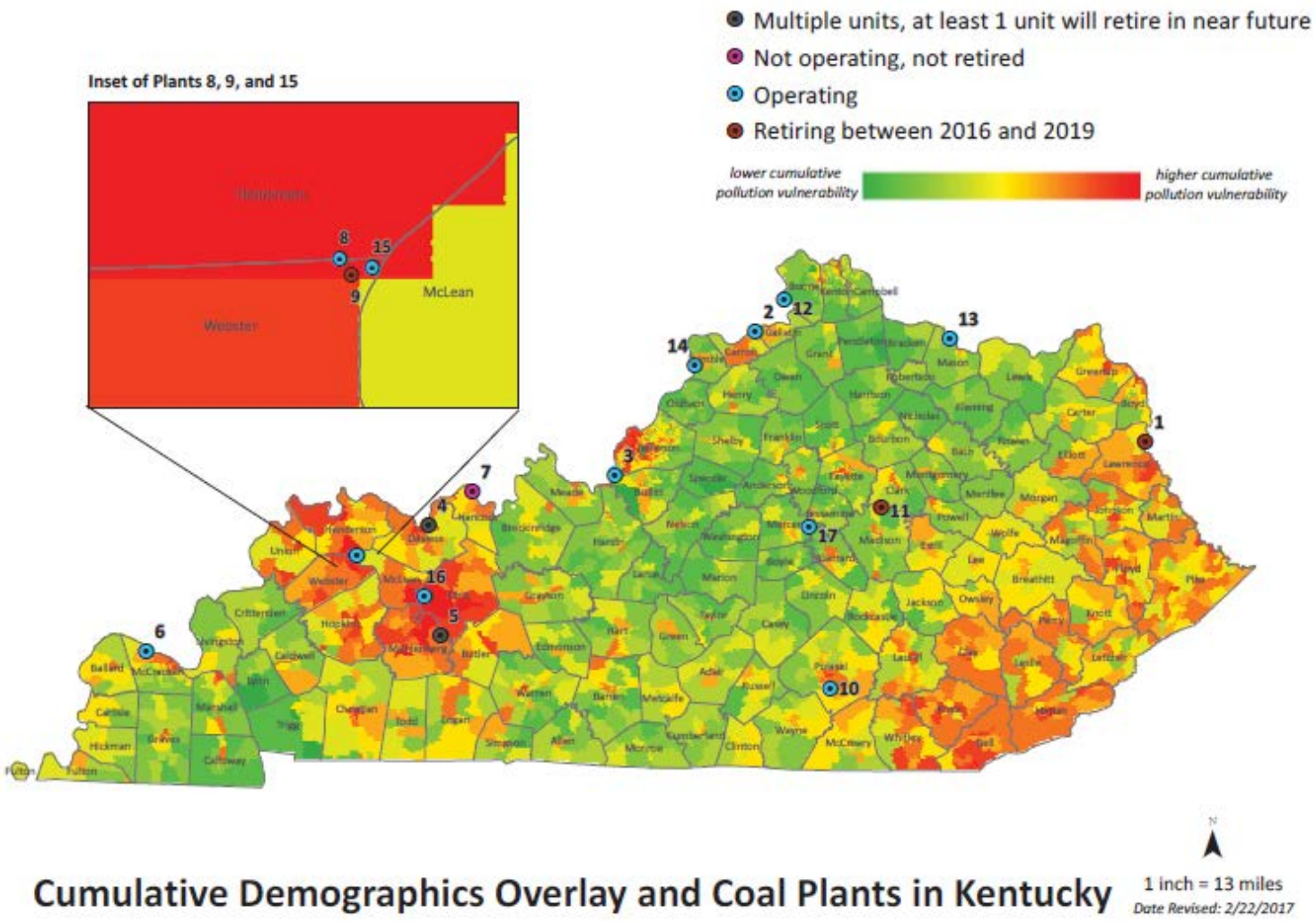
When the Cumulative Pollution and Cumulative Demographics (Demographic Vulnerability) overlays and Kentucky's coal-fired power plants are mapped together, it's clear that the power plants are in the areas which exhibit highest concentrations of pollution exposure and demographic vulnerability, according to the EJ data used in this analysis.

The map below displays the Cumulative Pollution Overlay with Kentucky's coal-fired power plants.



Cumulative Pollution Overlay and Coal Plants in Kentucky

The next map shows the same power plants on top of the Demographic Vulnerability Overlay (which includes all 5 of the demographic indicators: percent with less than high school degree, percent poverty, percent minority, percent over age 64, and percent below age 5).



Cumulative Demographics Overlay and Coal Plants in Kentucky

For a full list of the power plants shown (labelled by number) on these maps, see the table below:

	Plant Name	Utility Name	Total MW	Source(s)
1	Big Sandy	Kentucky Power Co	260	Coal (260 MW)
2	Ghent	Kentucky Utilities Co	1919	Coal (1919 MW)
3	Mill Creek (KY)	Louisville Gas & Electric Co	1472	Coal (1472 MW)
4	Elmer Smith	City of Owensboro - (KY)	398.7	Coal (398.7 MW)
5	Paradise	Tennessee Valley Authority	2201	Coal (2201 MW)
6	Shawnee	Tennessee Valley Authority	1206	Coal (1206 MW)
7	Kenneth C Coleman	Big Rivers Electric Corp	443	Coal (443 MW)
8	HMP&L Station Two Henderson	Big Rivers Electric Corp	312	Coal (312 MW)
9	Robert A Reid	Big Rivers Electric Corp	123	Coal (65 MW), Natural Gas (58 MW)
10	Cooper	East Kentucky Power Coop, Inc	341	Coal (341 MW)
11	Dale	East Kentucky Power Coop, Inc	149	Coal (149 MW)
12	East Bend	Duke Energy Kentucky Inc	600	Coal (600 MW)
13	H L Spurlock	East Kentucky Power Coop, Inc	1346	Coal (1346 MW)
14	Trimble County	Louisville Gas & Electric Co	2185	Coal (1243 MW), Natural Gas (942 MW)
15	R D Green	Big Rivers Electric Corp	454	Coal (454 MW)
16	D B Wilson	Big Rivers Electric Corp	417	Coal (417 MW)
17	E W Brown	Kentucky Utilities Co	1588	Coal (682 MW), Natural Gas (906 MW)

Why This Is Significant: A large part of both the energy and pollution landscapes in Kentucky are its coal-fired power plants. In a transition towards clean energy solutions, coal will be generating a smaller and smaller percentage of Kentucky's power. The communities in the immediate vicinities of the power plants, as demonstrated with the pollution and demographic overlay maps, are some of same Kentucky's areas which stand the most to benefit from a clean energy transition.

How We Apply This: We can use these maps and discussion to demonstrate, at the statewide level, the context surrounding Kentucky's coal-fired power plants. These maps also show us where to support localized EJ research at the community (instead of state-wide) level. When an area is highlighted on our overlay maps and also contains a power plant, we know that not only do resources and clean energy solutions need to be directed to that area but existing EJ work in that community and voices of community members need to be lifted up and heard.

Limitations and Uncertainties

This analysis used data and methodologies that matched time and resource constraints. Some limitations and uncertainties exist:

- Due to data availability limitations, the years of each dataset range from 2009 to 2016. Ideally, data would be collected from around the same time period. For the overlay maps (Cumulative Pollution Exposure, Concentration of Exposure-Related Health Problems, and Demographic Vulnerability), the most recent data sets are used. For the

spatial statistical correlation analysis, the earliest possible health and pollution data were used (ranging around 2009 when available).

- The maps and statistical analysis are completed at the state-wide scale. While this scale meets the goals of the project (examining EJ issues for all Kentucky), it is very difficult to infer processes that occur at a more localized scale. Environmental injustice is a multi-scalar issue, meaning that EJ processes at the state-level may be different than EJ processes at a smaller scale. For example, a map of poverty at a county-level, state-wide scale appears to be concentrated heavily in Eastern Kentucky and does not indicate the high poverty rates we know anecdotally and from experience are in the immediate vicinity of many Central and Western KY power plants. To approach EJ in Kentucky, we need to be examining the issues on appropriate scales.

The Takeaway

Any conversation and action regarding environmental justice issues in Kentucky needs to be inclusive of all the ways EJ is manifested. In our state, this analysis has shown that it is not just coal extraction and poverty which characterize Kentucky's "most vulnerable" communities and spaces. It is also the strong correlation between people of color and proximity to power plants and many hazardous waste facilities. It is the vulnerability of Kentucky's oldest and youngest. It is the strong relationship between a Kentuckian's educational status and health issues. It is the location of polluting sources, such as coal-fired power plants, in the areas which experience the most pollution and are most demographically vulnerable. Kentucky's EJ landscape is complex and our definition needs to acknowledge this.