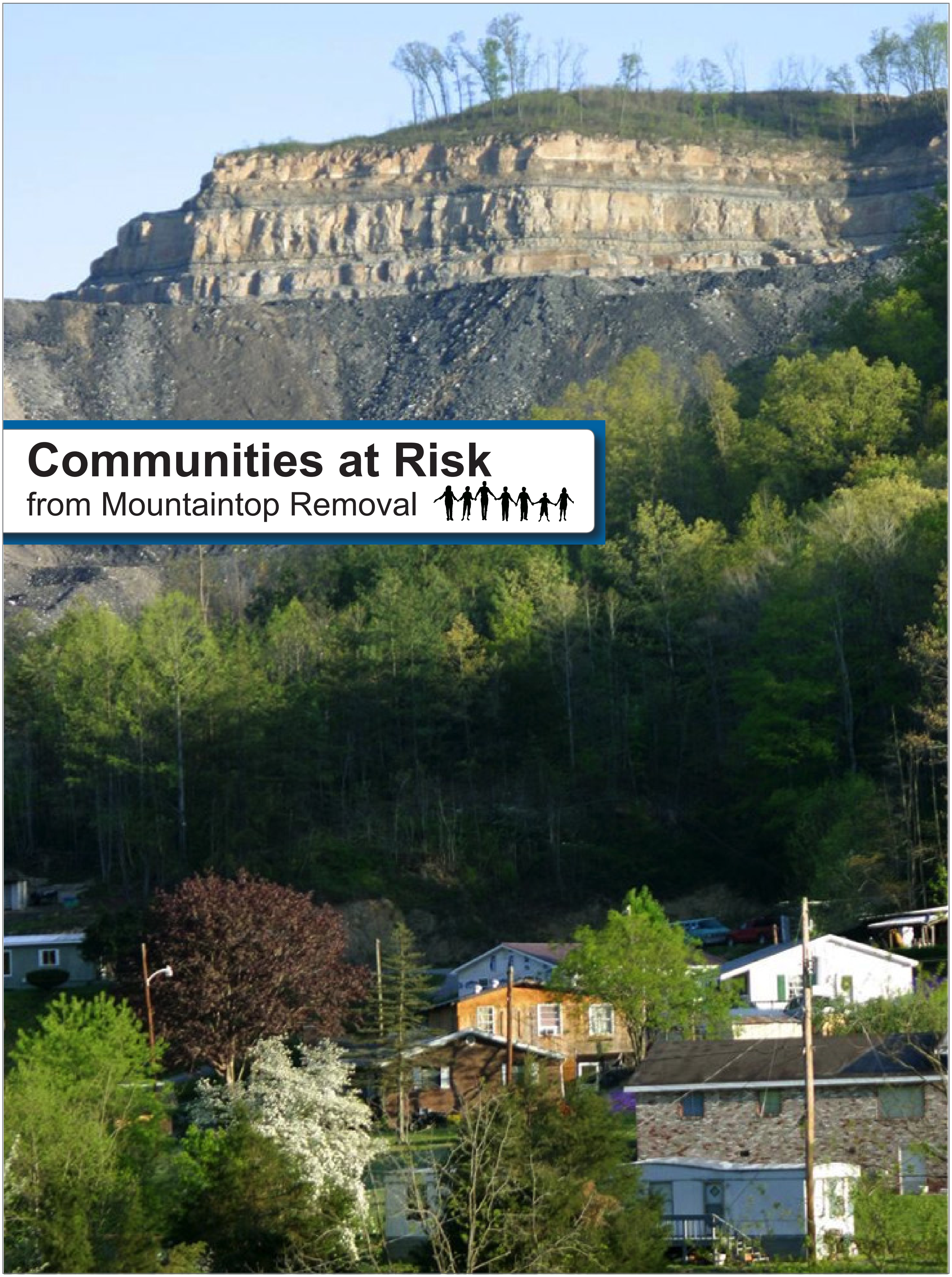
Communities at Risk
from Mountaintop Removal



Appalachian Voices

AppalachianVoices.org

Coal company bankruptcies, mine layoffs and steep declines in coal production have been the dominant national news stories out of the Appalachian coal mining region since 2012. That year, the surge of natural gas production from the Marcellus Shale crossed a critical threshold, sending natural gas prices plummeting below the level with which most Appalachian coal producers could compete for electricity generation market share. With Central Appalachian coal production down 50% since 2008, there's no debating the truth or relevance of these stories.

Prior to 2012, however, the dominant news story out of the region was the environmental and human impact of mountaintop removal coal mining and the Obama administration's efforts to reduce the impact of the practice. Mountaintop removal is a controversial form of large-scale surface coal mining that involves using explosives to blast the tops off of mountains to access thin seams of coal. Dozens of scientific papers have been published in the last six years linking mountaintop removal to a broad range of human and environmental impacts, ranging from increased rates of cancer and birth defects in people living near these mines, to high levels of pollutants in downstream water supplies and the disappearance of entire orders of aquatic organisms from mine-impacted streams.

The near-complete displacement of one news story by the other could leave the impression that the problems of mountaintop removal have largely been resolved by the collapse in demand for Appalachian coal—the more so when one learns that production from Appalachian mountaintop removal mines specifically has declined by nearly 60% since its peak in 2008.

> That impression is at odds with the perception of many residents of Appalachian coal mining communities who maintain that large mountaintop removal mining operations have continued to expand nearer to their homes and communities in recent years.

To help understand the extent of the threats Appalachian communities face from mountaintop removal—and the degree to which those threats are changing over time—Appalachian Voices undertook a research project to identify the current relationship between mountaintop removal and the communities in the region where it occurs. We asked three key questions:

1. As the pace of mountaintop removal mining has declined, has ongoing mining moved closer to or further from communities, on average?

2. In which communities have the impacts of mountaintop removal mines been increasing in recent years and are there clear patterns in the locations of these communities?

3. Are the demographic and socioeconomic trends more or less favorable in communities where nearby mountaintop removal mining is on the rise?

To address these questions, we constructed a novel dataset using geospatial analysis tools provided by Google Inc. to detect and map mining activities across 30 years worth of satellite imagery covering the coal mining region of Central Appalachia.

We combined this dataset with a comprehensive database of populated places provided by the U.S. Board on Geographic Names to determine whether mining had moved closer to or further from Appalachian communities in recent years, and to identify the 50 communities that had seen the greatest recent encroachment of large-scale mining activities.

Finally, we compiled data from the U.S. Census Bureau to analyze demographic and economic trends in these 50 "at risk" communities and compared them to trends in rural communities in the same counties with no surface mining activities nearby.

Our key findings include:

- Mountaintop removal mines are continuing to encroach on many communities in Central Appalachia, and the communities most at risk are spread widely across three states and 23 Central Appalachian counties;
- Communities where surface mine encroachment is increasing suffer higher rates of poverty and are losing population more than twice as fast as nearby rural communities with no mining in the immediate vicinity; and
- Communities that face the greatest current and future threat from mine encroachment are in areas where high-quality metallurgical coal is mined using mountaintop removal, particularly far southern West Virginia.

Methods

Our analysis of trends in surface coal mining near Appalachian communities and the socioeconomic impacts of those trends first required constructing a set of maps showing the extent of active surface mining over time. We then used these maps to analyze the proximity of mining to communities in Appalachia. Finally, we used U.S. Census Bureau data to detect differences in demographic and economic trends that correlate with recent encroachment of surface mines on communities.

All maps and datasets created by or used in this project are available as Google Fusion Tables, the links to which are listed in the appendix.

Creating maps of active surface mining

Large-scale surface mining activities across 53 Central Appalachian counties were detected over a 30-year period using Google Earth Engine, a cloud platform provided by Google Inc. that combines an extensive catalog of public satellite imagery with a powerful computational facility that conducts parallel processing of geospatial data. In addition, Google provides JavaScript and Python code libraries and a graphical user interface to facilitate analysis of the geospatial data provided in Earth Engine.

Our maps are based on annual composites of Landsat 5 and 8 satellite images from the U.S. Geological Survey's Earth Resources Observation and Science Center archive that were optimized by Google to detect changes in vegetation cover by using a "greenest pixel" algorithm to construct the composites. The greenest pixel composites contain computed top-of-atmosphere reflectance from L1T orthorectified Landsat scenes and contain all images for each year with the greenest pixel (i.e., the pixel with the greatest value of the Normalized Difference Vegetation Index) on top.

Our approach to detecting active surface mining began with computing the Normalized Difference Vegetation Index (NDVI) from the top layer of the annual greenest pixel composites for 53 Central Appalachian counties where significant surface coal mine production has occurred. NDVI is a graphical indicator frequently used by remote sensing specialists to detect the presence of living vegetation using a ratio of visible-to-near infrared light. Maps were created for every third year between 1984 and 2014 for a total of 11 maps.

Visual inspection using high-resolution aerial photography revealed that an NDVI value of 0.4 was an excellent threshold for distinguishing between active mining areas (which tended to have values in the 0.1 to 0.3 range) and reclaimed mine sites and logging operations, which typically exhibited values higher than 0.4. We constructed a binary raster image for each of the analysis years with areas with NDVI values below 0.4 classified as active mining and areas above the threshold classified as non-mining.

Because areas of urban and industrial development (e.g., parking lots) often exhibit low NDVI signatures similar to active surface mines, we used a mask layer created by SkyTruth, a non-profit organization that specializes in using remote sensing and digital mapping to expose landscape destruction and habitat degradation. The mask layer eliminated areas within or near streams, lakes, roads, urban areas and military bases from our maps of active surface mining. We found that a 120-meter buffer from these features was sufficient to eliminate nearly all "false positives" associated with urban and industrial development from the active mining layers, but did so at the cost of also eliminating a significant amount of actual surface-mined area adjacent to roads and streams. To minimize these "false negatives," we took an additional step of masking the mask layer itself with maps of areas permitted for surface mining provided by state agencies in charge of coal mine permitting in Kentucky, Virginia, West Virginia and Tennessee.

While these map layers from state agencies were incomplete—particularly for mines permitted before the late 1990s—we found that incorporating them into our analysis was useful in finding an optimal compromise between the competing goals of detecting as much active surface mining as possible while simultaneously avoiding spurious results.

Because our aim was to evaluate threats to communities from large mountaintop removal mines and not to create the most comprehensive map possible of surface coal mining, we took a conservative approach to classifying mined areas that was far more likely to yield “false negatives” than “false positives.” To that end, we incorporated one final measure to eliminate remaining specks of “false positive” results, which was a "sieve" routine that eliminated any sites that were smaller than 25,000 square meters of contiguous area.

While we are confident that these procedures resulted in maps that are an accurate representation of the extent of mountaintop removal and related forms of large-scale strip mining over time, because of the coarse resolution (25 meter) of Landsat imagery and the conservative approach we used to detect mining, this analysis does not take into account many of the small contour mines that are a ubiquitous feature of the landscape of the Appalachian coalfields.

Proximity of active mining to communities in Appalachia

The locations of communities in the 53-county coal mining region used for this analysis were derived from the Geographic Names Information System database, which is a joint project of the U.S. Board on Geographic Names and the U.S Geological Survey. From the database, we selected 3,778 populated places within that zone that were not listed as "historical" (i.e., abandoned).

Using Google Earth Engine, we created a distance map in which each pixel was assigned a value of its distance (in meters) from the nearest community. We then constructed a script that calculated the average of these distance values for all pixels classified as active mining in each of the 53 counties in each of the 11 years analyzed between 1984 and 2014. The resulting dataset consisted of a single value (average distance from the nearest community) of all active surface mining that occurred in each county for each year.

Identifying communities most at risk from mine encroachment

Using Google Earth Engine, we created a 1-mile buffer around each populated place and calculated the percentage of that area that was classified as active surface mining in each of the 11 years analyzed. The distance to the nearest active mining pixel was also calculated for each community in each year.

We identified the top 50 "at risk" communities by creating an index based on two variables: the proportion of area within the 1-mile radius classified as active mining in 2014 and the slope of a linear regression on the change in these percentages between 1990 and 2014. Each of the 3,778 communities was ranked in descending order for each of those variables and those rankings were summed to create an "at risk" index.

Finally, we visually reviewed each of the communities with the highest index values to identify and eliminate communities that were directly adjacent to higher-ranked communities. The 50 highest-ranked communities that were not eliminated through this procedure became the population of at-risk communities in the analysis of demographic and socioeconomic trends.

Impacts of mining on demographic and economic trends of communities

Census block groups were the smallest unit of geography for which both demographic and economic data were available and, as such, we chose to use block groups for our comparison of demographic trends between at-risk communities and communities with no mining nearby. While in many cases more than one rural community is encompassed by a single census block group, these are relatively small geographic units that, in contrast to census tracts or counties, allowed us to be confident that most communities within them experienced similar conditions with respect to mining activities nearby.

Unfortunately, block groups are not entirely immutable from one census to the next, although changes usually involve dividing or combining block groups without any additional adjustments to boundaries. This made it simple to compare identical geographic areas between one decadal census and the next by lumping several block groups together when necessary.

We identified the block group that encompasses each of the 50 at-risk communities in the 1990, 2000 and 2010 decadal censuses and determined whether the boundaries of that block group had changed over that period. In the roughly half of communities where block group boundaries changed, we lumped the minimum number of adjacent block groups together for each census year to ensure that the same geographic area was being compared between censuses. Because populations are declining in the region studied, the majority of these cases simply involved lumping two block groups in 1990, and sometimes 2000, that by 2010 had been combined into a single block group.

While our initial analysis of these data showed clearly that the block groups containing at-risk communities were declining in population and suffered far higher poverty rates than was characteristic for their respective counties as a whole (see results), we were concerned that this created an unfair comparison because many counties also contained urban areas where conditions were very different for a host of reasons that have little to do with proximity to mining. Thus, to create a better comparison, we identified a set of "no-mining communities" from the same counties to compare against the at-risk communities.

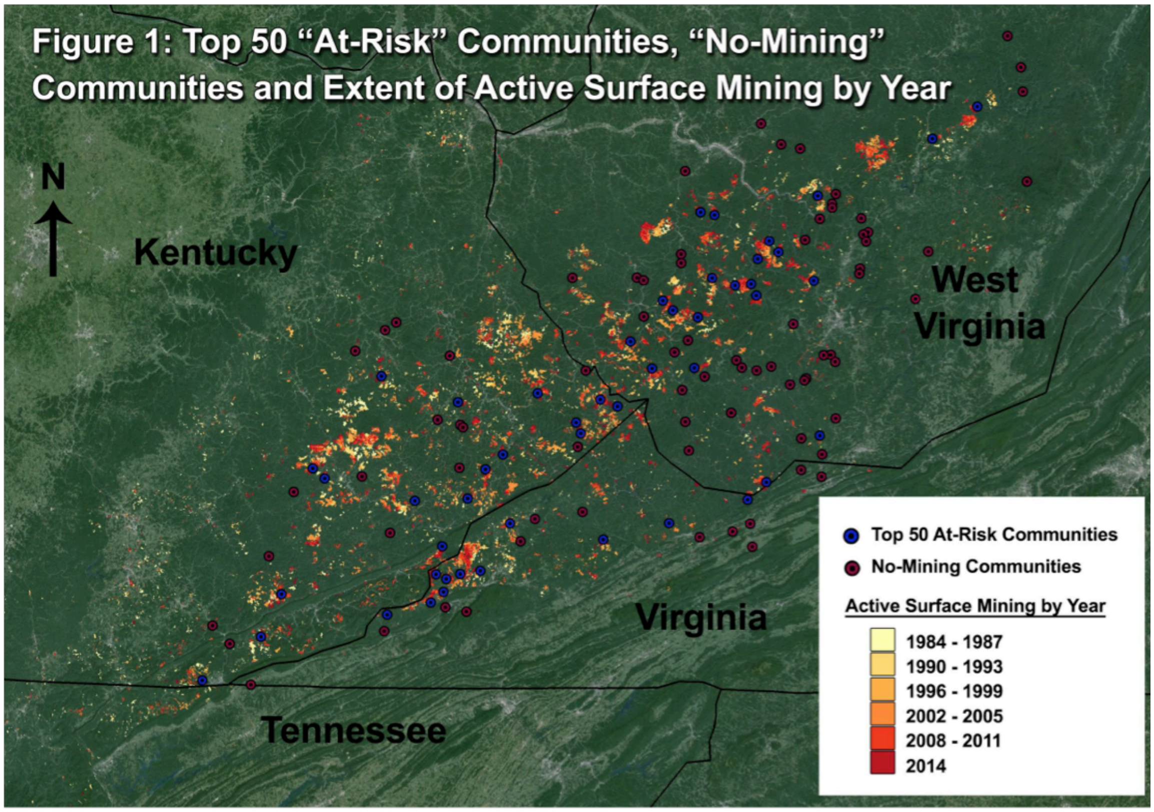
The procedure for selecting the population of no-mining communities began with identifying all communities for which no mining was detected between 1984 and 2014 in each of the 23 counties where the at-risk communities were located. We then randomly selected 100 of these communities using a random number generator and plotted them on a map. Any community located in a primarily urban area or which shared a census block group with one of the at-risk communities was discarded. For the remaining 74 communities, we followed the same procedure described above to identify their census block groups or, in cases where those changed between 1990 and 2010, lumped the smallest number of adjacent block groups together to allow comparison of the same geographic area across years.

Table 1: Summary of Central Appalachian Counties with Significant Coal Strip Mine Production between 1984 and 2014

State	County	Total Number of Communities	Number of Communities in Top 50 "At-Risk" list	Coal Strip Mine Production in 2014 (tons)	Total Coal Strip Mine Production, 1984-2014	Avg Distance of Surface Mining to Communities, 1999 (meters)	Avg Distance of Surface Mining to Communities, 2014 (meters)
KY	Bell	58	2	437,440	53,341,419	2,948	2,143
KY	Boyd	26	0	0	2,251,860	3,027	2,346
KY	Breathitt	64	0	491,742	63,687,153	1,392	1,573
KY	Carter	57	0	0	1,250,139	2,211	1,659
KY	Clay	56	0	174,620	11,018,444	2,113	1,987
KY	Elliott	34	0	8,684	2,296,590	*	*
KY	Floyd	84	1	1,160,060	74,187,164	2,531	2,437
KY	Greenup	43	0	0	5,532,728	4,069	3,455
KY	Harlan	104	0	1,561,630	52,864,611	2,758	2,517
KY	Jackson	49	0	0	2,366,548	*	*
KY	Johnson	41	0	166,483	5,997,180	3,017	3,252
KY	Knott	43	1	436,248	85,429,784	3,234	3,727
KY	Knox	38	0	615,888	11,821,289	1,392	1,573
KY	Laurel	45	0	0	2,364,407	*	*
KY	Lawrence	48	0	413,967	14,420,947	1,564	2,041
KY	Lee	33	0	1,869	1,578,263	*	*
KY	Leslie	35	1	659,270	53,056,806	3,053	3,243
KY	Letcher	67	2	504,908	72,627,564	1,716	2,350
KY	Magoffin	59	1	1,204,438	38,640,445	2,697	2,357
KY	Martin	17	0	191,549	112,203,811	2,804	3,846
KY	Morgan	56	0	0	2,483,589	*	*
KY	Owsley	25	0	0	3,394,684	*	*
KY	Perry	61	2	4,168,201	276,046,973	2,254	2,472
KY	Pike	121	7	4,848,066	271,474,167	2,330	2,239
KY	Whitley	46	0	250,809	15,316,304	1,525	1,744
KY	Wolfe	34	0	15,540	3,345,011	1,766	1,641
TN	Anderson	71	0	0	2,019,698	*	*
TN	Campbell	74	0	71,525	10,942,200	1,921	1,634
TN	Claiborne	74	0	120,111	15,117,991	3,956	3,576
TN	Cumberland	158	0	0	1,604,724	*	*
TN	Fentress	40	0	0	2,677,503	*	*
TN	Morgan	45	0	0	555,861	*	*
VA	Buchanan	61	0	1,519,678	46,599,194	2,747	2,952
VA	Dickenson	51	2	105,231	29,511,244	1,437	2,131
VA	Lee	63	1	0	4,341,882	1,118	1,291
VA	Russell	81	0	280,081	9,343,238	1,439	1,355
VA	Tazewell	95	1	684,810	5,429,333	1,122	1,706
VA	Wise	80	6	1,358,521	155,524,867	2,036	2,580
WV	Boone	101	5	7,578,984	290,392,090	2,470	2,530
WV	Clay	60	0	0	76,939,452	4,087	3,381
WV	Fayette	188	2	2,615,802	88,452,558	2,149	2,153
WV	Greenbrier	118	0	612,874	4,918,729	2,329	2,723
WV	Kanawha	207	2	3,925,101	152,575,283	2,255	1,901
WV	Lincoln	48	0	0	6,449,969	2,846	3,309
WV	Logan	140	4	7,370,824	269,341,267	1,941	2,027
WV	McDowell	113	2	1,122,271	41,117,283	2,388	1,792
WV	Mercer	82	1	224,128	1,205,915	1,661	1,805
WV	Mingo	82	2	3,090,839	180,832,362	2,343	2,478
WV	Nicholas	72	1	32,801	90,859,523	3,507	2,962
WV	Raleigh	147	2	1,938,556	29,333,395	2,252	2,414
WV	Wayne	58	0	0	26,281,792	*	*
WV	Webster	47	1	1,042,546	74,284,200	4,222	2,312
WV	Wyoming	78	1	19,783	33,760,739	3,844	3,112

** Insufficient active mining in 2014 for analysis*

	Total Number of Communities	Number of Communities in Top 50 "At-Risk" list	Coal Strip Mine Production in 2014 (tons)	Total Coal Strip Mine Production, 1984-2014	Avg Distance 1999 (meters)	Avg Distance 2014 (meters)
KY Total	1344	17	17,311,412	1,238,997,880	2,420	2,430
TN Total	462	0	191,636	32,917,977	2,938	2,605
VA Total	431	10	3,948,321	250,749,758	1,650	2,002
WV Total	1541	23	29,574,509	1,366,744,557	2,735	2,493
Grand Total	3778	50	51,025,878	2,889,410,172	2,440	2,398



Results and Implications

The 50 most at-risk communities were spread widely across 23 of the 53 Central Appalachian counties where significant surface coal mining has occurred since 1984 (see Table 1 and Figure 1). Unsurprisingly, the highest concentrations of at-risk communities were found in the counties with the greatest levels of 2014 surface coal mine production in each of the states, led by Pike County, Kentucky (seven at-risk communities), Wise County, Virginia (six at-risk communities) and Boone County, West Virginia (five at-risk communities). Overall, the 23 counties where at-risk communities were located accounted for more than 85% of Central Appalachian surface coal production in 2014.

One immediately striking pattern is the disproportionate number of at-risk communities located in West Virginia—nearly half (22) of 50 total. This can be explained by the fact that the 11 counties in West Virginia where surface mining occurred in 2014 accounted for 60% of Central Appalachian surface coal mine production in that year.

The most surprising result was the disproportionate number of at-risk communities that were located in southwest Virginia. The region contained ten at-risk communities (20%), but accounted for only 8% of Central Appalachia's surface mine coal production in 2014.

West Virginia dominates the top half of the "at-risk" list, with 14 of the top 25 communities (Table 2). Furthermore, several of the most at-risk communities are in counties that have traditionally accounted for a relatively small share of Central Appalachian surface mining such as McDowell County, West Virginia.

The reason for the recent increase in mining near many of the most at-risk communities in West Virginia is likely because they are near surface mines and mine complexes that produce high-quality metallurgical coal that is used to produce steel rather than electricity. The market for metallurgical coal is dominated by overseas buyers and largely insulated from the market forces (i.e., low natural gas prices) that have led to steep declines in thermal coal production across Appalachia in recent years. While there has been a recent dip in demand for metallurgical coal since exports of that commodity reached an all-time high in 2012, the overseas demand for Appalachian met coal remains at high levels compared to one or two decades ago.

In addition, there appears to be a trend toward more surface mining of metallurgical coal, the production of which has historically been mostly at underground mines in Appalachia.

While it goes beyond the scope of this report to delve into the nuances of domestic and international markets for various grades of coal, it is important for interpreting these results to understand that much of the coal produced in Virginia and West Virginia is sold into international metallurgical coal markets, while nearly all of the coal produced in eastern Kentucky is sold to electric power plants in the southeastern U.S. Domestic demand for Appalachian thermal coal, particularly in the Southeast, has fallen precipitously over the past five years as a result of competition from natural gas and the impending retirement of dozens of out-dated coal plants that lack modern pollution controls.

The difference in markets for thermal and metallurgical coal explains not only the disproportionate number of at-risk communities in Virginia and West Virginia relative to Kentucky and Tennessee, but other surprising results as well, including the presence of at-risk communities in counties such as Mercer County, West Virginia, which until recently accounted for a miniscule fraction of West Virginia's surface coal production.

An additional pattern that was evident from the mapping phase of the project was the importance of "coal synergy" highway projects, such as West Virginia's King Coal Highway, in driving new mountaintop removal mining in recent years. The idea behind coal synergy is that by coordinating highway construction projects with the permitting and reclamation plans of mining companies in order to take advantage of their larger earth-moving equipment, the costs of highway construction in mountainous areas can be reduced. From the perspective of mining companies, this provides an opportunity to streamline environmental permitting for new mountaintop removal mines and gain access to taxpayer funds for highway construction activities. The striking linear features apparent in the map that depict newly mined areas across portions of Mingo and Raleigh counties are a testament to the importance of these projects for directing patterns of new mining. In addition, the presence of two communities in Mingo County on the list of at-risk communities (Hampden and Puritan Mines) is attributable to mountaintop removal mining associated with West Virginia's nascent King Coal Highway.

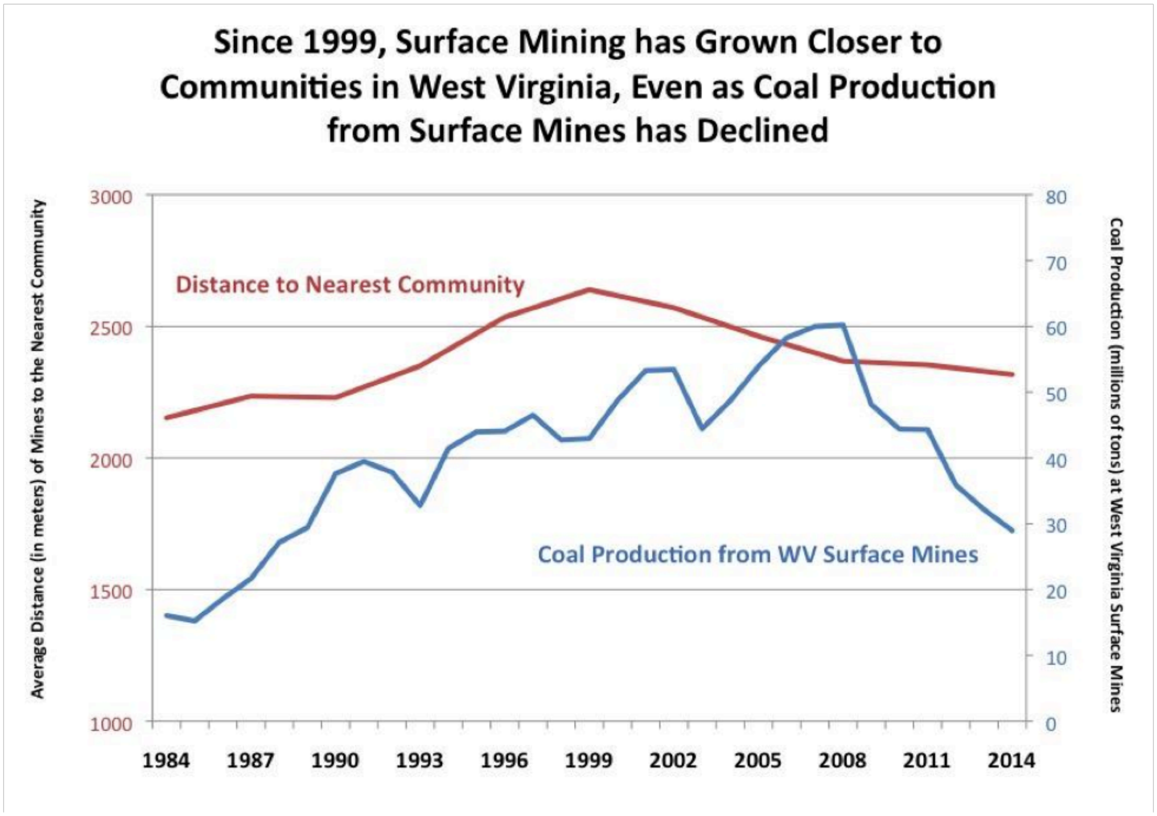
Table 2: Summary of Top 50 At-Risk Communities

Community Name	Rank	State	County	Block Group(s) Population in 1990	Block Group(s) Population in 2000	Block Group(s) Population in 2010	Block Group Population Change per Decade, 1990-2010	County Population Change per Decade, 1990-2010	State Population Change per Decade, 1990-2011	Block Group Poverty Rate, 2000	Block Group Poverty Rate, 2013
Krypton	1	KY	Perry	2,107	1,892	2,015	-2.2%	-2.6%	8.9%	14.8%	26.3%
Bishop	2	WV	McDowell	1,032	769	537	-24.0%	-18.6%	1.7%	14.1%	23.7%
Roaring Fork	3	VA	Wise	3,565	3,299	2,918	-9.1%	2.4%	14.7%	17.3%	27.8%
Wainville	4	WV	Webster	1,641	1,531	1,476	-5.0%	-7.3%	1.7%	31.4%	41.9%
Decota	5	WV	Kanawha	1,503	1,226	1,199	-10.1%	-3.5%	1.7%	21.4%	3.3%
Red Warrior	6	WV	Kanawha	1,424	1,176	1,732	10.8%	-3.5%	1.7%	21.1%	21.4%
Busy	7	KY	Perry	1,755	1,686	1,585	-4.8%	-2.6%	8.9%	22.6%	32.4%
Lindytown	8	WV	Boone	2,584	2,092	2,042	-10.5%	-2.4%	1.7%	19.8%	21.6%
Tiptop	9	KY	Magoffin	1,545	1,509	1,481	-2.1%	1.0%	8.9%	20.7%	23.0%
Yolyn	10	WV	Logan	8,651	6,239	5,704	-17.0%	-7.3%	1.7%	15.4%	21.9%
Duty	11	VA	Dickenson	711	617	559	-10.7%	-4.9%	14.7%	18.0%	9.2%
Oilville	12	WV	Logan	829	693	711	-7.1%	-7.3%	1.7%	16.5%	34.6%
Stonega	13	VA	Wise	3,565	3,299	2,918	-9.1%	2.4%	14.7%	17.3%	27.8%
Simers	14	KY	Pike	3,386	2,842	2,537	-12.5%	-5.2%	8.9%	22.5%	27.9%
Freeze Fork	15	WV	Logan	8,651	6,239	5,704	-17.0%	-7.3%	1.7%	15.4%	21.9%
Saylor	16	KY	Leslie	2,850	2,601	2,377	-8.3%	-8.5%	8.9%	29.3%	30.3%
Monarch	17	VA	Lee	967	847	601	-18.9%	2.2%	14.7%	18.9%	37.4%
Stopover	18	KY	Pike	1,764	1,552	1,390	-10.6%	-5.2%	8.9%	24.3%	22.7%
Hampden	19	WV	Mingo	1,019	931	712	-15.1%	-10.2%	1.7%	17.3%	20.3%
Monson	20	WV	McDowell	2,068	1,525	1,242	-20.0%	-18.6%	1.7%	27.1%	39.9%
Nellis	21	WV	Boone	1,954	2,246	2,227	7.0%	-2.4%	1.7%	15.2%	26.0%
Inman	22	VA	Wise	3,565	3,299	2,918	-9.1%	2.4%	14.7%	17.3%	27.8%
Marthatown	23	WV	Boone	2,584	2,092	2,042	-10.5%	-2.4%	1.7%	19.8%	21.6%
Montcoal	24	WV	Raleigh	3,708	3,108	2,720	-13.3%	1.3%	1.7%	14.3%	23.2%
Sundial	25	WV	Raleigh	3,708	3,108	2,720	-13.3%	1.3%	1.7%	14.3%	23.2%
Stowe	26	WV	Logan	8,651	6,239	5,704	-17.0%	-7.3%	1.7%	15.4%	21.9%
Laurel Grove	27	VA	Wise	1,312	1,529	1,497	7.1%	2.4%	14.7%	16.5%	13.6%
Peytona	28	WV	Boone	1,223	1,223	1,137	-3.5%	-2.4%	1.7%	21.5%	15.9%
Penny	29	KY	Pike	1,578	1,394	1,365	-6.7%	-5.2%	8.9%	18.6%	12.7%
Boone Furnace	30	KY	Carter	1,082	1,037	1,176	4.3%	6.9%	8.9%	17.3%	27.8%
Exeter	31	VA	Wise	3,565	3,299	2,918	-9.1%	2.4%	14.7%	15.6%	14.4%
Long Branch	32	WV	Fayette	781	821	780	-0.1%	-2.0%	1.7%	22.8%	30.8%
Board Tree	33	KY	Pike	3,276	2,605	2,301	-14.9%	-5.2%	8.9%	23.9%	31.9%
Hemphill	34	KY	Letcher	1,063	817	561	-23.6%	-4.6%	8.9%	22.5%	27.9%
Dunlap	35	KY	Pike	3,386	2,842	2,537	-12.5%	-5.2%	8.9%	26.4%	52.6%
Guyan	36	WV	Wyoming	639	590	513	-9.9%	-9.0%	1.7%	12.4%	30.0%
Hartley	37	KY	Pike	1,471	1,480	1,422	-1.7%	-5.2%	8.9%	17.3%	27.8%
Roda	38	VA	Wise	3,565	3,299	2,918	-9.1%	2.4%	14.7%	29.5%	9.5%
Garrison	39	WV	Boone	835	700	647	-11.3%	-2.4%	1.7%	22.8%	29.3%
Baden	40	VA	Dickenson	802	700	623	-11.2%	-4.9%	14.7%	17.6%	39.7%
Edgewood	41	KY	Bell	1,484	1,530	1,460	-0.8%	-4.5%	8.9%	25.7%	16.3%
Printer	42	KY	Floyd	862	769	689	-10.0%	-4.7%	8.9%	23.1%	29.2%
Amelia	43	KY	Knott	1,185	1,104	1,032	-6.5%	-4.4%	8.9%	23.5%	10.1%
Balkan	44	KY	Bell	1,104	1,028	1,053	-2.3%	-4.5%	8.9%	17.1%	29.2%
Fork Ridge	45	VA	Tazewell	1,025	827	810	-10.5%	-1.0%	14.7%	16.6%	22.5%
Oven Fork	46	KY	Letcher	1,222	1,032	938	-11.6%	-4.6%	8.9%	18.7%	33.1%
Weyanoke	47	WV	Mercer	3,504	2,755	2,193	-18.7%	-2.1%	1.7%	10.7%	9.7%
Marting	48	WV	Fayette	2,773	2,654	2,251	-9.4%	-2.0%	1.7%	14.4%	17.6%
Opal	49	WV	Nicholas	1,594	1,637	1,501	-2.9%	-1.0%	1.7%	11.5%	33.2%
Blackburn Bottom	50	KY	Pike	1,233	1,309	1,137	-3.9%	-5.2%	8.9%	16.6%	16.1%

Is surface mining moving closer to communities?

Prior to 1999, the proximity of surface mining to communities was trending toward greater distances. Our analysis shows a very slight trend of encroachment on communities in recent years (Table 1 and Figure 2).

Understanding these trends requires a brief history of surface coal mining in Central Appalachia. Before the 1970s, Appalachian surface mining was dominated by small-scale "contour" mining that involved digging into the side of a mountain to access a small portion of a single seam of coal, and rarely crossed over a ridgeline. Because of the small-scale of these operations, they tended to be concentrated near existing infrastructure (i.e., loadouts where coal is loaded onto trains), which, in turn, tend to be located in close proximity to, if not directly in, communities.



Initial development of large mountaintop removal mines in the 1980s and early 1990s, however, tended to move surface mining further away from communities, as the large scale of operations justified investments in new infrastructure like roads, rail spurs and beltlines to transport coal longer distances to preparation plants and loadouts. It has been suggested by many local residents who oppose mountaintop removal that, by the late 1990s when the coal that was easiest to access was depleted, mountaintop removal mines began expanding closer to communities.

The results of this analysis in part support that contention, as surface mining was, on average, closer to communities in 2014 than it was in 1999, despite the fact that surface coal mining has declined by more than 50% since that time (Table 1). As with the composition of the at-risk community list, however, the trends in West Virginia are very different from those in Kentucky. On average, surface mining in West Virginia has moved 320 meters (12%) closer to communities over the past 15 years, whereas in Kentucky it has moved further away.

As before, this can likely be explained by the different market forces that underlie the recent increase in West Virginia metallurgical coal production and the decline in eastern Kentucky thermal coal production. An analysis of trends in just Mercer, McDowell, Wyoming and Webster counties of West Virginia lends strong support to the theory that expansion of metallurgical coal production is driving the trends in that state. On average, surface mining in those four counties has moved 774 meters (26%) closer to communities since 1999.

Demographic and socioeconomic trends

A comparison of recent demographic and economic trends between at-risk and no-mining communities makes clear that communities near mining are suffering from their proximity to these operations. While most Appalachian coal counties have declined in population since 1990, the census block groups around the at-risk communities have been declining at a much faster rate. On average, these communities have been losing population at a rate of more than 10% per decade since 1990—more than twice the rate of decline in nearby communities with no surface mining (Table 3).

Similarly, poverty rates for the at-risk communities in 2013 were slightly higher than they were in the no-mining communities, although poverty rates in both populations increased substantially since 1990 (see Table 3). Interestingly, the poverty rates between the at-risk and no-mining communities were almost identical in 1990, lending support to the theory that close proximity of mining is a contributing factor to increasing poverty rates in coal mining communities.

Table 3: Comparison of Population Changes and Poverty Rates Between the At-Risk Communities and Communities in the Same Counties Where No Surface Mining Has Occcurred

	At-Risk Communities	Communities with No Mining Nearby
Number of Communities	**50**	**74**
Population Statistics, 1990-2010		
Communities where population increased	**3 (6%)**	**18 (24%)**
Communities where population decreased	**47 (94%)**	**56 (76%)**
Average rate of Change per Decade	**-10.4%**	**-4.5%**
Poverty Statistics		
Average Poverty Rate in 2000	**18.3%**	**18.0%**
Average Poverty Rate in 2013	**24.4%**	**22.5%**

Conclusions

As coal mine production has declined sharply across Central Appalachia over the past decade, the production from surface mines has declined even faster, falling by close to 60% since 2008. While the overall production decline is driven by falling demand resulting from competition from natural gas and, increasingly, retirement of aging coal-fired power plants that depend on low-sulfur Central Appalachian coal, the shift toward a greater ratio of underground-to-surface mine production provides some evidence that the actions of federal agencies to reduce the damage caused by mountaintop removal mining has had an effect.

Yet, the risk faced by many communities from encroachment of mountaintop removal mining is growing, not declining, as this report makes clear. Moreover, the trend toward greater reliance on mountaintop removal for metallurgical coal production in some counties in Virginia and West Virginia and the importance of "coal synergy" highway projects in driving new mountaintop removal mining mean that these threats are likely to continue to grow in certain areas, despite declining demand for coal.

For regulators and anyone concerned about the environmental damage and human health consequences associated with mountaintop removal coal mining, it would be much simpler if this controversial problem just quietly went away as the aging power plants that depend on low-sulfur Central Appalachian coal retire. It's apparent that that is a false hope. Protecting communities and water quality from the impacts of mountaintop removal mining will still require far more aggressive measures than those that have been taken to date.

The decline in Central Appalachian coal production and concomitant increase in unemployed coal miners certainly justifies the recent shift in focus by the White House, state elected officials and many community advocacy organizations toward economic transition, particularly in eastern Kentucky where the domestic market for thermal coal has all but collapsed. But allowing mountaintop removal mining to continue is doing communities in the region no favor.

If mountaintop removal mines continue to expand, even at the slower pace of recent years, the population declines and increased poverty rates clearly associated with the mines' encroachment on communities threaten to undermine any progress toward economic revitalization in traditional coal mining areas of Appalachia.

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