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A conceptual model for integrating community health in managing remediation of West Virginia and central Appalachia's abandoned coal mines

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Abstract

The decline of the coal industry and the associated ongoing bankruptcies of large coal companies create a serious concern that surface coal mining states may inherit large-scale liabilities for unremediated coal mines. These states may also have limited funding to remediate all abandoned mines at once, requiring prioritization of the cleanup of coal mines. In West Virginia and central Appalachia, these coal mines are often located in areas ranked as having poor public health outcomes, poor health factors, and extremely low-socioeconomic status. Epidemiological research has associated poor health outcomes for residents located near coal mining. Coal mine remediation presents an opportunity to improve the environment of the coalfields and perhaps improve health in communities surrounded by coal mines, as well as those downstream of polluted mining water discharges. By examining factors uniquely associated with the central Appalachia and West Virginia coalfields, a conceptual model that demonstrates how community health can be considered as a factor for prioritization of resources in remediation of abandoned coal mines was developed. The model utilizes health concerns specific to West Virginia and central Appalachia, relies on data already collected by the state, and identifies areas of the state with vulnerable health populations. Because this conceptual model is tailored to specific state concerns and existing state data, this model would be cost-effective as an off-the-shelf model for state agencies, and it could also be prospectively used when permitting new pollutant sources, such as new coal mines or natural gas drill sites and pipelines.

Introduction

Remediation background

Due to the significant and projected continuing declines in the central Appalachian coal industry, serious concerns exist as to the risk of large-scale forfeitures of unremediated coal mines. The West Virginia Department of Environmental Protection (WVDEP) estimated in 2016 that coal operators in various stages of bankruptcy held over 900 mine site permits. Although some of those operators have been able to emerge from bankruptcy under reorganization for the time being, other similar coal operators have failed after reorganization, leaving the long-term success of existing coal operators questionable. Other coal mine operators have since declared that they are at risk for bankruptcy as well. As a result, tens of thousands of coal mining acres (much of which is unremediated in various stages of mining) could be at risk to become abandoned in the near future.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) was designed to prevent the abandonment of unremediated surface mines by requiring financial assurance from mine operators to ensure cleanup of all mines. However, full site-specific financial assurance for every coal mine does not exist, presenting the risk that if the coal industry declines into large-scale bankruptcies, these states will not have sufficient funding or resources to remediate all of these coal mining sites (Surber and Simonton 2017). WVDEP currently funds remediation at 192 post-SMCRA forfeited mines with water pollution discharges. Funds to remediate sites in excess of the bond come from industry taxes collected on each ton of coal mined. As mining continues to decline, there will be less funding available for remediation needs, including those that require expensive water pollution treatment.

Because of existing cost deficits, state-financed remediation requires prioritization of resources. WV law requires that WVDEP maintain a priority listing of forfeited sites based upon (1) the severity of the water discharges, (2) the quality of the receiving stream, (3) the effects on downstream water users, and (4) "other factors" determined to affect the priority ranking.[Footnote1] Community public health is not currently considered. Health is considered in terms of immediate safety needs (such as landslides), but not chronic or acute illness found in vulnerable populations that live in communities surrounded by unremediated mines.

Poor public health is one of the unfortunate hallmarks of the WV and central Appalachia coalfields. Epidemiological research has associated coalfield residents with poor health outcomes compared to other areas of the country and other non-mining central Appalachian residents (Hendryx et al. 2007; Ahern and Hendryx 2008; Zullig and Hendryx 2010, 2011; Hendryx and Luo 2014). Biological research has identified air and water sources that may serve as physical pathways from which surface coal mining may cause or contribute to disease outcomes (Simonton and Spears 2007; Hitt and Hendryx 2010; Knuckles et al. 2013; Simonton and King 2013; Kurth et al. 2014; Luanpitpong et al. 2014; Kurth et al. 2015). Regardless of the causes or associations, it is indisputable that WV's coalfield regions have extremely poor health outcomes.

Coal mine remediation presents an excellent opportunity to improve the environment of the coalfields and perhaps improve—or at the very least not allow the unremediated mines to worsen—the health in communities surrounded by coal mines and downstream of polluted mining water discharges. WV and other surface mining states currently prioritize limited funding to remediate abandoned mines, and the public health of communities surrounded by coal mines should be considered as well. As such, WVDEP should consider the cumulative impacts on community health under its legal requirements to consider "other factors" when ranking the abandoned mines for remediation priority.

Prioritization of remediation

States have decades of experience in remediating abandoned coal mines, both under pre-SMCRA and post-SMCRA law.[Footnote2] WVDEP currently prioritizes remediation sites based on 3 order levels of priority. The highest priority sites are those that pose "extreme danger" to public health, safety, general welfare, and property. Public health is currently considered as emergency health and safety conditions or dangers. WVDEP does not consider chronic public health concerns, such as those raised and addressed by the epidemiological and biological research. Unremediated mines pose significant concerns for environmental pollution sources that may impact community health through discharges of contaminated water, both as surface and groundwater sources, as well as through emergency safety conditions or dangers. Second priority sites are those that pose a threat to public health, safety, welfare, and property values. Examples of this are sites with a high potential for landslides, dangerous highwalls, derelict buildings or other structures, flooding, high loading rates of acid mine drainage, and discharges into particularly valuable water resources. Third priority sites have four subgroups: sites that (1) cause or have a high potential for causing off-site environmental damage to the land and water resources, (2) are cost-effective to be "cluster" projects—those in close geographic proximity to first or second priority sites, (3) are near high-use public recreation areas and major thoroughfares, and (4) are nearly fully reclaimed and only require monitoring of vegetation or other parameters.

Public health is not considered as public health experts would consider “community public health,” measured through such metrics as vulnerable health populations, including the percentage of residents who are elderly or children or the prevalence of chronic illness. Therefore, the cumulative impact of pollution on community health is one factor that could be added for consideration in WVDEP’s prioritization. As a matter of policy, WVDEP could implement cumulative impacts on community health at any level of prioritization. However, because of the regulatory language used under existing law, implementing community health at the first or second prioritizations would likely require a change to existing legislative rules, which would also require approval through the federal Office of Surface Mining and Remediation (OSMRE), which is a lengthy process.

Without amending current law, cumulative impacts on community health could be applied to factors considered in the third-order level, after the first- and second-order levels of priority, as it does not address “emergency” danger to residents. This fits within the legal framework of “other factors” required by law, so adding this factor to WVDEP’s existing prioritization should not require any changes to existing law and is consistent with the purposes of the state and federal SMCRA program.

Community concerns

Many coalfields West Virginians live in close proximity to underground and surface coal mines, coal preparation plants, coal diesel truck traffic routes, slurry impoundments, surface blasting, underground slurry injection, and valley fills associated with the mountaintop removal mining (MTR) method of mining—all of which are potential pollution sources. Community residents surrounded by these pollution sources are often low-income, have high unemployment, and are living with poor health conditions (Freudenburg and Wilson 2002; Woods and Gordon 2011; Perdue and Pavela 2012; Greenberg 2017). High or increased environmental law violations, including public drinking water violations, have also been found in these areas (Stretesky and Lynch 2011; Hendryx et al. 2012; Surber 2013).

These community demographic issues combine to raise environmental justice concerns. WVDEP’s existing 2003 Environmental Equity Policy states that WVDEP will ensure that no segment of the population bears “a disproportionate share of the risks and consequences of environmental pollution” because of its status as low-income (defined as any community with an estimated poverty population greater than 19.3%) or minority (defined as an estimated minority population greater than 5%) community (2003). Further, this policy commits WVDEP to incorporating environmental equity into policy making and regulatory activities

The presence of these concerns indicates a need to address cumulative impacts on residents. Cumulative impacts not only consider combined exposures and public health and environmental effects but also take into account sensitive populations and socioeconomic factors (2016). Cumulative impacts on communities have been substantively addressed in and applied to policy and regulatory actions in California, but have not been explored in or applied to WV or central Appalachia.

In the absence of data on the public health impacts of multiple pollutants on low-socioeconomic communities, an understanding of cumulative impacts is a way to identify whether concerns exist that certain populations—particularly vulnerable health populations—disproportionately bear the burden of pollution. Vulnerable health populations are those that have both poor health outcomes and poor health factors. Vulnerability impacts the ability of individuals to respond or recover from stressors—particularly pollution—not as well as other individuals (DeFur et al. 2007). For example, not only can pollution cause health conditions, but also existing health conditions can intensify the impacts of pollution on health, making some individuals more sensitive to pollution (Payne-Sturges and Gee 2006). With the poor health outcomes, poor health factors, and low-socioeconomic status in the coalfields, combined with the existence of pollution from coal mining, cumulative impacts on this population likely exist.

Overview of cumulative impacts methods

A cumulative impacts model is supported by a scientific foundation on the relationships between pollution and negative health impacts. Disparities in the severity of pollution exposures and the quality of environmental conditions exist between communities, and hotspots of poor health, degraded environments, and poverty can often be identified. The goal of this assessment method is not to provide quantitative measurements of pollution or the extent of public health disparities between communities. Instead, it serves as a method for distinguishing the more impacted communities from others in order to prioritize mine cleanups, using cumulative impacts as one factor (Alexeeff et al. 2012). The goal is to identify communities that warrant priority consideration in reclaiming abandoned mines particularly because time, resources, and finances are limited. It provides a tool to address environmental justice using a practical application of both the existing legal duties and the financial resources of the state.

Methodology

Tailored conceptual model

This community health assessment conceptual model for coal mine remediation is based on the CalEnviroScreen, a screening model designed to identify areas that face multiple pollution burdens so that funding and programs can be directed to improve public health (Alexeeff et al. 2012; Meehan August et al. 2012, 2016). It is also modeled from other screening methods developed to address cumulative impacts on California communities (Morello-Frosch et al. 2002; Soobader et al. 2006; DeFur et al. 2007; Dunn and Alexeeff 2010; Sadd et al. 2011). However, this model is tailored to the unique characteristics and pollution sources in WV and may fit other coal mining regions of central Appalachia. Simplicity and transparency are paramount so that WVDEP and others can consider community health when prioritizing funding in the absence of quantitative biological exposure in individual communities. This model achieves this by clearly identifying the role, weight, and sources of the data. Governmental data collected for purposes unrelated to this model gives the data transparency and reliability that the data are not manipulated for purposes of remediating one mine over another. Moreover, this factor as proposed under existing state law is only utilized after sites with emergency exposures or safety risks have been prioritized, so that there is no concern that community health considerations interfere with remediating emergency conditions.

This model primarily addresses cumulative impacts for the purposes of the legally required coal mine remediation under SMCRA, but could be revised to address a broader range of community impacts from other pollution sources or designed to be used when permitting new sources, such as future coal mines or in shale gas exploration. A model such as this would be extremely useful when prospectively used to prevent or reduce cumulative impacts.

Community health scoring

This model uses a scoring system to compare cumulative impacts among abandoned mine site communities. The benefit of this scoring method is that it compares the communities surrounding mines on the priority list relative to other unremediated mining communities. It does not require an analysis of every county or ranking across all mine sites or pollution sources. The mining agency would use its existing factors to identify the mines requiring prioritization and then identify the communities by zip-code(s) and county(-ies) in and surrounding the mine. It could also be used to identify vulnerable health communities with multiple unremediated mines in order to consider remediate clusters of mines for economic and resource efficiency.

WVDEP would first identify the priority sites in categories 1 and 2 and apply those considerations. WVDEP would then list the mines in the third category that need reclamation. It would identify the counties and zip-codes where the unremediated mines are located, using the SMCRA and water permit databases. It would apply this model to these sites as a screening method to identify the communities that would benefit most from remediation because they have been cumulatively impacted by pollution burdens and have vulnerable health populations.

Similar to the California model, this assessment combines components related to the pollution burden and the population characteristics of the community (Alexeeff et al. 2012) (See Fig. 1).

Fig. 1

Cumulative impacts on community health score composition

The scores of the pollution burden and the population characteristics are multiplied to form a final score, reflecting the body of literature from human health studies finding that population characteristics can multiplicatively modify the body's response to pollution (Alexeeff et al. 2012). It is consistent with risk assessment where sensitivity factors are separated out because population characteristics can create sensitivity factors that may make pollution impacts on health intensified, resulting in vulnerabilities in the population (DeFur et al. 2007; Meehan August et al. 2012). In particular, existing poor health conditions—such as those found in coal mining communities—may lead to increased sensitivity to pollution (Payne-Sturges and Gee 2006; Payne-Sturges et al. 2006). Thus, it should be a goal of remediation to reduce pollution in communities with existing poor health.

The pollution burden score is composed of two separate components: pollution exposures and environmental conditions (see Fig. 1). Unlike the California model, this model incorporates the public health effects with the population characteristics using the rankings model established by the Robert Wood Johnson Foundation (RWJF) County Health Rankings (University of Wisconsin Population Health Institute) rather than separating these concepts. The pollution exposures are identified as potential sources of pollutant contacts with humans, which may constitute a risk for human health impairment.

The vulnerable health population score is composed of two separate components: health outcomes and health factors (Fig. 1). This reflects the analysis for county health rankings conducted by the RWJF. The vulnerable health population score addresses various characteristics and outcomes that indicate an increased risk of sensitivity to pollutant exposures.

Results

Cumulative impacts score composition model

To calculate the relative cumulative impact score, geographic areas are scored by their comparative values for each factor (Table 1).

Table 1 West Virginia unreclaimed coal mines community health assessment

Analyses can be conducted on both county and zip-code levels, depending on how data are collected by the data sources. Each factor is ranked on a scale of 1–10. The factor scores are then averaged to arrive at the component score and added to arrive at the pollution burden and vulnerable health population scores. These scores are then multiplied to arrive at a cumulative impact score. The cumulative impact scores can identify communities impacted by multiple environmental and social stressors that can place individuals at risk for negative health outcomes.

Exposures

This model identifies 5 exposures potentially impacting community health in WV and central Appalachia: (1) hazardous chemical sources, (2) hazardous land sources, (3) underground leaks, (4) drinking water pollution, and (5) diesel air emissions. The hazardous chemical sources are measured by the pounds of toxic releases from facilities, using the Toxic Release Inventory (TRI) data source. Facilities that meet threshold criteria and emit chemicals to air or water or place chemicals in land disposal must report the pounds of toxics released. The TRI database lists the hazard-weighted pounds to zip-codes surrounding the facility. The model would rank these sites using a range of scores and then use a weighted sum of the all TRI toxic pounds within each geographic area on the priority site listing to calculate the score.

The existence of Superfund, Brownfields, voluntary remediation, and WVDEP Landfill Closure Assistance (non-composite lined landfills) sites indicate environmental degradations that pose risks to human health from the migration of hazardous substances. The model would rank these sites as pending or active and then use a weighted sum of the all facilities within each geographic area on the priority site listing to calculate the score.

The existence of leaking underground pollution sources place groundwater sources at risk and present other human health risks. In the recent past, underground coal mine slurry injection sites have polluted and continue to pollute residential water wells. The model would identify the leaking underground storage tank (LUST) and leaking underground injection sites and then use a weighted sum of the all facilities within each geographic area on the priority site listing to calculate the score.

Drinking water pollution presents a direct threat to public health and has been found to exist more frequently in the coalfields (particularly in MTR areas) than other areas of WV (Hendryx et al. 2012). Therefore, it is an important measurement related specifically to mining remediation. Drinking water pollution would be measured by the existence of drinking water violations under the Safe Drinking Water Act (SDWA). The model would utilize a severity range of violations and then use a weighted sum of the all areas with SDWA violations within each geographic area on the priority site listing to calculate the score.

Particulate matter traffic air pollution, particularly ultrafine particulate matter (UFPM), has been associated with extremely poor health outcomes, including cardiovascular (Rich et al. 2005; Lepeule et al. 2012), neurological (Calderon-Garciduenas et al. 2013a, b; Kioumourtzoglou et al. 2016), and respiratory (Young et al. 2014) dysfunctions, as well as increased mortality (Lepeule et al. 2012). Within WV, the Coal Resource Transportation System (CRTS) allows coal trucks to exceed the typical limit of 80,000 lb to up to 120,000 lb (plus a 5% variance) of coal trucks in order to reduce coal shipment costs by reducing the number of truck trips. KY has a similar coal truck system. However, there may be pollution impacts—heavier diesel trucks may emit more pollution than lighter diesel trucks (Gajendran and Clark 2003). In fact, researchers found increased particulate matter emissions at 3 times above the federal standard for particulate matter along a coal truck route in a southwest Virginia community on days when coal truck traffic occurred (Aneja et al. 2012, 2017).

Coal truck routes may exist along residential areas with steep narrow valley hollows where air pollution from trucks can become concentrated (Aneja et al. 2012, 2017). Therefore, one measurement of air pollution exposure could be the number of miles or annual coal truck trips or tons in the individual county. The West Virginia Public Service Commission (WVPSC) collects data on the number of trips and total tons on truck traffic for specific routes, as well as at the county level. The model would utilize range values as a measurement for the exposed population and then use a weighted sum within each geographic area on the priority site listing to calculate the score.

Environmental conditions

The model identifies eight environmental conditions of environmental degradation that pose threats to public health but do not fall under the priority listing as “emergency” conditions: (1) legacy abandoned mines, (2) SMCRA forfeited mines, (3) impaired streams, (4) valley fills from surface coal mines, (5) coal waste underground injection, and (6) coal slurry impoundments. Both the legacy abandoned mines (administered by the WVDEP Office of Abandoned Mine Lands and Reclamation) and the SMCRA forfeited mines (administered by the WVDEP Division of Mining and Reclamation) would be measured by the amount of acres of unremediated land. WVDEP should take into account the existing sites on the SMCRA forfeiture list, including those in active and inactive remediation. Unremediated mines (both abandoned and forfeited) are a concern because many of the communities in the coalfields may be surrounded by multiple unremediated surface mine sites. The model would utilize a range of acres and then use a weighted sum within each geographic area on the priority site listing to calculate the score.

The model places impaired streams under the component of environmental conditions rather than exposures because impaired streams do not necessarily implicate direct risks to human health, although at least one epidemiological study has found an association between the impaired ecological integrity of streams and human cancer mortality (Hitt and Hendryx 2010). However, a stream may be impaired due to impairment for aquatic life, which does not necessarily imply a human health risk. Regardless, impaired streams are a serious source of environmental degradation. The model would utilize a range of the length of impaired streams and then use a weighted sum within each geographic area on the priority site listing to calculate the score.

Research has identified a multitude of environmental degradation impacts from the practice of coal mining valley fill operations, where mountain valley hollows are filled with the overburden waste from coal mining that contains a number of pollutants (Bernhardt and Palmer 2011; Hopkins et al. 2013; Vengosh et al. 2013). Surface water then percolates through the overburden waste in the valley fill, picking up pollutants, and carrying these pollutants into surface and groundwater below the valley fill. Therefore, valley fills are a potential environmental degradation source in the coalfields. The model would utilize a range of the number or size of these valley fills and then use a weighted sum within each geographic area on the priority site listing to calculate the score.

Throughout the coalfields, mine operators utilized previously mined underground mines or other underground sites for coal slurry waste disposal using underground injection. Coal slurry is a waste by-product from the coal production process and contains pollutants that are harmful to the environment and public health. WV courts have found that leaks from a number of these sites impacted private drinking water sources. Even when these sites are not currently found to be leaking, these sites pose a risk to the environment and are potential sources of environmental degradation. The model would utilize a range of the gallons of injected slurry and then use a weighted sum within each geographic area on the priority site listing to calculate the score.

Coal operators often use large-scale surface impoundments to dispose of coal slurry waste. Research has found that these impoundments are most often located in areas with high poverty and unemployment, as well as most often in areas that also have high levels of past mining disturbances (Greenberg 2017). These impoundments pose risks of failure, which could result in millions of gallons of slurry pollution. Coal slurry waste is also a concern because research has identified markers of coal slurry in residential wells in areas of WV and KY, indicating leaks from slurry disposal sites (Wigginton et al. 2008). The model would utilize a range of the gallons of coal slurry waste and then use a weighted sum within each geographic area on the priority site listing to calculate the score.

Health outcomes

The model identifies six health outcomes potentially impacting community health and a specific concern to WV and central Appalachia: (1) overall county health indicator, (2) cancer, (3) cardiovascular disease, (4) infant mortality and birth defects, (5) diabetes, and (6) chronic obstructive pulmonary disease (COPD)/asthma. The RWJF publishes annual rankings for all states, broken down by county, for the entire USA for both health outcomes and health factors. It compares characteristics of each county against other counties within that same state and assigns a rank to each county, relative to the significance of the factors, as broken down by the RWJF methodology section. The formulas for calculating the scores were not designed for any specific purpose other than to assess health in the USA. Therefore, it can be relied upon as an unbiased, transparent, and appropriate way to identify vulnerable health populations for the purposes of this model.

The health outcomes ranking score uses (1) length of life and (2) quality of life as measurements, and each component accounts for 50% of the total score. Length of life is calculated as the years of potential life lost using data from the National Center for Health Statistics. The quality of life is calculated from (1) adult reported health status—10% of score, (2) adult reported average number of physically unhealthy days—10%, (3) adult reported average number of mentally unhealthy days—10%, and (4) percentage of live births with low birthweight—20%. These data are collected from the federal Behavioral Risk Factor Surveillance System (BRFSS), which is a standard data source in public health research.

Because the RWJF rankings are uniform across the country, this model separates out certain characteristics of unique concern for WV and central Appalachia that are not considered in the RWJF ranking. Due to the existing epidemiological data regarding health impacts that are elevated in the coalfields, this model also includes (1) lifetime cancer risk, (2) cardiovascular disease, (3) infant mortality and birth defects, (4) diabetes, and (5) COPD/asthma (for adults and children). The WV Division of Health and Human Resources (WVDHHR) through its Vital Statistics department collects and publishes this data. The model would utilize a comparative score for each geographic area on the priority site listing.

Health factors

The model identifies eight health factors impacting community health and contributing to the poor health specifically found in WV and central Appalachia: (1) overall county health factors, (2) extreme poverty, (3) WVDEP-defined low-income community, (4) WVDEP minority community, (5) presence of children, (6) presence of elderly, and (7) sensitive land uses. For the overall county health factors, the model uses the RJWF health factors ranking score. It is composed of (1) health behaviors—30% of score, (2) clinical care—20%, (3) social and economic—40%, and (4) physical environment—10%.

The RWJF health behaviors score is composed of measurements of tobacco use, diet and exercise, alcohol and drug use, and sexual activity risks (data relating to teen pregnancies and total sexually transmitted infections) using federal databases. The clinical care score is based on access to care (using ratios of health care providers and resident health insurance status) and quality of care (using preventable hospital stays, diabetic monitoring tests, and mammography screening). The social and economic score uses (1) high school graduation and post-secondary education measures, (2) unemployment levels, (3) children in poverty and income inequality, (4) single-parent households, (5) membership in social associations, (6) violent crimes, and (7) injury deaths. The physical environment score is based on (1) water and air quality and (2) housing and transit. Water and air quality is based upon $PM_{2.5}$ air pollution data and drinking water violations. The air quality score is worth 5%, and the drinking water violations score is worth 2.5% of the total overall RJWF health factors score.

The model develops a measurement of the environment specifically tailored to the environmental concerns associated with the coalfields of WV and central Appalachia in order to address priorities for the remediation of coal mines. Because the RWJF rankings are uniform across the country, this model separates out certain characteristics of concern for WV and central Appalachia that are not considered in the RWJF ranking. This model includes extreme poverty, measured by residents living 2 times below the national poverty level. Poverty is a concern for environmental justice because extreme poverty can make populations less financially able to cope with the impacts from air and water pollution. It is also a specific concern because evidence exists that coal mining and impoundments are more likely to be located in low-income areas (Greenberg 2017).

Using the definitions in WVDEP Environmental Equity Policy, the model includes the presence of low-income and minority communities. Similar to the CalEnviroScreen, this model included indicators for sensitive populations by using separate scores for the percentages of children (under the age of 5) and the elderly (over the age of 65). These age groups are indicators of sensitive populations based on toxicological and epidemiological evidence that has shown these populations are more susceptible to pollution (Meehan August et al. 2012). The model also includes sensitive land uses such as schools, housing, hospitals, and other health care facilities because there have been concerns raised in WV about impoundments and mines being located directly above elementary schools and homes. Private well location should also be considered in calculating the score due to concerns for migration of pollutants.

Other considerations

In each component, the model identifies a factor for scores of "other." This other factor gives WVDEP the ability to use specialized knowledge of particular concerns in the community to impact the score. For example, WVDEP should incorporate a comment period in order to allow residents to voice specific concerns regarding remediation priorities. A public hearing could also be held so that the communities can become aware of the prioritization process and the proposed cleanup timelines. WVDEP should adopt a timeline for annual finalization of the priority list and designate that all proposed funding projects constitute a final agency action so that residents have legal recourse to the expenditure of state funds on mine remediation. Agencies should involve communities as much as possible in the decision-making process.

Conclusions with policy recommendations

To date, WV has not addressed the public health concerns raised in the epidemiological and biological research associated with coal mining in WV and central Appalachia. Because of the limited resources available to the state due to the potential under-bonding and taxation in the coal bonding system, the high risk of abandoned coal mines, and the declining state economy, it is vital that WV develops a strong model to prioritize mine remediation. Given the poor health and limited resources of many of these coal mining communities, community health should be considered as one factor. Coal mine remediation may be one way to improve public health using existing requirements and funding under law. This model is particularly relevant because many of the pollution risks identified and the poor health outcomes have been specifically associated with coal mining and coal mining methods used in WV and central Appalachia. By utilizing this model as one factor in ranking the priority of coal mine remediation, WV can work to redress some of the issues raised from decades of heavy coal mine permitting by the state, particularly the MTR form of surface coal mining.

One significant attribute of this model is that it does not require WVDEP to gather new data. It uses data already collected and maintained (and required by law in most cases) by WVDEP or another state agency. The model requires only estimations and ranges of data to estimate the rankings of the priority list, so application of the model should be flexible. Other states may need to tailor the model to existing data that they collect and the unique characteristics of vulnerable health populations.

Environmental impacts from multiple sources create complex issues that existing science may not fully understand. This prioritization method does not attempt to arrive at a definitive, quantitative cumulative risk analysis. Instead, it takes the existing understanding and concerns of the stressors on central Appalachian communities to try to assess cumulative impacts. It presents a starting place to improve community conditions using existing legal avenues, without relying on legislative or federal implementation. WVDEP can use this method to prioritize cleanups of abandoned mine sites to minimize further stressors on these communities.

WVDEP and other coal mine permitting agencies should use community health, particularly in vulnerable health populations, as a way to address public health, as well as the potential issues of environmental justice. As the agencies that permitted these coal mine sites and constructed the funding systems meant to protect its residents, these agencies should consider vulnerable health communities when cleaning up these same now-abandoned coal mines.

Notes

1. 1.

Codified in W.Va. Code of Regulations 38-2–12.5.b.

2. 2.

Remediation funding for pre-SMCRA sites is funded through a different mechanism than post-SMCRA sites.

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