Health, Mining, and Justice in Appalachia: A Rawlsian Approach

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Neda Rehan

Spring 2024

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

William J Davis, Department of Engineering and Society

Introduction

In March 2021, Lexington Coal, a Kentucky coal firm, was found to be releasing unsafe and illegal levels of ionic pollutants into waterways. Despite the court demanding a remediation plan to be submitted by the firm, Lexington Coal refused to comply and was found in contempt by the court in 2022, 2023, and 2024 ("Kentucky Coal Firm Held in Contempt Again over West Virginia Mine Pollution," 2024). District Judge Robert C. Chambers wrote in his 2023 opinion that Lexington Coal "appears to be looking for shortcuts and simply hoping disaster does not result" (*West Virginia Highlands Conservancy, Appalachian Voices, and Serria Club v Lexington Coal Company, LLC*, 2023, p. 12). Despite the coal firm showing a consistent lack of regard for environmental protections, the West Virginia Department of Environmental Protection (DEP) renewed Lexington Coal's permit to operate in the state (Tony, 2024).

In this paper, I argue that rural Appalachians bear the burden of environmental damage caused by industrial activities, leading to adverse health outcomes including higher rate of food allergy among other health problems. This work will explain the development of allergy as a potential health consequence of pollution from mining as well as well-established health risks faced by mining communities. Then, this work describes the current political and economic landscape of Appalachia to reveal injustices in environmental and health risk. Using John Rawls' *A Theory of Justice* and Environmental Justice Theory, I analyze the current structures and provide recommendations on restoring justice to the region.

The origins of allergy

The development of asthma, allergic rhinitis, atopic dermatitis, and food allergy is driven by allergic inflammation (Sahiner et al., 2022, pp. 1-24). The inflammation is caused by the activation of an antibody called immunoglobulin E (IgE), which can bind to receptors on immune cells (Godwin et al., 2025). Once bound to these receptors, IgE activates immune cells, causing inflammation (Sahiner et al., 2022, pp. 1-24). The relationship between IgE and allergy is so strong that IgE levels in blood can be measured to inform food allergy diagnosis (Anvari et al., 2019, p. 244).

IgE-mediated allergic diseases generate inflammation through the adaptive immune system, a memory-based pathway of the immune system. The immune system recognizes proteins called *antigens*; in a healthy person, the only antigens that will activate the immune system are from objects or pathogens that will harm the patient. Once the immune system has been exposed to a particular antigen, it will commit the antigen to memory via the adaptive immune system, forming an IgE specific to the antigen. Once the body is exposed to the antigen again, the adaptive immune system will respond precisely to target the intruder (Sahiner et al., 2022, pp. 1-24). Allergies develop when the immune system is over-active and mistakes a harmless antigen for a target (Ladics et al., 2014, p. 1).

Long-term exposure to air pollution in young children is associated with increased levels of inflammatory markers (He et al., 2022). Age may also affect this association; exposure to particulate matter among other pollutants during pregnancy and postpartum has been correlated to increased IgE levels of the baby (Herr et al., 2011; Zheng et al., 2023). An observational study of a powerplant in Louisville, Kentucky that

was converted from a coal-fired plant to a natural gas plant found that asthma hospitalizations and emergency room visits in nearby zip codes decreased after the conversion (Casey et al., 2020, p. 398). This finding suggests that though the direct pollutants responsible and pathway of disease may be unknown, the burning of coal can trigger allergic disease.

All allergic diseases are linked by IgE mediation. Allergic diseases expected to develop in infancy are allergic dermatitis and food allergy; there is an extremely high correlation between an infant having allergic dermatitis and the chances of developing food allergy later on to eggs, milk, or peanuts. IgE-mediated food allergy is considered a major risk factor for the development of additional allergic diseases, or *atopic march* (Yang et al., 2020, p. 2). Later in childhood, according to the atopic march, asthma and allergic rhinitis develop (p. 1). One theory for why the atopic march occurs is that a compromised skin barrier allows pathogens and environmental pollutants to enter to body (p. 3). Other theories include contributions of the gut microbiome and epigenetics (pp. 3-4).

Many unknowns remain in the field of allergy and much research is ongoing. Despite a lack of information available, there is some association between environmental pollution and inflammation, which may lead to the development of allergic disease. Likewise, there is a significant lack of information about the health effects of mining and the pollution associated with it. In fact, there is a history of doctors in the region downplaying the association between coal mining and disease; physicians in the 1960s denied that coal dust caused lung damage and that the dust was in fact beneficial to miners' health (McGinley, 2023, p. 912). This statement is not true; coal dust has been

associated with a disease commonly known as black lung among other health issues (Shriver & Bodenhamer, 2018, p. 1361). Health professionals have continued to be hesitant to establish connections between coal mining and disease. Researcher Michael Hendryx said that before he started studying the topic in 2006, “nothing had been published on the public health effects of coal mining in the United States.” Hendryx claims to be subject to harassment from lawyers and politicians, and to have witnessed supervisors in the federal government instruct agencies to stop their research on the health effects of coal mining (Hendryx, 2017). Little information is available, therefore, for health issues specific to Appalachia or coal-mining communities. Despite this lack of information, Appalachians witness these health issues with their own eyes (Hendryx, 2013, p. s79). West Virginia resident Paula Swearengin told reporters that when she moved back to West Virginia in 2000, “I noticed things weren’t right. A little girl had a rare form of bone cancer. There was a little boy, 14, dying of kidney failure” (Hawk, 2012, pp. 24-41). The large power held by the coal industry is a major contributor to this lack of public information, as outlined in future sections.

Big business has polluted Appalachia

Since at least the 1980s, environmental justice theory has championed the idea that poor people and people of color are disproportionately exposed to pollutants and other environmental hazards despite minimally contributing to or benefiting from the exploitation of natural resources (Organisation for Economic Co-operation and Development, 2024, p. 15). Indeed, Appalachia has a high proportion of poor people compared to the rest of the United States. The poverty rate in Appalachia is 14.3%, almost 2 percentage points higher than the national average of 12.5%. Most of the

poverty is concentrated in Central Appalachia, which includes Eastern Kentucky, Southwestern parts of West Virginia and Virginia, and Northern Tennessee (Srygley et al., 2024, p. 127). When comparing rural Appalachia to rural areas outside of Appalachia, rural Appalachia has greater poverty, lower educational attainment, less access to internet or computer devices, and a larger number of workers that commute outside of their county of residence for work (pp. 185-6). Appalachia, therefore, is a unique region that cannot be easily grouped in with other poor or rural parts of the United States.

Despite rural Appalachia's struggle with poverty, the land itself is rich in resources. A 1921 map by the West Virginia Geological and Economic Survey shows large deposits of coal, oil, and gas across the state (West Virginia Geological and Economic Survey et al., 1921). Coal has particularly dominated the natural resource exports of Appalachia: in 2022, Appalachia produced over 160 million tons of coal (Christiadi et al., 2023, p. 14). West Virginia alone generated almost $26 billion in revenue from mining, quarrying, and oil and gas extraction in 2022 (U.S. Census Bureau, 2024). Companies that mine, refine, and export these resources, therefore, have significant capital and influence over the natural environment in Appalachia. When these companies act in violation of environmental and worker protection laws, as seen in the case of Lexington Coal, state governments are often resistant to enforce the law in an effective way. Industry and politics in Appalachia are deeply intertwined with one another; the West Virginia Governor from 2017-2025, Jim Justice, is a coal magnate himself, and his family was found in 2021 to have almost 34,000 acres of mines across Appalachia in need of environmental cleanup (Dodson, 2021).

The combination of high poverty rates and rich natural resources has enabled the exploitation of the Appalachian environment and working class. Though there is a noticeable lack of information available about pollution in the region, the information that is published paints a harrowing picture. A 2022 study of satellite pictures found that 23,000 hectares of land, especially forest and grassland, was disturbed by unconventional oil and gas wells in Appalachian Pennsylvania, Ohio, and West Virginia (Grushecky et al., 2022, p. 869). Once these wells and mines are established, industries in the region release pollutants into the air, land, and water. Great Smoky National Park in Tennessee and North Carolina reported in 2010 that it had "some of the highest measured amounts of air pollution of any national park in the U.S." (National Park Service, 2010, p. 1); at the time, Great Smoky National Park was the only national park in the Appalachian region. In 2020, New River Gorge in West Virginia joined Great Smoky Mountain as the second national park in the Appalachian region. New River Gorge, too, has reported high levels of pollution in the park, particularly in its water systems (US National Park Service, 2021).

A common form of coal mining in Appalachia is mountaintop removal (MTR) is a controversial form of mining that uses explosives to remove the tops of mountains and reveal underground coal deposits (Hendryx, 2017). This process releases fine particulate matter into the air and toxic chemicals into the water, which harms both local ecosystems and nearby families (Dickens et al., 1989, p. 1249). MTR is often chosen as a method of coal removal because it is requires less labor than traditional underground mining (Fox, 1999, pp. 163-5). Once abandoned, however, these mines drain uncontrollably into the environment, spilling pollutants and altering the streams of the

region (Virginia and West Virginia Water Science Center, 2024). The late Judy Bonds, environmental activist, said of her childhood town that was destroyed by a MTR site: "The thing that really sticks in my mind is a six-year-old child, my grandson, standing in a stream full of dead fish" (Hattam, 2003). These bits of information paint a larger picture of general environmental disregard by coal, oil, and gas companies in the region.

Justice as Fairness

Surely the pollution and exploitation of Appalachian land is not for zero benefit. Utilitarianism assesses morality as the path to the greatest overall good (Sidgwick, n.d., p. 411). Considering the amount of coal sold and money generated from Appalachian coal, it is fair to say that Utilitarians would consider the current operations of mining in Appalachia to be ethical. U.S. Senator Shelly Capito said of regulations on the coal industry, "The result will be more job losses and more misery for American families in the coalfields and industrial towns that keep our national economy moving" (U.S. Senate Committee on Environment and Public Works, 2023). Utilitarianism does not limit the possible exploitation of Appalachian land so long as the end benefits – profit, coal production, and job creation – are maximized. In Utilitarianism, the ends justify the means. This assessment of morality cannot be accurate as it does not honor the basic notions of individual rights or justice. In the context of coal in Appalachia, Utilitarianism does not honor the rights of people to health and safety or to environmental protection. Therefore, this work will use the lenses of Environmental Justice and the Theory of Justice to interpret the current exploitation in the region.

John Rawls' *A Theory of Justice* proposes an alternative perspective to Utilitarianism with which to create a just society. Rawls writes: "justice denies that the loss of freedom

for some is made right by a greater good shared by others" (p. 3). Applied to the Appalachian stage, the wealth generated by the mining industry and the availability of its products to the rest of the world does not justify the treatment of the Appalachian people. In this setting, there is no justice. To create a truly just society in the region, Rawls argues that we must engage in the following thought experiment: rational beings in a state of nature together create the rules of their future society, a point of time called "the original position." These individuals are unaware of their future place in this society; this position is called the "veil of ignorance." Because these individuals are equals, Rawls describes justice as fairness. Rawls argues that these individuals would seek to maximize the wellbeing at the minimum level of society (*maximin*). Considering this thought experiment, can we imagine that a powerful coal magnate like Jim Justice would agree to live in a state whose Governor owned 34,000 acres of land in need of environmental cleanup if Justice did not know whether he would be the Governor or an average West Virginia resident? Assuming he would act rationally, the answer is likely no. Then how can the current reality be just?

Environmental Justice is a justice theory that focuses on land-use outcomes (Wood-Donnelly, 2023, p. 142). As defined by Bullard, "The environmental justice framework incorporates the principle of the right of all individuals to be protected from environmental degradation" (Bullard, 2000, p. 121). Incorporating this lens into Rawls' Theory of Justice demonstrates that a just society must protect all individuals from pollution, including that caused by the mining industry. As established earlier in this work, companies and local governments in Appalachia have not done enough work to minimize exposure to pollutants such as ozone, fine particulate matter, and mercury.

Thus, companies and local governments in Appalachia have not done enough work to uphold justice in the region.

A Veil of Ignorance

As discussed earlier in this work, in the present day, the Appalachian region faces significant inequities in the distribution of pollution; these inequities lead to disparities in health outcomes. In addition to these struggles, Appalachia has a unique combination of rurality and poverty that further complicates residents' access to healthcare, information, and environmental cleanup. Following in the tradition of John Rawls, this work will ask *by which system a group of rational individuals behind a veil of ignorance would choose to govern this area*?

The natural resources of Appalachia make it a prime location for mining. To be effective, a just system would need to address the mining industry while promoting fairness and equity. Including the Environmental Justice framework defined by Bullard, the system would also need to preserve residents' right to protection from environmental degradation caused by the mining industry. These two requirements of the just system require the system to be drastically different from the one that exists today. The just system, in fact, promotes the rights, health, and safety of the people over the profitability of the coal industry. As Rawls writes: "justice denies that the loss of freedom for some is made right by a greater good shared by others" (p. 3). Once profit is no longer a priority, the path towards health, safety, and environmental protection in Appalachia becomes much clearer.

The first point is to assess the type of mining that should be permitted in the region. Mountaintop removal (MTR) is far too destructive and uncontrolled of a mining process

to be allowed to occur. A report published in *Science* magazine recommended that MTR permits should not be granted until new data can show how to more effectively reduce the environmental degradation that MTR causes (Palmer et al., 2010, p.149). The primary author of the paper Margaret Palmer said "The science is so overwhelming that the only conclusion one can reach is that mountaintop mining has to be stopped" (Sheppard, 2010). In present day, MTR exists in clear violation of the previously outlined human rights to protection from environmental degradation. In a just society, therefore, MTR should be banned for so long as effective and reliable pollution mitigation methods are unknown.

Regulation of the coal industry in Appalachia has proven to be difficult due to an overwhelming unwillingness of state governments to enforce these laws, as seen in the case of Lexington Coal among other cases described earlier. Law professor Patrick McGinley writes extensively about this unwillingness, specifically in relation to the 1977 federal law the Surface Mining Control and Reclamation Act. This law ensured that "no coal mines would be abandoned by bankrupt coal companies without setting aside adequate funds to treat polluted mine discharges and fully reclaim mined lands" (McGinley, 2023, p. 918). Coal companies in Appalachia, however, did not follow this law, and it was not sufficiently enforced by state governments. McGinley writes, "hardly breaking stride, state regulators and politicians continued their long enduring, slavish obedience to coal industry interests" (p. 948). It is difficult to imagine that these state regulators and politicians would agree to this system if they were behind a veil of ignorance, not knowing whether they would be able to avoid the environmental degradation caused by coal companies. A just system, therefore, must take this

discrepancy into account and structure itself to reduce the influence of the coal industry on state politics.

Two methods of reducing this influence that should be adopted by this just system are 1) limits on political contributions from coal companies and 2) structures pursuing transparency about politicians' ties to industry. Reducing the ability of coal companies to financially back pro-coal candidates will make political elections fairer, thus in line with Rawls' definition of justice. Rawls himself writes, "when parties and elections are financed not by public funds but by private contributions, the political forum is so constrained by the wishes of the dominant interests that the basic measures needed to establish just constitutional rule are seldom properly presented" (Rawls, 1999, p. 199). To promote public awareness about this issue, transparency about politicians' campaign contributions and ties to industry should be pursued by an accountability structure independent of these politicians. Thus, the public may decide on which candidate to select based on their affiliation or lack of affiliation with industry. Assuming that the public will behave rationally, under an election with fair campaign finance laws, the people will be able to look out for their own concerns and elect officials who protect their rights, health, and safety.

Another concern of a just society should be the distribution of risk and benefit. In the current Appalachian society, people at the minimum level of society take the largest risk with the least benefit, while coal magnates make an overwhelming profit. (Billings, 2016, pp. 61-2). Donna Branham, a West Virginia resident who grew up in a coal camp, said in 2012: "I can tell you the true cost of that lump of coal. It cost my family. The only people that get rich are the people that own the coal mines" (Hawk, 2012). To promote

justice as fairness, the risks and benefits associated with mining should be distributed as equitably as possible. To do so, coal companies should be required to invest in the health of their local communities. The health impacts of MTR and other methods of mining should not be externalized to ordinary people, who are much less financially capable than the companies that profit off of their land (Billings, 2016, pp. 61-2). Of oil and gas companies in Native American Nations, lawyer Geneva Thompson writes, "having oil and gas money fund long-term investments is a type of distributive justice because it will ensure the community has access to education, health care, infrastructure, and hobs during the boom and bust of the oil and gas economy" (Thompson, 2016, p. 1841). Similarly, having coal companies in Appalachia provide revenue for state governments to invest in healthcare and education for local communities will both ensure the health and reduce the risk faced by ordinary people in the face of the coal industry.

Additionally, coal money should be used to invest in research about the extent and treatment of health effects associated with mining as well as the environmental health of the area. Currently, very little literature exists about the effects of coal mining on health and the environmental health of Appalachia (Hendryx, 2017). Rather than externalizing the cost of this research, coal money should be used by the government to fund these research inquiries and improve the general ability to mitigate health and environmental concerns associated with mining.

Conclusion

The evidence presented in this paper paints a harrowing picture of exploitation of the Appalachian people and land. Despite limited research on the public and environmental health of the region, pollution associated with the mining industry has been

demonstrated to be pervasive throughout. Coal mining and the pollution associated with it have been linked to poor health outcomes including allergic diseases such as asthma (Casey et al., 2020, p. 398). Intuitively, something is clearly wrong here. Using John Rawls' *Theory of Justice*, the 'something wrong' is illuminated as an unjust system that denies the common persons' right to protection from environmental degradation as well as their right to health and safety. Viewed through the veil of ignorance, the current structure is inacceptable. To restore justice and protect the environmental protection and health of all residents, several changes must be made, namely:

1) Ban MTR, at least until methods of improving environmental cleanup and mitigating pollutant leakage are established
2) Update campaign finance laws to limit the amount of money that the coal industry can contribute to a political candidate and improve transparency of politicians' ties to the coal industry
3) Distribute justice by using money generated by coal companies to fund healthcare and education for the region

To achieve these goals, however, leadership needs to value the individual rights of people over corporate profit. President Donald Trump told a gathering of senators from coal-producing states in April 2025, "never use the word 'coal' unless you put 'beautiful, clean' before it," before he deregulated emissions regulations on coal plants (Matthew Daly, 2025; Plumer & Rojanasakul, 2025). Let the current political state highlight the importance of demanding a just world.

References

Anvari, S., Miller, J., Yeh, C.-Y., & Davis, C. M. (2019). IgE-Mediated Food Allergy. *CLINICAL REVIEWS IN ALLERGY & IMMUNOLOGY*, *57*(2), 244–260. https://doi.org/10.1007/s12016-018-8710-3

Billings, D. B. (2016). Rethinking Class beyond Colonialism. *Journal of Appalachian Studies*, *22*(1), 57–64. https://doi.org/10.5406/jappastud.22.1.0057

Bullard, R. D. (2000). A Model Environmental Justice Framework. In *Dumping In Dixie: Race, Class, And Environmental Quality,* (3rd ed., pp. 121–125). Routledge. https://www.taylorfrancis.com/reader/read-online/6e33c3a4-ee03-44b4-a12f-ee7fa3e0e281/book/pdf?context=ubx

Casey, J. A., Su, J. G., Henneman, L. R. F., Zigler, C., Neophytou, A. M., Catalano, R., Gondalia, R., Chen, Y.-T., Kaye, L., Moyer, S. S., Combs, V., Simrall, G., Smith, T., Sublett, J., & Barrett, M. A. (2020). Improved asthma outcomes observed in the vicinity of coal power plant retirement, retrofit and conversion to natural gas. *Nature Energy*, *5*(5), 398–408. https://doi.org/10.1038/s41560-020-0600-2

Christiadi, E. B., Deskins, J., & Lego, B. (2023). *Coal Production and Employment in Appalachia*. West Virginia University. https://www.arc.gov/wp-content/uploads/2023/09/Coal-Production-and-Employment-in-Appalachia-2023.pdf

Dickens, P., Minear, R., & Tschantz, B. (1989). Hydrologic Alteration of Mountain Watersheds from Surface Mining. *JOURNAL WATER POLLUTION CONTROL FEDERATION*, *61*(7), 1249–1260.

Dodson, W. (2021, November 18). Cleaning up mines owned by Gov. Justice and his family would create hundreds of jobs. *Appalachian Voices*. https://appvoices.org/2021/11/18/mine-reclamation-jim-justice-jobs/

Fox, J. (1999). MOUNTAINTOP REMOVAL IN WEST VIRGINIA: An Environmental Sacrifice Zone. *Organization & Environment*, *12*(2), 163–183.

Godwin, L., Sinawe, H., & Crane, J. S. (2025). Biochemistry, Immunoglobulin E. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK541058/

Grushecky, S. T., Harris, K. J., Strager, M. P., Wang, J., & Mesa, A. N. (2022). Land Cover Change Associated with Unconventional Oil and Gas Development in the Appalachian Region. *Environmental Management*, *70*(5), 869–880. https://doi.org/10.1007/s00267-022-01702-y

Hattam, J. (2003, November 1). Julia Bonds: Dethroning King Coal | Sierra Club. *Sierra*. https://www.sierraclub.org/sierra/2003-6-november-december/treehugger/julia-bonds-dethroning-king-coal

Hawk, S. (2012). The Cost of Coal. (Cover story). *Sierra*, *97*(6), 24–41.

He, S., Klevebro, S., Baldanzi, G., Pershagen, G., Lundberg, B., Eneroth, K., Hedman, A. M., Andolf, E., Almqvist, C., Bottai, M., Melén, E., & Gruzieva, O. (2022). Ambient air pollution and inflammation-related proteins during early childhood. *Environmental Research*, *215*(Pt 2), 114364. https://doi.org/10.1016/j.envres.2022.114364

Hendryx, M. (2013). Personal and family health in rural areas of Kentucky with and without mountaintop coal mining. *The Journal of Rural Health: Official Journal*

of the American Rural Health Association and the National Rural Health Care Association, *29 Suppl 1*, s79-88. https://doi.org/10.1111/jrh.12016

Hendryx, M. (Director). (2017, November). *The shocking danger of mountaintop removal—And why it must end* [Video recording]. TED. https://www.ted.com/talks/michael_hendryx_the_shocking_danger_of_mountaintop_removal_and_why_it_must_end

Herr, C. E. W., Ghosh, R., Dostal, M., Skokanova, V., Ashwood, P., Lipsett, M., Joad, J. P., Pinkerton, K. E., Yap, P.-S., Frost, J. D., Sram, R., & Hertz-Picciotto, I. (2011). Exposure to air pollution in critical prenatal time windows and IgE levels in newborns. *Pediatric Allergy and Immunology*, *22*(1-Part-I), 75–84. https://doi.org/10.1111/j.1399-3038.2010.01074.x

Kentucky coal firm held in contempt again over West Virginia mine pollution. (2024, November 7). *AP News*. https://apnews.com/article/west-virginia-mine-pollution-contempt-c79a8cc73e9c70a7ac687a2b34732df5

Ladics, G. S., Fry, J., Goodman, R., Herouet-Guicheney, C., Hoffmann-Sommergruber, K., Madsen, C. B., Penninks, A., Pomés, A., Roggen, E. L., Smit, J., & Wal, J.-M. (2014). Allergic sensitization: Screening methods. *Clinical and Translational Allergy*, *4*(1), 13. https://doi.org/10.1186/2045-7022-4-13

Matthew Daly. (2025, April 15). Trump exempts nearly 70 coal plants from Biden-era rule on mercury and other toxic air pollution. *AP News*. https://apnews.com/article/trump-coal-power-plants-epa-exemptions-zeldin-2cd9f2697b5f46a88ab9882ab6fd1641

McGinley, P. (2023). With a Wink and a Nod: How Politicians, Regulators, and Corrupt Coal Companies Exploited Appalachia. *University of Richmond Law Review*, *57*(3), 899–964.

National Park Service. (2010). *Air Quality Issues* [Briefing statement]. National Park Service. https://www.nps.gov/im/aphn/air-quality.htm

Organisation for Economic Co-operation and Development. (2024). *Environmental Justice: Context, Challenges and National Approaches*. OECD Publishing. https://www.oecd.org/en/publications/environmental-justice_57616eb4-en.html

Palmer, M. A., Bernhardt, E. S., Schlesinger, W. H., Eshleman, K. N., Foufoula-Georgiou, E., Hendryx, M. S., Lemly, A. D., Likens, G. E., Loucks, O. L., Power, M. E., White, P. S., & Wilcock, P. R. (2010). Mountaintop Mining Consequences. *Science*, *327*(5962), 148–149. https://doi.org/10.1126/science.1180543

Plumer, B., & Rojanasakul, M. (2025, April 8). Trump Signs Orders Aimed at Reviving a Struggling Coal Industry. *The New York Times*. https://www.nytimes.com/2025/04/08/climate/trump-order-coal-mining.html

Rawls, J. (1999). *A Theory of Justice: Revised Edition*. Harvard University Press. https://doi.org/10.2307/j.ctvkjb25m

Sahiner, U., Adkis, M., & Akdis, C. A. (2022). Introduction to Mechanisms of Allergic Diseases. In *Allergy Essentials* (Second, pp. 1–24). Elsevier. https://www.clinicalkey.com/#!/browse/book/3-s2.0-C20180056066

Sheppard, K. (2010, January 7). Blowing Up Mountains: Not a Great Idea. *Mother Jones*. https://www.motherjones.com/politics/2010/01/blowing-mountains-not-great-idea/

Shriver, T. E., & Bodenhamer, A. (2018). The enduring legacy of black lung: Environmental health and contested illness in Appalachia. *SOCIOLOGY OF HEALTH & ILLNESS*, *40*(8), 1361–1375. https://doi.org/10.1111/1467-9566.12777

Sidgwick, H. (1907). *The Methods of Ethics* (7th ed.). Macmillan and Co., Limited. https://www.gutenberg.org/files/46743/46743-h/46743-h.htm

Srygley, S., Khairunnisa, N., & Elliot, D. (2024). *The Appalachian Region: A Data Overview from the 2018-2022 American Community Survey* (pp. 185–190). Population Reference Bureau. https://www.arc.gov/report/the-appalachian-region-a-data-overview-from-the-2018-2022-american-community-survey/

Thompson, G. E. B. (2016). The Double-Edged Sword of Sovereignty by the Barrel: How Native Nations Can Wield Environmental Justice in the Fight Against the Harms of Fracking. *UCLA Law Review*, *63*(6), 1818–1860.

Tim O. Moore, David C. Doughty, & Linsey C. Marr. (2009). Demonstration of a mobile Flux Laboratory for the Atmospheric Measurement of Emissions (FLAME) to assess emissions inventories. *Journal of Environmental Monitoring*, *11*(2), 259–268. https://doi.org/10.1039/b810798j

Tony, M. (2024, May 7). Prominent coal company's delinquent DEP fine debt exceeds $1.5 million. *Charleston Gazette-Mail*. https://archive.is/S1mWz

U.S. Census Bureau. (2024). *ECN Core Statistics Summary Statistics for the U.S., States, and Selected Geographies: 2022* [Dataset]. https://data.census.gov/table/ECNBASIC2022.EC2221BASIC?q=EC2221BASIC:%20Mining:%20Summary%20Statistics%20for%20the%20U.S.,%20States,%20and%20Selected%20Geographies:%202022&g=040XX00US54

US National Park Service. (2021, January 27). *Environmental Factors*. New River Gorge National Park & Preserve. https://www.nps.gov/neri/learn/nature/environmentalfactors.htm

U.S. Senate Committee on Environment and Public Works. (2023, February 17). *Ranking Member Capito Statement on EPA Reviving its Coal-Killing MATS Rule*. U.S. Senate Committee on Environment and Public Works. https://www.epw.senate.gov/public/index.cfm/2023/2/ranking-member-capito-statement-on-epa-reviving-its-coal-killing-mats-rule

Virginia and West Virginia Water Science Center. (2024, October 29). *Effects of Abandoned Coal Mine Drainage in the New River Gorge*. US Geological Survey. https://www.usgs.gov/centers/virginia-and-west-virginia-water-science-center/science/effects-abandoned-coal-mine

West Virginia et al. v Environmental Protection Agency et Al. (Supreme Court of the United States June 30, 2022).

West Virginia Geological and Economic Survey, White, I. C. (Israel C., Hennen, R. V. (Ray V., Reger, D. B. (David B., Tucker, R. C. (Rietz C., & A. Hoen & Co. (1921). *Map of West Virginia Showing Coal, Oil, Gas, Iron Ore and Limestone Areas* (Special Collections, Special Collections Stacks) [Map]. West Virginia Geological Survey, Lith. by A. Hoen & Co.).

West Virginia Highlands Conservancy, Appalachian Voices, and Serria Club v Lexington Coal Company, LLC, 3:19-0573 (UNITED STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF WEST VIRGINIA 2023). https://drive.google.com/file/d/1nZHVy9264YHaLt91BVmavi5MH-TpL3cE/view?usp=embed_facebook

Wood-Donnelly, C. (2023). Environmental Justice. In J. Ohlsson & S. Przybylinski (Eds.), *Theorising Justice* (1st ed., pp. 141–154). Bristol University Press. https://doi.org/10.2307/jj.7941370.16

Yang, L., Fu, J., & Zhou, Y. (2020). Research Progress in Atopic March. *Frontiers in Immunology*, *11*, 1907. https://doi.org/10.3389/fimmu.2020.01907

Zheng, K., Zeng, Z., Tian, Q., Huang, J., Zhong, Q., & Huo, X. (2023). Epidemiological evidence for the effect of environmental heavy metal exposure on the immune system in children. *Science of The Total Environment*, *868*, 161691. https://doi.org/10.1016/j.scitotenv.2023.161691