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EDITORIAL

Environmental impact and health risk assessment due to coal mining and utilization

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Background

Coal has served as a fundamental pillar of global energy production for centuries, fueling industries, households, and economies. Despite its crucial role in meeting energy demands, the mining and utilization of coal have given rise to grave concerns regarding environmental degradation and public health risks. Coal mining and usage significantly contribute to greenhouse gas emissions and air pollution, leading to global climate change and adverse health effects on both nearby communities and the wider population. The environmental consequences of coal extraction, transportation, and combustion are extensive, affecting ecosystems, water resources, and air quality. Hence, it is essential to conduct a comprehensive and rigorous assessment of these impacts to provide valuable insights to policymakers, industries, and communities, enabling them to adopt effective mitigation strategies. The health implications of coal mining and utilization are considerable and diverse. Exposure to particulate matter, heavy metals, and other harmful pollutants from coal-related activities can result in respiratory diseases, cardiovascular issues, and even long-term chronic health conditions. Vulnerable populations, such as children, the elderly, and socioeconomically disadvantaged communities, often bear a disproportionate burden of these health risks. This Special Issue brings together a wide array of research articles, reviews, and case studies from esteemed researchers and experts in the field. Through sharing their findings, insights, and recommendations, this collaborative effort aims to facilitate meaningful dialogue, inspire impactful actions, and contribute to a more comprehensive understanding of coal's environmental and health implications. We hope that this collection of research not only raises awareness about the challenges associated with coal mining and utilization

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but also paves the way for sustainable practices, policies, and technologies that prioritize the health of our planet and its inhabitants.

The Special Issue on "Environmental Impact and Health Risk Assessment Due to Coal Mining and Utilization" contains 26 different research papers from all over the world, including India, China, Republic of Korea, UK, Pakistan, Italy, Romania, Ecuador, Bangladesh, Brazil, Saudi Arabia, Turkey, South Africa, and Malaysia (Fig. 1). These papers focus on five different topics: (1) Geology and Geochemistry of Coal, (2) Coal Mining Areas on Groundwater, (3) Human Health Risk Assessment, (4) Heavy Metal and Trace Elements Pollution, and (5) Emission Due to Coal Combustion. This editorial briefly reviews the papers that focused on various topics related to Environmental Impact and Health Risk Assessment Due to Coal Mining and Utilization.

Geology and geochemistry of coal

For research papers in the topic of coal geology and coal chemistry, Pillai et al. (2023) studied the Lower Permian Gondwana rocks in Rajhara, Damodar Basin, India. It analyzes the flora and geochemical data within the sequence to gain insights into marine ingressions and the depositional environment during the Lower Permian period. The study highlights the fossilized plant assemblages found in the region and discusses the geochemical signatures that indicate past marine incursions. These findings contribute valuable information to understanding the palaeoenvironmental conditions and the interplay of marine and terrestrial influences during the Lower Permian period in this region. Santosh et al. (2023) investigated the effects of incorporating natural sub-bituminous coal as a filler in coir–polypropylene bio-composites. The study shows that the addition of sub-bituminous coal enhances the mechanical properties, making the bio-composites stronger and more durable. It also improves the insulation properties, resulting in better thermal resistance. Moreover,

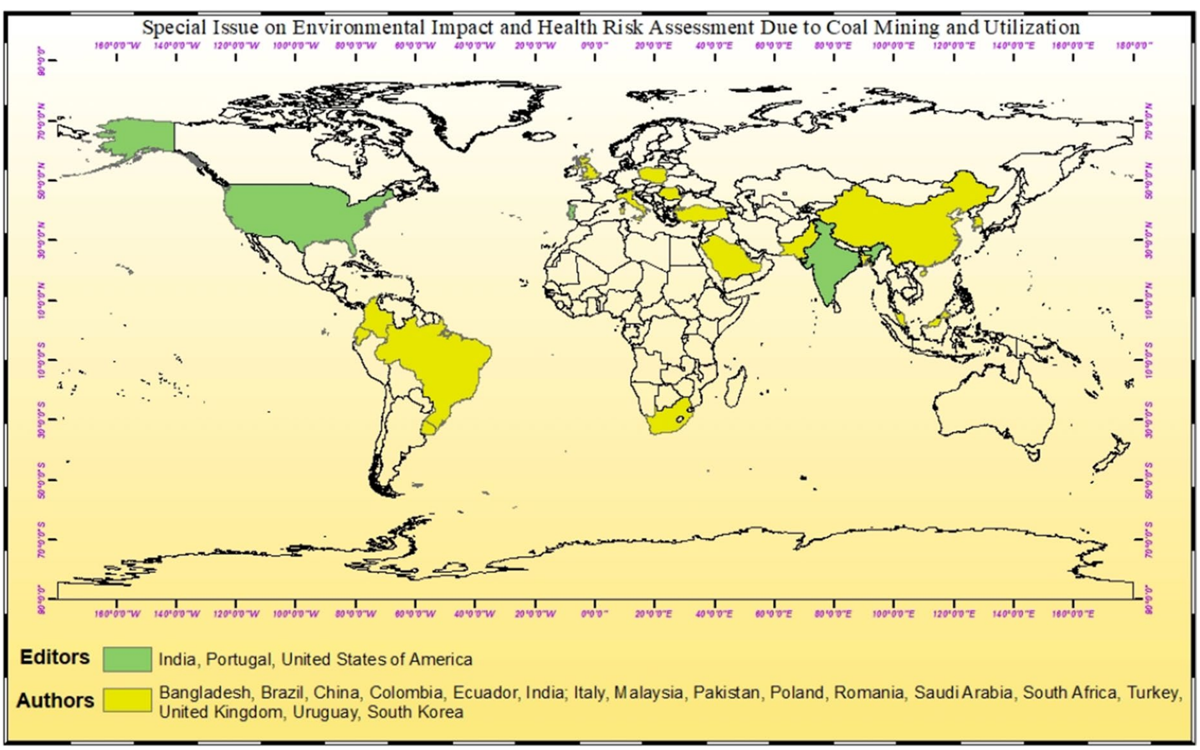

Fig. 1 The map shows authors who have contributed from different parts of the world

the presence of coal in the bio-composites enhances their flame-retardant capabilities, making them less susceptible to catching fire and slowing down the spread of flames. This research highlights the potential of using sub-bituminous coal as a sustainable and effective filler to enhance various properties of coir–polypropylene bio-composites, which could find applications in a range of industries such as construction, automotive, and packaging. Kumar et al. (2023) explored the geochemical properties of coal samples from the Rajmahal coalfields in Dhulia North Block, Eastern India. The study investigates the coal's chemical composition, mineralogy, and physical characteristics to assess its potential for utilization in various industries and its impact on the environment. The findings provide valuable insights into the coal's quality, calorific value, and ash content, which are crucial for optimizing its industrial applications. Additionally, the research highlights the environmental implications of using this coal as an energy resource, aiding in developing sustainable strategies for its exploitation and mitigating environmental impacts. Pradhan et al. (2023) investigated the Permian coal-bearing horizons in the South Karanpura Basin. Through a combination of biostratigraphic analysis, palaeovegetation reconstruction, and palaeoclimate assessment, the study aims to uncover the ecological and climatic conditions during the Permian period. The biostratigraphy provides insights into the ancient flora and fauna, while the palaeovegetation analysis offers a glimpse into the plant life of the region. Furthermore, the study's palaeoclimate assessment sheds light on the climatic conditions that prevailed during the Permian era in this specific basin. The integration of these multidisciplinary approaches enhances our understanding of the geological history, biodiversity, and environmental dynamics of the South Karanpura Basin during the Permian period.

Coal mining areas on groundwater

Four case studies are presented on the topic of groundwater impact caused by coal mining. Zhao et al. (2023) investigated the impact of coal mining on both groundwater and surface ecosystems. It explores how coal mining activities can lead to disturbances in the natural balance of groundwater systems and surface ecosystems. The study likely analyzes the changes in water quality, biodiversity, and ecological functioning caused by mining operations. The findings may highlight the potential risks to both human communities and the environment due to altered groundwater flow patterns and habitat disruptions. The paper may propose measures to mitigate the negative effects of coal mining on groundwater and surface ecosystems, emphasizing the importance of sustainable mining practices to protect the natural environment. Masood et al. (2023) studied natural carbon mineralization and its influence on the geochemical evolution of coal-based aquifers in the Salt Range, Punjab, Pakistan. The study explores the processes by which carbon is naturally sequestered in the geological formations and assesses its impact on the quality of groundwater in the region. The researchers conducted field surveys, laboratory experiments, and geochemical analyses to understand the mechanisms and rates of carbon mineralization in the aquifers. The findings suggest that natural carbon mineralization plays a crucial role in attenuating the groundwater's carbon content and affects the overall geochemical behavior of the aquifers in the Salt Range. The research provides valuable insights for the sustainable management of coal-based aquifers and their potential implications for carbon capture and storage strategies. Hu et al. (2022) discussed about a new biofilter system's application and mechanism for rapid oxidative removal of Fe^{2+} and Mn^{2+} from acidic mining wastewater. The system demonstrates effective removal of these metal ions through oxidation, leading to improved water quality. The study highlights the biofilter's capability to treat acidic wastewater containing Fe^{2+} and Mn^{2+} efficiently. The proposed mechanism involves microbial-mediated oxidation processes, elucidating the role of microorganisms in metal ion removal. The findings suggest that this new biofilter system holds promise as an eco-friendly and cost-effective approach for mitigating the environmental impacts of mining wastewater contaminated with Fe^{2+} and Mn^{2+}. Jiang et al. (2023) combined hydrochemistry and ^{13}C analysis to investigate the origins and proportions of dissolved inorganic carbon (DIC) in groundwater within coal mining regions of East China. The study employs these techniques to trace the sources of DIC, shedding light on its composition and how it relates to coal mining activities. Through comprehensive analysis, the paper reveals the varying contributions of different carbon sources to groundwater DIC, potentially identifying the impact of coal mining on groundwater quality. By examining hydrochemical properties and isotopic signatures, the research contributes to understanding the complex interplay between geological processes, mining activities, and groundwater quality in the studied area. This integrated approach offers insights into managing environmental concerns in coal mining regions and highlights the importance of interdisciplinary methods for investigating groundwater dynamics.

Human health risk assessment

The topic is represented by seven distinct papers, each comprising case studies on health risk assessment resulting from coal mining and utilization. Miranda-Guevara et al. (2023) explored the correlation between exposure to coal dust and DNA damage. It delves into the mechanisms by which certain chemical agents found in coal dust contribute to oxidative stress within cells, leading to DNA damage. The study highlights how prolonged exposure to coal dust can increase the risk of genetic mutations and potential health hazards for individuals working in coal-related industries or residing in polluted areas. The research sheds light on the intricate relationship between environmental pollutants, oxidative stress, and genetic integrity, emphasizing the importance of addressing these concerns for occupational and public health. Mestanza-Ramón et al. (2023) examined the levels of mercury (Hg) pollution in stream waters within regions affected by mining operations in the Ecuadorian Amazon. The study evaluates the potential risks posed to human health due to mercury exposure. The researchers collected water samples from streams near mining sites and analyzed the mercury concentrations. They also assessed the impact on local communities and estimated the potential health risks associated with consuming contaminated water and fish. The findings highlight the severity of mercury pollution in affected areas and emphasize the urgent need for environmental remediation and improved health awareness in the communities to mitigate the health risks posed by mercury exposure. Fengyan Li et al. (2023a, 2023b) proposed a novel approach to understanding the connection between geology and human health. The study presents a new assessment and zoning model rooted in the field of medical geology, which explores the impact of geological factors on health. The model aims to identify and categorize regions based on geological characteristics that may have implications for public health, such as mineral distributions, soil composition, and groundwater quality. By integrating geology and health data, the model provides valuable insights for policymakers and researchers to address health challenges associated with geological factors in specific regions, fostering more targeted health interventions and resource allocation. Li et al. (2023a, 2023b) studied about the distribution and relationship of antibiotics, heavy metals, and resistance genes in the upstream region of the Hanjiang River Basin in Shiyan, China. The study reveals that high levels of antibiotics and heavy metals were detected in the water samples, indicating contamination. Additionally, the presence of antibiotic resistance genes in the same area highlights the potential risk of antibiotic resistance development. The study suggests that human activities, such as industrial discharge and agricultural runoff, contribute to the pollution. This research emphasizes the importance of monitoring and managing the river basin to protect water quality and mitigate the spread of antibiotic resistance in the environment.

Feng et al. (2022) investigated the variations in the dynamic evolution of surface crack widths at different locations in the trench slope area. A case study approach is used to examine the mechanisms behind these differences. The study reveals that surface crack widths exhibit distinct behaviors depending on their specific locations within the trench slope area. The researchers identify various factors influencing crack propagation and highlight the importance of geological characteristics, stress distribution, and water content in the soil. The findings provide valuable insights into the mechanisms driving crack development in slopes, which can aid in better slope stability assessment and risk management. Lee et al. (2023) explored the use of Brewer's spent grain (BSG) formed by pyrolysis as an adsorbent to remove cobalt and strontium from wastewater. The study shows that BSG exhibits effective adsorption capacity for both cobalt and strontium ions. The adsorption process is influenced by factors like initial ion concentration, contact time, and pH. The Langmuir isotherm and pseudo-second-order kinetic model best describe the adsorption behavior. Pyrolysis-transformed BSG presents a sustainable and low-cost alternative for wastewater treatment, contributing to the removal of harmful heavy metal pollutants, cobalt, and strontium. Styszko et al. (2023) explored recent advancements in analytical techniques for identifying biomarkers of polycyclic aromatic hydrocarbons (PAHs) in human excreta. It discusses the importance of PAH biomarkers in assessing exposure to these harmful pollutants. The paper reviews various analytical methods such as chromatography, mass spectrometry, and metabolomics, highlighting their capabilities in detecting and quantifying PAH metabolites. The authors emphasize the significance of these biomarkers in understanding PAH exposure sources, metabolism, and potential health risks. The review underscores the need for accurate and sensitive techniques to monitor PAH exposure and provides insights into the development of effective strategies for PAH-related health assessments.

Heavy metal and trace elements pollution

The focal point is articulated through five distinct papers, each bearing case studies concerning the contamination of heavy metals and trace elements arising from coal mining and industrial regions. Song et al. (2023) investigated the spatial distribution patterns of soil heavy metal pollution surrounding a coal gangue hill in the Fengfeng Mining area. It assesses the potential risks associated with heavy metal contamination. The study utilizes spatial analysis techniques to identify the concentration levels and distribution of heavy metals in the soil. The results indicate that the soil near the coal gangue hill exhibits higher levels of heavy metal contamination, posing environmental risks to the surrounding areas. The findings highlight the importance of effective monitoring and remediation strategies to mitigate the adverse effects of heavy metal pollution in regions impacted by coal mining activities. Zhang et al. (2023) inspected heavy metal pollution in urban street dusts from various functional areas in a typical industrial and mining city in northwest China. The study investigates the concentration levels of heavy metals in the dust and evaluates the potential health risks posed to preschool children. The researchers analyze samples from different functional zones to assess the spatial distribution of heavy metals and their impact on children's health. The findings reveal significant contamination of dust with various heavy metals, indicating potential health hazards for young children. The study highlights the importance of monitoring and mitigating heavy metal pollution in urban environments to safeguard public health, especially in regions with industrial and mining activities.

Islam et al. (2023) investigated the community's awareness and understanding of soil contamination by chromium and lead resulting from small-scale coal mining activities. The study explores how this contamination impacts the community's health and environment, as well as the perception of risks and potential long-term consequences. The findings shed light on the significance of public awareness and knowledge of environmental contamination in such mining communities and its implications for health and socioeconomic aspects. The research emphasizes the importance of effective communication and informed decision-making processes to mitigate the adverse effects of soil contamination and protect the well-being of the affected population. Xu et al. (2023) studied the identification of heavy metal sources and assesses health risks associated with their presence in soils from an industrial and mining city in China. The study employs mineralogical techniques to determine the origin of heavy metals in the soils. It reveals that industrial and mining activities significantly contribute to heavy metal contamination. The health risk assessment indicates potential adverse effects on human health due to heavy metal exposure. The research emphasizes the importance of understanding mineralogy for accurate source identification and risk assessment of heavy metals in polluted environments, aiding in the development of effective mitigation strategies. Chakraborty et al. (2023) examined the levels of trace element contamination in soils surrounding the open-cast coal mines in the eastern Raniganj basin, India. The study reveals that the mining activities have led to significant accumulation of trace elements such as arsenic, lead, cadmium, and chromium in the soil. These contaminants pose environmental risks and potential health hazards to nearby communities. The research identifies the main sources of contamination, outlining the pathways through which trace elements spread in the surrounding soils. The findings underscore the need for improved waste management and environmental regulations to mitigate the adverse impacts of coal mining on soil quality and human health in the region.

Emission due to coal combustion and mining

In this topic, Qian et al. (2023) investigated the emissions of parent and alkylated polycyclic aromatic hydrocarbons (PAHs) from a coal seam fire in Wuda, Inner Mongolia, China. It explores the characteristics, spatial distribution, sources, and health risk assessment of these PAH emissions. The study reveals that the coal seam fire significantly contributes to the release of PAHs and their alkylated derivatives into the atmosphere. The spatial distribution analysis shows that the emissions are widespread around the coal seam fire area. The research identifies various sources of PAHs, including coal combustion and other anthropogenic activities. Furthermore, a health risk assessment highlights the potential adverse effects on human health due to exposure to these hazardous pollutants. Sawarkar et al. (2023) evaluated various plant species for their air pollution tolerance and phytoremediation potential in the vicinity of a coal thermal power station, with a focus on implications for smart green cities. The study identifies plants that can withstand air pollution and effectively remove pollutants, offering potential solutions for urban areas facing pollution challenges. The findings provide valuable insights into selecting suitable plants for green spaces and urban planning, contributing to the creation of environmentally friendly and sustainable cities. Kumari et al. (2023) assessed the levels of heavy metal contamination in street dust near a coal mine and thermal power plant complex. It examines the concentrations of various heavy metals in the dust samples. The study also investigates the bioaccessibility of these metals, which determines their potential to be absorbed by humans. Several heavy metals, such as lead, cadmium, mercury, and others, are likely analyzed in this context. The research likely quantifies the risks posed to human health due to exposure to these contaminated street dust particles. Potential health hazards and implications for the nearby communities are likely addressed. The study could provide insights into the environmental impact of coal mining and thermal power plant operations on air quality and public health. Recommendations for mitigation strategies may be discussed to reduce heavy metal exposure and associated risks to human health.

Kamanzi et al. (2023) investigated the "Pneumoconiotic Potency of Coals" explores how different coal mine dust characteristics can lead to respiratory harm in workers. The study investigates the varying potency of coals in causing pneumoconiosis, a group of lung diseases resulting from the inhalation of dust particles. The research examines factors such as coal composition, particle size, and mineralogy to understand their influence on the development and severity of respiratory conditions. The findings aim to provide insights into mitigating health risks in coal mining environments and improving worker safety. Jia et al. (2023) studied the accumulation, potential risk, and source identification of toxic metal elements in soil near a coal-fired power plant in Western China. The study analyzes the presence and distribution of toxic metals in the soil, focusing on elements like lead, cadmium, arsenic, and others. It assesses the potential risks posed by these contaminants to the environment and human health. Various analytical techniques, such as X-ray fluorescence and geochemical assessments, are employed to identify the sources of these toxic metals. The findings shed light on the environmental impact of coal-fired power plants and can aid in formulating strategies to mitigate the potential risks associated with soil contamination. Chen et al. (2023) examined the presence, distribution, and sources of polycyclic aromatic hydrocarbons (PAHs) in the Wuhan section of the Yangtze River. The study employs spatiotemporal analysis to understand the variations in PAH concentrations over time and across different locations. Additionally, source apportionment techniques are employed to identify the major contributors to PAH pollution in the region. The paper also assesses the ecological risks posed by PAHs to the aquatic environment. The findings shed light on the pollution levels of PAHs in the studied area, their potential sources, and their impact on the local ecosystem, providing valuable information for environmental management and remediation efforts.

Conclusions

Throughout this comprehensive study, we have delved into the multifaceted and critical aspects of coal mining and utilization, exploring its far-reaching implications on the environment and public health. The findings presented in this Special Issue underscore the urgent need for a holistic approach to address the challenges posed by coal-based industries. Our investigation revealed that coal mining and utilization have substantial adverse effects on the environment, including air and water pollution, land degradation, and biodiversity loss. Moreover, the release of greenhouse gases and particulate matter contributes significantly to climate change, exacerbating global environmental concerns. In addition to the environmental impacts, we have also shed light on the concerning health risks faced by communities living in proximity to coal mines and power plants. Exposure to harmful pollutants such as heavy metals, particulate matter, and volatile organic compounds has been linked to respiratory diseases, cardiovascular problems, and other health complications, disproportionately affecting vulnerable populations. The Special Issue has also emphasized the importance of implementing rigorous regulations, innovative technologies, and sustainable practices to mitigate the negative impacts of coal mining and utilization. The findings collectively indicate the urgency to transition toward cleaner and more sustainable energy alternatives to safeguard our planet's health and the well-being of our communities. We hope that this compilation of research will serve as a valuable resource for policymakers, industry stakeholders, researchers, and activists alike, facilitating informed decision-making and fostering collaborative efforts to address the environmental and health challenges posed by coal mining and utilization.

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