



Impacts of Coal-Fired Power Plant Emissions on the Environment: A Bangladesh Perspective

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Abstract

This study aimed to examine the extensive environmental ramifications of emissions from coal-fired power plants, specifically on the Rampal Power Plant, located in southwest Bangladesh. This study examined the environmental impacts of Rampal power plant emissions to help the region's sustainable energy strategy and environmental conservation. The study employed a research methodology that integrated a survey-based approach with a comprehensive literature review. This dual-method approach allowed for a deep understanding of maritime professionals' existing knowledge base and real-world insights. Thermal pollution, chemical contaminants, acidification, habitat disruption, and endocrine disruptors collectively degraded local water bodies and aquatic ecosystems, underlining the need for rigorous monitoring, strict restrictions, and sustainable practices. The study will benefit government, policymakers and environmental protection agencies by providing valuable insights into sustainable development and strategies for improving environmental practices. The study provided recommendations for enhancing environmental protection, improving emission standards, and supporting community development and research initiatives.

Keywords: Emission, Coal-Fired, Power plant, Environment, Bangladesh.



1. Introduction

Release of compounds or pollutants into air, water, or soil is emission (Penney et al., 2009). Power plant emissions are gases and particles released during fossil fuel burning (Hannun & Abdul Razzaq, 2022). Many emissions from coal-fired power plants harm the environment. The main emissions from coal-fired power facilities are CO₂, a primary greenhouse gas, that traps heat in Earth's atmosphere and causes climate change. Sulfur Dioxide (SO₂), Burning sulfur-containing coal produces acid rain, which affects aquatic plants, forests, and infrastructure. Humans also have respiratory issues from SO₂. Nitrogen Oxides (NO_x), Combustion produces NO and NO₂, which pollute the air. They can cause pollution and respiratory and environmental problems (Başhan & Kökkülünk, 2020). Particulate Matter (PM), is tiny particles emitted into the air after burning. PM can harm respiratory health and air quality. Trace Elements, Arsenic, lead, and cadmium from coal combustion can harm the environment and humans (Lin et al., 2019).

1.1 Rampal Power Plant

Bangladesh generates more coal power. The Rampal Power Plant, an establishment powered by coal and located in the Bagerhat District of southwestern Bangladesh, has emerged as a subject of significant academic and environmental scrutiny. The power project which was developed in partnership with India, serves as a symbol of Bangladesh's strategic emphasis on industrialization to foster economic progress (Hossain, 2014). The facility, which is anticipated to require an investment of USD 1.5 billion, has incited considerable discourse on account of its possible ecological ramifications. Contextualized within the densely inhabited coastal region, where pressing issues such as climate change, political instability, and population expansion are prevalent, the Rampal Power Plant has been subject to censure due to its potentially detrimental impacts on the Sundarbans ecosystem and adjacent regions. It is expected that emissions, including toxic particles, Sulphur dioxide, and nitrogen dioxide, will be dispersed by the prevailing wind patterns. These emissions are expected to affect various regions, including Satkhira, Khulna, Noakhali, Comilla, Narsingdi, and Dhaka in Bangladesh, Ashoknagar, Kalyangar, Basirhat, and Kolkata in West Bengal, India. The purpose of this research is to examine the extensive environmental ramifications of emissions from coal-fired power plants, with a specific emphasis on the Rampal Power Plant. By doing so, it hopes to make a significant contribution to the ongoing discussion surrounding sustainable energy practices and their ecological effects.

The proposed Rampal power plant has serious environmental problems, according to the Environmental Impact Assessment (EIA) report. To produce the anticipated 1,320 megawatts of power, the facility plans to burn 4.72 million tons of coal, which will result in the release of



significant carbon dioxide emissions, with at least 7.9 million tons contributing to fly ash. In addition, it is estimated that the facility will produce 142 tons of sulfur dioxide and 85 tons of nitrogen dioxide daily, which would pose a major threat to the Sundarbans ecosystem. This growth in pollution could eventually cause the forest to be destroyed. The transportation of the massive quantity of coal to the plant site poses a serious risk to the Sundarbans. According to the concept, large ships would make 59 trips annually to transport 4.72 million tons of coal to Akram Point in the Sundarbans. This transportation process is linked to three environmental hazards. First, the ships' discharge of coal, dirt, fuel, and chemicals will seriously harm the adjacent sea, rivers, and coast. Secondly, the water near Akram Point, where the switch from big to small ships occurs, will be tainted by the discharge of coal waste. Thirdly, frequent maritime traffic across the Pashur River is expected to damage its banks and contribute to light and sound pollution, which could jeopardize the local wildlife and ecosystem. Together, these components highlight the grave environmental risks associated with the Rampal power plant project (Iftekhharuzzaman et al., 2015).

Coal combustion at the power plant endangers the Poshur River and groundwater due to the enormous quantity of refuse it produces. The liquid waste, which comprises detrimental elements such as mercury, arsenic, cadmium, and chromium, has the potential to contaminate potable water and endanger the well-being of adjacent inhabitants and the Sundarbans' delicate ecosystem. In violation of environmental protection legislation, sections of the Poshur and Andharmanik rivers have been designated by the government as cetacean sanctuaries. Although this action is intended to protect wildlife, the damaging waste produced by coal combustion may still pose a threat to the area's natural resources. Sulfur-rich coal, such as that which is present in Indian coal, may also contribute to an escalation in air pollution. The proposed project utilizes high-quality Barapukuria coal, which contains less than 1% sulfur, thereby potentially mitigating concerns related to air pollution. However, at 14 kilometers from the Sundarbans, the project site violates the Ecologically Critical Area (ECA) regulations that prohibit power plants within 12 kilometers of the Sundarbans buffer zone (Kazi et al., 2018).

The results of the environmental evaluation of the coal-fired area in Rampal, Mongla, and the Sundarbans show that biological components have been thoroughly examined in addition to a thorough analysis of the physio-chemical conditions in the air, water, and soil. The majority of the wind direction over the ten-year study period was from northwest to southeast or from north to south from November to February. The monthly mean temperature ranged from 13.5 to 35 °C, with corresponding variations in relative humidity from 65 to 86% and rainfall from 7 to 320 mm. Variations were seen in air quality measures such as SPM, NO_x, and SO_x. Temperature, TDS,



conductivity, salinity, pH, DO, BOD5, COD, total hardness, and PO4 were among the properties of surface water. Groundwater had different amounts of arsenic. Soil factors encompass iron content, sulfur content, and pH. 24 herbs, grasses, and shrubs were recorded in the study; eight were found to be unusual within the project area and two were rare outside. Within the research area, a total of 47 woody plants and fruit trees were found, of which five were extinct and fifteen were unusual. There was diversity among medicinal plants and non-fruit trees, including eight extinct and twenty unusual species. There were 59 species of shrimp, crabs, molluscs, and fish among the aquatic macrophysics and aquatic life that were noted; of these, 18 fish species were extinct and 10 were rare. The survey also included birds, mammals, reptiles, and amphibians. It revealed the existence of rare and extinct species, which raised questions about how the proposed project may affect biodiversity (Chowdhury, 2017).

1.2 Objectives and Significance

In this study, we evaluated the relationship between coal-fired power plants and environmental emissions. We also assessed the issues involved in coal-fired power plant emissions. We identified the impacts of coal-fired power plant emissions on the environment and the challenges hindering efforts for a cleaner environment. This study is significant as it examines the environmental impact of emissions from the Rampal Power Plant in Bangladesh. Policymakers must assess the coal-fired power plant's environmental implications due to its controversy. Localizing the coal-fired energy generation argument, the study examines the Sundarban's environment, bordering regions, and vulnerable communities. The research seeks to inform stakeholders, politicians, and environmental advocates about air and water pollution, biodiversity loss, and health concerns. The findings will enhance the Rampal Power Plant's sustainable energy practices, mitigation strategies, and the balance between economic and environmental considerations. Policymakers and various government organizations can benefit from this study, which will also offer valuable insights for academic students and researchers.

2. Literature Review

Coal combustion emits sulfur dioxide (SO₂), which contributes to air pollution, acid rain formation, and poses serious risks to vegetation, soil fertility, aquatic ecosystems, and human respiratory health.

Nitrogen oxides are generated from the combustion of coal at elevated temperatures (Hannun & Abdul Razzaq, 2022). NO_x is a causative element in the development of respiratory issues, the formation of smog, and the contamination of the air. The release of NO_x has detrimental effects on both the environment and human health as it leads to the deterioration of air quality. Coal



combustion can result in the emission of particulate matter, which may contain high levels of heavy metals. These particles consist of fly ash and other ash particles.

"Coal-fired power plants" are power plants that utilize coal as fuel to generate energy. These plants have provided a great deal of energy to humanity for a long time, throughout the planet. But when they burn, they contaminate the water and air, which harms the ecosystem. Coal-fired power firms can now have a lower environmental effect because of new technologies and a global push toward greener energy (Lin et al., 2019). Although switching to green energy is still difficult, it is one of the most crucial things that can be done to combat environmental issues like climate change.

"Coal-fired power plants" are energy-generating facilities that utilize coal as a source of fuel through combustion. These plants have historically provided a substantial quantity of energy to people worldwide. Nevertheless, the combustion of these substances has detrimental effects on the ecology as it contaminates both the air and water. With the advent of advanced technology and the worldwide shift towards sustainable energy sources, coal-fired power firms are now able to significantly reduce their environmental footprint. Adopting green energy is a crucial step in tackling environmental issues such as climate change, despite its inherent difficulties.

Significant amounts of carbon dioxide (CO₂), a greenhouse gas that contributes to the intensification of the greenhouse effect and global warming, are emitted when coal is burned. The accumulation of CO₂ in the atmosphere is the primary driver of climate change, resulting in elevated global temperatures, rising sea levels, and disruption of ecosystems.

Inhalation of PM can lead to respiratory problems, while the environmental deposition of these particles might have detrimental effects on ecosystems. Efficient ash management is crucial to prevent environmental contamination. The concept underlying emissions from coal-fired power plants is the release of pollutants that exert a significant impact on the environment. These contaminants have the potential to impact the air and water quality, induce climate change, or detrimentally affect an entire ecosystem. To mitigate these emissions and transition to more sustainable energy sources, current endeavours are focused on developing and enforcing technology and legislation.

The coal-fired power station located in the southwestern region of Bangladesh, specifically the Rampal project, gives rise to substantial worries regarding emissions that have the potential to affect a wide expanse of land. The dominant wind patterns would scatter harmful particles, such as Sulphur dioxide and nitrogen dioxide, impacting the Sundarbans environment and the districts



of Satkhira, Khulna, Noakhali, Comilla, Narsingdi, and Dhaka in Bangladesh. Ashoknagar, Kalyangar, Basirhat, and Kolkata in West Bengal, India might also be affected by the negative consequences. Exposure to pollutants increases the susceptibility to diseases such as stroke, lung cancer, and heart and respiratory difficulties in adults while causing respiratory symptoms in children. The potential health repercussions underscore the immediate requirement for meticulous deliberation and evaluation of environmental impact throughout the execution of such operations (Daily Star, 2017).

Although the study recognizes issues regarding displacement and socioeconomic effects, additional in-depth qualitative research is warranted given the lack of awareness of the viewpoints of local people affected by such projects. There is a lack of research on how public activism and understanding can affect legislative decisions about power plant projects and how educated communities can influence environmentally friendly practices.

Coal is burned in a boiler to create steam, which is then propelled through a turbine that is coupled to a generator to produce electricity in coal-based power plants. Mechanical energy can be converted into electrical power using this method. However, the consequences of this energy-generating process on the environment are concerning. A typical 500-megawatt coal power plant produces roughly 125,000 tons of ash and 193,000 tons of sludge annually. Regretfully, over 75% of this garbage is disposed of in unsupervised on-site landfills and surface impoundments (Islam et al., 2019).

Around 8,500 coal-fired power plants are in operation worldwide, producing more than 2,000 gigawatts of electricity, or nearly one-third of the world's total power output. Over 125,000 tons of ash and 193,000 tons of sludge are produced annually by an average coal power station with an output of 500 megawatts. These waste products contain hazardous elements like arsenic, mercury, chromium, and cadmium. Surprisingly, about 75% of this garbage is disposed of carelessly in landfills and impoundments without proper liners. This thoughtless discharge contaminates sources of drinking water and may be harmful to human health. Hazardous materials found in the garbage include arsenic and mercury, which can impair the central nervous system and other vital human organs. These coal-fired power plants also contribute significantly to air pollution, which causes a host of diseases and premature deaths. Because of their detrimental consequences on the environment and human health, even though they produce a significant portion of the world's power, it is urgent to focus on developing safer and cleaner alternatives.



The National Thermal Power Company of India and the government of Bangladesh reached a consensus on January 29, 2012, to build a coal-fired power plant. There are worries that this project is located just 9 kilometers downstream of the Sundarbans. There are worries expressed about the possible consequences of building a coal-fired power station close to the Sundarbans, a significant and delicate ecosystem. The unique mangrove forests and diverse animals of the Sundarbans are well-known; any unfavourable effects from the power project could wipe out this invaluable ecosystem. The project site's proximity to the Sundarbans highlights the need to consider sensitive ecosystems when constructing efforts of this kind and raises concerns about potential environmental repercussions (Chowdhury, 2017).

To construct the power plant, the Rampal Upazila's Satmari-Katakhali and Koigordashkathi districts have seen 1,834 acres of agricultural land purchased by the government. The proprietors farmed rice and fish on the 86 acres of public property that remain; the rest area is used for cash land. In addition, 10 kilometers of the Poshur River would be dredged by the government to facilitate the port landing of ships carrying coal to the plant.

The Sundarbans buffer zone is only 4 km away from the Rampal coal-based power station. However, as of 2010, guidelines issued by the Indian Ministry of Environment and Forests prohibit the construction of thermal power facilities within 25 kilometers of natural forests or wildlife habitats. Remarkably, there is no available data or information regarding the potential environmental impacts of the proposed power project on the Sundarbans and the Rampal areas. Owing to the lack of information, an evaluation is now necessary to evaluate the possible dangers connected to the coal-fired power station and understand their effects on the Sundarbans' plant and animal life as well as the surrounding areas of the project. The goal of this study is to elucidate any possible impacts on the biological and ecological conditions of the Sundarbans and the surrounding areas that the Rampal coal-fired power station may have. It is necessary to thoroughly understand the potential risks to make decisions that prioritize protecting this unique and critical environment, and this can only be done by conducting this inquiry (Hossain, 2020).

Throughout its 40-year existence, the Rampal power plant would result in at least 6,000 early deaths and low birth weights in 24,000 babies. Because of the prevailing wind patterns, the emissions would raise the levels of nitrogen dioxide, sulfur dioxide, and hazardous particles over 100 km to the northeast and throughout the entirety of southwest Bangladesh. Due to wind patterns, the entire Sundarbans ecosystem, the districts of Satkhira, Khulna, Noakhali, Comilla, Narsingdi,



and Dhaka in Bangladesh, as well as Ashoknagar, Kalyangar, Basirhat, and Kolkata in West Bengal, would be affected (Daily Star, 2017).

Only roughly 33–35% of the heat generated when coal is burned in a power plant to create electricity is used; the remaining heat is either discharged into the atmosphere or absorbed by cooling water. This technique has detrimental effects on the environment in addition to being a major energy waste. Acid rain, global warming, and air pollution are all directly caused by burning coal. The Sundarbans, an important natural area located approximately 9 kilometers downstream from the project site, are especially concerned about the development of a coal-fired power station. Given that the Sundarbans are susceptible to the power plant's possible environmental repercussions, the influence on them is concerning. It highlights how crucial it is to give careful thought to where these kinds of projects are located to prevent negative effects on delicate ecosystems like the Sundarbans (Molla, 2022).

The power station might release an astounding 14 million tons of carbon dioxide into the atmosphere, endangering the forest. The devastation of the forest may result from these high carbon dioxide emissions. According to the Environmental Impact Assessment (EIA), there will also be three major environmental effects from the transportation of coal for the plant. First of all, the discharge of pollutants from both large and small ships, such as coal, dirt, and gasoline, will seriously contaminate the surrounding sea, rivers, and shorelines. Second, the discharge of coal wastes into the river will contaminate the water at Akram Point, where the changeover from large ships to smaller boats takes place. Last but not least, the Pashur River's banks would suffer from heavy and frequent maritime traffic, which will exacerbate light and noise pollution from ships. The local fauna will suffer as a result of these disruptions in addition to the ecosystem. The power plant's operations and the transportation of coal harm the environment, which highlights the need for careful evaluation and mitigation measures (Al-Amin M., 2022).

Coal is used in a coal-based power plant to produce energy. They create steam by heating water with coal, and then they use that steam to turn a turbine to produce energy. The problem is that a large portion of the heat produced is lost, and the procedure may have negative environmental effects. Coal burning produces a huge amount of trash, including sludge and ash. Over 75% of this garbage is often disposed of in on-site impoundments or landfills, which can be problematic because it frequently contains dangerous materials like arsenic and mercury. These dangerous materials in the garbage can contaminate our drinking water and lead to major health problems. Children who consume water tainted by coal plant waste, for instance, may be more susceptible to



cancer. The way we dispose of coal plant waste can have a major negative impact on ecosystems, just like it can on plants and animals. Occasionally, this harm may be quite severe and even irreversible. About 2.2 billion gallons of water are required by the power plant to run. The temperature of the water may change as a result of this water being heated and then discharged back into lakes or rivers. This alteration is unpopular with fish and may have negative health effects. Power plants frequently add chemicals to the water they use to maintain cleanliness. However, those chemicals may also pose a threat when they release this water back into the environment (Mahmud et al., 2020).

3. Methodology

The study employed a research methodology that integrated a survey-based approach with a comprehensive literature review. We have collected the literature through Google search Engine and Google Scholar search with the keywords: 'Emissions', 'Power Plant', 'Rampal Power Plant', 'Coal', 'Emission control on the environment' etc. Thus a total of 89 scholarly articles met the inclusion criteria. Thereafter we have chosen related news articles, government and non-government reports, etc. Although we found inadequate relevant scholarly works, secondary data on the associated issues from various books, policies, newspapers, and presentations made some valuable additions to this review. Finally, we did a thematic organization of the most recent literature to draw some policy directives.

4. Result and Discussions

4.1 Pollutants from Power Plant

Rampal power plant operations will produce air pollutants, causing environmental issues. PM emissions of fine particles and aerosols are major consequences that can harm respiratory health and air quality. The facility also releases SO_x and NO_x, which cause air pollution, acid rain, and health problems. Volatile Organic Compounds (VOCs) can cause ground-level ozone and smog, affecting air quality and health. The Rampal power plant's PM, SO_x, NO_x, and VOC emissions highlight the need to monitor and minimize its environmental impact on local air quality and public health.

4.2 Potential Health Impacts

The Rampal power plant releases several air pollutants with health risks. PM emissions, associated with asthma and bronchitis, can harm the respiratory system. Exposure to the plant's emissions causes eye, nose, and throat irritation, underlining the acute discomfort. Long-term exposure to these contaminants can damage the liver, kidneys, and nervous system. Pollution in ecosystems,



especially aquatic ones, threatens aquatic life and alters food chains. Certain contaminants are carcinogenic, increasing cancer risk in exposed populations. The combined health impacts highlight the need for rigorous monitoring, regulatory measures, and public health activities to prevent the Rampal power plant's emissions' negative effects on surrounding residents and the ecology.

4.3 Effects on Ecosystem

Rampal power plant effluent affects local waterways and aquatic ecosystems in several ways. The release of warm water causes thermal pollution, which harms aquatic environments. Chemical pollutants in water can cause toxicity and harm aquatic organisms. Acidifying water from acidic contaminants disrupts the pH equilibrium and endangers aquatic life. Water conditions change aquatic ecosystems, causing habitat disruption. Endocrine disruptors in wastewater can also disturb aquatic creatures' hormonal systems, causing reproductive and developmental difficulties. The cumulative effects of thermal pollution, chemical contaminants, acidification, habitat disturbance, and endocrine disruptors emphasize the need for comprehensive monitoring, strict regulatory measures, and sustainable practices to protect local water bodies and aquatic ecosystems affected by the Rampal power plant's wastewater discharge.

4.4 Overall Emissions

The Rampal power station greatly impacts global climate change by emitting greenhouse gases. Carbon dioxide (CO₂) emissions from coal combustion contribute significantly to the greenhouse effect and heat buildup in the atmosphere. Power plant methane (CH₄) and nitrous oxide (N₂O) emissions increase greenhouse gas emissions and warming potential. Black carbon (soot) emissions absorb sunlight, warming the atmosphere and affecting regional climate patterns. The plant's emissions affect air quality and aerosol composition. The Rampal power plant's overall impact on climate change challenges global climate mitigation efforts, underlining the need for cleaner energy and aggressive greenhouse gas emission reduction methods. Sustainable energy methods are needed to reduce the plant's worldwide environmental impact due to CO₂, CH₄, N₂O, black carbon, and climate patterns.

4.5 Impact on the Local Biodiversity and Ecosystem Health

The construction and operation of the Rampal power plant affect local biodiversity and ecosystem health in several ways. Land use changes during plant building destroy natural habitats and may displace native flora and fauna. Power plant discharges degrade water quality, endangering aquatic ecosystems and life. Plant activities' noise and light pollution affect wildlife, especially nocturnal



species, foraging and reproducing. Another result is soil pollution from power plant contaminants, which can reduce nutrient availability and harm terrestrial creatures. Due to its closeness to biodiversity hotspots, the power station threatens rare and ecologically significant species. The cumulative effects of habitat destruction, water quality degradation, noise and light pollution, soil contamination, and biodiversity hotspots highlight the need for comprehensive environmental management practices and mitigation strategies to protect local ecosystems and biodiversity.

4.6 Emissions by Transportation

Several mechanisms affect air quality along the coal delivery route to the Rampal power station. Coal transportation and handling release fine particulate matter into the air, causing dust emissions. These particles damage air quality and threaten respiratory health. Transportation emissions, especially CO₂, increase the carbon footprint and global climate change. Transport vehicles' noise pollution worsens air and noise pollution along the route. Accidental coal accidents during transportation threaten air, soil, and water quality, emphasizing the need for complete mitigation methods. Dust emissions, greenhouse gas emissions, noise pollution, and accidental spills highlight the need for sustainable transportation practices, technological upgrades, and regulatory measures to reduce air quality impacts along the coal transportation route to the Rampal power plant.

4.7 Socioeconomic Effects

The Rampal power plant has beneficial and negative socioeconomic consequences on nearby towns. Local locals gain jobs from the power plant, boosting economic growth and maybe improving livelihoods. A local economic transition may affect the community's traditional economic activities. The power plant spurs investments in roads, schools, and hospitals, boosting community development. The power plant's operations may affect nearby property values. Employment opportunities, a shift in the local economy, infrastructure development, and property value dynamics highlight the need for comprehensive community engagement, sustainable development practices, and measures to address potential challenges to ensure that the Rampal power plant communities benefit socioeconomically while mitigating any negative impacts.

4.8 Long-term Consequences

The Rampal power plant's emissions may have long-term effects on soil fertility and agricultural output. Power plant pollution can contaminate soil over time, affecting its quality and nutrient balance. Acidic pollutants change soil pH, altering nutrient availability and microbial activity. Emissions can affect soil microbial communities, altering symbiotic connections necessary for



nutrient cycling and soil health. These changes lower crop yields, hurting local farmers and food security. The long-term effects on soil fertility and agricultural productivity may also reduce biodiversity, disrupting ecosystem balance. The interplay of soil contamination, acidification, altered microbial communities, reduced crop yields, and biodiversity loss requires comprehensive mitigation strategies, sustainable agricultural practices, and ongoing monitoring to protect the soil and agricultural landscape near the Rampal power plant.

4.9 Formation of Acid Rain

The Rampal power plant will contribute to acid rain by emitting SO₂ and NO_x during coal burning. These pollutants react in the atmosphere to form sulfuric and nitric acids, which acidify rainwater. The effects on ecosystems and infrastructure are serious. Forest decrease due to acid rain exposure may harm ecosystems. Acid rain affects water pH, harming aquatic life and species composition. Power plant emissions cause acidic rain, which corrodes buildings and bridges. Acid rain fallout can cause respiratory and skin problems. Ecosystem impacts, forest decline, infrastructure corrosion, aquatic habitat disruption, and human health concerns highlight the need for strict emission controls and mitigation strategies at the Rampal power plant to prevent or mitigate acid rain's far-reaching effects.

4.10 Regulations and Monitoring Systems

Comprehensive measures demonstrate the effectiveness of environmental rules and monitoring systems in meeting emission criteria at the Rampal power station. Compliance audits help evaluate the plant's emission regulations and environmental performance. Transparent reporting techniques make emissions data available to the public and regulatory bodies, promoting accountability. Air quality monitoring systems continuously measure pollutants, detecting and correcting departures from regulations. Integration with worldwide standards matches the power plant's emission benchmarks with international best practices, boosting credibility and broadening environmental assessment. In addition, regulatory inspections ensure that the plant's operations meet standards and that remedial actions are implemented when needed. Regular compliance audits, transparent reporting, air quality monitoring systems, integration with worldwide standards, and regulatory inspections establish a strong framework for Rampal power plant emission regulations and environmental compliance.

4.11 Control and Mitigation

Many efforts are taken to reduce the impact of Rampal power station coal ash disposal on land and water quality. Ash pond liners protect soil and groundwater from coal ash leaching. Sustainability



is achieved by recycling ash, lowering disposal volume and environmental impact. Before ash pond effluent is released, water treatment facilities must filter it to meet quality standards. Geosynthetic coverings prevent ash and pollutants from spreading. Community health monitoring efforts help analyze local health impacts and resolve concerns quickly. Ash pond closure and rehabilitation strategies include land restoration and long-term environmental protection. These procedures form a comprehensive strategy to protect land and water quality from Rampal power plant coal ash disposal.

4.12 Cleaner and More Sustainable Energy Alternatives

Comprehensive efforts are needed to develop cleaner, more sustainable energy in Bangladesh. First, significant renewable energy infrastructure investment is needed to build and expand solar, wind, and other renewable projects. Local communities gain from decentralized clean energy and active participation in community-based renewable energy projects. Energy efficiency projects also reduce energy use, guaranteeing sustainable resource use. Green building standards reduce energy use in construction and promote sustainable practices. Finally, promoting wave, solar, and wind energy emphasizes the need to diversify the energy mix and use renewable sources. These approaches emphasise innovation, community involvement, efficiency, and green standards to transition Bangladesh to a cleaner, more sustainable energy landscape.

According to the analysis:

- a. The plant's operations are associated with significant environmental concerns. In addition to lowering air quality and causing acid rain, particulate matter (PM), nitrogen oxides (NO_x), sulfur oxides (SO_x), and volatile organic compounds (VOCs) can also be detrimental to respiratory health.
- b. Respondents express concerns about specific health implications, such as breathing problems and potential long-term injury to vital organs.
- c. The wastewater discharged from the facility causes acidification, heat pollution, chemical contamination, and habitat disturbance, among other detrimental effects on neighbouring water bodies.
- d. Coal ash disposal is managed by recycling and ash pond liners, among other measures, but community health monitoring and awareness campaigns are crucial.



The Rampal power plant caused significant environmental damage. Pollutants in the air pose a threat to both lung health and air quality. The terms "volatile organic compounds," "particulate matter," and "sulfur oxides" are all used to describe these. Breathing problems and potential harm to vital organs in the long run were major concerns for many people's health. As an added downside, the wastewater from the factory raises issues including acidification, heat pollution, chemical contamination, and the disturbance of habitat in neighbouring bodies of water. Although recycling and ash pond liners are in place to control the discharge of coal ash, it is important to emphasise community health monitoring and awareness efforts. When considered collectively, these findings highlight the crucial nature of taking comprehensive measures, including stringent regulatory actions, sustainable practices, and community involvement, to address the health and environmental issues created by the Rampal power plant.

4.13 Challenges

- a. Firstly, there is an immediate need to monitor and mitigate the release of air pollutants, such as particulate matter, sulfur oxides, nitrogen oxides, and volatile organic compounds. These pollutants pose serious hazards to both the local air quality and respiratory health.
- b. Second, extensive public health actions are necessary because of the wide range of health concerns linked to plant emissions, including respiratory problems and possible organ damage.
- c. Thirdly, severe regulatory measures and sustainable practices are required because of the complicated problems that arise from discharging effluents into water bodies, such as thermal pollution, chemical contamination, and habitat disruption. In addition, while there are initiatives to control the disposal of coal ash, the hazards associated with it must be adequately addressed through community health monitoring and education initiatives.

To address all of these concerns and lessen the negative effects of the Rampal power plant, it is crucial to have a comprehensive approach that incorporates environmental regulations, public health programs, and sustainable practices.

5. Recommendations

- The Government of Bangladesh (GoB) may strengthen and implement environmental regulations to guarantee that the Rampal Power Plant's emission standards are met.
- The Ministry of Health and Family Welfare (MoHFW) may carry out in-depth analyses of the effects of the Rampal power plant on local health.



- GoB might encourage sustainable development that benefits the community.
- To strengthen environmental protection and tighten emission requirements, plant authorities may collaborate with regulators.
- The GoB may allocate funds for community development, technological advancements, and research to lessen the environmental and social effects of the Rampal power plant.

5.1 Conclusion

To conclude, the analysis of the Rampal power plant highlights numerous social, health, and environmental issues. Emissions of particulate matter (PM), sulfur oxides (SO_x), nitrogen oxides (NO_x), and volatile organic compounds (VOCs) contribute to acid rain, deteriorate air quality, and negatively impact respiratory health. The discharge of coal ash and wastewater degrades aquatic ecosystems, soil fertility, and streams. To mitigate these environmental impacts, the research recommends strict regulations, continuous monitoring, and robust mitigation measures. Innovation and environmental preservation are crucial for the sustainable operation of the Rampal power plant. Addressing local respiratory issues and long-term health risks requires a comprehensive strategy that considers both environmental and public health outcomes. To optimize benefits and minimize drawbacks, it is crucial to address the community's socioeconomic implications, including infrastructure development and employment. The research advocates for the adoption of renewable energy sources, community-based initiatives, energy efficiency programs, and green standards to transform Bangladesh's energy sector. These strategies aim to tackle environmental concerns at their root, while simultaneously benefiting local communities and ecosystems. Effective implementation requires collaboration among regulatory agencies, industry stakeholders, and local communities. The findings of this study provide valuable insights for Bangladeshi policymakers, environmentalists, and community leaders in their efforts to establish a greener energy sector. As climate change intensifies, the Rampal power plant study can guide informed decision-making, fostering a cleaner, healthier, and more sustainable future.

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