ENVIRONMENTAL IMPACT ASSESSMENT REPORT REVIEW OF THERMAL POWER PLANT AND NUCLEAR POWER PLANT

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

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Sonargaon University

147/I, Green Road, Dhaka-1215, Bangladesh

Section: 19(C+E)

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DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

to

“Our Parents”

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ABSTRACT

This research conducts an extensive review and comparative analysis of Environmental Impact Assessments (EIA) associated with nuclear power plants and thermal power plants. The study aims to evaluate the environmental implications of these two prominent energy sources, considering factors such as carbon footprint, waste management, and ecosystem impact. The study explores parameters, regulatory frameworks, and community engagement aspects, emphasizing the environmental implications of each type of power generation. The assessment considers key factors such as air and water quality, soil impact, biodiversity, social consequences, and safety protocols. The paper reviews the level of public participation in the EIA processes for both types of power plants and analyzes how regulatory frameworks influence environmental considerations. Findings from this analysis contribute to a comprehensive understanding of the environmental impact of nuclear and thermal power generation, aiding policymakers, researchers, and environmental practitioners in making informed decisions about the future development of power infrastructure. Tailoring mitigation measures to the unique characteristics of each technology is crucial for effective environmental management. The review highlights the importance of public consultation, regulatory compliance, and presents case studies to elucidate environmental challenges and successes in the EIA process. The paper concludes by identifying avenues for future research and emphasizes the need for continuous adaptation of EIAs to address evolving challenges in the energy sector.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

Introduction

1.1 General

Environmental Impact Assessment(EIA) is a systematic process designed to identify, predict, and evaluate the potential environmental impacts of a proposed project, plan, or policy before it is implemented.

A power plant is a facility designed to generate electricity from various energy sources. Its primary function is to convert energy from one form to electrical energy, which can then be distributed and used to power homes, industries, and various other applications. Power plants play a crucial role in meeting the growing demand for electricity worldwide. [1],

Nuclear power plant is a complex facility designed to harness the incredible energy released during nuclear reactions, specifically the process of nuclear fission. This technological marvel represents a significant advancement in the field of energy production, utilizing the controlled splitting of atomic nuclei to generate vast amounts of heat. This heat, in turn, is employed to produce steam, which drives turbines connected to generators, ultimately transforming the nuclear energy into electricity. Thermal power plant is a sophisticated engineering marvel designed to convert thermal energy, often derived from the combustion of fossil fuels or other heat sources, into electricity. The interplay between power generation and its environmental repercussions has become a focal point of global discourse in an era marked by burgeoning energy demands and an unrelenting pursuit of sustainable solutions. As social orders endeavor to adjust the requirement for solid energy sources with the basic of natural stewardship, the investigation of different power age advances is fundamental. This proposal tries to unwind the perplexing connection between power plants and the climate, with a particular spotlight on the warm and atomic power age domains. [13],

1.2 Objectives of The Study

- This thesis aims to assess the environmental impacts of nuclear and thermal power plants, focusing on air and water quality, land use, biodiversity, and human health.
- This study evaluates environmental impacts of nuclear and thermal power, guiding decisions and policies for sustainable energy with a focus on minimizing ecological impact.

1.3 Organization of The Thesis

The report of the analysis is organized in this paper to represent and discuss the results and findings that come out from the studies.

Chapter 1: Introduction the topic, the role of environmental impact assessment is highlighted in this lesson.

Chapter 2: The literature review discusses the project background and importance of these projects.

Chapter 3: Papers reviewed and analyzed on environmental impact assessment methodology are presented.

Chapter 4: Result and discussion in this lesson, air quality, water quality, nuclear waste management, population density, soil analyses, noise modeling studies etc. are discussed in the area of the respective projects.

Chapter 5: In this text all the papers, websites, books, reports, journals, etc. that we have reviewed and analyzed are discussed in this reference section along with conclusions, limitations and recommendations for future work.

CHAPTER 2

Literature Review

2.1 Introduction

For nuclear and thermal power plants, environmental impact assessments are crucial. Throughout the numerous articles I have studied, the need of environmental impact assessments (EIAs) has been highlighted in each one. This includes air water, natural biological environmental harm components, and alternate concepts for these in specific circumstances. They will be more impacted by the potential for acid rain in the area as well as by nuclear power plants, which produce electricity through nuclear fusion reactions. These plants, or the areas around them, will emit radioactive radiation that is hazardous to the environment. These concerns have been brought to light.

2..2 Research Background

2.2.1 Rooppur Nuclear Power Plant:

The Rooppur Nuclear Power Plant is a significant energy project located in Bangladesh. Construction of the plant began in 2017, It is located in the Rooppur village of Pabna District. Executive of this project A.Z.M. Solaiman Khan (Project Director), Igor Kalema (Deputy Director), Elena Polischuk (Deputy Director), Mustafizur Rahman (Deputy Director). The project is a collaboration between Bangladesh and Russia, with assistance from Rosatom, the Russian state nuclear energy corporation. It is the first nuclear power plant in Bangladesh. The construction of Rooppur Nuclear Power Plant started in 2017 and is expected to be completed by 2024.It will have two VVER-1200 reactors with a total capacity of 2,400 megawatts. The project aims to enhance the country's energy independence, contribute to its economic development, and provide a reliable source of electricity. As of my last knowledge update in January 2022, the Rooppur Nuclear Power Plant was anticipated to become operational in the coming years, ushering in a new era for Bangladesh's energy landscape. Please verify with up-

to-date sources for the latest information on the project's progress. The main objective of the project is to meet the growing demand for electricity in Bangladesh and reduce the country's dependence on fossil fuels. The plant will help diversify the energy mix and contribute to sustainable development. The project is being implemented under the International Atomic Energy Agency (IAEA) guidelines to ensure safety and security standards. It involves rigorous planning, design, and collaboration with international partners. [12],

2.2.2 Kudankulam Nuclear Power Project:

The Kudankulam Nuclear Power Project, situated in Kudankulam, Tamil Nadu, is a joint venture between India and Russia. It involves the construction of nuclear power plants with VVER-1000 reactors. The primary objective is to address India's growing energy needs by harnessing nuclear power. The project faced scrutiny and protests over safety concerns, but Units 1 and 2 commenced operations in 2013 and 2016, respectively. The Kudankulam project signifies a major collaboration in the field of nuclear energy between the two countriesThe collaboration aimed to address India's increasing energy demands and diversify its energy mix. However, the project faced delays and public opposition, primarily due to safety concerns and environmental considerations. Despite challenges, the Kudankulam Nuclear Power Project has become operational, contributing to India's energy infrastructure. The audit standards utilized were based on various sources, including the Inter Government Agreement between the Government of India and the former USSR, as well as the supplementary Agreement between the Government of India and the Federation of Russia. Additionally, relevant policy decisions of both the GoI and Russian Federation, decisions made by the Board of Directors of NPCIL, the General Framework Agreement (GFA)/ Draft Project Report, the Program Evaluation and Review Technique Chart/ Integrated Action Plan Network, and Site Inspection Reports and related environmental reports were all taken into consideration during the audit process. [17],

2.2.3 2x660 MW Coal Based Thermal Power Plant:

Bangladesh government has announced a new policy called "the Vision 2041". It says that the power supply in 2041 will be 57,238 MW. Because the (PSMP) power system master plan in 2010 indicates, to reduce the rapid depletion of gas and its alternative

system. Adoption. And socio-economic development of Bangladesh in the coal sector to reduce Bangladesh's dependence on natural gas. Even for these power generation, coal will be used initially, which will contribute approximately 20% in the future. On the other hand, Sectors, thinking about the future, has started cooperation at the international level. A Power System Master Plan (PSMP) was made in 2016. It will help in economic growth, fuel supply, and demand-oriented internationalization. This plan is a comprehensive energy plan for Bangladesh. RPCL Power Generation Company is under the Power Department or Ministry of Bangladesh and undertakes to implement the project, which has an area of 371.5 hectares, it acquired land from Dhankhali, Laluar Londa and Nishanbaria Mouza of Kalapara Upazila, Patuakhali District. This project falls under a RED project as per Bangladesh Environment Conservation Regulations. which then started conducting EIA in balance with a ToR approved by DoE with a condition of RPCL Directorate. [14],

2.2.4 Taean coal power plant:

The Taean coal power plant is located in Taean-gun, Chungcheongnam-do, Republic of Korea at latitude 36.9043 ° and longitude 126.2326 °. It is a standard domestic coal-fired thermal power plant with supercritical (SC) and ultra-supercritical (USC) grades. Units 1 to 10 have a total installed capacity of 6100 MW (500 MW × 8 units, 1050 MW × 2 units). Units 1–8 are supercritical power plants and units 9–10 are high-efficiency ultra-supercritical power plants. They utilize sub-bituminous coal as. Initial response to climate change in Republic of Korea was in 2010 with enact of the Framework Act on Low-Carbon Green Growth, to prepare a national climate change energy response system (Ministry of Government Legislation, 2010). Afterward, as the Paris Agreement was signed in 2015, the national greenhouse gas reduction goal was established to reduce 24.4% of total greenhouse gas emissions in 2017 by 2030 (Government of the Republic of Korea, 2020). In the meantime, domestic carbon capture, utilization, and storage (CCUS) technology development has been promoted based on the Korean National CCS (Carbon Capture and Storage) Master Action Plan announced in 2010, but it has not been effectively implemented (Interagency Task Force on CCS, 2010). Thus, in the revised 2030 national GHG reduction basic roadmap, unlike the existing roadmap, the CCUS is differentiated as a separate reduction technology, and integrated into the plan to reduce CO2 by 10.3 million tons using

CCUS (ICT, 2021; Government of the Republic of Korea, 2020). A significant level of financial resources and time is required to introduce the technology with full transition to low-carbon renewable energy by 2030. CCUS technology with utilization of existing facilities would be a bridging technology to reduce greenhouse gas emissions. To reduce CO2 by minimal facility investment, the most realistic approach is to capture and reduce CO2 from point sources. For example, since 1995, when Mitsubishi Heavy Industries and Kansai Thermal Power developed a CO2 capture process utilizing an amine with steric resistance among monovalent amines (Mimura et al., 1995). In addition, the world's largest CO2 capture process research (Petronova, USA – 4776 tons of CO2/day) has recently been conducted for commercial-grade coal-fired power plants (Shimokata, 2018). Regarding the Republic of Korea, since the late 1990s, the Korea electric power cooperation (KEPCO) research institute has conducted CO2 capture researches from the exhaust gas of thermal power plants, a few pilot-scale CCS demonstration projects are in progress as well (Korea Research Institute of Chemical Technology Carbon Resources Institute, 2020). In terms of economic aspect, although CO2 capture at coal power plant poses CO2 reduction potential on central power source, it has higher electricity cost than that of maturing renewable sources. [28],

2.3 Importance

2.3.1 Importance of Rooppur Nuclear Power Plant:

The plant would be essential in supplying Bangladesh with the growing amount of energy it needs. Because of the nation's fast expanding population, dependable and sustainable electricity sources are required. By lowering greenhouse gas emissions, the plant will lessen the effects of climate change. It will support Bangladesh in fulfilling its commitment to the sustainable development goals and the Paris Agreement. Bangladeshi people's quality of life would increase and industrialization and economic progress will be supported by the plant's economical and dependable energy supply. It will strengthen the economy as a whole and generate job opportunities. The Rooppur station is essential for Bangladesh's drawn out energy arranging technique. It assumes a part in gathering the country's future energy needs and tending to the difficulties related with populace development and modern turn of events. It is essential to keep in mind that effective waste management and strict adherence to safety standards are necessary for the successful construction and operation of nuclear power plants. Public

mindfulness, administrative oversight, and worldwide collaboration are critical parts of guaranteeing the protected and capable utilization of thermal power. [16],

2.3.2 Importance of Kudankulam Nuclear Power Project:

The Kudankulam Nuclear Power Project's main goal is to use nuclear energy to meet India's growing energy needs. This joint effort with Russia intends to upgrade India's power age limit, lessen dependence on customary energy sources, and add to a more differentiated energy blend. The venture is important for India's methodology to fulfill expanding power needs and advance economical turn of events. While the overall objective is to give a steady and significant power supply, the undertaking likewise reflects worldwide collaboration in the field of thermal power. Kudankulam Atomic Power Task adds to India's energy security by expanding the country's energy blend. Reduced reliance on fossil fuels and imported energy sources is made possible by nuclear power's continuous and stable supply of electricity. Thermal energy stations, including Kudankulam, are appropriate for base burden power age. They can run continuously, complementing intermittent renewable sources by supplying the grid with a steady supply of electricity. Atomic power is a low-carbon energy source, and the Kudankulam Atomic Power Venture adds to endeavors to lessen ozone harming substance emanations. By providing electricity with a lower carbon intensity than fossil fuels, it contributes to the solution of climate change issues. [19],

2.3.3 Importance of 2x660 MW Coal Based Thermal Power Plant: It's vital to take note of that while coal-based power plants have generally assumed an urgent part in satisfying energy needs, there is expanding worldwide accentuation on progressing to cleaner and more practical energy sources to address ecological worries and environmental change. Thus, the drawn out significance of coal-based power plants might be dependent upon progressing conversations and strategy contemplations connected with natural maintainability and the worldwide shift toward sustainable power. In the monetary year 2013-2014, the power age limit was 11,532 MW and supply was 8,763 MW. 60% of the country's electricity requirements can be met through this. Power development rate is 12% each year. According to PSMP 2016 BPDB, solid power supply situation is recognized to around 71% customers in the country. It is assessed that in 2041 the pace of monetary development will enter the day

to day load bend. As seen in created nations. In this case, as per PSMP 2016, 26000 MW of power can be delivered in 2030. [11],

2.3.4 Importance of Taean Coal power plant:

Inventory development is key to the findings of this research. Therefore, the formation process of the inventory must be clearly illustrated for credibility and understanding of them modelled system, public data opened by KOKEPO are filtered and processed accordingly, to represent a power generation of 1 kWh. Sequentially, the primary data of relevant power plants are utilized to fill in missing information, and research papers and reports are referenced for construction. coal power plants are frequently connected with ecological worries because of the arrival of ozone depleting substances and different poisons. The significance of a coal power plant can be a subject of discussion, particularly with regards to endeavors to progress to cleaner and more maintainable energy sources. Coal power plants can have monetary ramifications, making position in the neighborhood local area and adding to the economy through charges and other monetary commitments. [18],

CHAPTER 3
Methodology

3.1 Methodology:

The purpose of an Environmental Impact Assessment (EIA) is to influence design and to ensure that mitigation measures are focus on the more significant impacts. The process of assessing environmental impacts can be considered in a prescribed manner. The EIA will aim to identify and assess the potential environmental impacts likely to result from the proposed project. These impacts will be assessed both from a temporary, residual and cumulative view point.

The EIA process makes sure that environmental issues are raised when a project or plan is first discussed and that all concerns are addressed as a project gains momentum through to implementation. This methodology provides a framework of interaction of different activities of a project with. potential environmental impacts caused by them. A simple interaction matrix is formed when project. actions are listed on one axis (usually vertical) and environmental impacts are listed along the other axis. EIA is a systematic process to identify, predict and evaluate the environmental effects of proposed actions and projects. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts. Identification of significant environmental issues and how these will be resolved.

Adequacy of mitigate measures and the Environmental Management Plan EIA is a tool used to assess the positive and negative environmental, economic, and social impacts of a project. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impact predict and evaluate the environmental effects of proposed actions and projects. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that

decisions can be taken to reduce the adverse impacts. Identification of significant environmental issues and how these will be resolved. Adequacy of mitigate measures and the Environmental Management Plan.

We have researched various reports in our report, we have presented the related content of air quality, water quality, socioeconomic impact etc eia related areas of this project, our report. With regard to environmental impact assessment, we investigate the environmental impact assessment aspects of these items from various paper books and the internet. We have highlighted the extent to which environmental aspects are valued in our research and which aspects of the environment are given importance. Our findings explain and review how human-made activities affect nature. These projects analyze how different types of planning can affect the region, the positive and negative aspects of the project, how to reduce environmental damage, and how to reduce environmental damage and negative aspects of the project, how to reduce environmental damage, and how different kinds of planning can affect the region.

CHAPTER 4

Results and Discussion

4.1 Result and Analysis of Rooppur Nuclear Power Plant:

4.1.1 Nuclear Waste: The waste from nuclear power plant in Rooppur is a major consideration. The waste from nuclear power plant will be radioactive and the wastes will be radioactive. Radioactive wastes are wastes that contain radioactive material. Around 20–30 tons of high-level wastes is produced per month per nuclear reactor. There are some 65,000 tons of nuclear waste now in temporary storage throughout the U.S., but in 2009, President Obama "halted work on a permanent repository at Yucca Mountain in Nevada, following years of controversy and legal wrangling". There are three types of waste. High–level, Mill Tailings and Low level waste. Among these high level waste is most dangerous. During fission, very harmful radiation rays are released. The most harmful of which are gamma rays. When the human body is exposed to radiation, it can cause tumors and can do extreme damage to the reproductive organs. For this reason, problems associated with radioactivity can be passed on to the victim's children as well. That is why radioactive waste produced by nuclear power plants is so toxic &dangerous. Radioactive fission products could pose a direct radiation hazard, contaminate soil and vegetation, and be ingested by humans and animals. Human exposure at high enough levels can cause both short-term illness and death, and longer-term deaths by cancer and other diseases. So it has seen that radioactive waste can cause a great herm in Bangladesh if any disaster is occur in the future nuclear power plant. But there is nothing to be worried about it. Because there are new waste disposal technologies invented now a day. Bangladesh can use Experimental Breeder Reactor II.A breeder reactor is a nuclear reactor that generates more fissile material in fuel than it consumes. Breeder Reactor II is being developed by Argonne National Laboratory in the US; almost 100% of the transuranic nuclear wastes produced through neutron capture can be caused to fission. Generally, the fission products created have shorter half-lives and are not as dangerous. This reactor, dubbed EBR-II, uses liquid sodium as a coolant, which means that the internal reactor temperature is much, much hotter than that of a normal PWR reactor, which uses water as a coolant.

4.1.2 Population Density: The first and major consideration to set a RNPP is the area and density of the people. According to the international law the radius of the area of nuclear power station is 30Km.The area is divided in to three circular zone with 3.14(30)2=2,826Sqr Km area. According to the zone, zone-1 is reactor area, zone-2 is security area and zone-3 is for planning disaster. The area of zone 1 is a circular area of 3.14 Sq. Km. This area is only for the people who are working with reactors, others entrance is strictly prohibited. The distance of zone-2 is 5 Km away from the center and the total area of is 3.14 (5)2=78.5 sq. Km. This area is prohibited for agriculture and industries and only 3 people can leave per sq. Km that is the total people of that zone will be only 200.The distance of zone-3 is 30 Km from the center. This 30 Km area must be free of population. If there are more people than there will be obstacles for rescuing the people. Developed countries nuclear power stations are free of population. That is for those reactors among 30Km is free from population. [3],

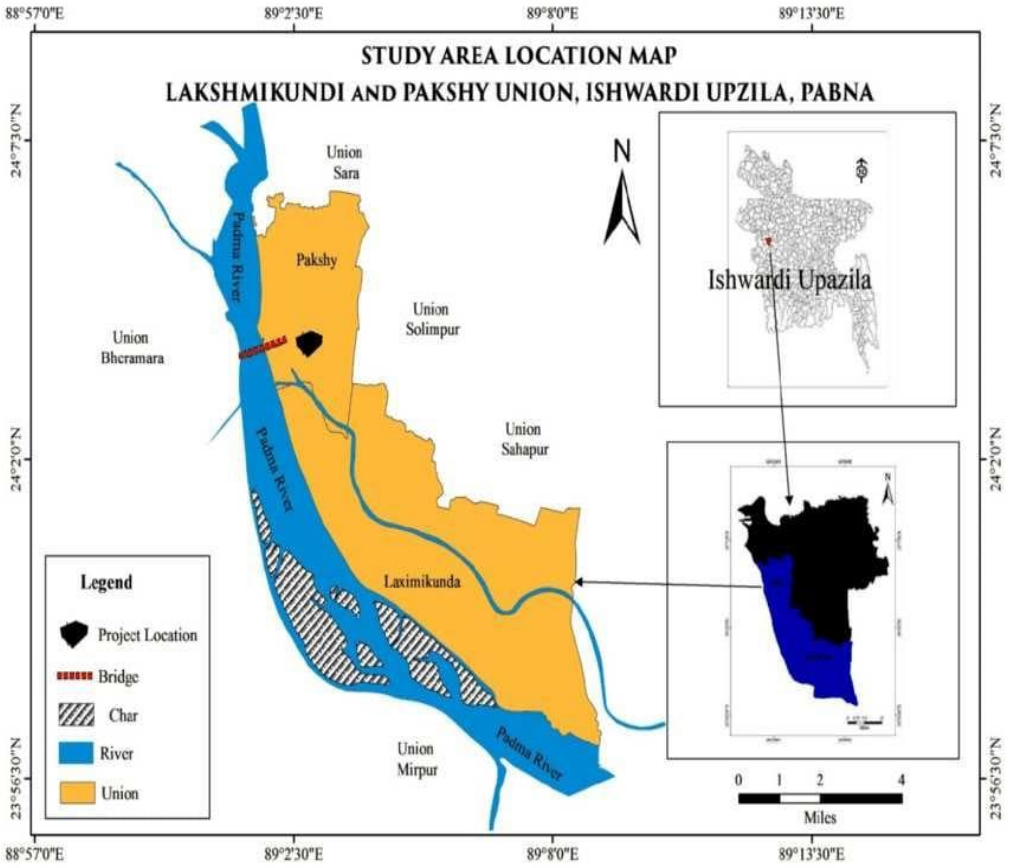


Figure 4.1: Study area Location Map Ihswardi, Pabna

4.1.3 Earthquake & Natural Disasters: The second major problem is earthquake and natural disaster. From the experience of Fukushima Daiichi Nuclear Power plant in Japan 9.0 MW earthquake occurred at 14:46 JST on Friday, 11 March 2011 with epicenter near the island of Honshu. It resulted in maximum ground accelerations of 0.56, 0.52, 0.56 g (5.50, 5.07 and 5.48 m/s2) at Units 2, 3 and 5 respectively, above their designed tolerances of 0.45, 0.45 and 0.46 g (4.38, 4.41 and 4.52 m/s2), but values within the design tolerances at Units 1, 4 and 6. When the earthquake occurred, the reactors on Units 1, 2, and 3 were operating, but those on Units 4, 5, and 6 had already been shut down for periodic inspection. Units 1, 2 and 3 underwent an automatic shutdown when the earthquake struck. When the reactors shut down, the plant stopped generating electricity, stopping the normal source of power for the plant. The subsoil investigations, geotechnical, site specific seismic hazard assessment investigation, any heavy structure like RNPP with the design basis H PGA values above 0.2g-0.25g could withstand a 7.5-9.5 Mw earthquake and can damage the RNPP in future. RNPP will be located in Pabna which is situated in the South-Western Region of Bangladesh and there is no big and wide river which will affect the nuclear power plant even though there is tsunami. [5],

4.1.4 Water Quality: Water Quality Index (WQI) is one of the most powerful and effective tools for analyzing overall characteristics of water quality any reservoirs, its way to transfer information on water quality trends to policy makers and the general public is with Indices. Our objective was to evaluate ground water quality in the Rooppur Nuclear Power Plant (RNPP) area, Pabna, Bangladesh using a Canadian Council of Ministers of the Environment (CCME) WQI. WQI represent a clear scenario about the usability of the water for different purposes. Water quality indices are useful for concise information in order to achieve a national perspective. Attempts have been made to review the WQI criteria for the appropriateness of drinking water sources. Till now any methodology is not developed for evaluation of water quality index purposes in Bangladesh. At the very recent a few researchers try to use WQI method for giving WQ rating in Bangladesh. But, has no specific guideline for indexing water resources. This study to explore a potential WQ indexing method which applies easily and measure overall WQ for managing purposes. Besides, the present article also highlights

and draws attention towards the development of a new and globally accepted " Water Quality Index " in a simplified format, which may be used at large and could represent the reliable picture of water quality. In the present paper, water quality index (WQI) was estimated for the groundwater of Rooppur Nuclear Power Plant area within the study period. The study also identifies the critical pollutants affecting the groundwater quality during the study period. The indices have been computed for the winter season at 17 locations, namely GW1, GW2, GW3 etc. It was found that the water quality ranged from poor to marginal category at all locations. Alkalinity, Conductivity, BOD, DO, Iron, Arsenic, Lead, Nitrite and fecal coliforms were found to be critical parameters. [8],

Components	Relative importance value	Degree of impact	Relative impact	Individual EIV
Environmental Parameters				
Water quality	15	-2	-30	
Aquatic ecosystem	15	-3	-45	
Sound Pollution	2	-1	-2	
Rise of temperature	4	-1	-4	
Forest	8	0	0	-65
Vegetation Cover	8	-4	-32	
Greenhouse emission	15	+5	75	
Particulate matter	4	-2	-8	
Regional ecosystem Change	8	-2	-16	
Aquaculture	10	-3	-30	
River Excavation	8	+3	24	
Socio-Economic Parameters				
Power Generation	18	+5	90	
Economic development	18	+4	72	
Loss of land	10	-2	-20	
Land use change	10	-3	-30	+198
Land Price	5	-2	-10	
Current use of lands/ resources	8	-3	-24	
Infrastructure development	15	+3	45	
Employment	15	+5	75	
Socio-Cultural Parameters				
Migration	20	-4	-80	
Language	8	0	0	
Religion	7	0	0	
Public Health	10	-2	-20	
Culture	10	0	0	-130
Community build up	10	-4	-40	
Social-well being	12	-3	-36	
Cultural heritage	6	0	0	
Knowledge transfer	12	+3	36	
Attitude of the society to the foreign people	5	+2	10	
Total Environmental Impact Value (EIV)				+3

Figure 4.2: Estimation of Environment Impact Value

Table 4.1: Water Quality Parameter

Sample ID	Water Quality Parameter							
	Temp	DO	pH	Alk	Na	Mg	K	Nitrate
GW1	25.5	2.8	7.4	70	10.22	28.29	2.77	0
GW2	22.3	3.2	6.7	170	16.74	28.6	2.85	2.88
GW3	26.2	2.7	7	430	8.47	33.91	4.18	0

4.1.5 Safety Features: The design of Rooppur NPP meets the high level of safety required worldwide for future NPP. The lessons learnt from the major nuclear accidents of Chernobyl, Three Miles Island and Fukushima accidents were incorporated in the design by defense in depth principle. Reliable five layers of barriers prevent the radiation exposure to people and environment even in the worst-case scenario as

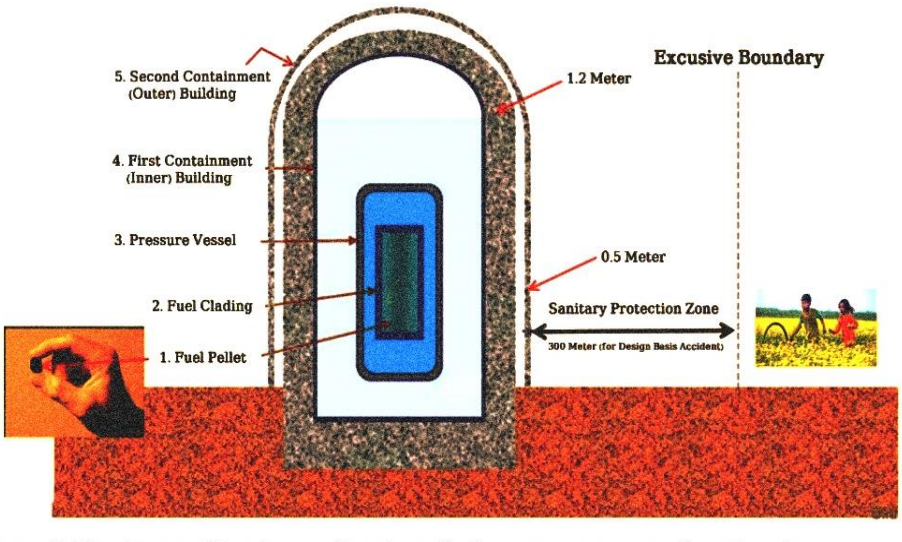


Figure 4.3 Five Layers of barriers against the radiation exposure to people and environment

The safety system of Rooppur NPP is based on active safety systems with both normal and emergency power supply. To prevent severe accidents or mitigate their consequences, passive safety systems are envisaged which function without the involvement of the NPP personnel and do not require any power supply. In case of a severe accident with extreme power loss due to grid failure (like Fukushima NPP accident) the Rooppur NPP will remain safely shut-down for at-least 72 hours without the involvement of external assistance and off-site power supply. The active and passive safety systems with 2 to 4 times redundancy and diversity will make this plant a real safe one. The active safety systems include emergency and planned cool down protection system, high pressure emergency injection system, emergency boron injection system, emergency feed water system, emergency gas removal system, primary and secondary circuit overpressure protection system, spray system, containment isolation system, intermediate circuit and service water supply, ventilation, essential power supply, etc. The passive safety system of Rooppur NPP are: quick boron injection system, emergency core cooling system hydro-accumulators, passive containment heat removal system, passive steam generator heat removal system, hydrogen concentration monitoring and hydrogen passive recombination system inside containment system, molten corium trap and cool down system etc. There will be also emergency power supply system and standby diesel power station etc.

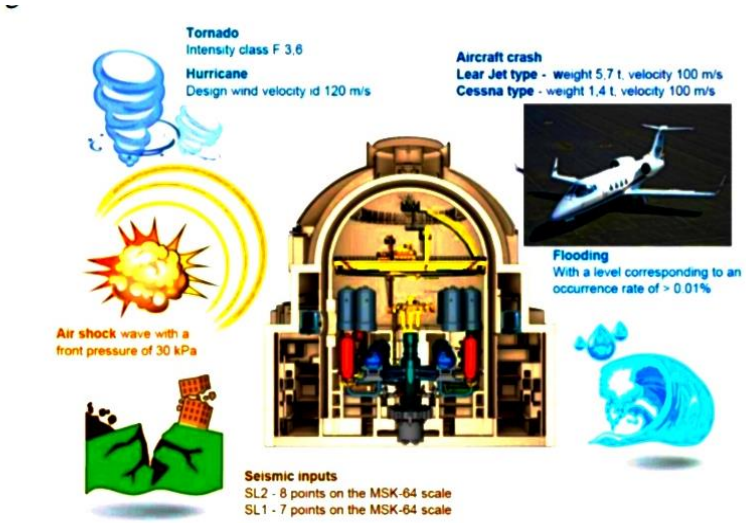


Figure 4.4: Design parameter of Rooppur NPP for Natural and Man-mad Impacts

Radiation safety is organized and implemented to prevent inadmissible effect of ionizing radiation sources on personnel, population and environment in the Rooppur NPP location area. The Rooppur NPP is designed in such a way that it will fulfill the fundamental principles and radiation safety norms, as well as to limit radiation impact on environment so as not to exceed the limits established by national and international organizations. During normal operation, the exposure doses absorbed by the personnel and population, and the release of radioactive substances into the environment shall be kept below the established limits at reasonably achievable and socially and economically justified low level. The radiation consequences of design basis accident in the worst case would be limited within 300 meter at the border of sanitary protection zone maintaining the dose limits as per the regulatory documents. In case of Beyond Design-Basis Accidents, the exposure doses at the boundary of protective measures planning zone and outside will not exceed the permissible level. [20],

4.1.6 Soil Analysis: Terrestrial ecosystems (soil and plants) accumulate artificial radionuclides from emissions of nuclear power plants. In order to control the radiation situation in the vicinity of the Rooppur Nuclear Power Plant (Bangladesh), a system of radio ecological monitoring of terrestrial (mainly agricultural) ecosystems has been created. Radio ecological studies were carried out in 2014–2017 before the start of operation of the Rooppur Nuclear Power Plant. Assessment of specific activity in soil of natural (40K − 750–855, 226Ra − 44–52, 232Th − 63– 75 Bq.kg−1) and artificial (90Sr − 0.5–1.6, 137Cs − 1.2–2.5 Bq.kg−1) radionuclides before the start of operation the Rooppur Nuclear Power Plant has revealed the radioisotope content in the soil being consistent with other areas in Bangladesh. The 137Cs/90Sr ratio in the soil is 1.5–2.8, which is close to the level of global radioactive fallout. Ambient dose equivalent rates in the 30-km zone of influence of the nuclear power plant vary within 0.11–0.15 μSv.h−1 and are determined by the natural background radiation. Agricultural crops of arable land, pastures and orchards accumulate 1.5–2 times more 90Sr compared to 137Cs. The accumulation coefficients of radionuclides by plants are determined by the crops species and soil characteristics. The monitoring system will make it possible to assess long-term changes in the radio ecological situation in the zone of influence of the Rooppur Nuclear Power Plant after the start of its operation.

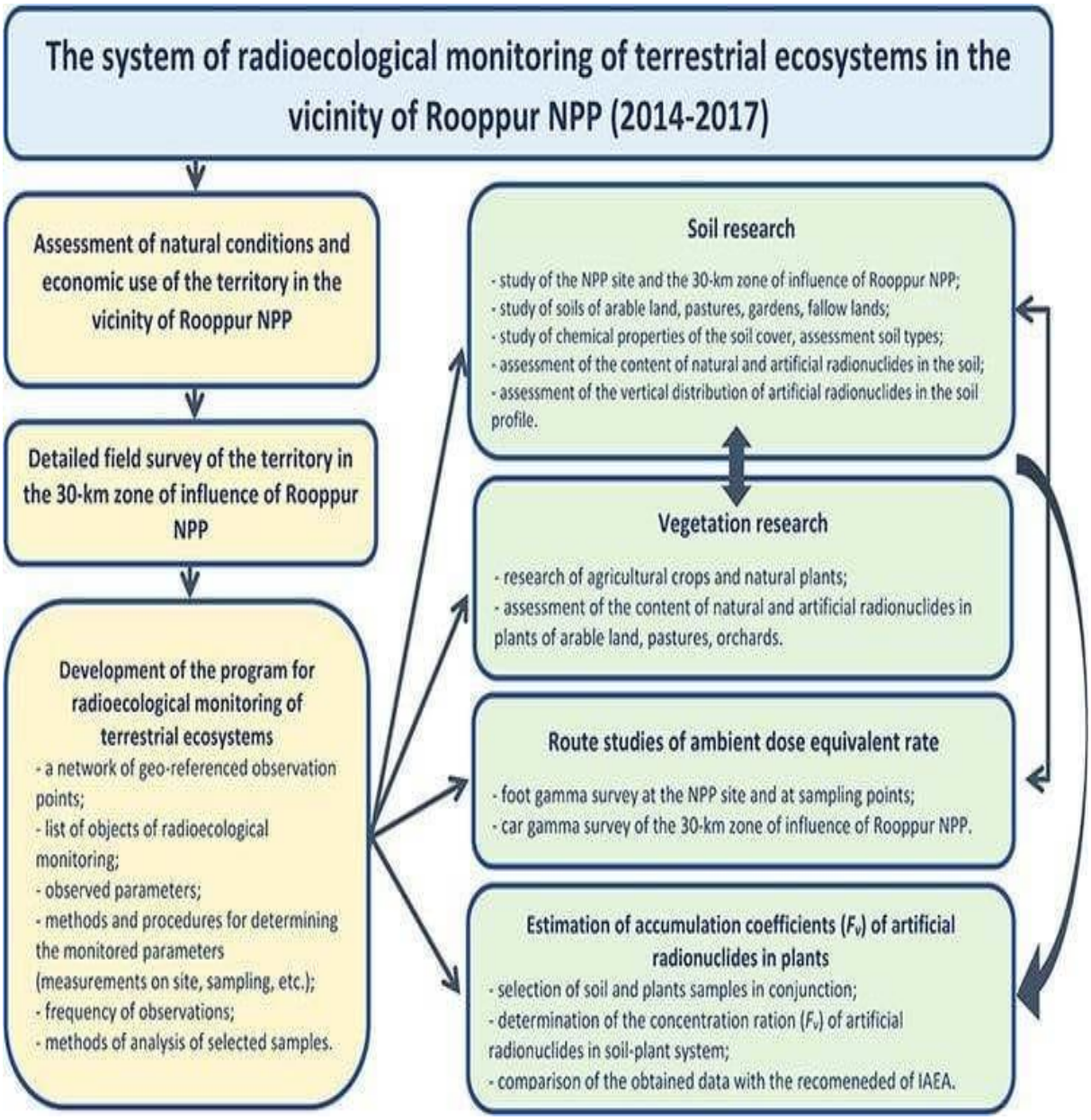


Figure:4.5 The system of radio ecological monitoring of terrestrial ecosystems in the vicinity of Rooppur NPP (2014-2017)

4.2 Result and Analysis of Kudankulam Nuclear Power Plant:

4.2.1 Radioactivity in Soil: Soil samples (470) were collected around the KKNPP site and activity levels of primordial radionuclides (232Th, 238U and 40K) measured using NaI (Tl) gamma ray spectrometer. In soil samples, 232Th activity varied between 18.4 and 2181.6 Bq kg-1 with a mean of 148.1 Bq kg-1 while 238U and 40K were found to be in the range of below detectable limit (BDL) (8.5 Bq kg-1)–453.7 Bq kg-1 and BDL (13.2 Bq kg-1)–1713.2 Bq kg-1 respectively, with a mean of 29.9 and 238.8 Bq kg-1 respectively. [23],

4.2.2 Chemical Oxygen Demand (COD): The COD varied from 32.2 to 72.7 mg/l in bottom waters. The surface waters also showed almost similar values i.e. from44 to 65.1 mg/l

Table 4.2: Chemical Oxygen Demand in seawater

Station	Surface (mg/l)	Middle (mg/l)	Bottom (mg/l)
S1	46.1	65.1	58.1
S2	50.6	42.3	68.3
S3	44.2	64.5	66.4
S4	53.1	46.8	65.7
S5	47.4	56.9	52.5
S6	54.4	64.5	46.8
S7	47.4	45.5	48.7
S8	48.0	41.1	72.7
S9	65.1	42.3	70.2
S10	48.0	55.0	32.2

4.2.3 Biochemical Oxygen Demand (BOD): The BOD values varied from 2.56 to 3.52 mg/l in surface waters and from 0.96 to 2.88 mg/l in bottom water. The range of variation in BOD values indicate that the water column is well mixed in the project.

Table 4.3: Biochemical Oxygen Demand in seawater

Station	Station (mg/l)	Middle (mg/l)	Bottom (mg/l)
S1	**3.52**	**2.72**	**2.56**
S2	**2.56**	**2.56**	**2.40**
S3	**3.20**	**2.88**	**2.24**
S4	**3.20**	**2.56**	**2.88**
S5	**2.72**	**2.72**	**2.08**
S6	**3.04**	**2.08**	**1.76**
S7	**2.56**	**2.24**	**0.96**
S8	**3.04**	**2.56**	**1.92**
S9	**3.20**	**3.04**	**2.72**
S10	**3.52**	**3.04**	**1.92**

Table 4.4: Standard classification of soil sampling analysis

S. No	Soil Test	Classification
1	pH	4.5 Extremely acidic 4.51-5.00 Very Strongly acidic 6.01-6.50 slightly acidic 6.51-7.30 Neutral 7.31-7.80 slightly alkaline 9.01 very strongly alkaline
2	Salinity Electrical conductivity (mm hos/cm) (1mmho/cm = 640 ppm)	Up to 1.00 Average, 1.00-2.00 Harmful to germination 2.01-3.00 Harmful to Crops (Sensitive to salts)
3	Organic Carbon	Up to 0.2: Very less 0.21-0.4: less 0.41-0.5 medium 0.51-0.8: On an average sufficient 0.81-1.00: Sufficient >1.0 more than sufficient
4	Nitrogen (Kg/ha)	Up to 50 very less 51-100 less 101-150 good 151-300 Better >300 sufficient
5	Phosphorus (Kg/ha)	Up to 15 very less 16-30 less 31-50 medium 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient

4.2.4 Air Quality: Ecological Effect Appraisal (EIA) is fundamental to survey the climate earlierto charging the undertaking, and the probable effect of that task on the climate, when it begins usiness activity. Legislature of India is presently developing 2 x 1000 MWe power plants in Kudankulam, Tamil Nadu and influence evaluation concentrate on has been done on different ecological lattices in and around Kudankulam Power Plant region. As a component of the EIA study, air toxins like in this way, NO, CO, suspended particulate matter (SPM) and respirable particulate matter (RPM) were observed in the area of the venture site. This concentrate additionally incorporated the assessment of the current status of the air quality through the examination of created and gathered standard information. [24],

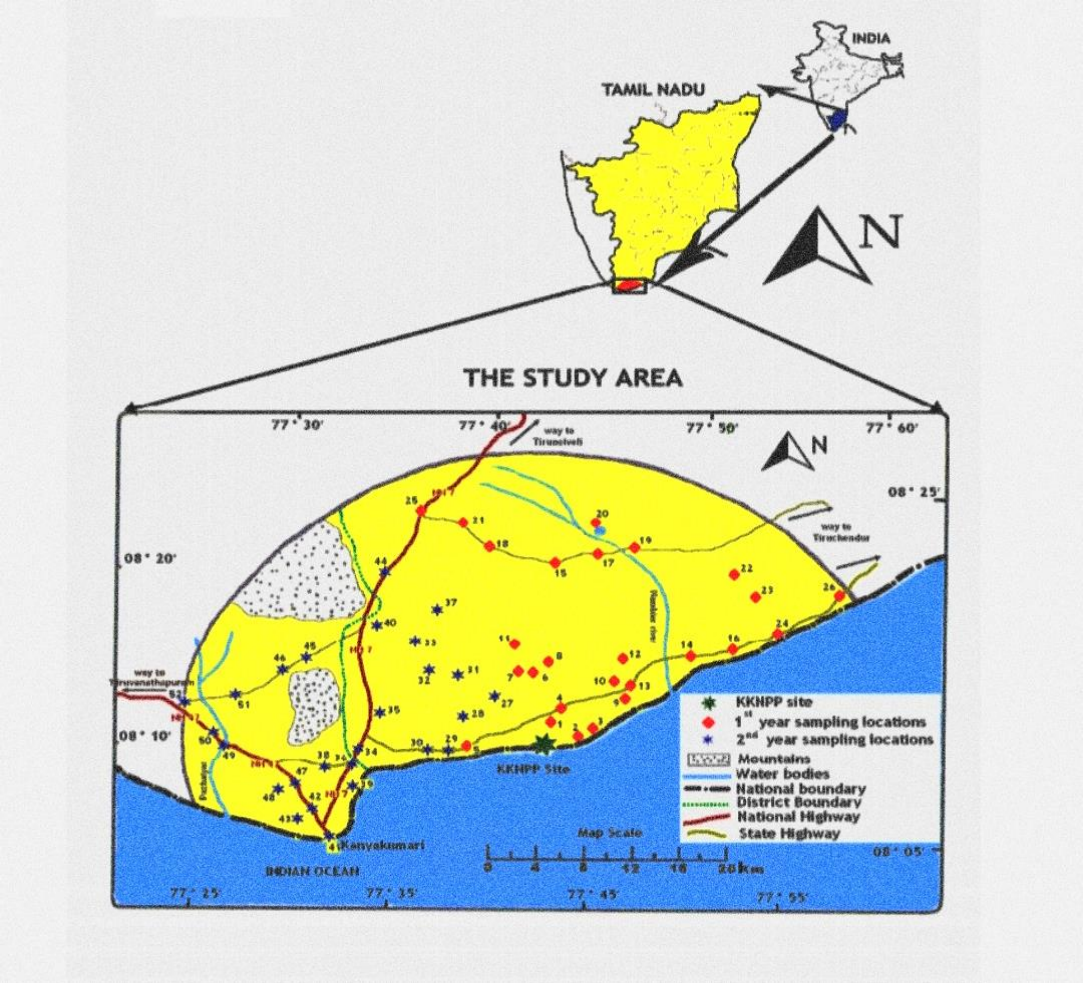


Figure 4.6: Map of the Study area with sampling locations

4.2.5 Waste Management: Tending to the taking care of, stockpiling, and removal of radioactive and non-radioactive waste produced by the plant. Guaranteeing consistence with squander the executives guidelines. The dry strong radioactive waste including compactable and non-compactable waste is pressed into boxes and drums. Drums are utilized for higher movement compactable and non-compactable water. The radioactivity of the dry dynamic waste is supposed to typically go from 0.1 curies each year to 8 curies each year with a limit of around 16 curies each year. This waste incorporates spent central air channels, compressible rubbish, non-compressible parts, blended squanders and cemented synthetic waste.

4.2.6 Noise Modeling Studies: The main sources of noise in the nuclear power plant are 1) Turbines, 2) Air Compressors, 3) Cooling water pump, 4) Diesel Generators, 5) Reactor Coolant pump, 6) Intake Ventilator, 7) Exhaust Ventilator, 8) Pump House Equipment, 9) Chillers, 10) Vents, 11) Exhaust Fans and 12) Heavy and medium automobiles moving around the plant. The noise levels likely to be generated by these sources are presented in. It is likely that improved technology may further reduce the noise levels. Most of the machines will be working continuously round the clock during operation of the nuclear power plant. However, these machines would be housed in acoustic enclosures / buildings such that they would not be contributing any additional noise levels in the surrounding environment. [9],

Table 4.5 Source of noise generating equipment and distance from noise source.

S No.	Source	Noise Levels Range-dB(A)	Distance-From Noise Source
1	Turbine	94-96	5 m
2	Diesel Generator	92-98	2m
3	Air Compressor	92-98	2m
4	Cooling water Pump	89-95	2m
5	Reactor Colant Pump	89-95	2m
6	Intake Ventilators	94-97	5m

4.2.7 Hazardous Chemicals: Modern exercises, which produce, treat, store and handle perilous substances, have a high risk potential imperiling the security of man and climate at work spot and outside. Perceiving the need to control and limit the dangers presented by such exercises, the Service of Climate and Timberlands have informed the "Production Capacity and Import of Dangerous Synthetic substances. Rules "in the year 1989 and accordingly altered, embedded and added various statements in the expressed rule to make it more severe. For compelling execution of the standard, Service of Climate and Woodlands has given a bunch of rules is addition to other aspects, the guidelines specify the procedure and the responsibilities that must be carried out by the occupier. The standard additionally drills down the industrial exercises and synthetics, which are expected to be viewed as dangerous. The Light Water Reactor, a nuclear power plant, is being planned for the proposed project.

4.2.8 Solid Radioactive Waste Management System: Drums and boxes are used to transport the compactable and non-compactable dry solid waste. Drums are utilized for higher movement compactable and non-compactable squanders. It is anticipated that the radioactivity of the dry active waste will typically range between 0.1 curies and 8 curies per year, with a maximum of approximately 16 curies per year. This waste incorporates spent air conditioning channels, compressible junk, non-compressible parts, blended squanders and hardened compound wastes compactable and non-compactable waste are stuffed into boxes and drums. Drums are utilized for higher movement compactable and non-compactable squanders. The radioactivity of the dry dynamic waste is supposed to regularly go from 0.1 curies each year to 8 curies each year with a limit of around 16 curies each year. This waste incorporates spent air conditioning channels, compressible rubbish, non-compressible parts, blended squanders and cemented substance waste. The strong squander the executive framework is intended to gather and aggregate spent particle trade gums and profound bed filtration media, spent channel cartridges, dry dynamic squanders, and blended squanders produced because of ordinary plant activity, including expected functional events. The dry strong radioactive waste involving compactable and non-compactable waste are pressed into boxes furthermore, drums. The volume of radioactive waste will be routinely observed and guaranteed that they are well underneath limit as specified by the Nuclear Energy Administrative Board. [25],

4.2.9 Air Climate: The poisons like Suspended Particulate Matter (SPM), PM10, PM2.5, SO2, NOx and ozone for the current land are to be checked. A deliberately planned air quality reconnaissance program frames the reason for influence appraisal on air climate because of proposed project exercises. According to NAAQS (2009), the selection of representative sampling locations, adequate sampling frequency, monitoring duration, and monitoring of all relevant and important pollution parameters are the primary considerations when designing such a program. The boundaries chose for air quality are SPM, PM10, PM2.5, Sulfur Dioxide (SO2), Oxides of Nitrogen (NOX) and Ozone (O3).

Component	Parameters	Location / Frequency of Monitoring	No. of Samples / year (Locations X Monitoring Frequency)	Monitoring Cost / Year (Rs.)
Air	SO_2, NO_x, PM_{10} & $PM_{2.5}$	At four locations, one at project site and three at 120 degrees in nearest adjacent villages. Once in a season (except monsoon) per year for 5 years	4 x 3	12x16000 = 192000/-
Water	Surface Water: CPCB surface water criteria; Ground Water: IS:10500	Two surface water, up-stream and downstream of project site. Two Ground Water: Up-gradient and Down-gradient of project site.	4 x 3	12x20000 = 240000/-
Noise	Noise Levels Leq (A)	At four locations, one at project site and three at 120 degrees in nearest adjacent villages. Once in a season (except monsoon) per year for 5 years	4 x 3	12x6000 = 72000/-

Figure 4.7: Environmental Monitoring Programme

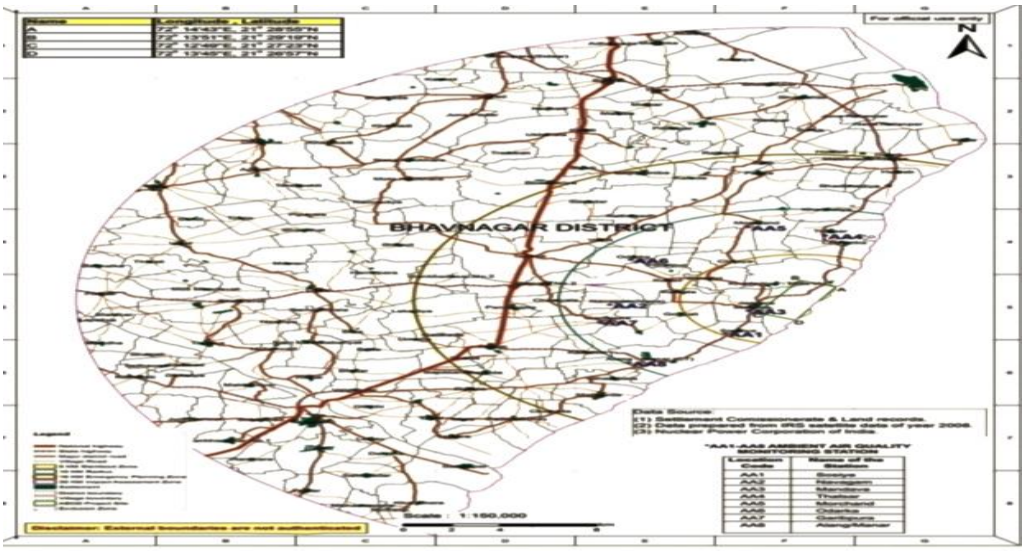
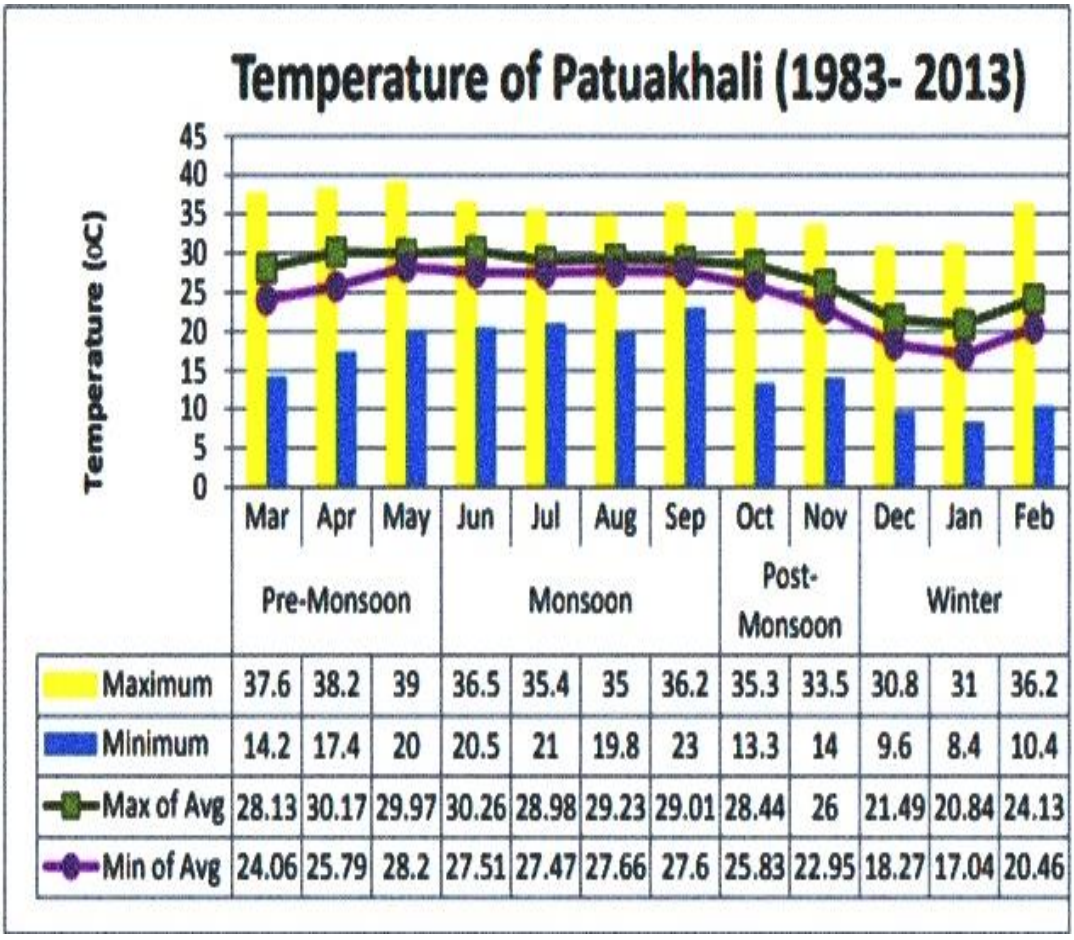


Figure 4.8: Map showing Ambient Air quality monitoring stations

4.3 Result and Analysis of 2x660 MW Coal Based Thermal Power Plant to be Constructed at Kalapara, Patuakhali:

4.3.1 Temperature: The Patuakhali Station temperature does not fluctuate significantly. Data from 1983 to 2013 show that the monthly maximum temperature ranges from 30.8°C to 39°C, with May being the warmest month during the pre-monsoon period. The month to month least temperature fluctuates inside a scope of 8.4°C to 23.0°C, and January is the coldest month. The most noteworthy recorded greatest temperature during the last 30 years is 39°C happened in May, 1990 and the most reduced at any point recorded least temperature is 8.4°C first happened in January, 2013. The month to month most extreme, least and normal temperature of the last 30 years (1983-2013) are given in the trend of annual maximum and minimum temperature of Patuakhali, which reveals that the winter season is getting colder and the summer, in contrast, is becoming hotter over time.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	37.6	38.2	39	36.5	35.4	35	36.2	35.3	33.5	30.8	31	36.2
Minimum	14.2	17.4	20	20.5	21	19.8	23	13.3	14	9.6	8.4	10.4
Max of Avg	28.13	30.17	29.97	30.26	28.98	29.23	29.01	28.44	26	21.49	20.84	24.13
Min of Avg	24.06	25.79	28.2	27.51	27.47	27.66	27.6	25.83	22.95	18.27	17.04	20.46

Figure 4.9: Monthly Maximum, Minimum and Average temperature (1983-2013)

4.3.2 Ambient Air Quality: The air nature of the review region is explored through standard testing interaction and research facility examination. A portion of the brickfields were found in the Itabaria Towns. RPCL is fostering the land through dug ruin from the Andharmanik Waterway. Discharge from the brickfields, little cars, motor van, weighty vehicles on the Barisal-Kuakata parkway, vessels in the Rabnabad, Andharmanik Stream and RPCL power plant advancement exercises are the significant wellsprings of contamination of the air in the review region. In addition, continuous precipitation eliminates any confusion routinely. Four destinations inside the review region have been chosen explore the surrounding air quality. The area has been chosen depending on the breeze course, area, and awareness and contamination possibility for future observing. All the tests were collected for 8 hrs. shows the encompassing air quality like SOx, NOx, PM2.5, PM10, CO, O3 andCO2 and so forth. at the chose points of the review region. On the day that the samples were taken, it was a clear, sunny day, and the wind was blowing in a relatively calm direction. For the estimation of emissions, the chemical composition of the fuel (coal) used in the proposed power plant is very important. Carbon dioxide (CO2), nitrogen oxides (NOx), sulfur oxides (SOX), carbon monoxide (CO), and particulate matter are among the pollutants released from the coal-burning stacks. The goal of the air quality displaying study is to (I) First evaluate the pattern condition in the air-shed, (ii) Second, survey the effect on air quality because of venture case, which incorporates outflows from the 1320 MW coal based power plant (counting line sources and block kline) and RPCL 1320 MW Power Plant discharges and (iii) At last, survey the total effect, including future proposed advancements in the air shed. USEPA administrative model CALPUFF is utilized to anticipate the impact on encompassing air quality SO2, NO2, CO, PM2.5 and PM10 discharges. There are a wide range of scattering models accessible, however CALPUFF was utilized in light of the fact that (I) it is intended for long-range examination, in excess of 50 kilometers from the source, (ii) it can precisely display both basic and complex territory, (iii) can show metropolitan and rustic regions, and (iv) different point, line, region, and volume sources can be displayed. This appraisal is finished as a piece of ESIA investigation of 1320 MW Coal based nuclear energy station to be built at Kalapara, Patuakhali Region to meet the consistence prerequisite of the Public authority of Bangladesh (GoB)and secure endorsement of the DoE to carry out the venture. [10],

Figure 4.10: Ambient air at different locations around the project site

Sl	Sample Location	Coordinates		Concentration present of different parameter in ambient air ($\mu g/m^3$)						
				$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	CO ($\mu g/m^3$)	O_3 (ppm)	CO_2 (ppm)
1	Itbaria village	21°58'36.9" N; 90°15'49.4"E	Dry	62	182	23	18	54	0.004	683
			Wet	5	10	10	6	51	0	554
2	Londakheyagha t, Dhankhali	22°00'43.7" N; 90°16'41.3"E	Dry	48	149	24	20	63	0.004	648
			Wet	11	23	8	9	49	0	612
3	Islampur, Pujakhola	22°02'39.3" N; 90°16'26.3"E	Dry	65	172	27	24	61	0	685
			Wet	6	25	7	6	55	0	633
4	Dhankhali Ashraf Academy	22°01'54.8" N; 90°19'5.9"E	Dry	48	106	24.5	22	70	0.001	664
			Wet	7	17	9	9	54	0.002	607
	Method of Analysis			Gravimetric	Gravimetric	West-Gaeke	Jacob & Hochheiser	CO Meter	O_3 Meter	CO_2 Meter
	Test Duration (minutes)			480	480	480	480	480	480	480
	DoE Standard for ambient Air quality			65 (24hr)	150 (24hr)	365 (24hr)	100 (Annual)	10,000 (8 hrs)	157 (8 hrs)	NF
	IFC/WB Standard			75 (24hr)	150 (24hr)	125 (24hr)	40 (Annual)	NF	160 (8 hrs)	NF

Source: CEGIS, 2015

Figure 4.10: Ambient air at different locations around the project site

4.3.3 Impacts on Socio-Economic Issues: Because electricity is the primary requirement for industrial development, the project's implementation will guarantee employment opportunities for both communities and the nation. This Task will empower in laying out ventures which will clearly give work open doors to an enormous number of populace. The affected individuals might confront a brief joblessness circumstance. Recently created businesses might show up as serious areas of strength for an of work. Land cost of the adjoining region of the undertaking will increment essentially. The deal worth of land will be expanded because of migration of individuals as well as specialized individuals around here. Various new enterprises might be created for the accessibility of power to satisfy the need of ventures. Climate particularly water and disinfection might be upset by the works. Wellbeing injury might be happened in power plant for treatment of weighty hardware. Effect of Non Dangerous waste: In general, the proposed power plant's effluents would include oily water from the turbine hall and substation yard, boiler blowdown, cooling tower blowdown, back flash from the ion exchanger and iron filter of the water treatment

plant, floor and yard drains (for cleaning), and so on. Typically, chlorine, chromium, copper, iron, zinc, and heavy metals are present in this waste water.

4.3.4 Noise level: Noise pollution, or sound pollution, is the propagation of noise or sound with ranging impacts on the activity of human or animal life, most of which are harmful to a degree. The source of outdoor noise worldwide is mainly caused by machines, transport and propagation systems.

Sl. No.	Measuring Location	Coordinates	Noise Level (dB)	
			Day	Night
1	Payra Port Administrative office	21°59'26.34"N 90°16'38.13"E	63	42
2	Lalua	21°59'13.70"N 90°17'30.43"E	52	35
3	Londaghat	22° 0'24.16"N 90°16'27.18"E	60	45
4	Londa Bazar	22° 0'38.93"N 90°16'45.20"E	63	46
5	Londa (East of RPCL)	22° 0'18.84"N 90°17'5.67"E	58	48
6	Madhu Para (S-W of RPCL Project)	21°59'47.66"N 90°17'16.82"E	57	41
7	Madhu Para (South of RPCL Project)	21°59'40.63"N 90°17'37.06"E	61	40
8	Madhu Para (South of RPCL Project)	21°59'32.60"N 90°18'4.37"E	54	44
9	Char Nishanbaria	21°59'4.41"N 90°18'23.11"E	65	50
10	Char Nishanbaria (S-E of RPCL Project)	21°59'26.05"N 90°18'34.43"E	51	46
11	Char Nishanbaria (E of RPCL Project)	21°59'53.86"N 90°18'43.75"E	43	35
12	Gondamari	22° 0'17.36"N 90°18'36.16"E	54	45
13	Gondamari (Proposed Approach Jetty Road)	22° 0'43.74"N 90°18'33.65"E	49	38
14	Debpur (E-of the Proposed power plant)	22° 1'18.76"N 90°18'53.24"E	47	35
15	Dhankhali (South of the proposed Project)	22° 0'53.21"N 90°18'5.61"E	45	40
16	Londa (Proposed resettlement village)	22° 0'49.51"N 90°17'40.93"E	43	35
17	Londa (East side community near the Tiakhali Khal)	22° 1'24.98"N 90°16'30.21"E	48	42
18	Londa (Opposite site of Pujakhola)	22° 2'8.96"N 90°16'57.00"E	50	33
19	Dhankhali (East side of the proposed project)	22° 2'3.18"N 90°18'28.13"E	46	30
20	Dhankhali Bazar	22° 2'6.52"N 90°19'15.69"E	56	50

Figure 4.11: Noise level at different locations around the projects area

4.3.5 Influences on Fisheries: Unintentional spillage of untreated effluents and spillage of HSD oil from transport/ freight into the close by stream, Khal and untamed water fish natural surroundings might make driving corruption of the catch fish natural surroundings. The local capture fisheries may suffer if this contaminated effluent is loaded continuously. Coal based power plant tends to emanate weighty metals during creation enough said. In the event that the squanders and exhaust are delivered untreated way it will cause a serious contamination in encompassing fisheries assets. Reflection of stream water at the pace of 1400 m3/hr for working power plant might cause emergency for stream water accessibility during dry season around the Task site. This episode may cause the decrease of fish efficiency of the catch territories. Withdrawal of another 1400 m3/hr for every one of two power plants might additionally exasperate what is going on.

4.3.6 Safety and Health at Work: Air contamination the executives plan incorporates activity and support of kettle, ESP; stack must be completed consistently according to guidance referenced in the maker's upkeep manual. Simultaneously, the nature of the coal must be kept up with according to plan of the evaporator. In order to determine whether or not the ash handling system complies with the standard, it must be inspected and tested on a regular basis. Ordinary examination of heater, FD and ID fans, partition and taking care of framework and other ancillaries will likewise be examined and tried consistently whether this level remaining parts lower than the passable breaking point. Wellbeing measures will must be guaranteed for all parts and frill all through the whole life time of the undertaking. During activity stage, the air quality will be estimated through Constant Discharge Checking Framework (CEMS) which will be arranged on the fireplace pipe conduit (not wind safeguard). CEMS will keep an eye on the PM2.5, PM10, SO2, and NOx from stack emissions. Typically, air quality needs to gauge at the places where the pipe gas stream is laminar. This will be at the very least distance of 2D from the section point where it becomes laminar and 8D from top. The D is breadth of vent can.

4.3.7 Development of Environmental and Social Management System: The EMP of the EIA report will guide the environmental and social aspects of the project during pre-construction and operation stage of the project. During the approval process of EIA, DoE will also make certain condition for better performance of the project. The

proponent will also develop of its own EHS policy. The EPC contractor has its own policy during construction phases. Combining those policies, detail design, DoE conditions and EMP of the EIA study, a site specific environmental and social management system (ESMS) will be developed before initiation of the construction works. This ESMS will regularly check and updated through the findings from the environmental and social monitoring reports and stakeholder consultation findings and suggestion from the regulatory authorities. [28],

4.3.8 Water Quality:

Table 4.6: Result of the water quality in the study area (In- situ) [2]

Sample Source	Location of sampling	season	pH	DO ppm	EC ppm	TDS ppm	BOD5 ppm	Salinity
GW-1	Near the Outlet of Majher Khal (from80 feet dept)	Dry	7.77	1.4	1140	570	-	0
		Wet	6.91	0.9	0.05	87	-	0
GW-2	Near to the mosque outside project area(from 110 feet depth)	Dry	8.17	2.7	1110	550	-	0
		Wet	7.3	0.8	0.05	88	-	0
SW-1	Payra Port Authority	Dry	7.75	6.3	-	-	2.5	2.2
		Wet	7.58	7.1	0.28	165	1.4	0
SW-2	Tiakhali Khal	Dry	7.9	5.6	-	-	2.0	0.5
		Wet	7.24	5.5	0.38	276	2.1	0
SW-3	Tiakhali Khal	Dry	7.9	5.3	-	-	2.2	2.0
		Wet	7.75	7.3	0.23	173	2.0	0
SW-4	Shonirvar Khal	Dry	7.8	4.2	300	140	2.4	0
		Wet	7.68	6.9	0.15	111	2.5	1.0

Table4 .7: Result from the water quality in the study area [2]

S.L	Water Quality Parameters	Season	SW1	SW2	SW3	SW4	SW5	SW6
1	Alkanity	Dry	108	107	108	80	115	90
		Wet	88	80	78	73	63	65
2	Arsenic	Dry	0.002	0.001	0.003	0.003	0.002	0.002
		Wet	0.002	0.003	0.003	0.001	0.002	0.001
3	Calcium	Dry	77	79	75	18	61	59
		Wet	28	15	19	20	10	17
4	COD	Dry	40	32	40	36	28	16
		Wet	28	4	8	8	4	4
5	Chloride	Dry	1588	2280	32767	40	1240	1142
		Wet	20	24	17	13	12	11
6	Iron	Dry	3.21	160	155	138	140	123
		Wet	7.48	0.78	1.17	1.97	1.16	1.15
7	Lead	Dry	0.026	0.052	0.182	<LOQ	0.02	0.047
		Wet	0.007	0.005	0.010	0.006	0.006	0.005
8	Magnesium	Dry	61	63	64	19	53	55
		Wet	13	11	11	5	8	4
9	Mercury	Dry	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
		Wet	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
10	Nitrogen	Dry	0.5	1	0.4	0.7	0.3	0.9
		Wet	7.31	9.81	11.07	13.16	10.33	17.10

4.4 Result and Analysis of Taean Coal Power Plant:

4.4.1 Air Quality: The 12 operating coal-based power plants listed in are estimated to emit 45.4 kilotons (kt)of SO2, 48.1 kt of NOx, and 3.0 kt of particulate matter (PM) pollution every year. With the 4 plants under construction, the annual emissions load increases to 55.3 kt of SO2, 56.5 kt of NOx, and 4.7 ktPM. Existing and projected pollution contribute significantly to outdoor air quality in South Koreaand in surrounding areas. Based on the results of the CALPUFF modelling, pollution from the coal-fired plants that exceeds maximum 1-hour concentrations of NO2 above the 200 µg/m3 threshold affects 5,800 people in an area of 34 km2. Maximum 1-hour concentrations for SO2 have an even greater effect with 140km2above the recommended 211.267 µg/m3 threshold. Exposure to SO2 exceedances is estimated at23,000 people. [4],

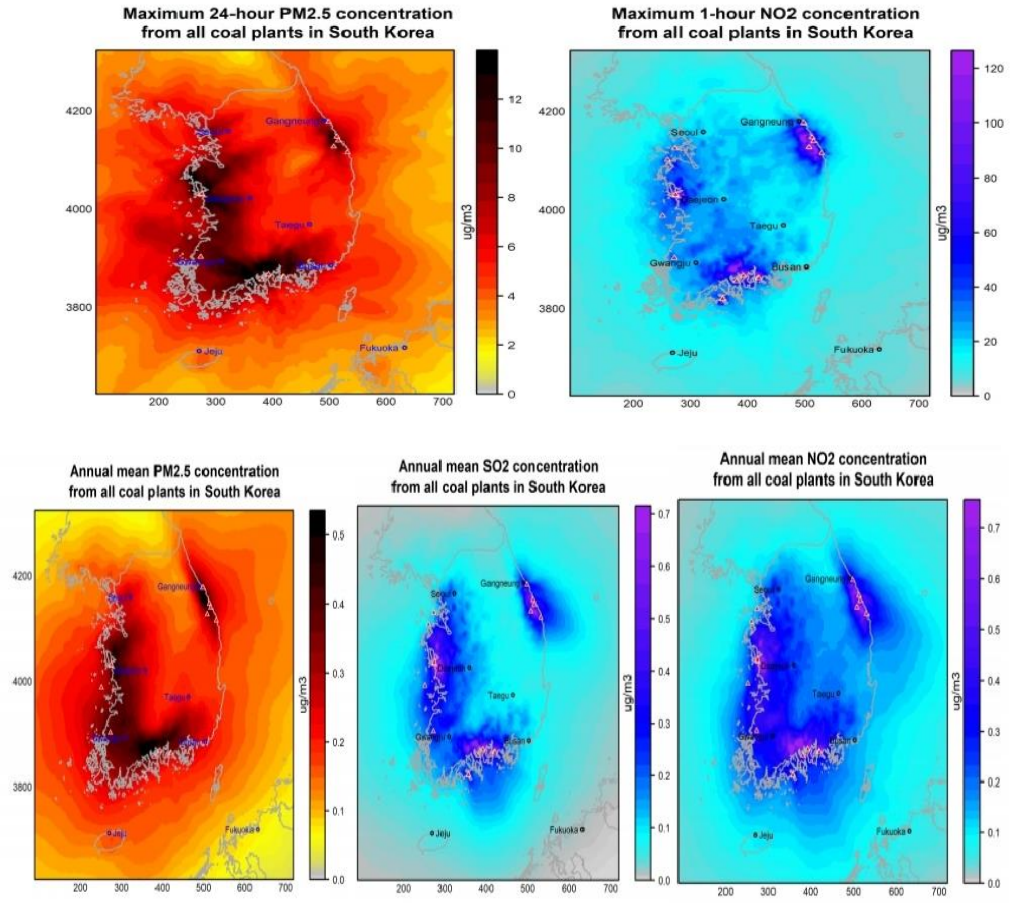


Figure 4.12: Annual mean concentrations from the modelled power plants.

4.4.2 Effects on Health: The creators gauge that the functional and arranged coal power plants in the concentrate on outcome in-approximately 720 unexpected losses the nation over each year. The expense of these health impacts on the economy is assessed at USD 1.03 billion (KRW 1.2 trillion) consistently. Larger part of these influences are from the presently working armada; Isolating the health impacts per plant, the highest impacts come from power plants with the highest capacities, specifically the 6040 MW Dangjin power plant, which is responsible for 210 premature deaths both inside and outside the plant. However, if the 7 GW of planned projects are not operationalized, more than 60 premature deaths and a cost of $90 million could be avoided annually. [22],

	work absence (sick leave days)	new cases of asthma in children	premature deaths	asthma emergency room visits	Preterm Births
Boryeong	50,667 (43,103 - 58,181)	35.3 (7.6 - 79.9)	122.7 (78.8 - 171.2)	70.6 (43.6 - 97.4)	18.6 (9.0 - 19.7)
Bukpyeong	11,044 (9,395 - 12,682)	8.8 (1.9 - 19.9)	30.9 (19.8 - 43.2)	16.4 (10.1 - 22.6)	4.5 (2.2 - 4.8)
Dangjin	79,829 (67,911 - 91,667)	64.9 (14.0 - 146.7)	209.4 (132.9 - 293.8)	112.4 (69.3 - 155.0)	29.4 (14.3 - 31.3)
Donghae	6,218 (5,290 - 7,140)	1.4 (0.3 - 3.1)	12.1 (8.5 - 16.1)	9.0 (5.5 - 12.4)	2.4 (1.2 - 2.5)
Gangneung Anin	10,318 (8,777 - 11,848)	4.9 (1.1 - 11.0)	24.2 (16.2 - 33.3)	15.7 (9.6 - 21.6)	4.4 (2.1 - 4.7)
Goseong Hi	19,721 (16,777 - 22,646)	7.9 (1.7 - 17.9)	43.2 (29.4 - 58.3)	27.0 (16.7 - 37.3)	7.0 (3.4 - 7.4)
Hadong	52,717 (44,847 - 60,534)	29.1 (6.3 - 65.8)	125.1 (83.0 - 171.1)	72.0 (44.5 - 99.2)	18.3 (8.9 - 19.5)
Honam	14,532 (12,363 - 16,687)	7.5 (1.6 - 16.9)	33.3 (22.1 - 45.8)	20.2 (12.4 - 27.8)	5.5 (2.6 - 5.8)
Samcheok Green Power	5,235 (4,453 - 6,011)	5.4 (1.2 - 12.2)	16.3 (10.2 - 23.0)	7.7 (4.7 - 10.6)	2.1 (1.0 - 2.2)
Samcheok POS Power	11,192 (9,521 - 12,852)	4.7 (1.0 - 10.7)	25.2 (17.0 - 34.2)	16.4 (10.1 - 22.6)	4.4 (2.1 - 4.7)
Samcheonpo	35,245 (29,983 - 40,472)	23.5 (5.1 - 53.2)	89.7 (58.6 - 123.6)	48.3 (29.8 - 66.5)	12.4 (6.0 - 13.1)
Shin Boryeong	19,536 (16,619 - 22,433)	7.4 (1.6 - 16.8)	39.8 (26.8 - 54.2)	27.3 (16.8 - 37.6)	7.2 (3.5 - 7.6)
Shin Seocheon	9,977 (8,488 - 11,457)	4.1 (0.9 - 9.2)	20.5 (13.7 - 28.1)	14.0 (8.6 - 19.4)	3.9 (1.9 - 4.1)
Taean	61,066 (51,949 - 70,122)	37.5 (8.1 - 84.7)	141.2 (91.1 - 197.2)	86.5 (53.3 - 119.4)	23.7 (11.5 - 25.2)
Yeongheung	61,926 (52,681 - 71,109)	44.0 (9.5 - 99.6)	162.5 (104.9 - 226.0)	87.1 (53.8 - 120.2)	22.7 (11.0 - 24.1)
Yeosu	2,084 (1,773 - 2,393)	3.1 (0.7 - 7.0)	7.5 (4.5 - 10.8)	2.9 (1.8 - 4.0)	0.8 (0.4 - 0.8)

Figure 4.13: Estimated annual health outcomes both within and outside of South Korea in 2019, per power plan

4.4.3 Water quality: This study intends to evaluate the pollution of water and fish with nine metals (Fe, Al, Pb, Cu, Zn, Disc, Ni, As, and Cr) produced by four coal-terminated power plants in Chungcheongnam-do, Korea. During the summer and fall, samples were collected at locations close to each coal-fired power plant. Additionally, control samples were gathered for comparison with study samples. In water, metal concentrations ranged from 0.01 to 4,654 g/L. Noncarcinogenic and cancer-causing gambles are related with human openness to Pb and As. Dealing with the presence of metals in the water climate is vital for safeguarding the sea-going environment. As per the World Wellbeing Association (WHO) [11], components are arranged as fundamental components (Zn, I, Mo, Cu, Se, and Cr), likely fundamental components (Mn, Si, Br, V, and Ni), and possibly poisonous components (Pb, F, Hg, Al, and As). Albeit some follow metals are important for the body, a few components have unfavorable impacts when the individual is overexposed also, might be lethally harmful, even in modest quantities. Accordingly, metal pollution from coal-terminated power plants should be made due. Fundamental components, for example, Zn and Cu are parts of numerous proteins, which play parts in the safe framework, reactant and primary capabilities, detoxification, cancer prevention agent impacts, pigmentation, and melanin creation. [21],

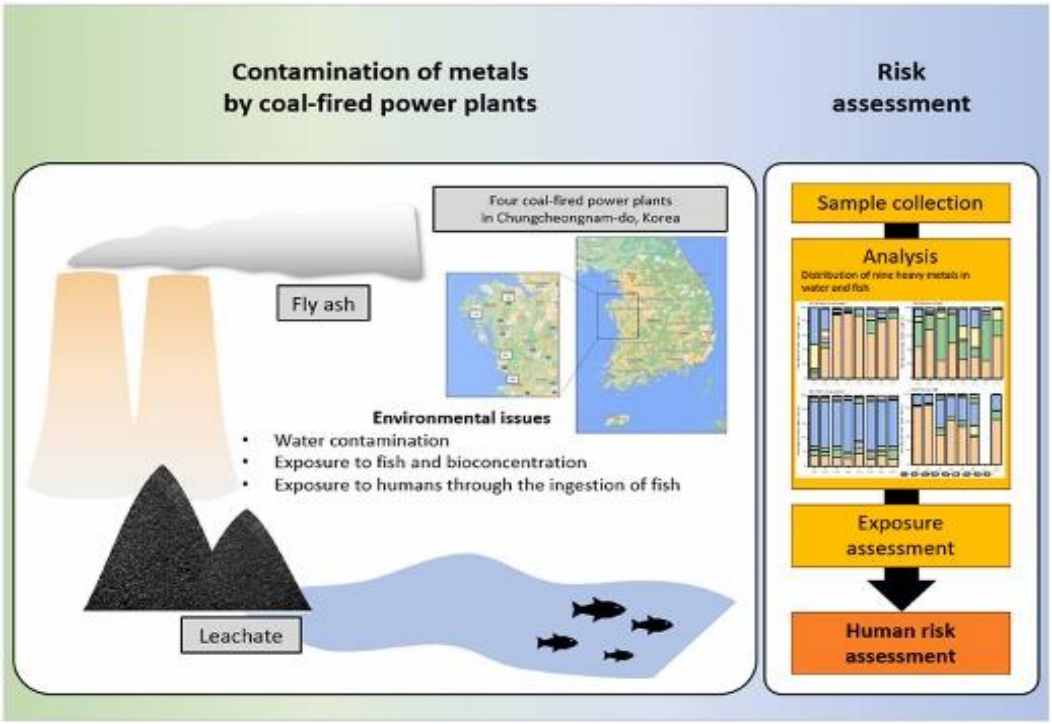


Figure 4.14: Contamination of metals by coal-fired power plants

4.4.4 Impact on the Environment: The audit sums up the drawn out observing consequences of HSOS EIA zeroed in on contamination status of seawater, dregs, and bivalves, eco toxicological impacts, what's more biological system recuperation. By and large, groupings of petrol hydrocarbons in the climate shown that their fixations were well down to at or close to foundation or pre-spill defilement levels all things considered locales after 1â year. The likely harmful impacts of lingering oils in dregs have diminished to foundation levels in most waterfront areas of Taean. The whole environment in the most impacted region of the Taean coasts give off an impression of being impressively, however not completely, recuperated as of now, in particular after 8â long stretches of the HSOS. The presence of waiting oil and raised pollution levels at a few destinations actually require nonstop long haul checking. [27],

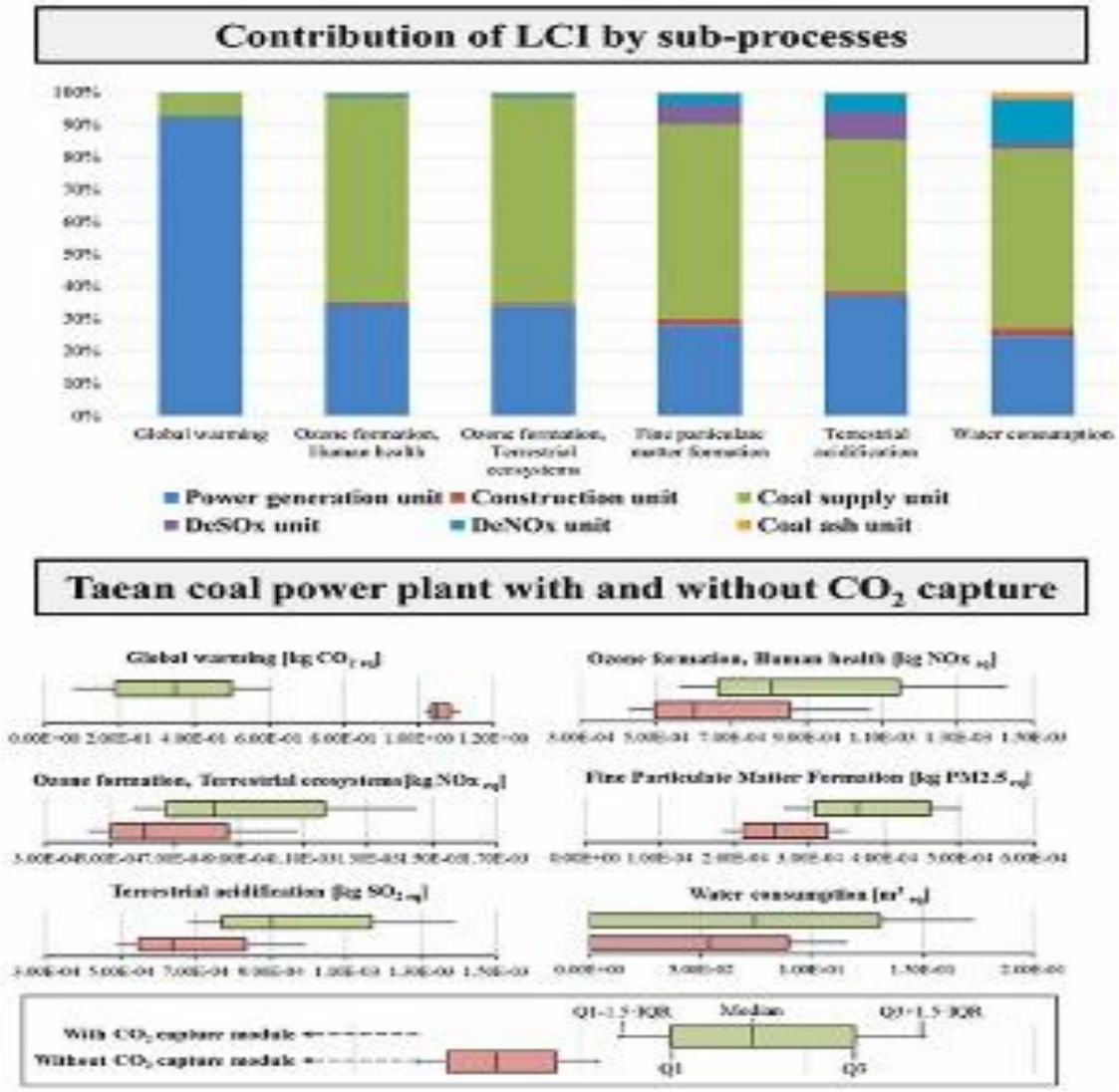


Figure 4.15: Contribution of LCI by sub-processes.

4.4.5 Economic Valuation: The health impact assessment methodology and the economic valuation is adapted from CREA's"Quantifying the Economic Costs of Air Pollution from Fossil Fuels" (Myllyvirta 2020). Data on totalpopulation and population age structure, as well as all mortality results, baseline death rates andyears of life lost for South Korea were taken from the GBD project 2019 (IHME 2020). The baseline concentrations of PM2.5 and NO2 were taken from van Donkelaar et al. (2016) and Larkin at all (2017), respectively. [29],

Outcome	World Avg GDP, 2011 USD	Valuation in South Korea, 2011 USD	Valuation in South Korea, 2019 USD	Valuation in South Korea, 2019 KRW
preterm births	105,725	283,419.47	211,010.67	245,902,871.97
work absence (sick leave days)	85	227.86	169.65	197,699.16
years of life lost	39,324	95,517.83	71,114.67	82,874,018.24
years lived with disability	31,047	83,228.41	61,964.99	72,211,364.07
number of children suffering from asthma due to pollution exposure *(increased prevalence)*	1,168	3,131.08	2,331.15	2,716,619.10
asthma emergency room visits	252	675.54	502.95	586,119.87

Figure 4.16: Input parameters and data used to estimate economic costs of health impacts converted to South Korean Won (KRW).

CHAPTER 5

Conclusions and Future Works

5.1 Conclusions:

- Environment Impact Assessment (EIA) investigations and paper survey of Thermal energy station and a delegate nuclear energy station uncover nuanced discoveries with respect to ecological, social, and security suggestions.
- The most important details in this text are that thermal energy stations offer low fossil fuel byproducts and decreased air contamination, but have concerns over long-term radioactive waste administration and potential disastrous occasions. Security measures are set up to limit radiation openness, and the systems for radioactive waste administration have been considered.
- Public worries have been considered, and the task exhibits a serious level of social worthiness. Alternative energy sources have been investigated, and the adequacy of proposed moderation measures is recognized. Elective energy sources have been investigated, and the adequacy of proposed moderation measures is recognized.
- The venture exhibits consistency with natural guidelines and norms, and the adherence to lawful and administrative structures has been highlighted. The general end focuses on the manageability of both power age techniques, taking into account ecological, social, and monetary variables

5.2 Limitations and Recommendations for Future Works: Future efforts should focus on improving data accessibility and collection methods, refining predictive modeling techniques, exploring methodologies to refine spatial and temporal resolutions, fostering stronger collaboration across disciplines, and exploring innovative methods to enhance public participation, communication, and understanding. Invest in advanced data collection strategies, research and implement improved predictive modeling techniques, refine spatial and temporal resolutions, foster stronger interdisciplinary collaboration, incorporate stakeholder feedback, implement continuous environmental monitoring programs, and develop education and training programs for practitioners involved in EIA analyses.

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