COMPREHENSIVE ENVIRONMENTAL MONITORING FOR THE DOUBLING OF AN EXISTING RAIL LINE PROJECT

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ABSTRACT

This study presents a comprehensive environmental monitoring framework for the Akhaura-Laksam Double Track project, a pivotal component of Bangladesh's Dhaka-Chittagong railway corridor upgrade. The project targets the modernization of a 72 km section, integrating it with major sub-regional corridors and the Trans-Asia Railway network. The track's passes through a diverse landscape encompassing low-lying, flat, and alluvial terrain, necessitates careful environmental oversight. The project involves the construction of 13 major bridges, 46 minor bridges, 11 new stations and 54 functional and residential buildings. The construction phase, marked by the erection of a substantial embankment (2-6 meters high) and utilization of millions of tons of fill material is expected to yield the most significant environmental impacts. The monitoring has been performed at six months interval to access air, water and noise quality to evaluate and mitigate potential environmental impacts. Air quality monitoring focused on critical pollutants like Particulate Matter (PM_{10}, and $PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Oxides (NOx) and Carbon Monoxide (CO). The surface water quality is assessed for parameters including temperature, pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), and Biochemical Oxygen Demand (BOD_5). This comprehensive monitoring program has been conducted from construction through the initial operational phase, allowing for a robust assessment of environmental impacts. Test results are compared with established environmental conversation standards to ensure compliance and environmental integrity throughout the project's lifecycle. The project's classification as a red category initiative by the Department of Environment (DoE) of the Government of Bangladesh underscores the need for rigorous monitoring. Through this study, the environmental impact during the construction period has been monitored to understand. It has been revealed that all the parameters are in the allowable standard limit. It provides a detailed understanding of the potential environmental impacts associated with the project, especially during the construction phase.

Keywords: *Environmental Monitoring, Railway Project, Surface water, Air*

1. INTRODUCTION

The exponential increase of population necessitates the creation of contemporary infrastructure systems, including roadways, railways, and airports. Nevertheless, this has resulted in a reduction in the amount of land that is accessible and an increase in deforestation. Construction operations exert substantial ecological effects, particularly when they transpire in environmentally safeguarded areas with varied ecosystems. Assessing the variety and number of species is essential for detecting possible conservation issues, such as the threat of species extinction. Bangladesh is currently implementing several railway projects, including Akhaura-Laksham, Dohazari-Cox's Bazar, and Khulna-Mongla (TITU et al., 2023). These projects have incorporated environmental monitoring measures, such as assessing air quality, noise levels, and surface quality, to ensure adherence to environmental conservation regulations (ECR). Mazumder et al., 2020 undertook research on air pollutants at Khulna railway station resulting from the emissions of locomotives. Sample collection of size segregated PM was conducted using a handheld 3016 laser particle counter. The sampling effort was conducted on June 22nd, August 1st, and August 2nd, 2019, between the hours of 9 AM and 5 PM. The sampling apparatus deployed on the ground platform is designed to collect data on both PM_{10} and $PM_{2.5}$ particles. According to their research, the freight train released bigger particles into the atmosphere, resulting in the PM10 levels reaching their highest point. Baitun et al., 2018 conducted research on the levels of air particulate matter and black carbon content in Ashuganj, located in the Brahmanbaria district. The region under investigation was a 50 MW power plant company called Midland Power Company Limited, which operated using heavy fuel as its energy source. Two particulate matter (PM) samplers, one for PM_{10} and the other for $PM_{2.5}$, were installed in the northern section of the facility. Data was collected throughout four distinct seasons: pre-monsoon, monsoon, post-monsoon, and winter. Their analysis concluded that the levels of PM10 and $PM_{2.5}$ surpassed the acceptable limits set by the BDS. Saha et al. 2021 performed physico-chemical parameter assessment of water quality of Haora River which is one of the major rivers of Tripura state, India. From the location of Brahmanbaria, October 2018 to September 2019 in this time frame the samples had been collected. The TDS, DO, EC, Ph have been tested in the laboratory. Shamsad et al., 2010 performed a study over water quality of major ponds of Comilla town. In this study, eight major ponds were selected and the samples were collected in the dry season. The parameters like pH, EC, DO, BOD, TSS, TDS etc had been analyzed. The study revealed that, the surface water of that ponds was highly contaminated. The reasons were bathing, washing and partial connection of sewage. TITU et al., 2023 studied the environmental status of Khulna-Mongla Port Rail Line Project over the 4 years. The study focused on the surface water and air quality. Every six months interval, data was collected and scripted. The study revealed that no impact on environment due to the rail line construction.

Project Description

Dhaka and Chittagong are the most important major cities of Bangladesh. Dhaka serves as the principal hub for economic and administrative activities within the nation, while Chittagong functions as the primary seaport (The Asian Development Bank (ADB), 2023). These two urban centres collectively contribute to over 90% of the country's import and export activities. A significant proportion, exceeding 25%, of Bangladesh's total population, which stands at approximately 150 million, is concentrated inside the Dhaka-Chittagong corridor. Hence, the Akhaura and Laksam Double Tracking Project holds significant importance and is considered a high-priority endeavour. The implementation of the Project is expected to yield substantial economic benefits across multiple sectors in Bangladesh. It will facilitate the operation of supplementary train services for sub-regional trade, connecting Chittagong Port with Bhutan, India, Nepal, and even Southeast Asia in the future. Within the 72-kilometer alignment (

Figure 1), there are a total of fourteen railway stations situated between the locations of Akhaura and Laksam. There are a total of 12 minor bridges in the dataset, each having a length of fewer than 100 metres. Additionally, there are 46 culverts included in the dataset. The Akhaura-Laksam section has embankment of two metres to six metres average height with high embankments of over four metres in some places and near bridges on deep foundations.

2. METHODOLOGY

The air sample was collected using the Respirable Dust Sampler (Model-Lata Envirotech APM 250), which is a sampler that combines PM_{10} and $PM_{2.5}$ collection. The particle and gaseous samples obtained while the monitoring have been examined according to the techniques outlined in the Table. The samples were gathered over a duration of 8 hours and the results were transformed to 24-hour values employing the fundamental power law approach. The findings from the monitoring of the surrounding air quality have been documented in a table.

The subsurface water sampling was conducted by identifying the principal surface water bodies that had passed through the construction site. The specimens are placed in an appropriate plastic receptacle and conveyed to a government-sanctioned laboratory for examination using established protocols. The surface water sample analysis results were compared to the government-prescribed standards for Inland Surface Water, as outlined in the Environment Conservation Rules (ECR) and ECR 2023-Schedule 3. In contrast, the groundwater test results were juxtaposed to the Drinking Water Standard ECR Schedule-3, 2023. The standards have been presented with the monitoring evaluations of surface and groundwater samples for the purpose of comparison. Given that the primary purpose of the tested streams is for fishing, the study of water quality conformance to requirements was based on the water quality standards specified specifically for this beneficial use.

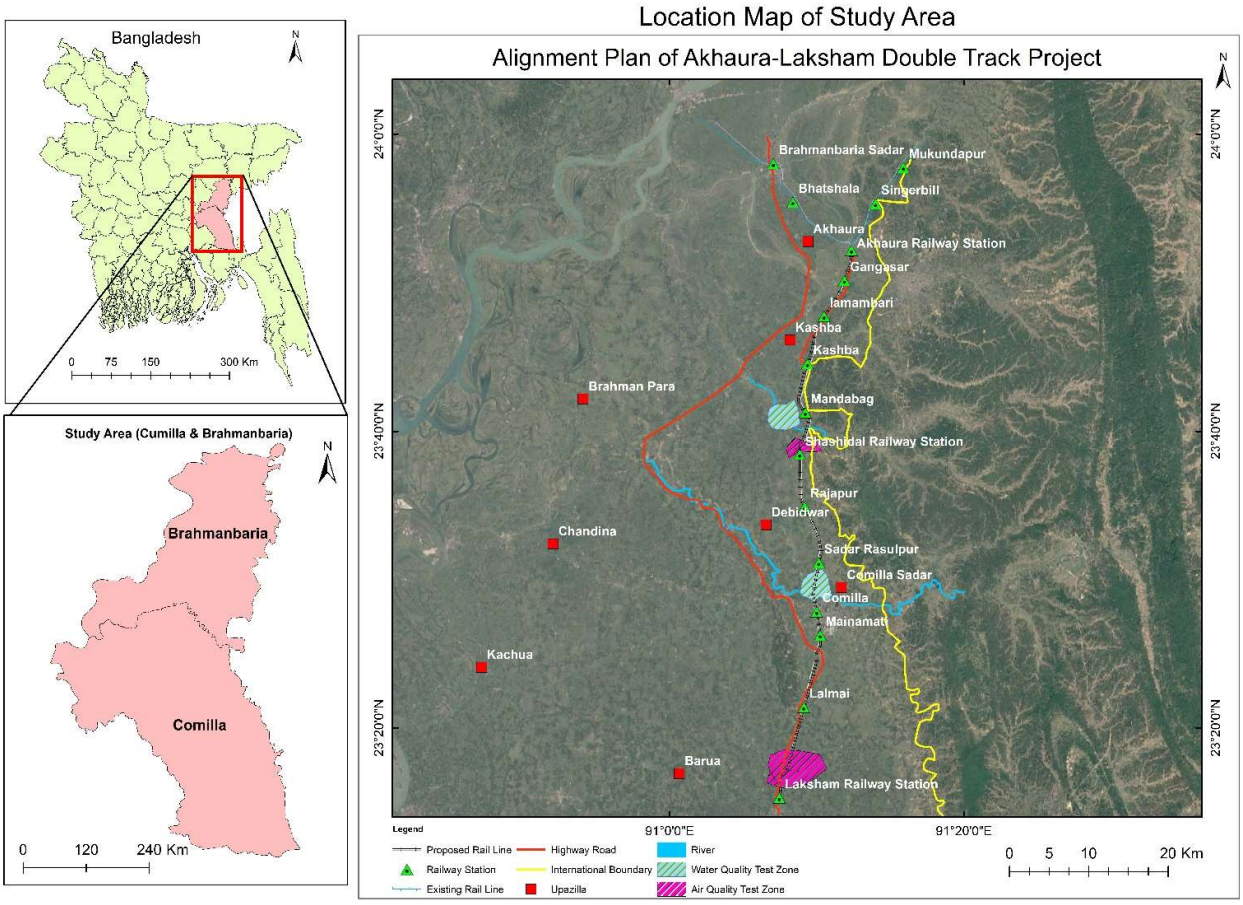
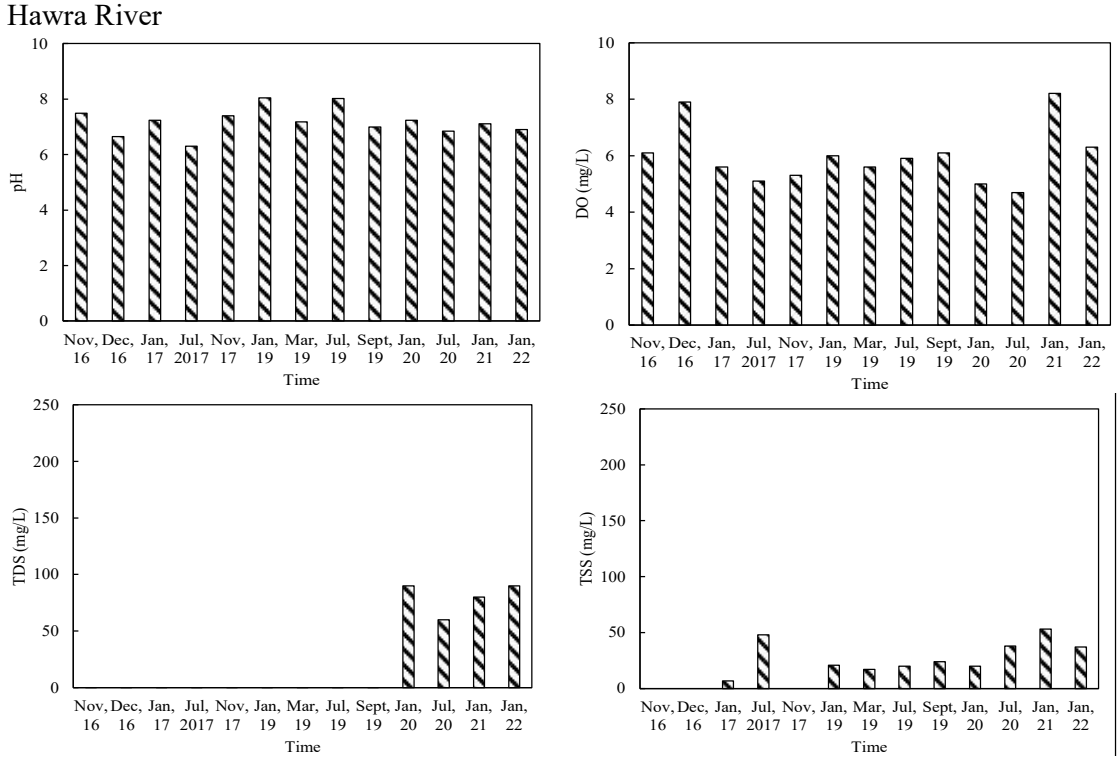


Figure 1:Alignment of plan of Akhaura-Laksam Double Track Project

3. RESULTS AND DISCUSSION

3.1 Surface Water Quality

For this study, the water was sampled from two different locations (e.g. Hawra River and Goniajuri River) and data was presented for comparison in Figure 2 and Figure 3. The pH value for the Goniajuari river was found between 6.68-7.58 where for Hawra River the pH value stayed between 6.3-8.04. Along with pH value, the other water quality paremeters such as BOD_5, COD, DO, TDS, TSS was measured for both river during the time of construction. The results from both river exhibits that the pH, COD, TDS value of the water during different time of construction remained within the prescribed standard ECR 2023. However, for the Hawra River, the BOD_5 value found 9 which exceeded the standard ECR 2023 limit of 6 or less. On the other hand, for Goniajuri river, the TSS value was found 238 which also exceeded the limit of 150. But, Saha et al.2020 concluded in their study that, the river carries much debris of plastic bottles, cans, garbage that are the wastes of India. It could be a reason for exceeding the limit. Figure 2 and Figure 3 demonstrate the required results obtained at different months interval and the Table 1 shows the overview of the results.



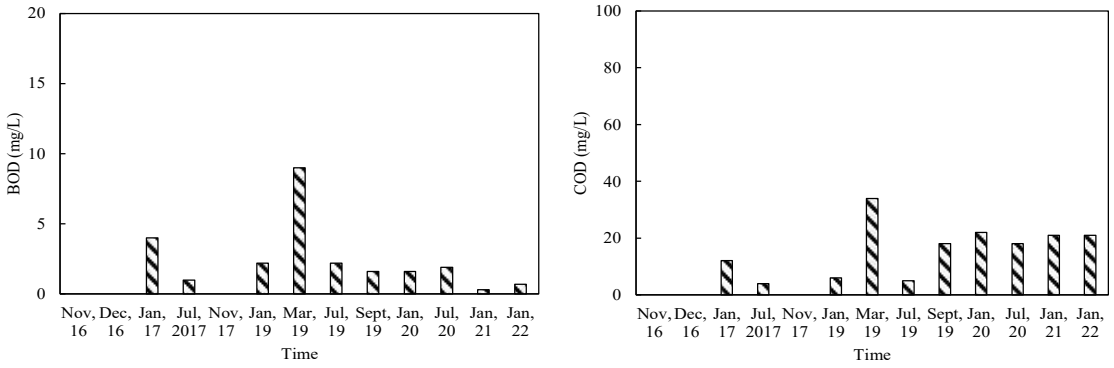


Figure 2: Surface water parameters of Hawra River

Goniajuri River

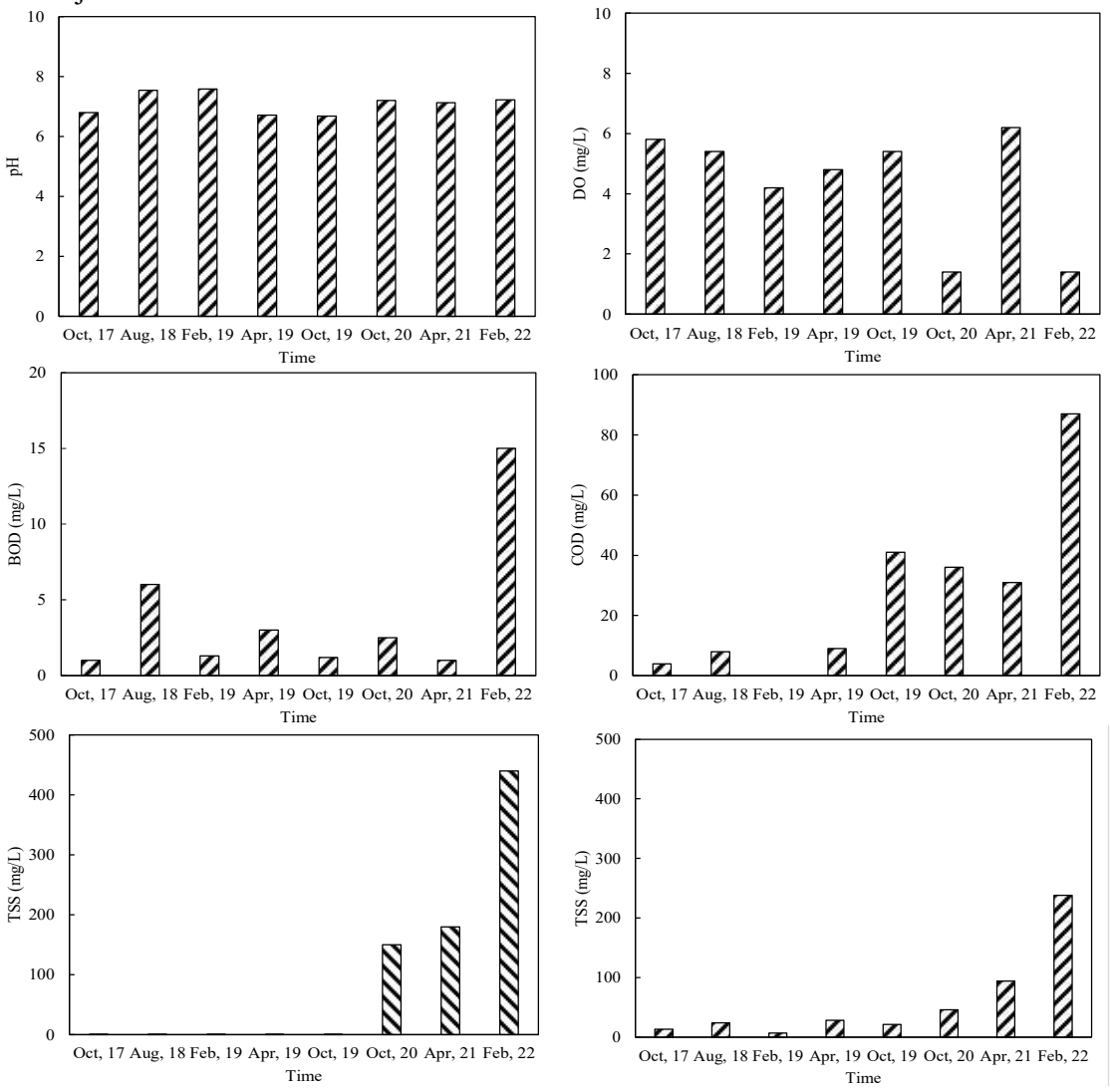


Figure 3: Surface water parameters of Goniajuri River

Table 1: Comparison of Surface water parameters

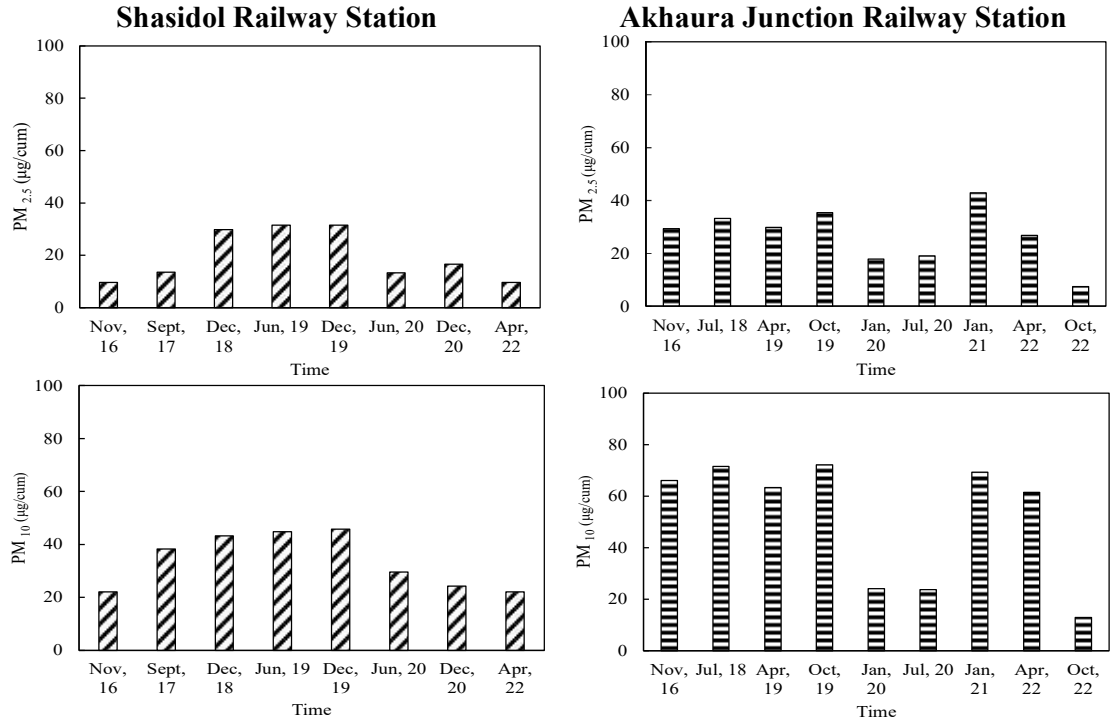
Locations	pH	TDS (mg/L)	DO (mg/L)	BOD_5 (mg/L)	COD (mg/L)	TSS (mg/L)
Goniajuri River	6.68-7.58	0.13-440	1.4-1.4	1-15	0-87	7-238
Hawra River	6.3-8.04	0.03-90	4.7	0.3-9	4-34	7-53
Khulna-Mongla (Titu et al. 2023)	7.7-9.2	560-1030	6.4	0.4-3.5	26-65	77-150
Bangladesh Standard*	6-9	1000	5 or more	6 or less	50	--

Note:

** According to ECR 2023, Schedule 2, Section A (2)*

3.2 Air Quality

For the air quality analysis, the data was recorded from two different locations (e.g. Shasidol Railway Station and Akhaura Railway Station) and presented for comparison in Figure 4. Air quality monitoring focuses on critical pollutants like Particulate Matter (PM_{10}, and $PM_{2.5}$), Sulphur Dioxide (SO_2) and Nitrogen Oxides (NOx). The obtained results showed that they were all within the standard limit. However, overall air quality is consistent with the study (TITU et al., 2023) as tabulated in Table 2 .



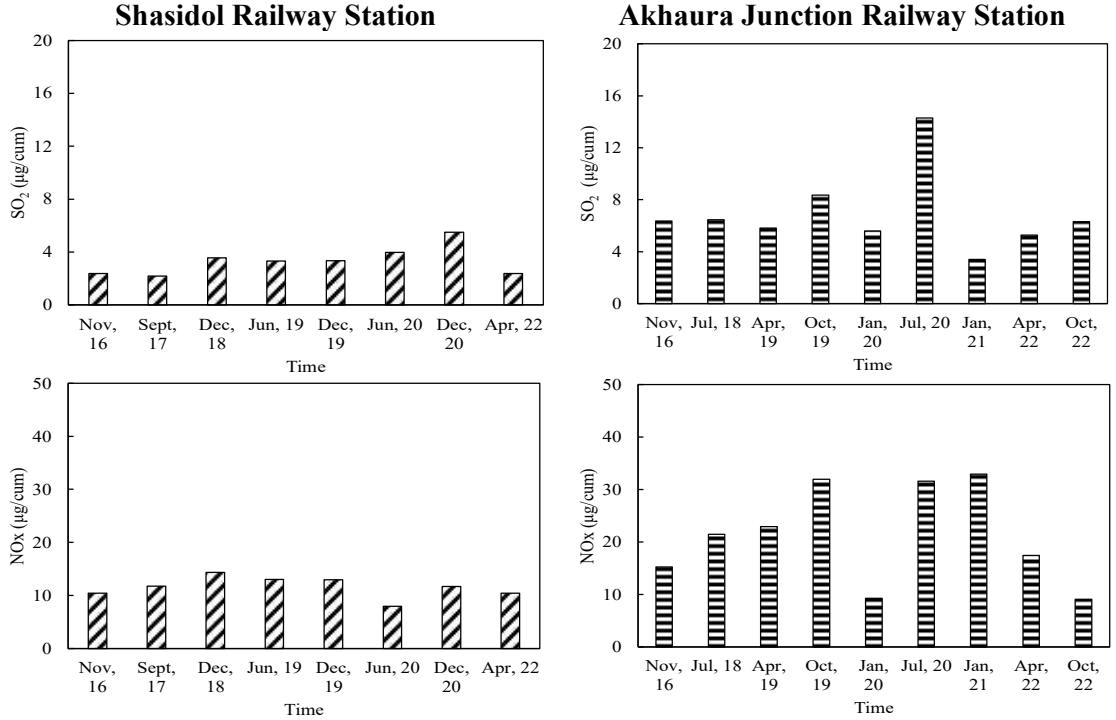


Figure 4: Air quality parameters at Shasidol and Akhaura Railway Station

Table 2:Comparison of Air quality parameters

Locations	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	SO_2 µg/m³	NO_x µg/m³
Akhaura Railway Station	42.9-7.44	72.24-12.9	14.3-3.4	32.94-9.07
Shashidal Railway Station	31.6-9.59	45.78-22.12	5.49-2.19	14.34-7.91
Khulna-Mongla (Titu et al. 2023)	52.1-24.6	69.2-43.9	46.1-25.6	43.7-14.1
Bangladesh Standard*	65	150	80	80

Note:

**According to Air Pollution Control Rules of Bangladesh 2022 and Subsequent amendment 26th July 2022 vide S.R.O. No.255-Law/2022*

4. CONCLUSIONS

The construction phase increased most parameters, such as pH, total dissolved solids (TDS), biochemical oxygen demand (BOD), chloride (Cl^-), sulphate (SO_4^{2-}), and nitrate (NO_3^-). However, the COD, TSS, and Turbidity levels were unchanged compared to the baseline data. Nevertheless, the outcomes stayed within the acceptable range of the standard values outlined by ECR 2023 for pre- and post-construction periods.

Furthermore, the study found an increase in sulphur dioxide (SO_2) levels in the project area once construction began when compared to the initial data. The rise in pollution levels can be ascribed to the increased traffic caused by ongoing construction activities and construction products that release sulphur dioxide (SO_2) into the atmosphere. In contrast, compared to the initial data, the levels of nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$) in the air reduced after building began. However, larger particulate matter (PM_{10}) remained generally stable before and after construction.

In summary, this research offers essential information on the environmental effects of construction operations. It emphasises the significance of proactive environmental monitoring and the adoption of efficient management systems to safeguard and conserve the environment.

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