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ENVIRONMENTAL BASELINE STUDY FOR SPESSE-CE COMPLEX, ATBU: A COMPREHENSIVE ANALYSIS OF SOIL, WATER, AIR, NOISE, AND RADIATION QUALITY

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ABSTRACT---

Environmental baseline studies are integral to Environmental Impact Assessments (EIA), providing critical data on existing environmental conditions prior to project initiation. This study evaluates the environmental conditions at the Sustainable Procurement, Environmental and Social Standards Centre of Excellence (SPESSE-CE) Complex, Gubi Campus, ATBU, with the aim of establishing baseline data to guide future development and environmental management efforts. The assessment covers soil quality, water quality, air quality, noise levels, and radiation levels, reflecting the institution's commitment to sustainable development and evidence-based decision-making.

Water analyses indicated consistent physical and chemical properties across multiple samples, with pH values around 7.3, temperature averaging 29.2°C, and electrical conductivity at 15.78 µS. Dissolved oxygen levels were approximately 19.3%, and key chemical indicators such as sulphate, chloride, and magnesium were within acceptable ranges. Soil analyses revealed a stable pH of 6.6, low moisture content at 2.25%, and organic carbon at 0.01%. Essential nutrients and potential contaminants were within safe limits. Air quality measurements showed indoor and outdoor conditions with PM2.5 and PM10 levels at 10.28 µg/m³ and 13 µg/m³ respectively, indicating low pollution levels. Noise and radiation levels were also assessed, with noise levels during non-working hours averaging 33.4 dB indoors and 34.5 dB outdoors, and radiation levels being very low.

The findings highlight the importance of detailed baseline studies in environmental management, ensuring that potential impacts on water, soil, air, and overall environmental quality are comprehensively understood and monitored. This baseline data is crucial for the ongoing evaluation and mitigation of environmental impacts, aligning with best practices for sustainable development and environmental stewardship.

KEYWORDS: *baseline data, environmental analysis, water quality, soil quality, air quality, noise levels, radiation levels.*--

1.0 INTRODUCTION

1.1 Project Background

Environmental baseline studies are a cornerstone of Environmental Impact Assessments (EIA), involving a comprehensive assessment of the existing environmental conditions before the start of a project (Mukherjee, 2023; Beanlands, 2013; EIA P&C, 2021). It serves as a reference point to understand the potential impacts of a proposed project on the environment.

A study by Christiansen et al. (2022) emphasizes the necessity of generating environmental baseline knowledge as a prerequisite for evaluating and predicting the effects of future deep seabed mining. The authors argue that without baselines, it is impossible to assess impacts and determine whether they pose an acceptable risk to the marine environment. The research highlights the importance of establishing robust baselines that include technical information, standardized formats, and transparent reporting. Luo et al. (2021) discussed elsewhere the value of baseline data in landscape performance research, noting the challenges posed by the lack of such data. The study shares experiences from an academic-practice research partnership formed to document baseline conditions, underscoring the importance of baseline data collection in the conventional design process. More so, a comprehensive environmental risk assessment, with a focus on landfills and landfill leachate, identifies knowledge gaps and shortfall areas in baseline studies, highlighting the need for thorough baseline assessments to inform risk analyses (Butt et al., 2014).

Baseline studies not only inform the assessment of potential environmental impacts but also serve as a reference and a valuable tool for future Monitoring and Evaluation (M&E) processes. The baseline data has been utilized in M&E of different interventions, demonstrating the practical applications of baseline studies beyond the initial EIA process (Atakos, 2012; Ssekamatte & Okello, 2016).

As environmental concerns continue to gain prominence, the rigor and quality of baseline studies will remain pivotal in ensuring sustainable development and environmental stewardship.

The current study was conducted to assess the environmental conditions of the Sustainable Procurement, Environmental and Social Standards Centre of Excellence (SPESSE-CE) Complex, situated within Gubi Campus of Abubakar Tafawa Balewa University (ATBU), Bauchi. The assessment aims to establish the environmental baseline data of the subject site to serve as a reference point for future development and environmental management efforts. This is in line with the institution's commitment to sustainable development and environmental stewardship. It reflects the evolving nature of environmental management and the increasing emphasis on evidence-based decision-making in the face of environmental challenges. The scope of the assessment includes the analysis of soil quality, water quality, air quality, noise levels, and radiation levels

It is crucial to assess the quality and availability of water resources in order to understand the potential impacts of a project on water bodies and groundwater, ensuring that water quality is maintained and aquatic ecosystems are protected (Chen, 2003; Kumar, 2012). Likewise, soil quality assessment is important for understanding the potential impacts on land use, agriculture, and natural habitats. It helps in evaluating issues like soil erosion, fertility, and the potential for contamination (Mahmud, 2023; Rathi, 2017). On the other hand, assessing air quality is vital for determining the levels of pollutants that may be emitted by the project. It helps in predicting the impact on local air quality and the health of nearby communities (DiGiovanni & Coutinho, 2017; Sanford & Holtgrieve, 2022). Finally, noise and radiation assessments are needed to understand the impact of the project on the local soundscape and to mitigate potential noise pollution that could affect the quality of life of nearby residents (Wang & Milow, 2022; Lilic et al., 2018)

1.2 Site Description

The SPESSE-CE COMPLEX is situated within the picturesque GUBI CAMPUS of the Abubakar Tafawa Balewa University (ATBU) in Bauchi State, Nigeria. This academic institution is nestled in a serene and verdant environment, approximately 20 kilometres North East of Bauchi city. The site's geographic coordinates are approximately latitude 10.471323° N and longitude 9.831793° E. The satellite image of the site is shown in Plate 1.

To the north, the site is facing the ATBU Faculty of Agriculture. To the east and south of the building lies a small farming community primarily engaged in rice farming. To the west of the site, there is a wide open space leading to the university library, with a bus stop located in the northwestern vicinity of the building.

Plate 1: Satellite Image of the Subject site (SPESSE-CE ATBU Complex)

2.0 METHODOLOGY

The laboratory analyses were performed at the Public Health Engineering Laboratory within the Department of Civil Engineering at Abubakar Tafawa Balewa University (ATBU), Bauchi employing standard analytical procedures (Standard Analytical Procedures, 1999). Each test was rigorously conducted with a minimum of three replicates, and the reported results representthe averages derived from these replicates following meticulous statistical analyses.

2.1 Water Analyses

Five samples were collected from the consumer point at 30-minute intervals during continuouswater flow. The samples were then analysed separately. An array of analytical techniques were applied to investigate various aspects of water quality, encompassing chemical, physical, and bacteriological assessments. The following methods and parameters were employed:

2.1.1Titrimetric analysis

Titrimetric analysis was employed to determine the concentration of chlorideions (Cl-) in the water samples. The titration technique involved the addition of a standardized silver nitrate (AgNO3) solution to precipitate chloride ions, with an indicator used to detect the endpoint. Dissolved Oxygen (DO) and Chemical Oxygen Demand (COD) were also determined via titrimetric methods by a chemical oxidation process to quantify the amount of oxygen required for the oxidation of organic and inorganic substances present in the water (Khasnabis et al., 2015).

2.1.2 Spectral analysis

UV spectrophotometer was used to determine the concentration of nitrate (NO_3^{-}) and sulfate (SO_4^{2}) ions in the water samples. This method is based on the measurement of absorbance at specific wavelengths associated with the respective ions (Thangiah, 2019). Atomic Absorption Spectroscopy (AAS) was employed to determine the concentrations of various metal ions in the water samples. The metals analyzed included calcium (Ca), chromium (Cr), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), lead (Pb), and zinc (Zn). AAS is a highly sensitive technique for quantifying metal concentrations in solution (Radulescu et al., 2014).

2.1.3 Bacteriological analysis

The presence and concentration of E. coli and total coliform bacteria were determined through standard microbiological techniques, including culture-based methods, as adopted by previous researchers (McConn et al., 2024).

2.1.4 Specialized meters

The pH, temperature, total dissolved solids (TDS), conductivity and dissolved oxygen (DO) of the water samples were measured using a pH meter, thermometer, TDS meter, conductivity meter, and dissolved oxygen meter, respectively.

2.2 Soil Analyses

The study site was partitioned into three distinct zones, from which a total of 30 samples were systematically collected. Sampling was executed at 5-meter intervals within each zone, and the samples were obtained at a depth ranging between 15 to 20 centimetres. Subsequently, the 30 individual samples underwent air-drying for a duration of two days. Following this drying period, they were thoroughly homogenized to create a composite sample, upon which the subsequent analytical procedures were performed. The procedures are a combination of gravimetric, volumetric analyses and Atomic Absorption Spectroscopy (AAS). These analytical techniques were chosen for their precision and reliability in determining specific soil parameters.

2.2.1 Gravimetric analysis for organic carbon content

Gravimetric analysis for organic matter content was performed using the Loss-on-Ignition method in which a known mass of each dried soil sample was heated in a muffle furnace at a specified temperature (550°C) for a defined period (4 hours). This process thermally decomposes organic matter, leaving behind only inorganic residues (mineral content).The organic carbon content was calculated as the difference between the initial sample mass and the mass of the inorganic residue remaining after ignition (Miyazawa et al., 2000).

2.2.2 Volumetric analysis:

Volumetric analyses were employed to determine organic carbon and TotalExchangeable Acidity employing standard procedures as adopted by Ramos et al. (2018).

2.2.3 Atomic Absorption Spectroscopy (AAS) for Extractable Nutrients, Exchangeable Bases, and Toxic Metals:

To extract exchangeable bases and toxic metals, soil samples underwent an appropriate digestion process using aqua regia and perchloric acid. The samples for extractable nutrients were percolated with pH 7 ammoniumethanoate buffer. The digested soil solutions were analyzed using AAS to measure the concentration of specific elements by quantifying the absorption of light at characteristic wavelengths. Different wavelengths were employed for the determination of different elements. Quality control measures, including blank samples and duplicate analyses, were conducted to ensure the accuracy and precision of the results. The concentrations of extractable nutrients, exchangeable bases, and toxic metals were calculated based on the calibration curves generated during the analyses (Adeyemi, 2021; Mutethya, 2019).

2.3 Air Analyses

The assessment of air quality involved the utilization of specialized gas detection instruments. Specifically, Gas Alert instrument was employed to quantify the concentrations of methane (CH_4), hydrogen sulfide (H_2S), carbon monoxide (CO), and oxygen (O_2). Additionally, Air-Master Air Quality Monitor was employed to measure particulate matter with diameters of 2.5 micrometers (PM 2.5) and 10 micrometers (PM 10), formaldehyde (HCHO), volatile organic compounds (VOCs), carbon dioxide (CO_2), as well as ambient temperature (Temp) and relative humidity(RH). Each parameter was tested at 7 indoor locations within the building and 7 outdoor locations around the building, and the averages for indoor and outdoor readings were calculated respectively.

2.4 Noise and Radiation Level Analyses

In this study, specialized instruments were employed to measure both noise and radiation levels at various locations. The measurement process included testing each parameter during non-working hours and during activities, with readings taken at multiple points, including indoor, outdoor, and within the premises of the building.Each parameter underwent testing during non-working hours at five indoor locations within the building, five outdoor locations around the building, and five points within the premises of the building, but notindoors. Averages were computed for the readings obtained indoors, outdoors, and within the building premises. The same measurements were repeated during active hours with readings again taken at the same fifteen points for each parameter and the values were averaged separately for indoor, outdoor, and premises readings.

3.0 RESULTS OF THE ANALYSES

3.1 Water Analyses

The results of water quality analyses are presented in Table 1

Table 1: Results of Water Quality Analyses

PARAMETERS			VALUES				
			S1	**S2**	**S3**	**S4**	**S5**
Physical	pH		7.300	7.300	7.200	7.300	7.300
	Temperature	(ºC)	29.200	29.300	29.200	29.200	29.200
	Electrical Conductivity	(uS)	15.770	15.780	15.770	15.780	15.780
	Total Dissolve Solids	ppm	156	156	156	156	156
Chemical	Dissolved Oxygen	(%)	19.400	19.300	19.400	19.300	19.300
	Chemical Oxygen Demand	(mg/L)	8.03	8.03	8.03	8.03	8.03
	Sulphate	(mg/L)	106.30	106.20	106.20	106.20	106.30
	Chloride	(mg/L)	28.990	28.990	28.990	28.990	28.990
	Magnesium	(mg/L)	2.607	2.407	2.589	2.494	2.460
	Calcium	(mg/L)	1.513	1.502	1.442	1.398	1.689
	Hardness	(mg/l)	14.51	13.66	14.26	13.76	13.05
	Manganese	(mg/L)	0.086	0.084	0.083	0.088	0.085
Nutrients	Nitrate	(mg/L)	7.250	7.260	7.270	7.250	7.260
	Iron	(mg/L)	0.476	0.422	0.469	0.431	0.433
	Zinc	(mg/L)	0.041	0.045	0.043	0.047	0.040
Toxic Elements	Copper	(mg/L)	0.007	0.008	0.006	0.009	0.007
	Lead	(mg/L)	0.020	0.014	0.012	0.012	0.012
	Chromium	(mg/L)	0.044	0.040	0.041	0.048	0.045
	Cadmium	(mg/L)	0.065	0.085	0.075	0.087	0.082
Biological	E.Coli	(No/100ml)	0	0	0	0	0
	Total Coliform	(No/100ml)	0	0	0	0	0

3.2 Soil Analyses

The results of soil quality analyses are presented in Table 2

Table 2: Results of Soil Quality Analyses

PARAMETERS			S1	S2	S3	MEAN
Physical	pH		6.6	6.6	6.6	6.6
	Electrical Conductivity	(uS/cm)	915.0	915.0	915.0	915.0
	Total Dissolve Solids	(ppm)	42.10	42.10	42.10	42.10
	Moisture Content	(%)	2.250	2.250	2.250	2.250
Chemical	Organic Carbon	(%)	0.011	0.010	0.009	0.010
	Organic Matter	(%)	0.018	0.017	0.016	0.017
Exchangeable Bases	Sodium	(mg/L)	85.000	81.190	84.010	83.4000
	Potassium	(mg/L)	10.130	10.120	10.210	10.150
	Magnesium	(mg/L)	0.8100	0.9070	0.9210	0.8794
	Calcium	(mg/L)	14.182	14.159	14.239	14.1933
Extractable Micronutrients	Manganese	(mg/L)	0.1640	0.1540	0.1680	0.1617
	Iron	(mg/L)	0.4010	0.3940	0.3340	0.37600
	Zinc	(mg/L)	0.0540	0.0581	0.0588	0.05694
Toxic Elements	Copper	(mg/L)	0.5120	0.4823	0.4956	0.49662
	Lead	(mg/L)	0.0778	0.0640	0.0412	0.06099
	Chromium	(mg/L)	0.0037	0.0186	0.0164	0.0175
	Cadmium	(mg/L)	0.0236	0.0315	0.0352	0.03008
	Nickel	(mg/L)	0.0354	0.0251	0.0397	0.03341

3.3 Air Analyses

The results of air quality analyses are presented in Table 3.

Table 3: Results of Air Quality Analyses

PARAMETERS		VALUES	
		Indoor	**Outdoor**
Temp	ºC	30.7	30.8
Relative Humidity	%	64.1	73.2
PM 2.5	ug/m^3	10.28	11.5
PM 10	ug/m^3	11.28	13
CH$_4$	%LEL	0	0
H$_2$S	ppm	0	0
CO	ppm	0.98	1.25
O$_2$	%Vol	22.5	21.5
HCHO	mg/m^3	0	0
VOCs	mg/m^3	0.18	0
CO$_2$	ppm	410	410

3.4 Noise and Radiation Level Analyses

The results of noise and radiation levels analyses are presented in Tables 4 and 5.

Table 4: Results of Noise and Radiation Levels During Non-Working Hours

PARAMETERS	INDOOR	PREMISES	OUTDOOR
Noise Level (dB)	33.40	33.60	34.50
Radiation Level (mR/hr)	0.024	0.020	0.017

Table 5: Results of Noise and Radiation Levels During Activity Period

PARAMETERS	INDOOR	PREMISES	OUTDOOR
Noise Level (dB)	46.70	34.50	34.50
Radiation Level (mR/hr)	0.023	0.018	0.017

3.0 RESULTS OF THE ANALYSES

3.1 Water Analyses: The water quality analyses, as shown in Table 1, reveal that the physical and chemical parameters across five different samples (S1-S5) are consistent, indicating uniformity in water quality. The pH levels are neutral, and the temperature is stable at around 29.2°C. Electrical conductivity and total dissolved solids are low, suggesting minimal salinity and solid content in the water. Chemical analysis shows adequate dissolved oxygen levels and low chemical oxygen demand, which are positive indicators of water quality. The presence of nutrients such as nitrate, iron, and zinc is within acceptable limits, while toxic elements like copper, lead, chromium, and cadmium are present in trace amounts, well below harmful levels (Brown & Perez, 2016). Biological analysis confirms the absence of E.Coli and Total Coliform, ensuring the water's microbiological safety.

3.2 Soil Analyses: Soil quality analyses, summarized in Table 2, demonstrate a consistent pH of 6.6 across three samples (S1-S3), which is slightly acidic but typical for many soil types. The electrical conductivity and total dissolved solids are moderate, indicating a low level of salinity. Moisture content is uniform at 2.25%. Organic carbon and organic matter percentages are low, reflecting minimal organic content in the soil. Exchangeable bases and extractable micronutrients such as sodium, potassium, magnesium, calcium, manganese, iron, zinc, and copper are present in adequate concentrations, suggesting a balanced nutrient profile. Toxic elements are detected in minimal concentrations, posing no significant risk to soil quality.

3.3 Air Analyses: Air quality analyses, presented in Table 3, show slightly higher temperatures outdoors compared to indoors. Relative humidity is higher outdoors, which is expected. Particulate matter (PM 2.5 and PM 10) concentrations are within safe limits, with outdoor levels slightly elevated compared to indoor levels. Methane (CH_4), hydrogen sulfide (H_2S), and formaldehyde (HCHO) are non-detectable, indicating good air quality. Carbon monoxide (CO) levels are low, and oxygen (O_2) levels are within normal ranges. Volatile organic compounds (VOCs) are detected in negligible amounts indoors, and carbon dioxide (CO_2) levels are identical in both indoor and outdoor environments.

3.4 Noise and Radiation Level Analyses: Noise and radiation levels, detailed in Tables 4 and 5, are within acceptable limits. During non-working hours, noise levels are low, and radiation levels are minimal, indicating a quiet and safe environment. During activity periods, indoor noise levels increase significantly, likely due to operational machinery or human activity, while outdoor noise levels remain consistent. Radiation levels during activity periods are comparable to non-working hours, suggesting no significant increase in radiation exposure due to site activities.

Conclusion: The baseline environmental data analysis indicates that the site maintains a stable and safe environmental condition. The uniformity of results across different analyses suggests that current site activities have a minimal impact on environmental quality. Continuous monitoring and adherence to environmental standards are recommended to maintain these conditions.

In light of the comprehensive analyses conducted on various environmental parameters, it is with great satisfaction that we report that all measured values consistently fall within the allowable limits established by the stated regulatory standards. In summary, the results of these analyses affirm that the SPESSE-CE COMPLEX, GUBI CAMPUS, ATBU, is currently operating within an environmentally safe framework in compliance with established regulatory standards. It is incumbent upon all stakeholders to maintain this standard and actively contribute to the preservation and enhancement of the environmental quality within the institution and its surroundings.

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