Environmental Sampling and Analysis

(Field and Laboratory Works)

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Abstract:

This book provides hands-on activities related to environmental sampling and analysis, designed for students in the Bachelor of Civil Engineering Technology (Environment) program at UTHM. Each chapter focuses on different field and experimental works. The first chapter covers water sampling, followed by the second chapter on water quality analysis. The third chapter discusses soil sampling, while the fourth chapter focuses on soil quality analysis. Chapter five explores air sampling, and the sixth chapter presents air quality analysis.

Keywords: Amber, Dry Sieve Analysis, Filter Cassette, Homogenization, Pooled Standard Deviation

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Preface

The book Environmental Sampling and Analysis (Field and Laboratory Works) outlines hands-on activities designed for students of the Bachelor of Civil Engineering Technology (Environment) program at UTHM. These activities cover the fundamentals of environmental sampling and analysis. The book serves as a guide for students to perform field and laboratory work related to environmental sampling and analysis. In Chapter 1, Water Sampling, students are introduced to the preparation and fieldwork involved in water sampling. Chapter 2, Water Quality Analysis, focuses on the laboratory analysis of the collected water samples. Chapter 3, Soil Sampling, covers the preparation and fieldwork required for soil sampling, followed by Chapter 4, Soil Quality Analysis, where the collected soil samples are analyzed in the laboratory. Chapter 5, Air Sampling, describes the preparation and fieldwork procedures for air sampling. Finally, Chapter 6, Air Quality Analysis, introduces statistical methods used to analyze air quality. For additional resources, please visit the YouTube channel linked via the QR code, where videos of the field and laboratory activities for this course can be found.

https://rb.gy/61s0n8

CHAPTER 1

WATER SAMPLING

1.1 Introduction

Water sampling is the process of collecting a sample of water from a specific location or source to analyse its physical, chemical, biological, and microbiological characteristics. This process is essential for monitoring and assessing water quality, ensuring it meets safety standards, and understanding the environmental health of water bodies. Water sampling can be done in various environments, such as rivers, lakes, streams, or groundwater. The location from which water will be sampled is chosen based on the purpose of the study (e.g., upstream vs. downstream, near a potential pollution source, etc.). The sampling method can be conducted by grab sampling (taking a single sample at a point in time) or composite sampling (collecting multiple samples over a period of time). Clean, sterile bottles or containers are used to avoid contamination of the sample and the sample is preserved properly to prevent changes in water quality before analysis (e.g., refrigeration or use of preservatives). Accurate records of the location, time, and conditions of the sample are kept for analysis.

1.2 Objectives

1. To investigate the steps involved in planning a water sampling event.
2. To conduct water sampling using either the grab or composite method.

1.3 Equipment and Apparatus

The equipment and apparatus required for conducting water sampling are shown in Table 1.1.

CHAPTER 2

WATER QUALITY ANALYSIS

2.1 Introduction

Water quality analysis refers to the process of examining and assessing the physical, chemical, biological, and sometimes radiological characteristics of water. This analysis helps determine the suitability of water for various purposes, such as drinking, irrigation, industrial use, or aquatic life support. The goal is to ensure that water meets health standards and environmental regulations. Physical properties include temperature, color, turbidity (cloudiness), suspended solids, and odor, which can affect water's aesthetic qualities and its usability. Chemical properties involve the concentration of dissolved substances such as pH, dissolved oxygen, salts, heavy metals, nutrients, and chemical pollutants. High levels of certain chemicals can be harmful to humans, animals, or aquatic ecosystems. Biological properties include the detection of microorganisms such as bacteria, viruses, and protozoa. Common indicators are coliform bacteria and E. coli, which can indicate contamination from sewage or animal waste. Water quality analysis is conducted through various laboratory tests, field testing, and monitoring systems to assess and ensure that water remains safe and suitable for its intended use. The results are used to guide water treatment processes and environmental protection efforts.

2.2 Objectives

1. To perform water quality analysis on the collected sample in the laboratory.
2. To assess the water quality of the water sample.

2.3 Equipment and Apparatus

The equipment and apparatus required for conducting water quality analysis are shown in Table 2.1.

CHAPTER 3

SOIL SAMPLING

3.1 Introduction

Soil sampling is the process of collecting soil from a specific area in order to analyze its composition, nutrient content, and other characteristics. In terms of environmental sampling and analysis, soil sampling is crucial in assessing and monitoring environmental quality, contamination, and land health. Unlike agricultural sampling, which is focused on improving soil fertility for crop production, environmental soil sampling deals more with identifying pollutants, assessing ecosystem health, and ensuring that the land is safe for human, plant, and animal life. This is particularly important in areas with industrial activity or potential pollution risks. The main goal of environmental soil sampling is to detect contaminants such as heavy metals, pesticides, hydrocarbons, and other toxic substances that might have entered the soil through industrial activities, waste disposal, or agricultural practices. Environmental soil sampling is also conducted to assess nutrient imbalance such as nitrate and phosphate contents in the soil which can indicate agricultural runoff or contamination from sewage systems. In addition, analyzing the pH of the soil is essential to understand if acidic or alkaline conditions are conducive to contaminant mobility, as some pollutants are more mobile in either acidic or basic environments. Accurate soil sampling process minimizes errors and ensures reliability in subsequent analyses.

3.2 Objectives

1. To conduct soil sampling using appropriate method.
2. To obtain a representative soil sample that reflects the soil's condition.

CHAPTER 4

SOIL QUALITY ANALYSIS

4.1 Introduction

Soil quality analysis is a vital component of environmental studies because soil plays a critical role in supporting ecosystems, regulating the hydrological cycle, and influencing atmospheric and climate processes. Understanding soil quality allows for better land management practices that conserve resources, promote biodiversity, and mitigate environmental issues such as pollution, erosion, and climate change. Dry sieve analysis is used in environmental studies to understand the physical properties of soils. This analysis is particularly relevant in assessing soil health, its ability to support ecosystems, its role in water infiltration, and its resilience to erosion and other environmental stressors. Moisture content in soil directly influences plant growth, nutrient availability, and the overall health of ecosystems. It also plays a crucial role in several environmental processes, including the hydrological cycle, soil erosion, and climate regulation. Analyzing soil moisture helps in understanding the impacts of water management, climate change, and land use on soil health and ecosystem sustainability. Acid rain, excessive fertilization, and industrial pollution can lower the pH of the soil, leading to soil acidification. This can harm plant roots and disrupt nutrient availability. Regular pH analysis as part of soil quality assessment helps monitor soil acidity levels and suggests corrective actions like liming. Healthy soil is vital for the cycling of nutrients such as nitrogen and phosphorus. Poor soil quality, such as nutrient depletion or imbalanced nutrients, can disrupt the ecosystem.

4.2 Objectives

1. To perform soil quality analysis on the collected sample in the laboratory.
2. To assess the quality of the soil sample.

CHAPTER 5

AIR SAMPLING

5.1 Introduction

Air sampling is the process of collecting air samples to measure the presence and concentration of specific substances, pollutants, or gases in the atmosphere. The goal is to monitor air quality, detect harmful chemicals or particulates, and assess environmental or health risks. Air sampling is used to study both natural and anthropogenic emissions that impact air quality. It provides essential data such as particulate matter (PM2.5 and PM10) for maintaining air quality and safety standards across various sectors. Air sampling can be performed using a variety of methods, depending on the substances being monitored and the conditions of the environment. Weather conditions such as wind, temperature, and humidity can influence the concentration and dispersion of pollutants. Pollution levels can vary widely depending on location, season, and time of day. Accurate environmental studies require careful planning to account for these variations, including choosing appropriate sampling sites and periods. Data from air sampling is critical for the environmental regulations and policies aimed at improving air quality. It helps set standards for acceptable pollution levels, informs air quality forecasts, and ensures industries comply with emission limits.

5.2 Objectives

1. To conduct air sampling using an E-sampler.
2. To monitor the levels of air pollutants.

5.3 Equipment and Apparatus

The equipment and apparatus required for conducting air sampling are shown in Table 5.1.

CHAPTER 6

AIR QUALITY ANALYSIS

6.1 Introduction

Air quality analysis refers to the process of measuring, monitoring, and evaluating the concentration of various pollutants in the atmosphere to assess the health and environmental impact of air quality. The goal of air quality analysis is to understand the composition of the air, identify harmful pollutants, and evaluate their potential effects on human health, ecosystems, and climate. Air quality analysis is typically conducted to compare pollutant levels against established standards or guidelines for common air pollutants such as particulate matter (PM2.5 and PM10). Once air samples are collected, the data is analyzed. The data helps identify patterns over time, allowing to assess whether pollution levels are increasing or decreasing, which can help in formulating policies. Statistical techniques are employed to assess relationships between pollutants and environmental factors, and predict future air quality trends. Plotting the data using graphs such as histograms, box plots, Gaussian curve, time series plots, or scatter plots can identify patterns, trends, and outliers. Visualization can reveal daily, seasonal, or yearly variations in pollution levels, as well as how different pollutants correlate with each other. Since air quality data is often collected over time, time series analysis can help identify trends, periodic fluctuations, and sudden spikes in pollutant levels.

6.2 Objectives

1. To evaluate changes in air quality over time.
2. To assess air quality data by using statistical method.

6.3 Equipment

The equipment required for conducting air quality analysis is shown in Table 6.1.

Bibliography

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Author Biography

Dr Mimi Suliza Muhamad is currently a senior lecturer at Civil Engineering Technology Department, Faculty Technology Engineering, Universiti Tun Hussein Onn Malaysia (UTHM). She received her Diploma in Civil Engineering at Universiti Teknologi Malaysia (UTM) in 2009. Then she received Bachelor of Civil Engineering at UTM in 2012 and proceed her study in postgraduate under fast-track programme and received PhD in Civil Engineering at UTM in 2016. Her experienced in teaching Environmental Sampling and Analysis course is since 2020.

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