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Salahaddin University-Erbil

On Some Mathematical Applications In Environmental Science

Research Project

Submitted to the department of (Mathematic) in partial fulfillment of the requirements for the degree of BSc. in (forth)

By:

Esra Husen Jalall

Supervised by:

Dr. Hogir Mohammed Yaseen

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Certification of the Supervisors

I certify that this report was prepared under my supervision at the Department of Mathematics / College of Education / Salahaddin University-Erbil in partial fulfillment of the requirements for the degree of Bachelor of philosophy of Science in Mathematics.

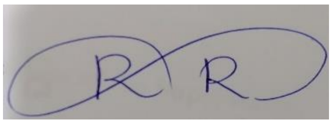
Signature: 

Supervisor: Dr. Hogir Mohammed Yaseen

Scientific grade: Lecturer

Date: 2 / 4 / 2024

In view of the available recommendations, I forward this report for debate by the examining committee.

Signature: 

Name: Assistant Prof. **Dr. Rashad Rashid Haji**

Scientific grade: Professor

Chairman of the Mathematics Department

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My deepest gratitude goes to my supervisor Dr. Hogir , who’s worked hard with me from the beginning till the completion of the present research. A special thanks to Dr. Rashad the head mathematic Department for his continuous help during this study.

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Abstract

In this work we study on some mathematical applications in environmental science. First we study mathematical applications in climate change and sea-level rise projection. Then we study mathematical applications in air Emissions inventory and air pollution monitoring and water quality Index (WQI) calculation and air emissions inventory and air quality index (AQI) calculation. At the end, we study mathematical applications in carbon budget and ocean acidification prediction and erosion control planning. Furthermore, we solve many examples that illustrate the applications.

Table of Contents

List of abbreviation units of Quantity

1. Ppm**:** PPM is the abbreviation of PARTS PER MILLION

2. µg/m3**:**Micrograms per cubic meter

3. BTU **:**The abbreviation for "British thermal unit" is Btu. "Btu" is used for both singular and plural cases

4. units/decade**:** One decade (symbol dec) is a unit for measuring ratios on a logarithmic scale, with one decade corresponding to a ratio of 10 between two numbers

5. PPb**:** PPM and PPB are units used in atmospheric chemistry to describe the concentration of gases. PPM stands for parts of gas per million parts of air, and PPB is parts per billion

6. PM**:**PM or pm (also written P.M. or p.m.) is an abbreviation for Latin post meridiem, meaning "after midday" in the 12-hour clock

7. AQI**:** The Air Quality Index (AQI) is used for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you

8. lHI**:** Intestinal Health Institute

9. ILO**:** Organization - Office of the Secretary-General's Envoy on Youth.

10. BPHI**:** Balai Pengobatan Haji Indonesia · BPHI — Boost Phase Intercept · BPHI — Broward Partnership for the Homeless, Inc.

11. BPLO**:** Business Permits and Licensing Office

12. Cpm**:** cost per mille

13. cost**:** Council on State Taxation

INTRODUCTION

Mathematics can be applied in a wide range of environmental science disciplines. Derivatives and integrals, ordinary and partial differential equations, and linear and nonlinear algebraic equations plays a key role in environmental science for example statistical analysis is used to examine data acquired from environmental research, such as population surveys or climate data. It aids in understanding trends, formulating forecasts, and reaching meaningful conclusions. Calculus is used to predict and assess rates of change in areas such as population dynamics, ecological modeling, and nutrient flow analysis. Algebra is used to solve equations and represent numerous environmental processes, such as estimating a habitat's carrying capacity or calculating pollutant concentrations. Geometry is used in environmental mapping and spatial analysis to calculate areas and distances, as well as to create maps that investigate land use patterns or habitat fragmentation. Linear programming optimizes resource allocation and decision-making processes in sustainable management methods.

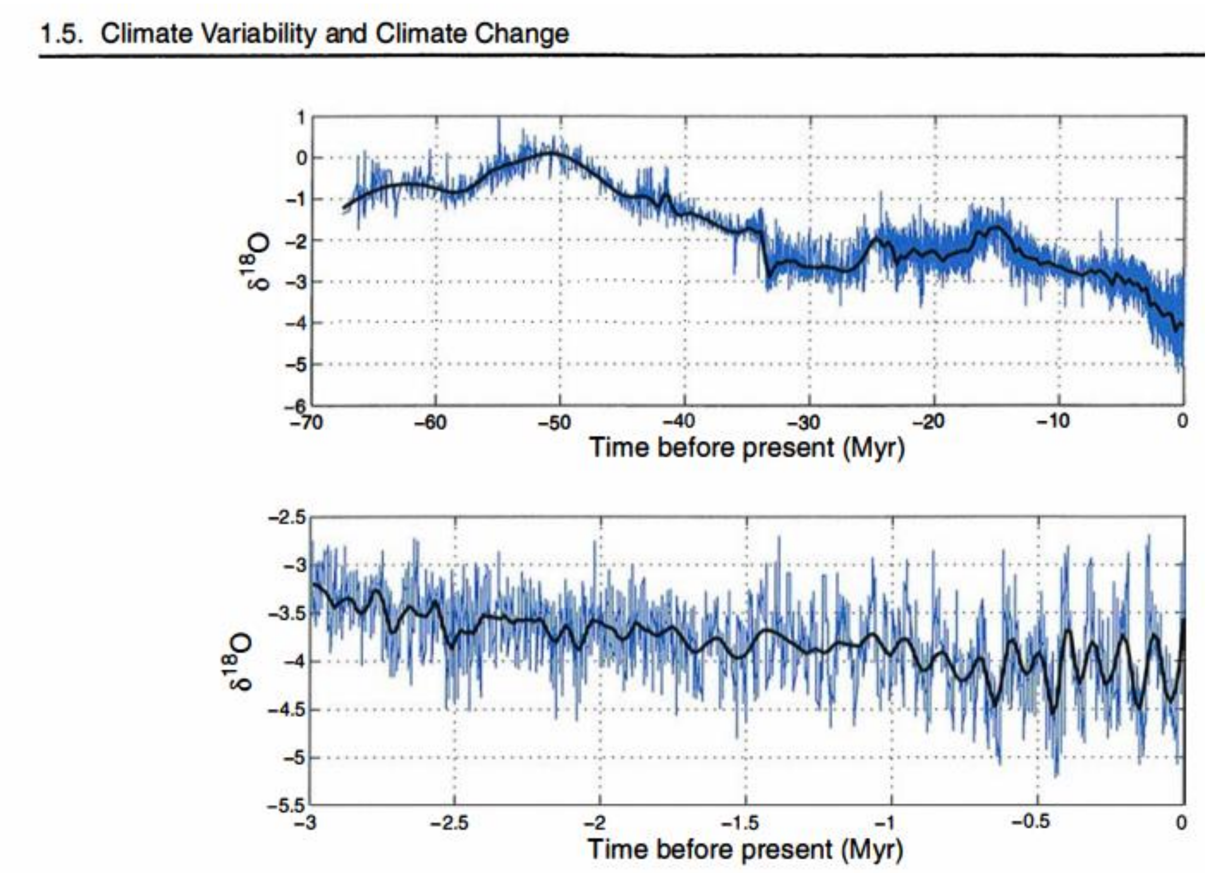
In this work we study on some mathematical applications in environmental science. This work consists of three chapters and is organized as follows. In chapter one mathematical applications in climate change and sea-level rise projection. In chapter two we study mathematical applications in air emissions inventory and air pollution monitoring and water quality index (WQI). Furthermore, we study calculation and air emissions inventory and air quality index (AQI) calculation. At the last chapter, we study mathematical applications in carbon budget and ocean acidification prediction and erosion control planning. In addition, we solve many examples that illustrate the applications.

Chapter one

Mathematical applications in climate change and sea-level rise projection

Climate Change and Climate Variabilities Differentiating between climate variability and climate change is a significant difficulty for climate scientists. Records of former climates, both direct and indirect, demonstrate how much the climate of Earth has varied over time. Two paleoclimate records, one spanning 6 million years and the other 3 million years, are displayed in Figure 1.S. Both exhibit a notable and intricate evolution, a blend of change and unpredictability, along with slow warming and cooling patterns. Naturally, these records have not been obtained through direct temperature measurements, but have instead been reconstructed using "proxy data"—that is, measurements of parameters that are known to be closely associated with the planetary temperature. The proxy data in this instance originated from oxygen isotope ratios in sediment cores from deep seas. Are these reconstructions trustworthy? Which of these changes are real, and which are probably the result of random variation and chance? Further inquiries are suggested by the graph in Figure 1.6. It displays temperature reconstructions from Antarctic ice core samples based on isotope ratios. Despite being reconstructed using extremely different proxy data, the graph exhibits strong similarities with the graph covering the previous 400,000 years in Figure 1.S's bottom panel. It is evident that ice ages come and go on a regular basis; the last one million years or so may have had a lengthier duration than previous ones. It's also evident that warming and cooling have happened on distinct time frames, with a quick warming phase being followed by a gradual cooling phase. Can we explain the changes, assuming that variability has been isolated from changes? Is it possible to find alterations in similar records that could provide insight into the processes behind the observed evolution? It is obvious that there are more questions than there are answers, and each response raises new ones.

(Kaper, H., & Engler ,2000)



In the example below, we study mathematical applications in temperature anomaly calculation.

Example 1.1:

Math is used to calculate temperature anomalies, which help track climate change. Suppose we have monthly temperature data for a city over several years. To calculate the temperature anomaly for a specific month, subtract the long-term average temperature for that month from the observed temperature. Let's say the long-term average for July is 25°C, and the observed temperature is 28°C. Calculate the temperature anomaly for July.

Solution:

Temperature Anomaly = Observed Temperature - Long-Term Average Temperature

Temperature Anomaly = 28°C - 25°C = 3°C

So, the temperature anomaly for July is 3°C, indicating that it was 3 degrees Celsius warmer than the long-term average for that month.

of more complex artificial intelligence, probability theory, and statistics.

In the sense that they depend on precise identification of water-quality characteristics and then on precise methods of aggregation using deterministic tools that can resolve sets of characteristics into overall water quality, all of the approaches to water-quality index formulation covered in the previous chapters are "crisp" and "deterministic." However, all experimental techniques used to evaluate the quality of water are likewise significantly "reductionist" in the sense that they attempt to determine the nature of the whole based on a small number of its constituent elements. For example, hundreds of compounds can be found in any natural or artificially altered water supply. Additionally, the type of radioactivity may vary depending on the source. If we choose to To obtain a precise and accurate evaluation of a source's water quality, we must examine the water for all possible chemical, physical, and biological characteristics. However, the expense of such an evaluation will be too high. Therefore, a "reductionist" method is used, in which a small number of the most likely elements are selected for study, with the assumption that these selections fairly represent the other constituents. This first introduces a degree of subjectivity and unpredictability to the project. Furthermore, the features of any naturally occurring water channel to To obtain a precise and accurate evaluation of a source's water quality, we must examine the water for all possible chemical, physical, and biological characteristics. However, the expense of such an evaluation will be too high. Therefore, a "reductionist" method is used, in which a small number of the most likely elements are selected for study, with the assumption that these selections fairly represent the other constituents. This first introduces a degree of subjectivity and unpredictability to the project. Furthermore, the features of any naturally occurring water channel alter significantly over time and in different places (Abbasi, 1998). For instance, at any one time, the depth or breadth of a lake may have significantly different water quality at any two locations. Additionally, the qualities may alter over time. For example, the biological assemblage and physico-chemical characteristics of a lake might vary greatly depending on the time of day. Figures 4.1 and 4.2 provide instructive instances that help explain this. The patterns of temperature and dissolved oxygen (DO) concentration as functions of depth that are present in tropical lakes are presented in Figure 4.1. Should a surface sample reveal a DO of less than 10 mg 11 and a temperature of -30°C, A sample collected at five metres below the surface could have a DO of only -2 mg 1- and a temperature drop of up to 10°C.(Kaper, H., & Engler,2000)

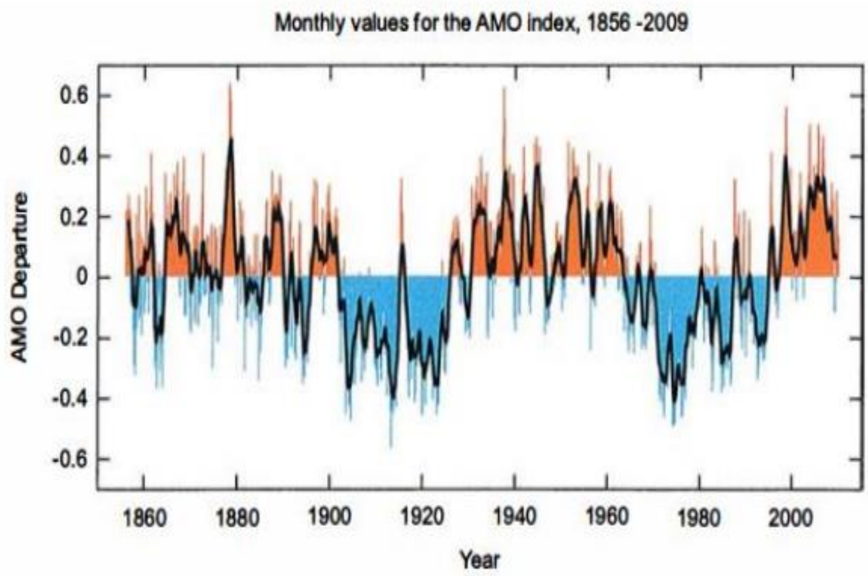


Figure 1.7. *Ocean temperature anomalies for AMO*, 1856–2009 [51].

In the example below, we study mathematical applications in sea-level rise projection.

Example 1.2:

Mathematical models are used to project future sea-level rise based on various factors, including the melting of polar ice, thermal expansion of seawater, and the contribution from glaciers. These models involve complex equations that take into account these variables.

Solution: Let's calculate the projected sea-level rise for the year 2100 based on a simplified linear model. Suppose the current rate of sea-level rise is 3 millimeters per year. To calculate the projected sea-level rise for 2100:

Projected Sea-Level Rise = Current Rate of Rise × Number of Years

Projected Sea-Level Rise = 3 mm/year × 80 years

Projected Sea-Level Rise = 240 mm

So, based on this simplified model, the projected sea-level rise by the year 2100 is 240 millimeters, or 0.24 meters. This projection is a crucial component of climate modeling and informs decisions related to coastal planning, infrastructure resilience, and adaptation strategies.

Chapter two

Air emissions inventory, air pollution monitoring and (WQI and AQI) calculation

Emission factors and inventories have long been important instruments for air quality control. Emission estimates are critical for developing emission control strategies, determining the applicability of permitting and control programmes, assessing the effects of sources and appropriate mitigation strategies, and a variety of other related applications by a wide range of users, including federal, state, and local agencies, consultants, and industry. Data from source-specific emission tests or continuous emission monitors are typically used to estimate a source's emissions since they provide the most accurate depiction of the tested source's emissions. However, test data from particular sources are not always accessible and may not reflect the fluctuation of actual emissions over time Thus, despite their shortcomings, emission factors are sometimes the most effective or the only way to estimate emissions. Criteria and hazardous air pollutant (HAP) emission factors and inventories are becoming more and more important with the enactment of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and the Clean Air Act Amendments of 1990 (CAAA). To support the numerous tasks listed above, the U.S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards (OAQPS) Emission Factor and Inventory Group (EFIG) creates and maintains emission estimate tools. The primary method used by EFIG to record its emission factors is the AP-42 series. Numerous other EPA publications and electronic databases highlight these factors but without the process details and supporting reference material provided in AP-42. What Is An AP-42 Emission Factor? An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e. g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category the source category (a population average, for example). E = A x EF x (1-ER/100) is the general equation for estimating emissions, in which A stands for activity rate, EF for emission factor, and ER for total emission reduction efficiency, percent. ER can also be described as the result of the control system's capture efficiency and the control device's destruction or removal efficiency. When projecting emissions over an extended length of time the source category (say, the average population). The typical formula for estimating emissions is E = A x EF x (1-ER/100), where A is the activity rate, EF is the emission factor, and ER is the total emission reduction efficiency, expressed as a percentage. ER can also be defined as the outcome of the destruction or removal efficiency of the control device and the capture efficiency of the control system. When estimating emissions for a long period of time , he was validated when his findings were linked to the periodic variations in water temperature off the coast of South America, which take place every three to seven years. Local fishermen had noticed these oscillations and named them "El Nino," because they usually had a negative impact on fishing harvests around Christmas. The Norwegian-American meteorologist JACOB BJERKNES (1897-1975) first put up a thorough explanation of the two phenomena' connection in the 1960s. These days, the El Nino-Southern Oscillation (ENSO) phenomena is thought to constitute the predominant mode of variability in the global climate. Climate scientists have discovered numerous other spatially connected or temporally recurrent patterns in the atmosphere and ocean of the modern climate system. For instance, the pressure differential between the "Icelandic low" and the "Azores high" characterises the North Atlantic Oscillation (NAO), a North-South oscillating pattern in air pressure over the North Atlantic. People in western and central Europe are aware of this, as it affects a significant portion of the everyday weather there. Sir Gilbert also made the discovery of the NAO. With a half-century timeframe, the Atlantic Multidecadal Oscillation (AMO) is a temporal pattern in sea surface temperatures in the North Atlantic. It was first noted in the middle of the 1800s. Figure 1.7 shows a graph. Recent research indicates that large snowfalls on the US East Coast, as occurred during the exceptionally snowy winter of 2009–2010, may be linked to positive anomalies in the AMO (unusually high ocean surface temperatures). Dipole structures are pairs of related patterns in climate science where specific variables of interest move together with in each region but move in opposite directions.(Das, T. K. (2020).)

In the example below, we study mathematical applications in Air Emissions Inventory

Example 2.1:

Mathematics is used to calculate emissions of pollutants from various sources, such as factories or vehicles, for regulatory reporting. Suppose a factory produces 500 tons of sulfur dioxide (SO_2) annually. Calculate the daily average emissions in pounds (lbs) of SO_2.

Solution:

To calculate daily average emissions, divide the annual emissions by the number of days in a year:

Daily Average Emissions (lbs/day) = Annual Emissions (tons/year) / Number of Days in a Year

Daily Average Emissions (lbs/day) = 500 tons/year / 365 days/year

Calculate this to get the daily average emissions in pounds.

Executive summary

Air pollution is now considered to be the world's largest environmental health threat, accounting for seven million deaths around the world every year. Air pollution causes and aggravates many diseases, ranging from asthma to cancer, lung illnesses and heart disease.1 The estimated daily economic cost of air pollution has been figured at $8 billion (USD), or 3 to 4% of the gross world product.2 Air pollution affects those that are most vulnerable the most. It is estimated that in 2021, the deaths of 40,000 children under the age of five were directly linked to PM2.5 air pollution. And in this age of COVID-19, researchers have found that exposure to PM2.5 increases both the risk of contracting the virus and of suffering more severe symptoms when infected, including death.3 In September 2021, the World Health Organization (WHO) released a timely and ambitious update to its global air quality guidelines, 15 years after the last update released in 2006. Acknowledging the significant impact of air pollution on global health, the WHO cut the recommended annual PM2.5 concentration by half, from 10 µg/m3 down to 5 µg/m3 , with the ultimate goal of preventing millions of deaths.4 IQAir's annual World Air Quality Report aggregates and compares millions of PM2.5 measurements taken in thousands of locations around the world. The data is gathered over the course of the year from a combination of regulatory and non-regulatory ground-based air quality monitors. Although many areas around the world still lack access to publicly available air quality information, global air quality data continued to increase in 2021. While the 2020 World Air Quality Report included data from 4,745 locations in 106 countries and regions, the 2021 report coverage expanded to 6,475 locations in 117 countries, territories, and regions. This is in part due to the increasing number of low-cost air quality sensors mostly operated by non-profit organizations, governments, and citizen scientists. The increased number of PM2.5 stations helps to create a more accurate picture of hyper-local air quality, and global air quality.(IQAir. (2021).

In the example below, we study mathematical applications in Air Pollution Monitoring:

Example 2.2:

Problem: A city has air quality sensors placed at different locations. The average air pollutant level at location A is 25 micrograms per cubic meter ($\mu g/m^3$), while the average at location B is 35 $\mu g/m^3$. Calculate the city's overall average air quality.

Solution:

To find the overall average, add the values and divide by the number of locations: $(25\ \mu g/m^3 + 35\ \mu g/m^3) / 2 = 60\ \mu g/m^3 / 2 = 30\ \mu g/m^3$. The city's overall average air quality is 30 $\mu g/m^3$.

of More Complex Artificial Intelligence, Probability Theory, and Statistics

In the sense that they depend on precise identification of water-quality characteristics and then on precise methods of aggregation using deterministic tools that can resolve sets of characteristics into overall water quality, all of the approaches to water-quality index formulation covered in the previous chapters are "crisp" and "deterministic." However, all experimental techniques used to evaluate the quality of water are likewise significantly "reductionist" in the sense that they attempt to determine the nature of the whole based on a small number of its constituent elements.For example, hundreds of compounds can be found in any natural or artificially altered water supply. Additionally, the type of radioactivity may vary depending on the source. If we choose to To obtain a precise and accurate evaluation of a source's water quality, we must examine the water for all possible chemical, physical, and biological characteristics. However, the expense of such an evaluation will be too high. Therefore, a "reductionist" method is used, in which a small number of the most likely elements are selected for study, with the assumption that these selections fairly represent the other constituents. This first introduces a degree of subjectivity and unpredictability to the project. Furthermore, the features of any naturally occurring water channel to To obtain a precise and accurate evaluation of a source's water quality, we must examine the water for all possible chemical, physical, and biological characteristics. However, the expense of such an evaluation will be too high. Therefore, a "reductionist" method is used, in which a small number of the most likely elements are selected for study, with the assumption that these selections fairly represent the other constituents. This first introduces a degree of subjectivity and unpredictability to the project. Furthermore, the features of any naturally occurring water channel alter significantly over time and in different places (Abbasi, 1998). For instance, at any one time, the depth or breadth of a lake may have significantly different water quality at any two locations. Additionally, the qualities may alter over time. For example, the biological assemblage and physico-chemical characteristics of a lake might vary greatly depending on the time of day. Figures 4.1 and 4.2 provide instructive instances that help explain this. The patterns of temperature and dissolved oxygen (DO) concentration as functions of depth that are present in tropical lakes are presented in Figure 4.1. Should a surface sample reveal a DO of less than 10 mg 11 and a temperature of -30°C, A sample collected at five metres below the surface could have a DO of only -2 mg 1- and a temperature drop of up to 10°C.(Smith, J. (2010))

Now we study mathematical applications in water quality index calculation

Example 2.3:

Mathematics is used to calculate the Water Quality Index (WQI) to assess the overall quality of water in a body of water like a river or lake. The WQI is determined based on various water quality parameters, each contributing to the index. Let's calculate the WQI for a river using the following parameters and their respective weightings:

- Parameter 1: Dissolved Oxygen (DO) = 8.5 mg/L (Weighting: 0.2)

- Parameter 2: pH = 6.8 (Weighting: 0.1)

- Parameter 3: Total Suspended Solids (TSS) = 12 mg/L (Weighting: 0.3)

- Parameter 4: Biochemical Oxygen Demand (BOD) = 4.2 mg/L (Weighting: 0.4)

Solution:

$$WQI = (W1 \times I1 + W2 \times I2 + W3 \times I3 + W4 \times I4) / (W1 + W2 + W3 + W4)$$

Where:

- W1, W2, W3, and W4 are the weightings of the parameters.

- I1, I2, I3, and I4 are the sub-indices for each parameter.

Now, plug in the values:

$$WQI = (0.2 \times I1 + 0.1 \times I2 + 0.3 \times I3 + 0.4 \times I4) / (0.2 + 0.1 + 0.3 + 0.4)$$

Calculate each sub-index (I1, I2, I3, I4) using the respective parameter's measurement and its associated scale. Then, calculate the WQI based on these values.

These examples demonstrate how mathematics is applied in climate modeling to understand, monitor, and predict environmental changes related to climate and carbon dynamics.

The Environmental Protection Agency (EPA) has identified six “criteria pollutants” as pollutants of concern because of their impacts on health and the environment2 . The criteria pollutants are ozone3 (O3), particulate matter4 (PM), carbon monoxide5 (CO), nitrogen dioxide6 (NO2), sulfur dioxide7 (SO2), and lead8 (Pb). Under the Clean Air Act, the EPA has established primary and secondary National Ambient Air Quality Standards (NAAQS) for these six pollutants. Primary standards are designed to protect public health, particularly sensitive populations, while secondary standards are designed to protect the public welfare which includes the environment. If a geographical area does not meet one or more of the NAAQS, it is designated as a nonattainment area and must design a plan to meet the standard9 . NAAQS concentration limits are shown in Table 2-2. The current monitoring network for criteria pollutants is comprised of monitors that meet Federal Reference Method (FRM) or Federal Equivalent Method (FEM) requirements. Monitors are operated by state, local and tribal air pollution agencies across the United States to assess pollutant concentrations in relation to the NAAQS; a variety of instruments and techniques are needed to measure specific pollutants. Regulatory monitoring generally requires very sophisticated and well-established instrumentation to meet measurement accuracy requirements and an extensive set of procedures to ensure that data quality is sufficient. These requirements (e.g., calibration, maintenance, audits, data validation)10 help ensure the collection (Williams, R., Kilaru, V., Snyder, E., Kaufman, A., Dye, T., Rutter, A., Russell, A., & Hafner, H. (2014))

Example 2.4:

Mathematics is used to calculate emissions of pollutants from various sources, such as factories or vehicles, for regulatory reporting. Suppose a factory produces 500 tons of sulfur dioxide (SO2) annually. Calculate the daily average emissions in pounds (lbs) of SO2.

Solution:

To calculate daily average emissions, divide the annual emissions by the number of days in a year:

Daily Average Emissions (lbs/day) = Annual Emissions (tons/year) / Number of Days in a Year

Daily Average Emissions (lbs/day) = 500 tons/year / 365 days/year

Calculate this to get the daily average emissions in pounds.

Example 2.5: In the example below we study mathematical applications in Air Quality Index (AQI) Calculation. Mathematics is extensively used to calculate the Air Quality Index (AQI), which provides information about air pollution levels in a specific area. AQI is calculated based on the concentrations of various air pollutants, including ground-level ozone (O3), particulate matter (PM2.5 and PM10), carbon monoxide (CO), sulfur dioxide (SO2), and nitrogen dioxide (NO2). Each pollutant has its own AQI scale, and the final AQI is determined by the highest individual pollutant value. Let's calculate the AQI for a location with the following pollutant concentrations:

- PM2.5 concentration = 30 $\mu g/m^3$
- PM10 concentration = 40 $\mu g/m^3$
- O3 concentration = 70 ppb
- CO concentration = 3 ppm
- SO2 concentration = 20 ppb
- NO2 concentration = 25 ppb

We'll focus on PM2.5, which has its AQI scale:

- AQI(PM2.5) = [(IHI - ILO) / (BPHI - BPLO)] * (CPM2.5 - BPLO) + ILO

Where IHI and ILO are the AQI values for the "Breakpoint High" (BPHI) and "Breakpoint Low" (BPLO) of the PM2.5 scale, respectively.

- CPM2.5 is the concentration of PM2.5.

Let's use the following values:

- IHI = 300
- ILO = 201
- BPHI = 250.4
- BPLO = 150.5

Solution: AQI(PM2.5) = [(300 - 201) / (250.4 - 150.5)] * (30 - 150.5) + 201

Now, calculate:

AQI(PM2.5) = [(99 / 99.9)] * (-120.5) + 201

AQI(PM2.5) ≈ (-1.0005) * (-120.5) + 201

AQI(PM2.5) ≈ 121.01 + 201

AQI(PM2.5) ≈ 322.01

So, the AQI for PM2.5 in this location is approximately 322.01. This indicates the air quality is in the "Very Unhealthy" range, which signifies that prolonged exposure could have serious health.

Chapter three

Carbon Budget Calculation, Ocean Acidification Prediction and Erosion Control Planning

Write something With the release of the Fifth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC)1 37, the idea of a carbon budget has gained traction as a means of directing climate policy2. 38. The finite total amount of CO2 that may be released into the atmosphere 40 by human activity and yet keep global warming below a targeted temperature threshold is what we refer to as the 39 remaining carbon budgets. This should not be confused with another idea, the historical carbon budget, which provides an estimate of all significant carbon fluxes in the Earth system, both historical and modern. Remaining carbon budget theory is 43 supported by reliable climate science Over the last ten years, a number of studies have elucidated and measured the reasons behind the nearly proportional increase in the world average temperature that results from the cumulative amount of CO2 emissions created by human activities since the industrial revolution (4–13, 46). The transient climatic response to cumulative CO2 emissions has been defined as the linear association between warming and 47 cumulative CO2 emissions thanks to this literature (TCRE). 48 As soon as this idea was conceived, its attraction became clear: the potential for the 49 response of an incredibly complex system If certain factors, like how the Earth reacts to our CO2 emissions, could be simplified to a nearly linear relationship, scientists would be able to make 51 conclusions that are understandable and straightforward. But more recently, phenomena like permafrost thawing have been incorporated into 53 Earth-system models that both influence and are influenced by future warming. These recent additions raise questions and have the potential to alter our perception of the 54 linear relationship. Furthermore, CO2 emissions are not the only thing causing global warming. Additional 55 greenhouse gases, including nitrous oxide, methane, and fluorinated gases Considering that aerosols and their 56 precursors, such as soot or sulphur dioxide, have an impact on global temperatures, predicting the remaining 57 carbon budgets necessitates making assumptions regarding these non-CO2 contributions. The connection between future CO2 emissions and global warming is made more difficult by this 58. (Smith, J. (2010))

In the example below, we study mathematical applications in Carbon Budget Calculation

Example 3.1: Mathematical models are used to calculate carbon budgets for various regions or ecosystems. Let's calculate the carbon budget for a forested area based on the amount of carbon stored in trees. Suppose there are 10,000 trees in the forest, each storing 100 kilograms of carbon. Calculate the total carbon stored in the forest.

Solution: Total Carbon Stored = Number of Trees × Carbon Stored per Tree

Total Carbon Stored = 10,000 trees × 100 kg/tree = 1,000,000 kg

So, the forest stores 1,000,000 kilograms (1,000 metric tons) of carbon.

Ocean acidification refers to the continual decline in the pH of the Earth's oceans. Between 1950 and 2020, the average pH of the ocean surface decreased from around 8.15 to 8.05.[2] Carbon dioxide emissions from human activities are the principal cause of ocean acidification, with atmospheric carbon dioxide (CO2) levels nearing 410 ppm (2020). The ocean absorbs CO2 from the atmosphere. This chemical reaction generates carbonic acid (H2CO3), which dissociates into two ions: bicarbonate (HCO) and hydrogen (H+). The presence of free hydrogen ions (H+) reduces the pH of the ocean, increasing acidity (this does not imply that saltwater is acidic; it remains alkaline, with a pH greater than 8). Mollusks and corals are two examples of marine calcifying creatures. They are particularly fragile since their shells and skeletons are made of calcium carbonate.(Gattuso, J.-P., & Hansson, L. (Eds.). (2011)).

Now we study mathematical applications in Ocean Acidification Prediction.

Example 3.2:

Mathematical models can predict future ocean acidification levels due to increased carbon dioxide (CO2) emissions. Let's use a simplified model to estimate the change in ocean pH. Suppose current ocean pH is 8.1, and it is decreasing by 0.02 units per decade due to CO2 absorption. Calculate the projected ocean pH in 30 years.

Solution: Projected Ocean pH = Current Ocean pH - (Rate of Change × Time)

Projected Ocean pH = 8.1 - (0.02 units/decade × 3 decades)

= 8.1 - 0.06 units = 8.04

So, the projected ocean pH in 30 years is 8.04, indicating a decrease in pH due to ocean acidification.

Erosion caused by construction has impacts off-site as well. Erosion leads to two main water pollution issues: extra sediment and extra nutrients, which damage the ecosystems in the water.

Too many nutrients? Too many nutrients in the water can, in fact, cause a lot of damage. This is because they cause something called "Eutrophication." Eutrophication is the process in which extra nitrogen and phosphorus leads to overgrowth.

Extra sediment in the water makes it cloudy which is called "Turbidity." Turbidity is damaging because it blocks sunlight from entering the water. This, in turn, leads to a reduction of photosynthesis and damages vegetation growth. Lessened photosynthesis causes a reduction of oxygen levels, which impacts the habitat for the fish and other plants and animals.(Williams, R., Kilaru, V., Snyder, E., Kaufman, A., Dye, T., Rutter, A., Russell, A., & Hafner, H. (2014))

Now we study mathematical applications in Erosion Control Planning:

Example 3.3:

Problem: A construction site has an exposed area of 500 square meters. To prevent soil erosion, the site needs to be covered with erosion control matting. Each roll of matting covers 50 square meters. How many rolls of matting are required?

Solution:

Divide the area to be covered by the area each roll of matting can cover: 500 square meters / 50 square meters/roll = 10 rolls. The construction site needs 10 rolls of erosion control matting.

These examples demonstrate how math is used in various environmental applications, from air quality monitoring to solar energy calculations and erosion control planning.

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پوختە

لەم کارەدا ئێمە لێکۆڵینەوە لە هەندێک لە بەکارهێنانی بیرکاری لە ژینگەیی دەکەین لە سەرەتادا ئێمە لێکۆڵینەوە لە بەکارهێنانی بیرکاری لە گۆڕانی کەشوهەوا و ئاستی دەریا و پێشبینی پاشان ئێمە لێکۆڵینەوە لە بەکارهێنانی بیرکاری لە ئینفۆنتۆری دەردانی هەوا و چاودێری پیسبوونی هەوا و پێوەرەکانی کوالیتی ئاو (WQI) و ئینفۆنتۆری دەردانی هەوا و حیسابکردنی پێوەرەکانی کوالیتی هەوا (AQI) دەکەین وە لە کۆتاییدا، ئێمە لە بەکارهێنانی بیرکاری لە حیسابکردنی بودجەی کاربۆن و پێشبینیکردنی ترشبوونی زەریاکان و پلاندانانی کۆنترۆڵکردنی وەرینی زەریاکان دەکۆڵینەوە.

زانکۆی سەلاحەدین - هەولێر
Salahaddin University-Erbil

دەربارەی هەندێ لە جێبەجێکردنەکانی بیرکاری لە زانستی ژینگە

پرۆژەی دەرچوونە

پێشکەش بە بەشی ماتماتیك کراوە، وەك بەشێك لە پێداویستیەکانی بەدەستهێنانی بڕوانامەی بەکالۆریۆس لە زانستی ماتماتیك

ئامادەکراوە لەلایەن :
اسرا حسين جليل

بەسەرپەرشتی :
د .هۆگر محمد یاسین

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