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Environmental Dynamics and Remediation Strategies in the Dravyavati River Basin: A Comprehensive Case Study of Amanishah Nallah, Sanganer Region, Jaipur

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ABSTRACT

Environmental monitoring refers to the systematic observation and analysis of the environment to assess its condition and ensure that it meets predetermined requirements. It involves the organized collection of air, noise, water, and soil samples to observe and analyse the environment, as well as to get knowledge from this procedure. The primary objective of Environmental Monitoring is to assess the progress of any developing activity or project and evaluate the effectiveness of the implemented mitigating measures. The developmental or industrial activity can either be a newly established one or an existing one undergoing expansion. Another important objective of Environmental Monitoring is to validate the effects of developmental or industrial activities on the environment, as predicted during Environment Impact Assessment (EIA) studies. Environmental monitoring is a crucial technique used to assess and track pollution management programmes and Environmental Impact Assessments (EIA). In order to evaluate the current level of pollution and evaluate the effectiveness of the actions taken to reduce it, it is suggested to conduct environmental monitoring in the specified research area.This study includes data on the specific locations within the study region where sampling and monitoring took place. It furthermore entails the gathering and analysis of waste water and silt from **Dravyavati River Basin (Amanishah Nallah), Sanganer Area**, ground water from the neighboring villages, and soil samples from the agricultural areas in the vicinity. The investigations were done in accordance with the specified approach.

Keywords: Environmental monitoring, wastewater analysis, sediment characterization, groundwater quality, soil health, Amanishah Nallah.

INTRODUCTION

Investigation conducted in the field

The field investigation encompassed the gathering of waste water, ground water, soil, and sediment samples from the designated study region. The sample collection, preservation, and analysis were conducted according to the recommended standard protocols. The field survey also assessed the biological and socioeconomic conditions of the research area.

Additionally, individualized conversations will be conducted with the inhabitants in accordance with the predetermined questionnaires. The field investigations encompassed the following segments:

Aquatic Sampling

The water samples from the Sanganer region, Pre-Sanganer area, and Post-Sanganer area were collected and analysed to determine the physicochemical features of the water environment in the area. The purpose was to assess the impact of industrial discharge on the properties of the water.

Type of Sampling Method

Grab sampling involves the collection of a single sample at a defined location, depth, and time. It is conducted at a selected point and site for a brief duration.

(a) **Sampling Method:** Samples were collected manually from various sampling locations using the method outlined below-
(b) **Wastewater from Nallah**: Samples were gathered at several points along the whole length of the Nallah.
(c) **Groundwater:** samples were obtained from bore wells and hand pumps in the research area.

Effluent from Nallah

Water samples from waste water or Nallah were taken at several points throughout the length of the Nallah. The samples were obtained from twelve locations spanning the Nallah. Specifically, three samples were collected from the pre Sanganer area, six samples from the Sanganer area, and the remaining three from the post Sanganer area. These collections were made during the pre-monsoon (June), monsoon (August), and post-monsoon (January) seasons of the year 2023. The samples were taken from the main channel of the Nallah and from sampling stations located at different distances and depths therein. 4L plastic containers that have been thoroughly cleaned and sterilised. The locations where the samples were collected are detailed in Table.1 and visually shown in Figure 1.1. The wastewater samples were collected in individual containers for the purpose of detecting heavy metals such as Iron (Fe), Zinc (Zn), Cadmium (Cd), Chromium (Cr), Copper (Cu), and Lead (Pb). To retain the metal content, the samples were acidified using concentrated Nitric Acid (HNO3). Subsequently, the samples were sent to the laboratory for additional analysis in accordance with the established standard procedures.

Station code	Sampling Location	Description
SWS 1	Sanganer	Bridge over Nallah, dalda factory road
SWS 2	Sanganer	Nallah Stream near Shri Dadu temple
SWS 3	Sanganer	Opp. A.L. Paper House, Shirkarpur Road

SWS 4	Sanganer	Opp. Jyoti wheelcare, Ramsinghpura
SWS 5	Sanganer	Flyover near Haldighati marg
SWS 6	Sanganer	Opp. Shree maruti wheel care
SWS 7	Sanganer	Gular ka banda, subhash nagar colony

Ground water

Water samples were obtained from the accessible water sources in the study area during the pre-monsoon (June), monsoon (August), and post-monsoon (January) seasons of 2016. Various samples were gathered and examined from distinct locations. A study was conducted to assess the quality of groundwater by collecting three water samples from both the before and post Sanganer locations, as well as six water samples from the Sanganer area. The samples were obtained from hand pumps and tube-wells located at different distances and depths. They were gathered in clean and sterilised plastic containers with a capacity of 4 litres. The water was flushed for about fifteen to twenty minutes before collecting samples in order to prevent any water that may have been stagnant in the handpump or borewell pipes from contaminating the samples. The locations where the samples were collected are detailed in Table 1.2 and visually shown in Figure 1.1. The groundwater samples were collected in individual containers for the purpose of detecting heavy metals such as Iron (Fe), Zinc (Zn), Cadmium (Cd), Chromium (Cr), Copper (Cu), and Lead (Pb). To retain the metal content, the samples were acidified using concentrated Nitric Acid (HNO3). Subsequently, these samples were transported to the laboratory for additional analysis.

Table 1.2: Ground Water Sampling Stations

Station code	Sampling Station	Source	Description
GWS 1	Pre Sanganer	Tubewell	Near Khatri nagar
GWS 2	Pre Sanganer	Handpump	Near Kundan nagar
GWS 3	Pre Sanganer	Tubewell	Near Gem vihar colony
GWS 4	Sanganer	Handpump	Swami leela shah colony
GWS 5	Sanganer	Tubewell	Near Agricultural field ramsinghpura

GWS 6	Sanganer	Handpump	Near Kagzi colony
GWS 7	Sanganer	Handpump	Near Khatik mohalla
GWS 8	Sanganer	Tubewell	Near Agricultural field subhash colony
GWS 9	Sanganer	Handpump	Boharon ka mohalla
GWS 10	Post Sanganer	Handpump	Near Shyam nagar
GWS 11	Post Sanganer	Tubewell	Sector 11 Pratap Nagar
GWS 12	Post Sanganer	Tubewell	Krishna vihar colony

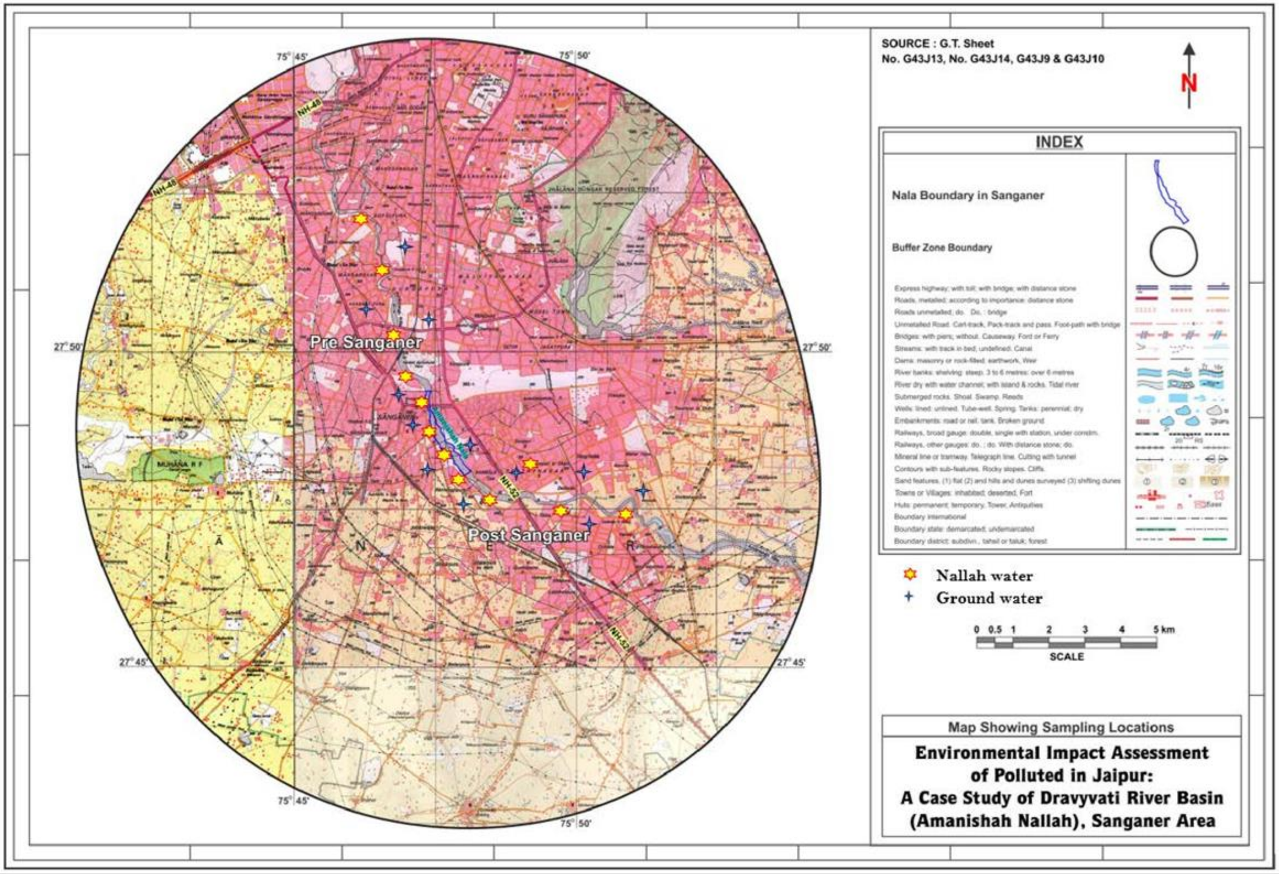

Figure 1.1 – Map Showing Nallah Water And Ground Water Sampling Locations

Sampling of soil and sediment

The data on soil and sediment quality was obtained through the collection and analysis of samples from typical locations throughout the pre-monsoon (June), monsoon (August), and post-monsoon (January) seasons in 2023.

To assess the current attributes of the soil and sediment profile in the research area, samples were examined for important physical and chemical parameters. The sampling areas were selected based on the following criteria: •

To gather data on the existing characteristics

• To assess the influence of contaminated water on the properties of soil and sediment.

Soil Samples - Soil samples were obtained from certain sites within the study region to ensure their representativeness. Conventional protocols were implemented for the collection and examination of physicochemical factors. During the sample collection process, any debris such as dried leaves and pebbles was removed from the surface. Soil samples were collected from various depths using a spade and then weighed using a scale. The soil samples were obtained in properly labelled and sterile polythene bags that were securely sealed to prevent any potential biological or chemical interactions. The soil samples were thereafter transported to the laboratory and subjected to a drying process in an oven set at a temperature of 30 degrees Celsius for a duration of 24 hours. This drying process was carried out in petri-plates that had been previously cleaned, dried, and weighed. Subsequently, the soil samples underwent analysis to determine their pH, electrical conductivity (EC), moisture content, organic matter, organic carbon, chloride levels, and the presence of heavy metals such as Iron (Fe), Zinc (Zn), Cadmium (Cd), Chromium (Cr), Copper (Cu), and Lead (Pb). The table below provides the coordinates of the soil sample stations. Materials and methodology

Table 1.3: Locations of Soil Sampling Stations

Station Code	Sampling Location	Description
SS1	Pre Sanganer	Park sector 116, dalda factory road
SS2	Pre Sanganer	Near Tagore path, mahaveer marg
SS3	Pre Sanganer	Gem vihar colony
SS4	Sanganer	Swami krishi farm,Shikarpur road
SS5	Sanganer	Land opp.Shyam Coloniser, subhash colony
SS6	Sanganer	Agricultural field near paras paper board
SS7	Sanganer	Near utkarsh chilrens academy
SS8	Sanganer	Land behind ganpati prints

SS9	Sanganer	Agricultural land near RAVUSV
SS10	Post Sanganer	Near National Institute of Agriculture Marketing
SS11	Post Sanganer	Near indraprastha garden
SS12	Post Sanganer	Opp. Pooja dhabha, rana sanga marg

Analysis of Waste Water and Ground Water Samples:

The collected samples underwent analysis to determine their physico-chemical properties, such as temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), chloride, total hardness, calcium hardness, magnesium hardness, alkalinity, acidity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), phosphate, sodium, potassium, fluoride, and metal ion concentration. Standard Methods as per APHA and Maiti (2011) were adopted for the analysis.

i) The measurement of the degree of heat or coldness in an object or environment.

The temperature of contaminated water and groundwater fluctuated seasonally and was also influenced by their geographical locations. The measurement was conducted using a mercury thermometer.

ii) pH (acidity level) pH is defined as the logarithm to the base 10 of the reciprocal of the concentration of hydrogen ions in a solution. The pH of water samples was determined using a digital pH metre (Labman, model LMPH10).

Chemical substances used in a scientific experiment or process.

Buffer tablets were dissolved in distilled water and diluted to 100 ml to generate standard buffer solutions with pH values of 4.00, 7.00, and 9.2.

Method

Calibrate the instrument by submerging the electrode in a buffer solution with predetermined pH values, such as 4.00, 7.00, and 9.2. This process is referred to as standardisation. The electrode was subsequently extracted from the buffer, rinsed, blotted, and then re-immersed in a second buffer. Next, the electrode was immersed in distilled water and then gently dried. Subsequently, the object was immersed in the water sample and the pH measurement was recorded using the metre.

iii) Electrical Conductivity (EC)

Electrical conductance refers to the ability of a substance to facilitate the flow of electric current. The sample's electrical conductivity was assessed using a digital conductivity metre (Labman, LMCM-20) and is typically expressed in Siemens per centimetre (mho/cm).

iv) TDS (Total Dissolved Solids)

Total Dissolved Solids (TDS) refers to the combined concentration of cations and anions in a given sample, and is often measured in milligrammes per litre (mg/L). The determination of total dissolved solids involves the measurement of the remaining substances following the evaporation of the filtered sample. The measurement of total dissolved solids in drinking water provides insight into the water's salinity, which serves as an indicator of the quantity of organic pollution in the water. The sample's total dissolved solids were measured using a digital water analysis kit (Model No. 161E).

v) Chloride

The concentration of chloride in water samples was analysed using either Mohr's method or the Argentometric titration method. The reaction between silver nitrate (AgNO3) and chloride forms a minimally soluble white precipitate of silver chloride (AgCl). Upon reaching the endpoint, and all chloride has been precipitated, the remaining free silver ions react with chromate to produce silver chromate, which exhibits a reddish brown hue. The presence of a significant amount of chloride typically imparts a salty flavour to the water.

Chemical substances used in a scientific experiment or process.

1. Silver Nitrate, with a concentration of 0.02N, denoted as AgNO3.

A solution was prepared by dissolving 3.4 grammes of dried silver nitrate in distilled water to obtain a one-liter volume. The solution was then stored in a dark bottle to protect it from photooxidation.

2. **Potassium chromate,** with a concentration of 5%, is represented by the chemical formula K2CrO4.A solution was prepared by dissolving 5 grammes of potassium chromate in 100 ml of distilled water.

Method

A volume of 25 millilitres of the sample was placed into a conical flask, followed by the addition of 1 milliliter of K2CrO4 solution. This solution was then titrated with 0.2 N AgNO3 solution till brick red hue develops at the end point. The quantity of AgNO3 utilized was recorded.

vi) Total Hardness

Hardness is the measure of the amount of multivalent metallic cations, such as Ca2+ and Mg2+, present in a solution. Calcium and magnesium react with Eriochrome black T at a pH of 10.0 ± 0.1 to produce a wine red coloured complex. Ethylenediaminetetraacetic acid (EDTA) exhibits a higher attraction to calcium (Ca+2) and magnesium (Mg+2) ions. Consequently, when EDTA is added, it disrupts the previous complex and forms a new complex that appears blue in colour.

Chemical substances used in a scientific experiment or process.

1. Solution of ethylenediaminetetraacetic acid (EDTA) with a concentration of 0.01M.

A solution was prepared by dissolving 3.723 grammes of disodium salt of EDTA in one litre of distilled water.

2. Buffer solution (a)A solution was prepared by dissolving 16.9 grammes of ammonium chloride in 143 ml of concentrated solution. Ammonium hydroxide (b)A solution was prepared by dissolving 1.179 grammes of disodium EDTA and 0.780 grammes of $MgSO_4.7H_2O$ in 50 ml of distilled water.

Subsequently, both the (a) and (b) solutions were combined and thinned down to a volume of 250 ml using distilled water.

The indicator known as Eriochrome Black T (sometimes referred to as Solochrome Black T) is used.

A total of 0.40 grammes of indicator was combined with 100 grammes of sodium chloride (NaCl) and ground.

Solution of sodium sulphide

A solution was prepared by dissolving either 5 grammes of $Na_2S.9H_2O$ or 3.7 grammes of $Na_2S.5H_2O$ in 100 ml of distilled water. The solution was then stored in a tightly closed bottle to prevent oxidation.

Methodology

A 25ml water sample was collected in a conical flask, and then 1ml of buffer solution and a little amount of Eriochrome black T indicator were added to create a wine red hue. Subsequently, the solution was subjected to titration using an EDTA solution until the wine red colour transitioned to blue, indicating the endpoint. The burette reading was recorded for the blank solution and subsequently for each sample.

Calculation: The millilitres (ml) of EDTA used can be multiplied by 1000 to determine the hardness of the sample in milligrammes per litre (mg/L) as $CaCO_3$.

vii) Calcium Hardness

Calcium can be quantified using EDTA directly, by adjusting the pH to a level between 12 and 13. Magnesium, on the other hand, is mostly precipitated as the hydroxide. To differentiate between the two, an indicator called murexide is employed, which selectively reacts with Calcium.

Chemical substances used in a scientific experiment or process.

1. A solution of ethylenediaminetetraacetic acid (EDTA) with a concentration of 0.01 moles per litre.

A solution of disodium salt of EDTA was prepared by dissolving 3.723 grammes of the salt in one litre of distilled water.

Sodium hydroxide solution at a concentration of 1N.A solution was prepared by dissolving 40 grammes of NaOH in distilled water and then diluting it to a volume of one litre.

The Murexide indication

Method

A conical flask was used to collect a 25 ml sample of water. Subsequently, 1 ml of buffer solution was combined with 1 ml of NaOH, along with the addition of Murexide indicator, resulting in the solution acquiring a pink hue. Subsequently, the solution underwent titration with EDTA, resulting in a transition from a pink hue to a purple hue at the endpoint.

Computation

The calcium hardness as $CaCO_3$ (mg/L) is calculated by multiplying the volume of EDTA used by 1000 and then multiplying the result by 1.05. This value is then divided by the volume of the sample in millilitres.

8) Magnesium Hardness

The magnesium hardness is determined by calculating the discrepancy between a portion of the sample at pH 10 and another portion that is titrated at pH 12 or 13.

The hardness of magnesium (expressed in mg/L as $CaCO_3$) can be calculated by subtracting the calcium hardness from the total hardness.

ix) Alkalinity refers to the capacity of a substance to neutralise acids or maintain a basic pH level.

Total alkalinity refers to the ability of water to counteract the effects of a powerful acid by neutralising it. While alkalinity is generally benign, high amounts can result in water having a harsh taste. The estimation can be determined by doing a titration of the sample using standardised sulphuric acid. Titration to a pH of 8.3 or the removal of colour from the phenolphthalein indicator will indicate the complete neutralisation of hydroxide ions and half of carbonate ions, CO_3^{2-}. On the other hand, a pH of 4.5 (followed by a distinct colour change from yellow to pink in methyl orange) will show the total alkalinity.

Chemical substances used in a scientific experiment or process.

1. Distilled water that is free of carbon dioxide (CO_2).

A solution of sodium carbonate with a concentration of 0.05N.

A quantity of 5.300 grammes of dehydrated Na_2CO_3 was placed into a volumetric flask with a capacity of 1000 millilitres and then filled to the brim with distilled water.

3. A solution of sulfuric acid with a concentration of 0.02 moles per litre (0.02N).

To begin, a 0.1N H_2SO_4 solution was prepared by diluting 3ml of concentrated H_2SO_4 with 1000 ml of solvent. This solution was then further diluted to achieve a concentration of 0.02N H_2SO_4.

4. The indicator used is phenolphthalein, which has a pH of 8.3.

The substance used is methyl orange, which serves as an indication.

Methodology Analysis was conducted promptly following sample collection. A 100 ml sample was collected in a conical flask, followed by the addition of 2-3 drops of phenolphthalein indicator. If no coloration is observed, the alkalinity of phenolphthalein is regarded to be zero. Subsequently, methyl orange is introduced. If a pink hue arises, the solution is titrated with sulphuric acid (H_2SO_4) until the coloration vanishes. The quantity of H_2SO_4 utilised in this process is recorded as (A). In the same flask, 2-3 drops of methyl orange were introduced and the titration was continued until the orange hue transformed into pink. The volume of H_2SO_4 utilised was also recorded as (B).

Calculation: (A) plus (B) multiplied by N multiplied by 50 multiplied by 1000 Alkalinity (mg/L as $CaCO_3$) equals the millilitres of the sample.

x) Dissolved Oxygen (D.O.)

Dissolved oxygen serves as a metric for assessing the level of contamination in wastewater. The oxygen in the sample causes the divalent manganese to undergo oxidation, resulting in the formation of higher valency manganese. This higher valency manganese then precipitates as brown-hydrated oxides when NaOH and KI (potassium iodide) are added. When the pH decreases, manganese returns to its two-valent form and releases iodine from potassium iodide, which is proportional to the dissolved oxygen level in the sample. Subsequently, the freed iodine is quantitatively measured by titrating it against $Na_2S_2O_3$ with the aid of starch as an indicator.

Reagents: 1. Solution of manganous sulphate

A solution was prepared by dissolving 364 grammes of monohydrate manganous sulphate ($MnSO_4$. H_2O) in distilled water.

2. Solution containing alkaline iodide azide

A solution was prepared by dissolving 500 grammes of NaOH and 150 grammes of KI, and then diluting the resulting mixture to a volume of 950 millilitres. Subsequently, 10 grammes of sodium azide was introduced and completely dissolved in 40 millilitres of distilled water. The solution was chilled and diluted to a volume of 1 litre.

3. Sulphuric acid in a very concentrated form

4. Starch indicator solution

5. Sodium thiosulfate solution with a standard concentration of 0.025N.

A solution of 6.025 grammes of $Na_2S_2O_3.5H_2O$ was prepared by dissolving it in distilled water that had been cooked and then cooled. Subsequently, a volume of 1.5 ml of 6N NaOH per 1L was introduced.

6. A solution of potassium dichromate with a concentration of 0.25N.

A quantity of 12.259 grammes of dehydrated $K_2Cr_2O_7$ was placed into a volumetric flask and subsequently filled up to a volume of 1 litre.

Method

The collection of water samples was carried out using B.O.D. bottles, ensuring that any formation of bubbles was carefully prevented. The bottles were filled to the brim with the samples, after which 1 ml of manganous sulphate was added, followed by 1 ml of alkaline iodide azide solution. A stopper was meticulously inserted to prevent the presence of air bubbles, and the bottle was repeatedly inverted to mix its contents. Subsequently, the yellow precipitate was left undisturbed for around 30 minutes to allow it to settle. After cautiously removing the stopper, 1 ml of concentrated sulphuric acid was introduced until the yellow precipitate dissolves or transforms into a light yellow hue. Subsequently, the bottle was sealed and agitated to facilitate the dissolution of the complex. Subsequently, Starch was included as an indication, leading to the manifestation of a blue hue. Subsequently, the solution was subjected to titration using $Na_2S_2O_3$, resulting in the complete disappearance of the blue hue at the endpoint.

Formula: Dissolved Oxygen (D.O.) concentration in mg/L can be calculated using the following formula: D.O. (mg/L) = ml of titrant x Normality x 8 x 1000 / $V_2(V_1-v)/V_1$

At what location, V_1 represents the volume of the BOD bottle, measured in millilitres.The volume (v) is equal to the sum of the volumes of $MnSO_4$ and Iodide Azide, which is 1ml + 1ml = 2ml.V_2 represents the volume of the substance being titrated, measured in millilitres.

RESULTS AND DISCUSSION

In the Results and Discussion section of the research paper, the focus is on interpreting the findings obtained from the various environmental samples. Here's an expansion on the analysis of each sample type:

1. **Wastewater Analysis:**
    - Elevated pollutant levels suggest potential contamination sources, such as industrial effluents or domestic sewage.
    - Identified pollutants could include heavy metals, organic compounds, nutrients like nitrogen and phosphorus, or other harmful substances.
    - Further investigation is necessary to pinpoint specific sources and develop effective treatment measures to reduce or eliminate these contaminants from entering the water bodies.
2. **Sediment Composition and Heavy Metal Concentration:**
    - Variations in heavy metal concentrations within sediments suggest localized pollution origins, possibly from industrial runoff or agricultural activities.
    - Identification of specific heavy metals and their levels helps in understanding potential environmental risks and guiding remediation strategies.
    - Patterns of sediment accumulation can indicate areas of higher contamination and help prioritize cleanup efforts.

3. **Groundwater Quality Analysis:**
    - Parameters exceeding permissible limits in groundwater raise significant concerns for the health and safety of nearby villages reliant on this water source.
    - The identified parameters (such as heavy metals, nitrate, or microbial contamination) may pose immediate or long-term health risks to the community.
    - Urgent measures are required to address contamination sources and implement purification or remediation systems to ensure safe drinking water access.
4. **Soil Nutrient Levels and Agricultural Impacts:**
    - Diverse nutrient levels in soil could be due to varying agricultural practices, such as fertilizer use or land management techniques.
    - High nutrient levels might lead to soil degradation, affecting crop productivity and potentially causing nutrient runoff into water bodies.
    - Sustainable agricultural practices need to be promoted to maintain soil fertility while minimizing environmental impacts.

Conclusion:

The findings from this comprehensive study highlight the need for immediate environmental interventions and management strategies in the Amanishah Nallah area. Addressing wastewater treatment, sediment control measures, groundwater protection, and sustainable agricultural practices are essential to mitigate environmental risks. This research contributes valuable insights into understanding local environmental dynamics, guiding policymakers and stakeholders toward informed decision-making for environmental conservation and sustainable development

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