Vegetation Analysis of Mubarak Village: A Comprehensive Study of Plant Types and Distribution

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Abstract

This report documents the fieldwork conducted at Mubarak Village, a coastal area near Karachi, Pakistan, to study the spatial distribution of plantations and the geological features of the region. The research involved collecting precise geographic data using GPS and tape measures, focusing on parameters such as longitude, latitude, height, width, and plantation type. Observations of sedimentary rock formations, including sandstone, limestone, and shale, provided insights into the geological history shaped by ancient marine environments and tectonic shifts.

Data collected was processed in ArcGIS, where spatial mapping and Inverse Distance Weighted (IDW) analysis revealed patterns of plantation density. Denser clusters were observed in fertile areas, while sparse regions reflected environmental limitations such as poor soil or water availability. The analysis emphasised the ecological importance of coastal vegetation, particularly mangroves, which stabilise the shoreline and support biodiversity.

Additionally, Mubarak Village presents significant eco-tourism potential due to its unique geology, vibrant marine life, and activities such as snorkelling, fishing, and scuba diving. However, infrastructural challenges, including a lack of basic amenities, hinder development. This study highlights the value of integrating geospatial technologies with fieldwork to deepen the understanding of environmental dynamics and support sustainable management efforts.

Chapter 1
(Introduction)

1.1 Overview of Mubarak Village and Its Regional Importance

Mubarak Village, located along the tranquil coastline of Karachi, is a vibrant yet underdeveloped fishing community that serves as a significant hub for local fisheries. As the second-largest fishing village in Karachi, it plays a crucial role in the local economy, providing livelihoods to many of its residents. Despite its natural beauty and ecological richness, the village remains deprived of basic infrastructure, such as reliable electricity, healthcare, and education. These challenges highlight its dual identity as both a site of immense natural potential and a neglected part of urban Karachi, warranting further study and attention.

Fig 1.1 *A striking view of the Mubarak Village lighthouse, surrounded by rocky terrain and overlooking the vast coastline, exemplifying the area's geological diversity and coastal significance.*

1.2 Objectives of the Field Study and Their Relevance to the Region

The primary aim of this field study was to combine academic learning with practical application in a real-world setting. The objectives included:

1. Geospatial data collection of plantations, focusing on geographic coordinates, height, width, and types of vegetation.
2. Conducting spatial analysis of the collected data using GIS tools such as ArcGIS, particularly employing IDW (Inverse Distance Weighted) interpolation to reveal patterns in plantation distribution.
3. Observing and documenting the geological characteristics of the region, including sedimentary rock formations like sandstone, limestone, and shale, to understand the area's geological evolution.
4. Assessing Mubarak Village's ecological and tourism potential while addressing challenges related to infrastructure and sustainability.

1.3 Geographical and Geological Importance of Mubarak Village

The geographical location of Mubarak Village along the Arabian Sea lends it a unique natural appeal, characterized by pristine beaches and rugged coastal topography. The region's geology is dominated by sedimentary rock formations that narrate a story of ancient marine environments and tectonic movements spanning millions of years. Layers of sandstone, limestone, and shale not only add to the area's aesthetic charm but also provide valuable information for geological studies. The interplay between the rocky hills, coastal plains, and the Arabian Sea creates a dynamic environment that is ideal for academic research and exploration.

Fig 1.2 *A serene view of Mubarak Village, with its scattered settlements bordered by vibrant coastal vegetation and the vast blue ocean in the background.*

1.4 Ecological Significance and the Role of Coastal Vegetation

The ecological profile of Mubarak Village is shaped by its coastal vegetation, including mangroves, palm trees, and resilient shrubs that thrive in saline environments. These plants serve as critical components of the local ecosystem, stabilizing the shoreline against erosion, providing habitats for wildlife, and supporting marine biodiversity. Mangroves, in particular, act as natural buffers against coastal erosion while serving as nurseries for marine life. The study aimed to explore the spatial distribution and ecological importance of these plantations, shedding light on their role in maintaining environmental balance and supporting local livelihoods.

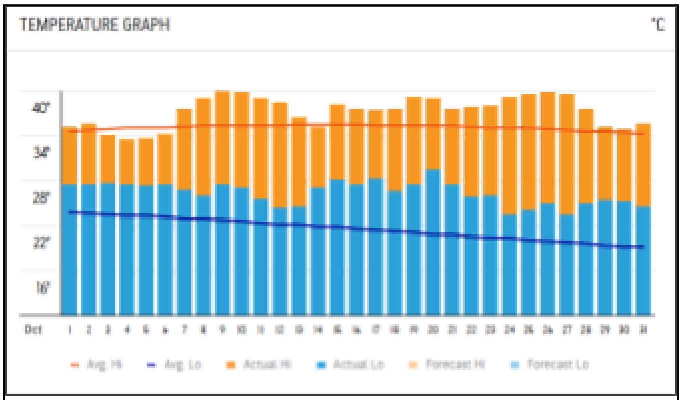

Fig 1.3 *A temperature graph illustrating seasonal variations in Mubarak Village highlights the climatic conditions influencing plantation growth and ecological balance in the region.*

1.5 Climate and Its Influence on Plantation and Geological Stability

The climate of Mubarak Village is typical of a coastal region, characterized by hot, humid summers and mild winters. These climatic conditions have a direct impact on the growth of plantations and the stability of geological structures. Limited rainfall, mainly occurring during the monsoon season, further influences soil quality and water availability. Understanding these environmental factors was crucial to analyzing plantation density and their reliance on the microclimatic conditions of the area. The study integrated climatic data to provide a comprehensive understanding of how the environment shapes both ecological and geological dynamics.

1.6 Eco-Tourism Potential and Challenges in Mubarak Village

Mubarak Village offers significant potential as a destination for eco-tourism due to its scenic landscapes, vibrant marine biodiversity, and opportunities for water-based activities such as snorkelling, scuba diving, and fishing. The coral reefs and clean beaches make it an attractive spot for both local and international tourists. However, the lack of basic infrastructure—such as consistent electricity, healthcare facilities, and adequate transportation—hinders its development. The study also assessed how sustainable tourism practices could be implemented to protect the area's natural resources while fostering economic growth.

Fig 1.4 *Mubarak Village, with its unique blend of coastal ecosystems and geological features, offers immense potential for ecotourism, promoting sustainable development while preserving the environment.*

1.7 Integrating Classroom Knowledge with Field-Based Learning in Mubarak Village

This field trip provided an invaluable opportunity to apply theoretical concepts in a real-world setting. Students were able to employ geospatial tools like GPS and ArcGIS to collect and analyze data, enhancing their technical skills and understanding of spatial patterns. Beyond the technical aspects, the fieldwork offered insights into the interconnectedness of ecological, geological, and socio-economic factors.

Chapter 2
(Methods)

2.1 Objectives and Scope of the Fieldwork

The fieldwork at Mubarak Village aimed to address several interrelated objectives by combining data collection with analytical approaches. The core goals included:

1. Documenting geospatial and physical data of plantations, including coordinates (latitude and longitude), height, width, and type.
2. Studying the geological characteristics of the region, focusing on sedimentary rock formations and their spatial patterns.
3. Conducting a detailed analysis of spatial patterns in plantation distribution using GIS tools, specifically employing Inverse Distance Weighted (IDW) interpolation.
4. Integrating field observations with digital geospatial platforms to create maps and identify correlations between plantation density, geological features, and environmental factors.

The study's scope extended beyond academic learning, aiming to contribute insights into environmental management, sustainable development, and tourism planning in the Mubarak Village region.

2.2 Tools and Equipment Used for Data Collection and Processing

The success of the fieldwork relied on the appropriate selection and use of tools and equipment, which were chosen to ensure precision and efficiency in data collection. The following tools were utilized:

1. **Global Positioning System (GPS):**
    - GPS devices were essential for recording the exact locations of plantations and geological features.
    - The data captured through GPS was used to pinpoint spatial patterns and create accurate maps in GIS software.

Fig (2.1) shows the GPS Device
This was the GPS device which was more authentic, especially in remote area like this.

2. **Tape Measurer:**
    - Measurements of plantation dimensions (height and width) were taken using tape measures.
    - These measurements provided essential physical data that was later correlated with plantation types and environmental factors.
3. **Notebook and Camera:**
    - Field observations, including qualitative descriptions of plantations and geological formations, were recorded in notebooks.
    - High-resolution photographs taken during the fieldwork served as a visual record for cross-referencing and documentation.

Fig 2.2 *A collage showcasing fieldwork activities, including capturing photographs, recording observations, and measuring plantation dimensions with a tape measure, highlights the systematic approach to data collection in Mubarak Village.*

4. **ArcGIS Software:**
    - ArcGIS was used to digitize the collected data, create spatial maps, and conduct advanced analyses such as IDW interpolation.
    - Attribute tables in ArcGIS allowed for the systematic organization of plantation data, facilitating in-depth spatial analysis.
5. **Satellite Imagery:**
    - High-resolution satellite images were obtained to provide an aerial perspective of the study area.
    - These images were used to supplement field observations, allowing the identification of patterns and relationships that were not immediately apparent from ground-level data.

2.3 Data Collection Process

The data collection process was meticulously planned and executed to ensure accuracy and reliability. It was divided into several key steps:

2.3.1 Plantation Survey

- The field team systematically surveyed the allocated area, documenting all plantations.
- GPS devices were used to record the geographic coordinates of each plantation. The precision of this data ensured that all spatial analyses were based on accurate locations.
- Tape measurements were used to measure the height and width of each plantation. These dimensions provided valuable insights into plantation health and growth patterns.
- Each plantation was classified based on its type (e.g., mangroves, shrubs, or palm trees), and observations regarding their condition and ecological role were noted.

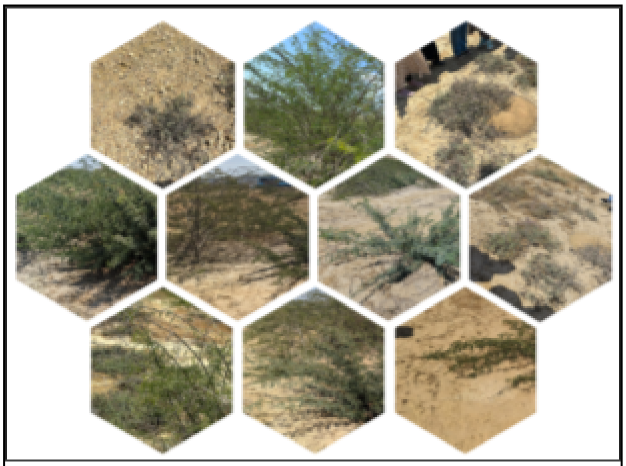

Fig 2.3 *A visually engaging collage showcasing various plant samples collected during fieldwork, highlighting the diversity of vegetation in the study area.*

2.3.2 Geological Observations

Fig 2.4 *An intricate close-up of a rock sample, illustrating the geological features and stratification patterns vital for the study of terrain characteristics.*

- Sedimentary rock formations were observed and documented in detail. Key characteristics, such as composition, layering, and structural orientation, were recorded.
- Photographs supplemented visual inspection to create a comprehensive record of the geological features in the study area.
- Observations focused on identifying relationships between geological features and their surrounding environment, such as the influence of rock formations on soil conditions.

2.3.3 Climate and Environmental Context

- The team noted weather conditions, including temperature, wind speed, and humidity, as these factors directly affect plantation health and soil stability.
- The interplay between climatic conditions and plantation density was explored, forming the basis for understanding environmental influences on vegetation.

2.4 Data Integration and Analysis Using Geospatial Tools

Once the field data was collected, it underwent a systematic process of integration and analysis in ArcGIS:

2.4.1 Data Entry and Organization

- All recorded data, including geographic coordinates, dimensions, and plantation types, were entered into attribute tables within ArcGIS.
- Each entry was assigned a unique identifier to ensure traceability and facilitate analysis.

2.4.2 Creation of Spatial Maps

- The geographic data from GPS devices was visualized on maps, marking the locations of plantations and geological features.
- Additional layers, such as high-resolution satellite imagery, were overlaid to provide contextual information and enhance visual interpretation.

2.4.3 Spatial Interpolation Analysis

- An IDW (Inverse Distance Weighted) interpolation analysis was conducted to visualize patterns in plantation density. This technique helped identify areas with high and low concentrations of vegetation, revealing correlations with environmental conditions.
- The analysis also highlighted potential environmental factors, such as soil fertility and water availability, that influenced plantation health and distribution.

2.5 Challenges Encountered During Fieldwork

The fieldwork team faced several challenges, which required strategic problem-solving and adaptability:

1. **Access to Remote Areas:**
    - Certain parts of the study area were difficult to access due to rugged terrain and lack of infrastructure.
    - The team relied on local guides and alternative routes to navigate these areas safely.
2. **Environmental Conditions:**
    - High temperatures and humidity posed physical challenges for the team, requiring frequent breaks and hydration.
    - Wind and dust in the coastal environment sometimes interfered with the use of equipment, such as GPS devices and tape measurers.
3. **Data Accuracy:**
    - Ensuring the precision of GPS data was occasionally challenging due to limited satellite visibility in certain areas.

    - Cross-referencing data and repeating measurements helped mitigate potential inaccuracies.

2.6 Ethical and Environmental Considerations

The study adhered to ethical guidelines and prioritized minimizing environmental impact:

- **Respect for Local Communities:** The team maintained open communication with the local community, explaining the purpose of the fieldwork and ensuring that it did not disrupt their daily lives.
- **Non-Invasive Methods:** All data collection techniques were non-invasive, ensuring no harm was caused to plantations, geological formations, or the surrounding ecosystem.
- **Sustainable Practices:** The team took care to leave the study area undisturbed, avoiding any activities that could negatively impact the environment.

2.7 Summary of Methodological Approaches

This study employed a comprehensive and integrated methodology, combining traditional field techniques with advanced geospatial technologies. The use of GPS devices, tape measurers, and ArcGIS allowed for accurate data collection and sophisticated analysis, resulting in meaningful insights into the ecological and geological dynamics of Mubarak Village.

The methodological rigour and systematic approach ensured that the findings of this study are both reliable and applicable to future research, environmental management, and sustainable development initiatives for the region.

Chapter 3
(Result and discussion)

The fieldwork conducted at Mubarak Village resulted in a comprehensive dataset, which was analysed to understand the spatial distribution of plantations, geological formations, and environmental interactions. This chapter elaborates on the results derived from field observations, geospatial analyses, and ecological assessments while discussing their implications for the region's environment and development.

FID	Shape *	Id	X	Y	Height
0	Point	1	66.691051	24.851994	0
1	Point	2	66.691854	24.852515	30
2	Point	3	66.691676	24.852246	0
3	Point	4	66.691914	24.852411	20
4	Point	5	66.691848	24.852409	30
5	Point	6	66.691907	24.85236	0
6	Point	7	66.691798	24.852246	60
7	Point	8	66.692927	24.851519	7
8	Point	9	66.691795	24.852077	60
9	Point	10	66.691026	24.851865	22
10	Point	11	66.693031	24.851178	15
11	Point	12	66.693461	24.851216	90
12	Point	13	66.693202	24.851191	22
13	Point	14	66.692908	24.851375	30
14	Point	15	66.69134	24.85094	15
15	Point	16	66.691816	24.850879	22
16	Point	17	66.691075	24.851355	90
17	Point	18	66.691202	24.849245	7
18	Point	19	66.692856	24.85141	22
19	Point	20	66.692318	24.849942	60
20	Point	21	66.690543	24.849535	8
21	Point	22	66.692241	24.850897	25
22	Point	23	66.691334	24.850788	22
23	Point	24	66.692492	24.849873	30
24	Point	25	66.691304	24.849713	7
25	Point	26	66.691389	24.851392	60
26	Point	27	66.690917	24.851419	15
27	Point	28	66.691028	24.851414	7
28	Point	29	66.691556	24.851544	30
29	Point	30	66.691365	24.850359	90

Fig 3.1 *An attribute table displaying essential data, including latitude, longitude, and height, serving as a foundation for spatial analysis and mapping.*

3.1 Spatial Distribution of Plantations

The distribution of plantations across Mubarak Village revealed distinct patterns influenced by environmental conditions, topography, and human activity:

1. **High-Density Plantation Zones**
    - Areas close to water sources, such as natural springs and low-lying regions with better soil moisture, exhibited dense clusters of vegetation.
    - Mangroves dominated these regions due to their ability to thrive in saline conditions, highlighting the critical role of water availability in vegetation density.

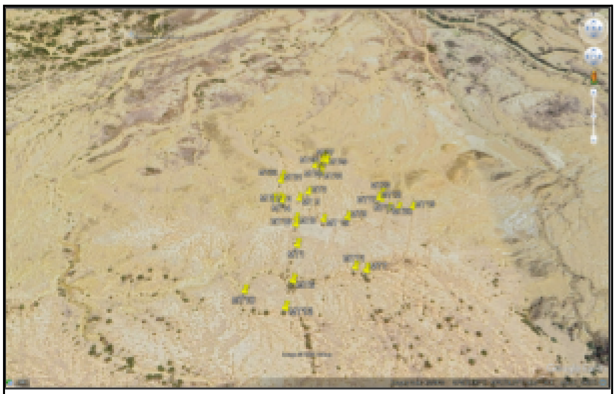

Fig 3.2 *An overview of field data points plotted in Google Earth, providing a geospatial reference for the study area.*

2. **Low-Density Plantation Zones**
    - Sparse vegetation was observed in elevated or rocky areas, where poor soil quality and limited access to water inhibited plant growth.
    - These areas were characterized by the presence of resilient shrubs and salt-tolerant plants, reflecting adaptations to harsh environmental conditions.
3. **Variation in Plantation Dimensions**

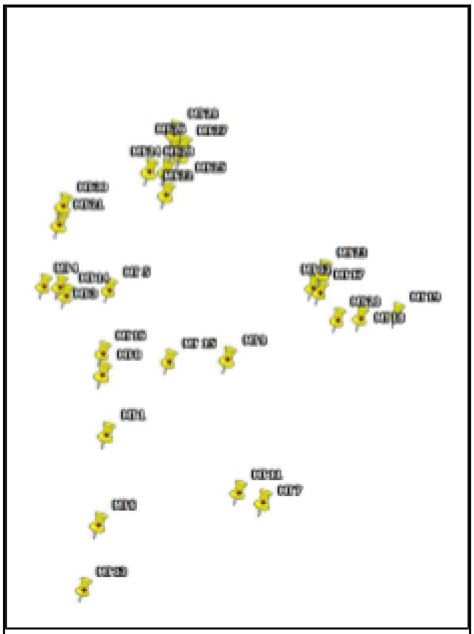

Fig 3.3 *A snapshot of the data integration process, showcasing the transformation of Google Earth points into a feature class in ArcMap for analysis*.

- Height and width measurements of plantations varied across the study area, with coastal palms displaying the highest variability.
- Mangroves exhibited consistent growth in dense clusters, while stunted growth was observed in regions exposed to high winds or poor soil conditions.

The spatial data collected during fieldwork provided a baseline for analyzing the ecological dynamics of the area and identifying areas suitable for conservation or reforestation.

3.2 IDW Analysis: Mapping Plantation Density

The Inverse Distance Weighted (IDW) analysis in ArcGIS visualized the spatial variation in plantation density:

- **Hotspots of Dense Vegetation**
  - Areas with high plantation density were identified near water bodies and regions with fertile soil. These zones demonstrated the strongest correlation between environmental factors and vegetation health.
- **Gradual Transitions in Density**
  - The IDW analysis revealed gradients of decreasing density moving away from favourable zones, transitioning into regions with sparse vegetation. These transitions marked the boundary between fertile soils and arid, rocky terrain.
- **Sparse Vegetation Patterns**
  - Areas with minimal vegetation were concentrated in regions with poor water retention, rocky outcrops, and high salinity.

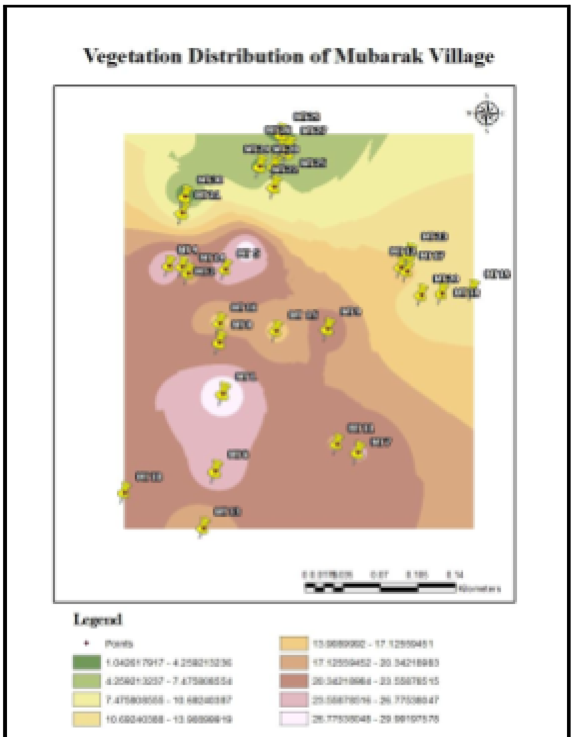

Fig 3.4 *The final layout of the Inverse Distance Weighted (IDW) analysis, visually representing spatial distribution patterns derived from field data.*

These findings underscore the influence of soil properties and topography on plantation growth.

The spatial trends observed through IDW analysis provide actionable insights for targeted ecological interventions, such as soil enrichment or water management in low-density zones.

3.3 Geological Observations and Their Environmental Impacts

The geological features of Mubarak Village played a significant role in shaping its environment, influencing soil characteristics, vegetation patterns, and overall topography:

1. **Composition of Sedimentary Rocks**
    - The area is predominantly composed of sandstone, limestone, and shale, with visible stratification indicative of ancient sedimentary processes.
    - Sandstone formations, interspersed with shale, were found in compact layers, suggesting deposition in a marine environment over millions of years.
2. **Tectonic and Structural Features**
    - The region exhibited evidence of tectonic activity, including folding and faulting, which have shaped the rugged landscape.
    - Geological disturbances have created natural barriers, influencing water flow and soil deposition, which in turn affect plantation distribution.
3. **Influence on Soil and Vegetation**
    - Limestone-rich areas contributed to calcium-enriched soils, supporting specific types of vegetation, including certain shrubs and grasses.
    - In contrast, rocky outcrops with poor soil development were largely barren, emphasizing the strong interdependence between geological and ecological factors.

Fig 3.5 *A group of researchers actively engaged in geological observations, collecting data through collaborative efforts, including measuring, documenting, and photographing geological features.*

The geological observations not only deepen our understanding of the region's history but also provide a foundation for future geological and ecological research.

3.4 Climate and Its Role in Shaping Vegetation Patterns

The climate of Mubarak Village directly impacts plantation health and spatial distribution, with several critical factors influencing vegetation:

1. **Temperature and Humidity**
    - The warm, humid climate during the field visit created optimal conditions for mangrove growth, particularly in low-lying areas.
    - However, high temperatures in arid regions contributed to water stress, leading to reduced vegetation density in these areas.
2. **Wind and Erosion**
    - Strong coastal winds shaped the structure of vegetation, particularly in exposed areas where stunted growth and physical deformities in plants were observed.
    - Wind-driven soil erosion, especially in rocky zones, further limited soil fertility and inhibited plant growth.
3. **Rainfall and Water Availability**
    - The region receives minimal rainfall, concentrated during the monsoon season. This scarcity of water resources has a direct impact on plantation density, particularly in areas without supplementary water sources.

Understanding these climatic influences provides essential insights for managing vegetation and mitigating the adverse effects of climate variability.

3.5 Ecological Observations and Significance

The ecological assessment of Mubarak Village highlighted its role as a critical habitat for coastal and marine biodiversity:

1. **Mangroves as Ecological Pillars**
    - Mangroves were identified as keystone species, supporting a wide range of marine life, stabilizing shorelines, and protecting against coastal erosion.
    - Their ability to sequester carbon highlights their importance in mitigating climate change impacts.
2. **Biodiversity and Habitat Support**
    - Coastal palms, grasses, and shrubs provide habitat for insects, birds, and small mammals, contributing to the region's biodiversity.

    - Marine ecosystems, supported by coral reefs and mangrove roots, host diverse species, including fish, crabs, and molluscs.
3. **Threats to Vegetation and Ecosystems**
    - Human activities, such as overgrazing and waste dumping, were observed to impact vegetation health negatively.
    - Rising sea levels and increasing salinity due to climate change pose additional risks to the local ecosystem.

The findings emphasize the need for conservation initiatives to protect the region's unique biodiversity and mitigate environmental threats.

3.6 Tourism Potential and Development Challenges

The natural beauty and unique features of Mubarak Village make it a promising eco-tourism destination:

1. **Tourism Attractions**
    - Pristine beaches, vibrant coral reefs, and opportunities for water-based activities such as snorkelling, scuba diving, and fishing attract visitors to the region.
    - Geological landmarks and coastal landscapes provide additional attractions for eco-tourists.
2. **Challenges to Tourism Development**
    - The village's tourism potential is limited by the lack of infrastructure, including basic amenities such as electricity, water supply, and healthcare facilities.
    - Unregulated tourism could lead to environmental degradation, emphasizing the need for sustainable tourism practices.
3. **Future Potential**
    - Investing in eco-tourism infrastructure could create opportunities for sustainable development while preserving the natural environment.
    - Community-based tourism initiatives could empower local residents and promote environmental stewardship.

3.7 Implications of Findings for Environmental Management

The results of this study have broad implications for the sustainable management of Mubarak Village:

1. **Conservation Priorities**

    - Dense vegetation hotspots identified through spatial analysis should be prioritized for conservation to protect biodiversity and maintain ecological balance.
2. **Sustainable Development**
    - Integrating ecotourism with local economic activities could support community development while preserving natural resources.
3. **Future Research Directions**
    - Long-term monitoring of climate impacts on vegetation and soil conditions would provide valuable data for adaptive management.
    - Advanced techniques, such as drone mapping and remote sensing, could enhance the accuracy and scope of future studies.

3.8 Summary of Results and Discussion

The fieldwork in Mubarak Village provided critical insights into the region's ecological and geological dynamics. The spatial analysis of plantations and geological observations revealed the intricate relationships between environmental factors, vegetation patterns, and geological features. These findings underscore the importance of integrating geospatial technologies with field observations to inform conservation strategies, sustainable tourism development, and future research initiatives.

Chapter 4
(Conclusion)

The fieldwork at Mubarak Village significantly contributes to understanding the complex interplay between ecological, geological, and environmental factors in a coastal ecosystem. The study achieved its objectives of documenting plantation patterns, analyzing spatial distributions, and exploring the region's geological characteristics. By combining field-based observations with advanced geospatial analysis, this research has provided valuable insights that are essential for conservation, development, and academic purposes.

4.1 Ecological and Geological Significance

One of the key outcomes of the study was the identification of plantation hotspots and their correlation with environmental factors such as soil quality, water availability, and topography. Mangroves were highlighted as keystone species, playing a pivotal role in shoreline stabilization, biodiversity support, and carbon sequestration. Sparse vegetation zones, often associated with rocky outcrops and poor soil development, underscored the challenges posed by natural limitations.

The geological observations revealed the region's fascinating history, marked by sedimentary formations of sandstone, limestone, and shale. These rocks, shaped over millions of years, narrate the story of ancient marine environments and tectonic shifts. Their influence on soil fertility and vegetation patterns emphasizes the interdependence between geological and ecological systems.

4.2 Role of Geospatial Technologies

The use of GIS tools, particularly ArcGIS and IDW interpolation, added significant value to the study. The spatial analysis visualized plantation densities and trends that were not immediately apparent from field observations alone. The ability to integrate field data with satellite imagery and digital mapping tools highlights the transformative potential of geospatial technologies in environmental research.

4.3 Environmental Challenges and Solutions

The findings also brought attention to the challenges facing Mubarak Village, including environmental degradation, limited water resources, and the impact of human activities such as overgrazing and waste dumping. These issues are compounded by the effects of climate change, including rising sea levels and increased salinity, which pose significant threats to the delicate balance of the coastal ecosystem.

To address these challenges, targeted conservation efforts are needed, particularly in dense vegetation zones that provide critical ecological services. Soil improvement, reforestation, and the introduction of sustainable water management practices could enhance the resilience of sparse vegetation zones.

4.4 Sustainable Development and Eco-Tourism

Mubarak Village's unique combination of natural beauty, vibrant biodiversity, and geological features positions it as an ideal location for eco-tourism. Activities such as snorkelling, scuba diving, and geological exploration can attract visitors while generating economic opportunities for local communities. However, infrastructural gaps, including unreliable electricity, limited healthcare, and inadequate transportation, must be addressed to unlock the area's full potential.

Sustainable tourism initiatives, when integrated with conservation efforts, can create a balanced approach to development. Community-based tourism models, where locals are actively involved in tourism management, can ensure that economic benefits are equitably distributed while preserving the region's natural resources.

4.5 Broader Implications and Future Research

This study highlights the importance of integrating geospatial technologies, field observations, and community engagement in environmental management. The findings provide a foundation for future research, including:

- Long-term monitoring of vegetation patterns and soil conditions in response to climate change.
- Advanced studies using remote sensing and soil analysis to refine spatial data and improve ecological understanding.
- Collaborative efforts between academic institutions, local authorities, and environmental organizations to develop sustainable strategies for the region.

In conclusion, the fieldwork at Mubarak Village underscores the value of interdisciplinary approaches in addressing complex environmental challenges. By combining scientific research with practical applications, this study not only deepens our understanding of the region but also paves the way for sustainable management and development initiatives.

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