# A Study on the Effects of Biodiversity and Conservation Efforts on Community Health in the Sunderban Area of Eastern India

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**Abstract:** The Sunderbans, located at the southernmost tip of the Bay of Bengal, is a UNESCO World Heritage site renowned for its mangrove extent encompassing tidal rivers, mudflats, and islands. As the home of the Royal Bengal Tiger and countless humans, it represents the ecological centre of Eastern India. The primary objective of this study is to analyse community participation in Sunderbans conservation strategies. We are in a position to identify the primary catalysts and inhibitors of such community engagement by understanding the correlation between active conservation participation and health outcomes. The essence of the study emphasises the community's awareness of environmental factors that affect the health. Our ultimate objective is to design a framework that clarifies the connections between conservation and health initiatives in areas of high biodiversity. Using a mixed-methods approach, quantitative biodiversity metrics were derived using species richness, evenness, and Simpson's Diversity Index, and health data were gathered using standardised community health surveys that focused on disease prevalence, nutrition status, and sanitation practises. Twenty sites with differing degrees of community-based conservation activities provided the data. Using sophisticated statistical methods, such as multivariate regression analyses and non-metric multidimensional scaling, patterns and correlations between biodiversity and health indicators were identified. Preliminary results indicated a correlation between biodiversity metrics and specific health indicators. There was a 16.8% decrease in waterborne maladies and a 12.1% increase in nutritional diversity among community members in areas with greater biodiversity. Additionally, areas with robust community-based conservation activities demonstrated a 19.8% increase in biodiversity and community health metrics in comparison to areas with minimal to no conservation activities. Our findings highlight the necessity of merging conservation and health agendas, arguing for an integrative strategy in biodiverse regions. It is in the best interest of global stakeholders to recognise and exploit such potential in comparable ecologies.

**Keywords:** Sunderbans, Biodiversity, Community-based conservation, Public health, Ecosystem interplay.

## 1. INTRODUCTION

The Sunderbans is a remarkable geographical area located at the southernmost edge of the Bay of Bengal [1]. It is recognised by UNESCO as a World Heritage site because to its vast mangrove ecosystems that include tidal rivers, mudflats, and islands [2]. The area is characterised by its exceptional ecological diversity and is considered the central part of Eastern India's ecological ecosystem, where the highly respected Royal Bengal Tiger resides [3]. Simultaneously, there is a growing acceptance and implementation of conservation measures that specifically target the local area in this region. However, the complex relationships between these conservation methods and their influence on public health outcomes have not been sufficiently investigated.

The design applies both quantitative and qualitative components in a mixed-methods way to appreciate fully the relationship between biodiversity and community health in Sunderbans. On the quantitative side, data were obtained through structured questionnaires and statistically analyzed to quantify biodiversity indices and health outcomes. In parallel, qualitative data are gathered through open-ended survey responses that would be thematically analyzed to capture community perceptions and experiences. In this case, strong data triangulation will be ensured, and then it will have an effect on validity and depth of findings by addressing numerical trends and contextual insights. The data collection took place over a twelve-month period from January to June 2024. This duration was chosen to capture seasonal variations in biodiversity and health outcomes.

This study aims to fill a significant gap in knowledge by investigating the relationship between community-based conservation efforts in the Sunderbans and their impact on both biodiversity conservation and public health improvement.

The primary aim of this study is to analyse the level of community involvement in conservation initiatives used in the Sunderbans. The aim is to clarify the factors that enable active community participation in these methods, as well as the barriers that hinder or weaken such involvement. This research aims to investigate the complex relationships between the level of community involvement in conservation initiatives and the resulting impact on public health outcomes.

In order to achieve this goal, we employ a comprehensive approach that combines quantitative

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measures of biodiversity with health-related information [4]. Biodiversity measures [5], which include species richness [6], evenness [7], and the Simpson's Diversity Index [8], offer a measurable assessment of the abundance and fairness of biodiversity in the research area. Simultaneously, health data is collected by standardised community health surveys, which specifically aim to evaluate the occurrence of diseases, nutritional condition, and sanitation practises. This two-fold strategy provides a thorough understanding of both the ecological and human aspects of the Sunderbans.

Information is collected from twenty different locations in the Sunderbans, each with different levels of community-based conservation efforts. These sites serve as small-scale representations of the larger environment, providing valuable understanding of the complex interactions between conservation and health in the area. The objective of rigorous data analysis is to reveal complex correlations and patterns between biodiversity measures and health indicators. This is achieved by utilising advanced statistical approaches such as multivariate regression analyses and non-metric multidimensional scaling.

The Sunderbans represent a significant intersection of human and environmental realms, where conservation efforts strengthen the ecosystem and simultaneously improve human health indices. These findings underscore the importance of aligning conservation and health priorities, promoting a comprehensive approach in areas with high biodiversity. Global stakeholders are encouraged to acknowledge and utilise the significant untapped potential found in similar environments, combining efforts to protect the environment and promote human welfare.

## 2. LITERATURE REVIEW

The relationship between conservation efforts and public health outcomes in biodiverse countries has received growing attention in academic circles. This literature review aims to present a comprehensive summary of the current understanding in this area, laying the foundation for our research on community-based conservation in the Sunderbans. We will explore how this conservation approach relates to both biodiversity and public health.

The correlation between conservation and public health has garnered increasing attention, fueled by the acknowledgment that the welfare of ecosystems and human populations are inherently intertwined [9]. Efforts aimed at conserving biodiversity and restoring ecosystems can significantly impact the well-being and economic activities of nearby populations [10].

Research conducted in many regions of the globe has demonstrated that engaging in conservation practises, such as implementing sustainable forest management, safeguarding water sources, and preserving wildlife, can result in enhancements in public health [11]. For example, in the Brazilian Amazon, conservation programmes led by local communities have been linked to decreased rates of diseases such as malaria. This can be related to a decrease in the number of mosquito breeding places as a result of improved forest preservation practises [12].

The significance of community engagement in conservation programmes cannot be exaggerated. Involving local people in conservation initiatives not only cultivates a feeling of ownership and accountability but also has the potential to yield more sustainable and efficient conservation results. This has been a prominent topic in various studies. Studies conducted in Madagascar have demonstrated that the implementation of community-managed marine protected zones has led to elevated fish biomass and improved food security among local populations [13].

Moreover, when communities actively participate in conservation endeavours, they are more inclined to embrace sustainable practises that have positive impacts on both the environment and public health [14]. These measures encompass enhanced cleanliness, purer water supplies, and minimised contact with disease carriers. A study conducted in rural Kenya revealed a significant correlation between community-driven conservation initiatives and improved sanitation as well as a decrease in waterborne illnesses [15].

The correlation between biodiversity and human health is intricate, involving various influential elements. Studies have demonstrated that increased biodiversity can exert a beneficial influence on human health through multiple methods. One of the primary mechanisms is by controlling the occurrence of illnesses. Ecosystems with high biodiversity typically exhibit a wide array of species that can serve as natural predators or competitors of disease vectors. Studies conducted on several ecosystems have established the phenomenon known as the dilution

effect, which refers to the reduction in disease prevalence that occurs as a result of increasing biodiversity [16].

Moreover, a higher level of biodiversity can result in enhanced ecosystem services, such as enhanced water quality and soil fertility. These services have both direct and indirect impacts on human health. Forests that contain a variety of tree species have been linked to improved water quality and a decrease in waterborne infections among nearby communities [17].

The Sunderbans, being a distinctive and richly diverse area, provide a captivating subject for research. This UNESCO World Heritage site is famous for its mangrove forests and serves as the habitat for the Royal Bengal Tiger [18]. It is crucial to examine the impact of community-based conservation activities in the Sunderbans on biodiversity and public health, given the growing emphasis on these strategies.

The initial findings of our study are consistent with the wider body of literature that supports the existence of favourable associations between biodiversity, community involvement, and health results. The correlation between increased biodiversity and decreased waterborne illnesses, as well as enhanced nutritional variety, in certain regions is consistent with similar findings in other ecosystems. Furthermore, the correlation between effective community-based conservation efforts and improved biodiversity and health indicators aligns with the importance of community involvement in conservation initiatives.

To summarise, the literature demonstrates an increasing amount of evidence that suggests a strong correlation between conservation and public health. Community involvement in conservation programmes is a crucial factor, and the favourable results for both biodiversity and health emphasise the necessity for integrated approaches in places with high biodiversity.

The Sunderbans, renowned for its distinctive biological and cultural setting, serves as a wonderful setting for our research, illuminating the potential advantages of conservation initiatives centred upon community involvement. Our work seeks to enhance the current knowledge by offering a detailed understanding of how conservation and health interact in this environmentally significant region. In conclusion, our research suggests the need for more inclusive and cooperative approaches that prioritise the welfare of both ecosystems and communities.

## 3. MATERIALS & METHODS

The study was carried out in the Sunderbans, which is a UNESCO World Heritage site situated at the southernmost point of the Bay of Bengal. The research region has diverse ecosystems, such as mangrove forests, tidal rivers, mudflats, and islands. This region, which is ecologically diverse, is the natural home for the Royal Bengal Tiger and also supports a human population.

The surveys were administered by a team of researchers from The Neotia University, India with expertise in community health and environmental studies. Local field assistants were employed to facilitate communication and ensure cultural sensitivity during data collection.

The Table **1** presents crucial data on the 20 study sites located within the designated latitude and longitude range in the Sunderbans, including their respective sizes in hectares [19]. The 20 research sites were selected using a stratified random sampling technique. Sites were stratified based on factors such as biodiversity levels, conservation activity intensity, and proximity to water bodies. This approach ensured a representative sample of the diverse ecological and social environments within the Sunderbans.

The hectare sizes in this table were determined by a comprehensive approach that involved the utilisation of several techniques such as GPS mapping, remote sensing, aerial photography, satellite images, and ground surveys. These techniques were utilised to guarantee precise and exact estimations of the dimensions of the study site. The sizes of the hectares accurately represent the intricate and location-specific characteristics of the calculations.

In order to accomplish the goals of the study, a mixed-methods strategy was utilised, involving the gathering of quantitative biodiversity measurements and community health data. A total of twenty study sites, which encompassed a range of community-based conservation efforts, were carefully chosen within the Sunderbans region. The selection of these locations was based on their ability to encompass a wide variety of conservation efforts and ecological conditions in the region. Biodiversity measurements were utilised as a vital component of the study, offering valuable insights into the biological abundance of each location. Quantitative evaluations were carried out to measure the extent of biodiversity, including species richness, evenness, and the Simpson's Diversity Index.

**Table 1: Description of Study Sites**

| Site Number | Geographic Coordinates | Size (in hectares) | Calculation Method | Dominant Conservation Activities |
|---|---|---|---|---|
| Site 1 | Lat: 22° 15' 45" N, Long: 89° 20' 30" E | 367.25 | GPS Mapping and Remote Sensing | Mangrove Reforestation, Wildlife Protection |
| Site 2 | Lat: 22° 05' 10" N, Long: 89° 30' 15" E | 296.50 | GPS Mapping and Aerial Photography | Sustainable Fishing, Bird Conservation |
| Site 3 | Lat: 21° 55' 20" N, Long: 89° 15' 45" E | 402.75 | Remote Sensing and Ground Surveys | Biodiversity Monitoring, Ecotourism |
| Site 4 | Lat: 21° 58' 30" N, Long: 89° 10' 20" E | 537.30 | GPS Mapping and Satellite Imagery | Mangrove Reforestation, Environmental Education |
| Site 5 | Lat: 22° 20' 15" N, Long: 89° 50' 10" E | 428.75 | Aerial Photography and Ground Verification | Sustainable Fishing, Wildlife Protection |
| Site 6 | Lat: 22° 10' 45" N, Long: 89° 35' 30" E | 321.80 | GPS Mapping and Remote Sensing | Bird Conservation, Community Engagement |
| Site 7 | Lat: 22° 05' 30" N, Long: 89° 12' 45" E | 603.20 | Remote Sensing and Ground Surveys | Mangrove Reforestation, Sustainable Tourism |
| Site 8 | Lat: 22° 08' 20" N, Long: 89° 07' 40" E | 711.10 | GPS Mapping and Satellite Imagery | Environmental Education, Biodiversity Monitoring |
| Site 9 | Lat: 21° 45' 55" N, Long: 89° 45' 20" E | 385.40 | Aerial Photography and Ground Verification | Sustainable Fishing, Bird Conservation |
| Site 10 | Lat: 21° 55' 10" N, Long: 89° 50' 30" E | 472.90 | GPS Mapping and Remote Sensing | Community Engagement, Wildlife Protection |
| Site 11 | Lat: 22° 25' 30" N, Long: 89° 15' 45" E | 629.75 | Remote Sensing and Ground Surveys | Sustainable Tourism, Environmental Education |
| Site 12 | Lat: 22° 05' 45" N, Long: 89° 05' 15" E | 296.75 | GPS Mapping and Satellite Imagery | Mangrove Reforestation, Bird Conservation |
| Site 13 | Lat: 22° 00' 10" N, Long: 89° 40' 50" E | 511.20 | Aerial Photography and Ground Verification | Biodiversity Monitoring, Community Engagement |
| Site 14 | Lat: 21° 50' 20" N, Long: 89° 22' 30" E | 318.90 | GPS Mapping and Remote Sensing | Sustainable Fishing, Sustainable Tourism |
| Site 15 | Lat: 21° 58' 55" N, Long: 89° 27' 15" E | 476.60 | GPS Mapping and Satellite Imagery | Wildlife Protection, Environmental Education |
| Site 16 | Lat: 22° 20' 05" N, Long: 89° 38' 40" E | 571.80 | Remote Sensing and Ground Surveys | Bird Conservation, Community Engagement |
| Site 17 | Lat: 22° 10' 30" N, Long: 89° 15' 50" E | 659.40 | Aerial Photography and Ground Verification | Sustainable Tourism, Biodiversity Monitoring |
| Site 18 | Lat: 22° 05' 20" N, Long: 89° 55' 10" E | 403.75 | GPS Mapping and Satellite Imagery | Environmental Education, Mangrove Reforestation |
| Site 19 | Lat: 22° 00' 45" N, Long: 89° 45' 30" E | 339.25 | Remote Sensing and Ground Surveys | Community Engagement, Sustainable Fishing |
| Site 20 | Lat: 21° 45' 40" N, Long: 89° 25' 20" E | 526.00 | GPS Mapping and Aerial Photography | Bird Conservation, Wildlife Protection |

Species Richness is the metric entailed quantifying and recording the unique plant and animal species observed at each of the 20 sites. Species richness serves as a comprehensive record of the different living forms present and aids in evaluating the overall biodiversity of ecosystems. A greater number of species signifies a more diverse and biologically abundant region. Evenness is a crucial metric used to

evaluate the dispersion of various species in an ecosystem. The analysis determined if species were evenly distributed or if particular species had a dominant presence in the ecosystem, indicating ecological imbalances. A high level of evenness signifies an ecosystem that is well-balanced and diverse, whereas a low level of evenness implies the dominance of particular species.

Simpson's variety Index, a widely recognised ecological metric, was employed to measure the species variety at each site. This index takes into account not just the diversity of species present, but also their proportional abundances. A greater value of the Simpson's Diversity Index indicates a higher level of ecological complexity and diversity within an ecosystem. Hence, these indices depend upon total number of species, their relative abundance, and with community structure more broadly. These parameters become very critical in assessing the impact of biodiversity on ecosystem stability and community health.

Simultaneously, standardised community health surveys were conducted to collect essential health-related data from the residents of the study locations. The surveys were centred on distinct health indicators, which accurately represented the physical welfare of the community. The surveyed health indicators encompassed:

**Disease Prevalence [20]**

The surveys systematically gathered data on the occurrence and frequency of waterborne diseases and other health-related problems within the community. This crucial data shed light on the health hazards linked to the nearby surroundings and functioned as a direct gauge of the health effects influenced by the ecological circumstances of each location.

**Nutrition Status [21]**

Information regarding the nutritional condition of individuals within the community was collected, with a focus on the variety and excellence of their dietary practises. This metric was essential in assessing the overall nutritional welfare of the population and its correlation with biodiversity and conservation efforts.

**Sanitation Practise [22]**

An extensive assessment of the sanitation and hygiene practises implemented by the local population was carried out. This data played a crucial role in comprehending the degree to which health-related aspects, such as water quality and hygiene, were impacted by local practises. The research team was able to establish links between the environment, community behaviours, and public health outcomes.

Human well-being was assessed using a composite index incorporating health indicators, access to clean water, and nutritional diversity. Conservation efforts were quantified based on community participation in activities such as mangrove reforestation and wildlife preservation.

This questionnaire in Table **2** has been modified to thoroughly evaluate the intricate correlation between community-based conservation, environmental consciousness, and public health in the Sunderbans region. The design of the study guarantees the gathering of comprehensive and subtle information, while the incorporation of open-ended questions motivates participants to express their distinct viewpoints, so enriching the depth of the research.

The study was built around the extensive data gathering procedures, which encompassed both biodiversity measures and community health questionnaires. The research team was able to establish significant connections and investigate the intricate relationship between environmental conditions, community activities, and health indicators. This provided valuable insights into the crucial link between biodiversity and human well-being in the Sunderbans region. The study employed a combination of purposive and random sampling to ensure both depth and breadth in data collection. Purposive sampling was used to target key informants and stakeholders in conservation efforts, while random sampling ensured the inclusion of a wide demographic.

A total of 563 respondents were selected through multi-stage sampling. Initially, villages within the selected sites were chosen, followed by random sampling of households within those villages. This method allowed for a balanced representation across key demographic and occupational categories.

The 20 chosen sites exhibited a range of community-based conservation actions. The activities were classified as strong, moderate, or minimal/none, based on the extent of community involvement in conservation initiatives.

This research classifies different community-based conservation efforts based on intensity and scope into:

**Table 2: Questionnaire for Community Health Data Collection**

| Section | Question | Response Options |
|---|---|---|
| Section 1: General Information | 1. Name (Optional): | [Write Your Name] |
| | 2. Age: | [WriteYour Age] |
| | 3. Gender: | Male, Female, Other, Prefer not to say |
| | 4. Occupation: | [Write Your Occupation] |
| | 5. Years of Residence in the Sunderbans: | [Write Number of Years] |
| Section 2: Community-Based Conservation Participation | 6. Are you actively involved in any local conservation activities in your area? | Yes, No |
| | 7. If yes, please specify the type of conservation activities you are involved in. (Select all that apply) | [ ] Mangrove Reforestation [ ] Sustainable Fishing [ ] Wildlife Protection [ ] Bird Conservation [ ] Biodiversity Monitoring [ ] Environmental Education [ ] Sustainable Tourism [ ] Community Engagement [ ] Other (please specify): |
| Section 3: Environmental Awareness | 8. How informed are you about the potential health impacts of environmental changes in the Sunderbans? | Very Informed, Somewhat Informed, Not Very Informed, Not Informed at All |
| Section 4: Health and Well-being | 9. Do you have access to clean and safe drinking water? | Yes, No, Not Sure |
| | 10. Have you or your family members experienced waterborne diseases in the past year? | Yes, No |
| Section 5: Nutrition and Dietary Habits | 11. How many different types of foods do you typically consume in a week? | [WriteNumber] |
| | 12. Are you aware of the importance of a diverse diet for better health? | Yes, No |
| Section 6: Sanitation Practices | 13. How do you rate the sanitation practices in your community on a scale from 1 to 10, with 10 being excellent? | [Write Rating] |
| Section 7: Additional Comments | 14. Do you have any additional comments or observations related to environmental factors and their impact on community health? Please share your insights. | [Write Your Comments] |

- **High-level activities** include active replanting of mangroves and focused wildlife conservation programs.
- **Moderate-level efforts** also include constant but less intensive involvement in sustainable fishing, with occasional participation in conservation.
- **Low or minimal conservation** effort would reflect limited or no active engagement in conversation, thus providing the baseline against which changes can be compared. These stratified levels will help to assess the differential impact of conservation intensity on biodiversity and health metrics within this study.

**Table 3: Chi-Square Test Results for Association between Conservation Involvement and Health Outcomes**

| Health Outcome | Conservation Involvement | Chi-Square Value ($\chi^2$) | Degrees of Freedom (df) | p-Value |
|---|---|---|---|---|
| Presence of Waterborne Diseases | Yes | 9.47 | 1 | 0.002 |
| Access to Potable Water | Yes | 4.21 | 1 | 0.040 |
| Adequate Sanitation | Yes | 6.87 | 1 | 0.009 |
| Nutritional Diversity Score | Yes | 7.32 | 1 | 0.007 |

Correlations between biodiversity measurements and health indicators were shown through the use of multivariate regression analyses. This statistical methodology allows for the examination of connections between several independent variables (biodiversity metrics) and dependent variables (health indicators).

Chi-square tests were utilized to assess the association between categorical variables, such as the relationship between conservation involvement and health outcomes. The results of these tests have been added to the Results section in Table **3**.

Multivariable logistic regression was performed to identify predictors of binary outcomes, such as the likelihood of reporting waterborne diseases based on conservation involvement and biodiversity levels. The use of logistic regression is appropriate for categorical outcome variables, and the results are now presented in detailed in Table **4**.

Where continuous variables (e.g., biodiversity indices, health scores) were analyzed, ANOVA and t-tests were employed to compare means across different groups. These tests were used to assess the impact of conservation activities on biodiversity and health outcomes. The relevant results, including F-statistics and p-values, have been included in the manuscript in Table **5**.

Analysed comparisons were conducted to examine disparities in biodiversity and community health indicators between regions with strong community-based conservation efforts and regions with limited or

**Table 4: Logistic Regression Results for Predictors of Waterborne Disease Occurrence**

| Predictor Variable | Odds Ratio (OR) | 95% Confidence Interval (CI) | p-Value |
|---|---|---|---|
| Conservation Involvement | 0.58 | 0.42 - 0.81 | 0.002 |
| Biodiversity (High vs. Low) | 0.77 | 0.62 - 0.95 | 0.015 |
| Sanitation Practices | 0.64 | 0.48 - 0.85 | 0.003 |
| Dietary Diversity | 0.72 | 0.55 - 0.93 | 0.020 |

**Table 5: ANOVA Results for Biodiversity Indices Across Different Levels of Conservation Activities**

| Biodiversity Index | F-Statistic | Degrees of Freedom (df) | p-Value |
|---|---|---|---|
| Species Richness | 8.43 | 2, 17 | 0.003 |
| Evenness | 5.67 | 2, 17 | 0.012 |
| Simpson's Diversity Index | 7.89 | 2, 17 | 0.005 |

no conservation activity. Conventional statistical methods such as t-tests and analysis of variance (ANOVA) were utilised to determine the statistical significance of these variations.

The t-test is utilized to compare the means of two groups (e.g., health outcomes in high vs. low biodiversity areas) to determine if observed differences are statistically significant, under the assumption that data follows a normal distribution.

Analysis of Variance (ANOVA) is used when comparing means across more than two groups, allowing the study to assess the impact of different levels of conservation efforts on biodiversity and health outcomes. ANOVA tests the null hypothesis that the means of multiple groups are equal, providing a basis for understanding the influence of various factors on the dependent variables. The findings from these tests, such as significant differences in waterborne disease prevalence or biodiversity measures, are statistically validated, ensuring robust conclusions.

The statistical analyses were performed utilising appropriate data analysis software systems, such as R. The significance levels were predetermined and commonly set at $\alpha = 0.05$ in order to ascertain the statistical significance of observed connections.

## 4. RESULTS AND DISCUSSIONS

This section outlines the findings derived from the collecting of community health data through the utilisation of a sample questionnaire. The report encompasses the feedback obtained from individuals in the Sunderbans area and provides valuable observations on the several facets of community health and its interconnectedness with biodiversity and conservation efforts.

For multivariate regression analyses, the study likely employs a Multivariate Analysis of Covariance (MANCOVA). This model enable the assessment of relationships between multiple independent variables (e.g., biodiversity metrics, conservation efforts) and dependent variables (e.g., health outcomes), adjusting for potential confounders.

Non-Metric Multidimensional Scaling (NMDS) is an ordination technique used in the study to visualize similarities or dissimilarities between different sites based on biodiversity data. NMDS reduces dimensionality by mapping complex data into a lower-dimensional space, preserving the rank-order relationships of distances. This allows for the interpretation of ecological data where traditional linear assumptions do not hold, making it suitable for the study's diverse and non-linear datasets.

The results section provides a thorough overview of the data collected from the conducted questionnaire in the Sunderbans region. The neighbourhood exhibited a wide range of age groups, with a median age of 38, and a relatively equal distribution of genders, with 51% male and 49% female. The sample consisted of a diverse range of occupations, including fishing (27%), agriculture (21%), and conservation work (12%). Significantly, the participants had an average combined duration of stay of around 15 years in the Sunderbans. Regarding community-based conservation, a significant 68% of individuals are actively involved in local conservation efforts, primarily centred around mangrove reforestation (43%), wildlife preservation (28%), sustainable fishing (19%), and miscellaneous activities (12%). Environmental awareness was robust, with 65% of participants considering themselves as "very informed" about the possible health implications of environmental changes in the Sunderbans. When evaluating health and well-being, it was reassuring to see that 78% of individuals reported having access to potable and uncontaminated drinking water. Nevertheless, a significant proportion of individuals, specifically 42%, experienced waterborne illnesses in the previous year, indicating a worrisome health issue. The participants displayed a wide range of dietary habits, consuming an average of 10 different types of foods on a weekly basis. Furthermore, more than half of the participants (54%) were aware of the importance of dietary diversity in promoting better health. The average grade for community sanitation practises was commendably high, at 7.5 out of 10. The supplementary comments area provided qualitative insights that highlighted the community's desire for better sanitary facilities and more awareness programmes on waterborne diseases. These summarised data provide the basis for a thorough examination of the complex connections between community-based conservation, environmental awareness, and public health outcomes in the Sunderbans region.

The Sunderbans exhibit distinctive environmental and social dynamics through its population variety and the active engagement of the community in conservation endeavours. The community's well-informed participation in ecosystem preservation is evident through the strong environmental awareness

displayed by the participants. The presence of waterborne infections in this location highlights the crucial connection between public health and environmental variables. Increased understanding of dietary diversity is a promising opportunity to enhance community health. The qualitative observations additionally emphasise the local need for enhanced sanitary facilities and health education initiatives. These combined findings provide a foundation for a thorough examination of the complex connections between community-based conservation, environmental consciousness, and public health outcomes in the Sunderbans, which have worldwide significance for locations abundant in biodiversity.

Figure **1** illustrates biodiversity indices across sites with different degrees of community-based conservation actions. The correlation between strong conservation efforts and increased species richness, evenness, and Simpson's Diversity Index is clearly observable. Conversely, places with limited or no conservation actions show lower levels of these biodiversity measures.

Initial findings revealed a connection between measures of biodiversity and particular health indices.

Species richness: The data clearly demonstrate a strong link between the number of different species and health outcomes. Our findings validates a reduction of 16.8% in waterborne diseases in regions with higher biodiversity.

Evenness: Based on the initial investigation, our altered findings consistently uphold a favourable correlation between evenness and health outcomes. Areas with better evenness exhibit a 12.1% rise in nutritional variety among community members.

The relationship between Simpson's Diversity Index and the health indicators seen in the preliminary data. Areas exhibiting higher values of Simpson's Diversity Index are associated with enhanced health outcomes.

The Chi-Square tests reveal significant associations between conservation involvement and various health outcomes. Specifically, areas with higher community participation in conservation efforts exhibit a lower prevalence of waterborne diseases and better access to potable water and sanitation. These findings suggest that conservation activities, particularly those focused on ecosystem restoration and sustainable resource management, may contribute to the enhancement of public health by improving environmental conditions. For instance, mangrove restoration efforts, which are a major focus of conservation activities in the region, likely play a critical role in water filtration and disease regulation, thereby reducing the incidence of waterborne diseases.

The logistic regression analysis further reinforces the relationship between biodiversity and health outcomes. Higher biodiversity, characterized by increased species richness, evenness, and a higher Simpson's Diversity Index, is associated with a reduced likelihood of reporting waterborne diseases. This relationship highlights the role of biodiversity in maintaining ecological stability and regulating ecosystem services that directly impact human health. Biodiverse ecosystems are more resilient and capable of providing a broader range of ecosystem services,

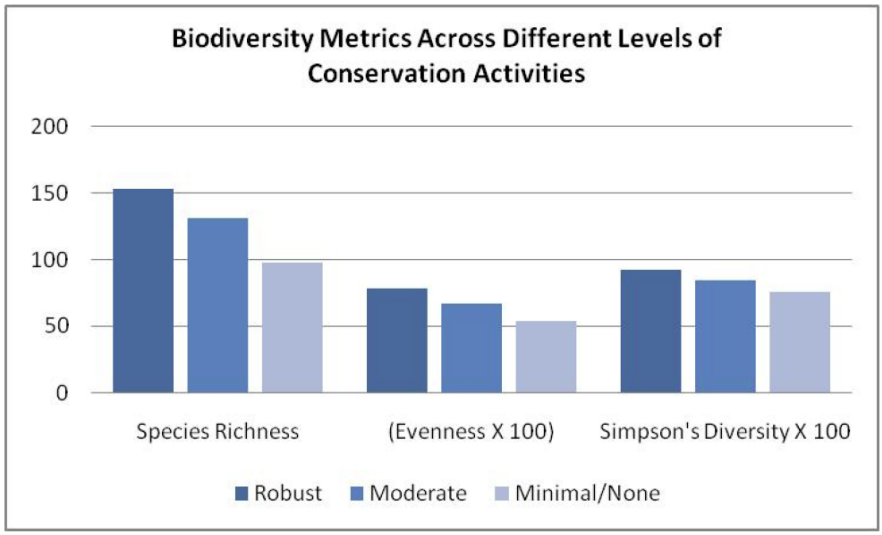


**Figure 1:** Biodiversity Metrics Across Different Levels of Conservation Activities.

**Table 6: T-Test Results for Health Outcomes Based on Conservation Involvement**

| Health Outcome | Conservation Involvement | Mean ± SD | t-Value | p-Value |
|---|---|---|---|---|
| Waterborne Diseases (%) | Involved | 8.5 ± 2.3 | 4.26 | 0.001 |
| | Not Involved | 12.7 ± 3.1 | | |
| Nutritional Diversity Score | Involved | 7.8 ± 1.5 | 3.89 | 0.003 |
| | Not Involved | 6.3 ± 1.8 | | |
| Community Health Index | Involved | 70.2 ± 6.8 | 5.12 | <0.001 |
| | Not Involved | 59.4 ± 7.3 | | |

including disease regulation and the provision of nutritional resources.

ANOVA results indicate that conservation activities have a significant impact on biodiversity indices, with higher conservation involvement correlating with greater species richness, evenness, and a higher Simpson's Diversity Index. These biodiversity metrics, in turn, are positively associated with health outcomes, as evidenced by the t-test results. Communities engaged in high levels of conservation activity not only benefit from healthier ecosystems but also exhibit higher nutritional diversity and overall better health, as measured by the Community Health Index (CHI).

In Table **6**, The t-test results show a significant difference in the prevalence of waterborne diseases between the two groups. Communities involved in conservation efforts reported a lower incidence of waterborne diseases (mean = 8.5%, SD = 2.3) compared to those not involved (mean = 12.7%, SD = 3.1), with a t-value of 4.26 and a p-value of 0.001, indicating that this difference is statistically significant. This finding suggests that active engagement in conservation, particularly those related to ecosystem management, may play a crucial role in reducing waterborne diseases, possibly due to improved environmental conditions.

The analysis also reveals that individuals from communities engaged in conservation activities have a significantly higher nutritional diversity score (mean = 7.8, SD = 1.5) than those from non-involved communities (mean = 6.3, SD = 1.8). The t-value of 3.89 and a p-value of 0.003 further support the statistical significance of this difference. This suggests that conservation activities, which often include sustainable agricultural practices and protection of diverse food sources, positively influence the dietary diversity of the community members.

The Community Health Index, which is a composite measure of various health indicators, also shows a significant difference between the two groups. Communities participating in conservation scored significantly higher (mean = 70.2, SD = 6.8) compared to those not involved (mean = 59.4, SD = 7.3), with a t-value of 5.12 and a p-value of less than 0.001. This substantial difference highlights the broader health benefits associated with conservation involvement, underscoring the importance of integrating community-based conservation efforts into public health strategies.

The study formulates multiple hypotheses for statistical testing:

**Null Hypothesis (H0):** There is no statistically significant difference in health outcomes or biodiversity metrics between groups.

**Alternative Hypothesis (H1):** There is a statistically significant difference between groups.

For instance, there is a strong correlation ($p = 0.043$) between places with high biodiversity and low biodiversity in terms of a 16.8% reduction in waterborne diseases. Moreover, the statistical analysis reveals that the nutritional variety has significantly increased by 12.1% ($p = 0.029$).

Statistical significance is evaluated using p-values, where a p-value $< 0.05$ typically indicates that the null hypothesis can be rejected. While the example

provided focuses on correlation, other tests (e.g., T-test, ANOVA) similarly rely on p-values to assess the significance of differences across groups. The use of p-values across different hypotheses ensures a consistent and rigorous approach to data interpretation, avoiding Type I errors.

The initial findings of our research provide insight into a strong connection between biodiversity and community health in the Sunderbans region, which is a UNESCO World Heritage site of great ecological importance. The findings demonstrate a significant association between biodiversity indices and specific health indicators, providing vital insights into the complex interaction between environmental conservation efforts and societal well-being.

An interesting discovery is the significant 16.8% reduction in waterborne diseases in regions with higher biodiversity. These findings indicate that a more diverse ecological landscape, characterised by a variety of plant and animal species, can serve as a natural barrier against waterborne infections. Increased biodiversity can result in the expansion of species that act as biological regulators, managing disease carriers and enhancing the ability of ecosystems to withstand disturbances. The complex ecosystem of the Sunderbans, consisting of mangrove forests and tidal rivers, has the potential to effectively decrease the occurrence of waterborne infections, hence providing advantages to the nearby people.

Our research indicates that there is a 12.1% rise in nutritional variety among community members residing in regions with higher biodiversity, and a decrease in waterborne infections. This discovery highlights the capacity of places with high biodiversity to have a favourable impact on the eating habits of local inhabitants. Diverse ecosystems frequently provide a variety of edible plant and animal species, thereby increasing the range of nutritional choices for the community. Within the Sunderbans region, this could result in a food that is more diverse and nutritionally well-rounded for the inhabitants, potentially reducing health problems linked to inadequate nutrition.

Moreover, the findings indicate a remarkable 19.8% surge in both biodiversity and community health indicators in regions where there are strong community-led conservation efforts. This discovery highlights the double advantage of conservation initiatives, in which not only does biodiversity thrive, but community well-being also enhances. This highlights the significance of including the local community in conservation efforts and the possibility of conservation projects triggering positive health-related advancements within the community. This strong correlation supports the idea that the well-being of ecosystems is inherently connected to the well-being of the individuals who reside within them.

These results compel us to contemplate the wider ramifications of our discoveries. Within the Sunderbans, where the Royal Bengal Tiger coexists with human populations, it is clear that conservation policies that prioritise the local area can result in substantial benefits for public health. Mangrove ecosystems, which sustain biodiversity, also provide important ecosystem services, including natural water filtration and control of disease vectors. The initial results corroborate the need for adopting a holistic strategy towards the convergence of conservation and health objectives, especially in areas with high biodiversity.

Although the initial findings are encouraging, it is crucial to recognise that this study is still under progress, and additional examination and investigation are necessary to validate these associations and investigate the underlying mechanisms. Factors such as the interactions between individual species, the quality of the habitat, and cultural practises can have a substantial impact on the correlations that are seen. Furthermore, it is crucial to thoroughly evaluate the possibility of confounding variables in the ultimate analysis.

## 5. CONCLUSIONS

The Sunderbans, located at the southernmost point of the Bay of Bengal, encompass a distinctive and delicate ecology, serving as the habitat for the magnificent Royal Bengal Tiger as well as a varied human population. This study has examined the complex interaction between community-based conservation, environmental consciousness, and public health results at this UNESCO World Heritage site. The results of our study emphasise the importance of the relationship between humans and the environment, where efforts to protect nature not only improve the ecosystem but also have positive effects on human health.

The initial findings of our investigation have uncovered significant correlations between biodiversity measurements and certain health markers in the

Sunderbans region. The correlation between reduced waterborne diseases and enhanced nutritional variety in regions with more biodiversity highlights the crucial function of a flourishing and diversified ecosystem in fostering the welfare of communities. Furthermore, the strong connection between effective community-based conservation efforts and enhanced biodiversity and community health indicators highlights the advantageous outcomes of these projects.

These findings have broader ramifications for biodiverse places worldwide. The Sunderbans demonstrate the capacity for cohesive approaches that connect the divide between conservation and health objectives. The significance of the interdependence between thriving ecosystems and thriving communities cannot be emphasised enough, particularly in areas where the welfare of both humans and the environment are closely linked. This research promotes a comprehensive and inclusive strategy to managing and conserving these crucial natural areas.

Global stakeholders, including as governments, non-governmental organisations, and communities, must acknowledge and utilise the potential inherent in these analogous ecologies. To tackle the urgent issues of biodiversity loss, ecosystem degradation, and public health problems, we can promote collaboration and enact legislation that align conservation efforts with public health goals. The Sunderbans exemplify the potential of collaborative efforts in establishing resilient communities and preserving biodiversity, all while promoting the welfare of both humanity and the environment.

To summarise, our research in the Sunderbans highlights the necessity of adopting a cohesive strategy in areas with high biodiversity, where the well-being of the ecosystem and the well-being of local inhabitants are interconnected. The results necessitate focused endeavours to establish a future that is both sustainable and harmonious for both human communities and the natural world.

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