



Gujarat Ecology Commission  
Government of Gujarat



Gujarat State Petronet Limited

# **The Impact Assessment of Plantation at Smritivan Earthquake Memorial, Bhujio Hill, Bhuj-Kachchh, Gujarat.**

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## **The Impact Assessment of Plantation at Smritivan Earthquake Memorial, Bhujio Hill, Bhuj-Kutch, Gujarat.**

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**The Impact Assessment of Plantation at Smritivan Earthquake Memorial, Bhujio Hill,  
Bhuj-Kutch, Gujarat.**

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## MESSAGE

Gujarat State is predominately an arid and semi-arid region, and the unique features of the State are the climatic and geomorphologic conditions. The devastating Gujarat Earthquake of 2001 profoundly impacted the people of Kachchh, causing immense loss of lives and property and Biological diversity. In response, the idea of Smritivan was conceived, a memorial to pay tribute to the earthquake victims and create a place for solace amidst nature.

To assess the Ecological Status of Miyawaki Plantation at Bhujio Hill, GSPL has endorsed a project entitled "Impact Assessment of Plantation at Smritivan Earthquake Memorial, Bhujio Hill, Bhuj-Kachchh, Gujarat." To GEC. As an apex entity in environmental management, the GEC was entrusted with evaluating the Miyawaki Plantation project's impact, backed by our expertise in ecological profiling and conservation initiatives. Gujarat State Petronet Limited (GSPL) was pivotal in funding and supporting this project as part of its Corporate Social Responsibility (CSR) efforts. Their vision and commitment to a greener and more sustainable environment allowed us to execute and monitor the Miyawaki Plantation at Smritivan Bhuj.

The project's objectives encompassed several crucial aspects: biodiversity conservation, hill slope soil conservation, carbon sequestration, aesthetic value addition, and a better tourist experience. The Miyawaki Plantation at Smritivan has achieved remarkable success, with an average survival rate of 86% for the planted species.

It is recommended to prioritize native species' plantations to enhance the ecological balance and promote native Biodiversity. Continuous monitoring and re-plantation efforts will further augment the project's positive impact. Long-term documentation and carbon credit assessments will also help track environmental benefits and carbon sequestration. Capacity building and training for staff members will ensure efficient implementation and monitoring protocols. Stakeholder-specific tours and eco-education workshops will generate awareness among various groups about the significance of ecological conservation and sustainable practices.

This success story not only celebrates the achievements of the Miyawaki Plantation project but also serves as an inspiration for future initiatives in environmental protection. It underscores the significance of collaborative efforts between the government, corporates, and ecological entities in creating a greener and more sustainable future for our communities.

It is through collective determination and action that we can build a better, healthier, and more environmentally conscious world for generations to come.

  
**Mahesh Singh, IFS**  
**Member Secretary,**  
**Gujarat Ecology Commission**

## ACKNOWLEDGEMENT

I am pleased to bring out the report titled “Impact Assessment of Plantation at Smritivan Earthquake Memorial, Bhujio Hill, Bhuj-Kachchh, and Gujarat.”

I extend my gratitude to GSPL and its officials, particularly Shri Raj Kumar, IAS, Managing Director and Shri. Milind Torawane, IAS, Joint Managing Director, for entrusting GEC for the project work.

I also would like to thank Shri Mahesh Singh, IFS, Member Secretary, Gujarat Ecology Commission, for periodically reviewing the progress and giving valuable guidance.

The respective nodal officers facilitated the collection of secondary data from various Government Departments and other agencies. GEC always will remain indebted to all of them. GEC Team has put in untiring efforts in designing the methodology, analyzing primary and secondary data and drawing broad inferences. Hence, the team has been instrumental in giving the final shape to this report. I appreciate the GEC team’s meticulous efforts that made it all possible.

Last but not least, our gratitude also goes to all those who have, in some way or other way, contributed towards the successful completion of this report.



**Dr. G. S. Singh, IFS**

**Director**

**Gujarat Ecology Commission**

## EXECUTIVE SUMMARY

This executive summary provides an overview of the Miyawaki Plantation project at Smritivan, Bhuj, including its background, objectives, project details, assessment of flora and fauna, faunal diversity, visitor trends, soil analysis, tangible and non-tangible outcomes, questionnaire survey findings, and the project's cultural and social impact.

The project aims to restore the ecosystem and create a memorial for the victims of the 2001 Gujarat Earthquake using the innovative Miyawaki plantation method. The Smritivan Earthquake Memorial in Bhuj was established to honor the victims of the 2001 Gujarat Earthquake by planting trees at Bhujio Hill. The project adopted the Miyawaki plantation technique, which involves planting diverse native species adapted to the local environment to create dense forests quickly. The primary objectives of the Miyawaki plantations include biodiversity conservation, soil stabilization, carbon sequestration, aesthetic value, and improving the tourist experience.

The project area covers over 470 acres on the mountain hills of Bhuj-Bhujio Dungar in Gujarat, India. It houses the world's largest Miyawaki Forest, with over 300,000 plants. The project also includes a solar power plant, check dam reservoirs and nameplates of earthquake victims. GSPL entrusted the GEC to evaluate the Miyawaki plantation activity and its impacts based on their experience and expertise. The present study assessed the plantation area covered by Forest Creators- Restoring Ecosystem- Enviro Creators Foundation (ECF), the implementing agency appointed by GSPL. The project was funded by Gujarat State Petronet Ltd. (GSPL). The main objectives of the assessment were to evaluate the environmental and social impact of the plantation activity, assess the success of the Miyawaki plantation intervention, and study the sustainability provided by the plantation. In total, 117 native tree species with 2,23,533 saplings were planted across six identified zones within Smritivan; with the help of Enviro Creators Foundation, GSPL planted a total of 4 Zone (Z-3,4,5,6) with 1,75,853 trees adapted to local climate conditions.

The flora and fauna assessment at Smritivan Bhuj was conducted using various methods. For the flora assessment, three tiers of terrestrial systems were covered: herbs, shrubs, and trees. Quadrats of different sizes were used to sample each level, with an approximately minimum of 10% coverage in each zone. All species within the quadrats were listed and identified using standard identification manuals and books.

Direct sightings of mammals were recorded for faunal assessment, and night trail surveys were conducted to identify and report the presence of several mammals. Indirect evidence such as burrows, dung, droppings, pellets, pugmarks and tracks were also noted to mark the presence of mammals. Reptile species present in the transects were recorded as well. The primary data was collected and analyzed to determine the status of species based on the IUCN Red List.

Bird Diversity and estimation were conducted using the point count and transect methods. These methods involve counting and recording bird species observed within designated points or along predetermined transects.

A questionnaire survey was conducted to gather information on visitors' perceptions of the plantation at Smritivan. Interviews were conducted with visitors to understand their views on aesthetics, importance, and other aspects of the plantation. Additionally, secondary literature was reviewed to collect data on the botanical and traditional knowledge of the planted species. Overall, these assessment methodologies provided valuable insights into the flora, fauna, and visitor perceptions at Smritivan Bhuj.

The assessment of flora and fauna in Smritivan revealed positive results. The survival rates of the Miyawaki plantation ranged from 79.7% to 94.7%, with an overall survival rate of 86.2%. The survey recorded a diverse range of species, including various insects, reptiles, birds, and mammals, highlighting the area's rich Biodiversity. The project has successfully created a thriving and sustainable ecosystem, serving as a living monument.

The survey recorded 28 butterfly species, 18 insect species, 21 reptile species, and 79 bird species. Notable butterfly species included Pioneer White, Spotted Joker, Blue Pansy, and Yellow Pansy. Additionally, the survey identified 39 insect species from various orders. Two types of fish, Mozambique Tilapia (*Oreochromis mossambicus*) and Nile Tilapia (*Oreochromis niloticus*) were observed in the water bodies. A total of 21 reptile species were recorded, including the Bengal/Indian Monitor Lizard (*Varanus bengalensis*), Checkered Keelback (*Xenochrophis piscator*), Indian Cobra (*Naja naja*), and Indian Rat Snake (*Ptyas mucosa*). The survey also recorded a diverse avian population with 79 bird species observed, including the Shikra (*Accipiter badius*), Honey Buzzard (*Pernis ptilorhynchus*), Common Myna (*Acridotheres tristis*), and Indian Peafowl (*Pavo cristatus*). The presence of nests of various bird species highlighted the establishment of species-habitat interactions.

Nine mammal species, including predators such as Jungle Cats and Grey Mongooses, were observed, indicating a balanced food chain. However, threats from Nilgai, domestic dogs, and cats during the initial phase of the plantation could impact the Biodiversity, requiring suitable mitigation measures. Overall, the survey highlighted the rich faunal diversity in the Smritivan Bhuj area, emphasizing the need for conservation efforts to protect critical ecological species and their habitats to preserve the region's unique Biodiversity.

The Miyawaki plantation has brought tangible benefits, such as reduced soil erosion, increased soil moisture retention, improved soil nutrient capacity, and established a natural food web. Non-tangible benefits include the creation of suitable microclimates for various species and the enhancement of Biodiversity. The project has had a significant positive impact on the ecosystem and demonstrates the effectiveness of the Miyawaki plantation.

The questionnaire survey provided insights into visitor demographics, awareness of positive environmental changes, and suggestions for improvement. The data revealed a noticeable shift in visitor behaviours, with changing preferences and increased environmental consciousness.

Efforts to promote awareness and enhance visitor engagement are recommended to maximize the impact of Smritivan on the community.

The Miyawaki plantation project has also strengthened Bhuj's cultural and social values. It has become a socio-cultural centre, attracting visitors, supporting local businesses, and fostering unity and a sense of belonging. Smritivan serves as a venue for community events, festivals, and celebrations, enriching the local culture.

In conclusion, the Miyawaki plantation project at Smritivan Bhuj has successfully established an urban oasis, promoting Biodiversity and serving as a memorial for earthquake victims.

Recommendations include:

- Prioritizing native species.
- Monitoring Biodiversity.
- Utilizing satellite-based monitoring.

Conducting long-term documentation and carbon credit assessments.

Capacity-building activities and stakeholder engagement are essential for the project's continued success.

By implementing these recommendations, the Smritivan -Miyawaki plantation project at Bhujiyo Hill can thrive and positively impact the environment and the local community.

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## CHAPTER 1 BACKGROUND OF THE PROJECT

### BACKGROUND

The devastating Gujarat Earthquake of 26th January 2001 caused unprecedented damage to properties, and more than 13500 people lost their lives. The Bhujio Dungar was selected after careful consideration as the site for the establishment of Smriti Van. The Earthquake memorial was built to pay tribute to the people of Kachchh who lost their lives during the devastating earthquake with the concept of the memorial is to plant one tree for each earthquake victims in the Smritivan.

### Miyawaki Plantation

The Miyawaki technique is a modern approach to plant trees in areas with limited space, inspired by the work of a Japanese botanist and an expert in the study of Natural Forests and the Restoration of Natural Vegetation- Akira Miyawaki. The Miyawaki method accelerates forest development by constructing soil, utilizing native plant diversity, growing healthy saplings, and planting them close together. This method involves planting a variety of native plant species close together to create a dense forest in a small area within a short period. By replicating the natural regeneration processes of forests and using healthy saplings and native plant diversity, this technique is highly effective in creating forest cover on degraded land that has been used for other purposes. The method is designed to promote natural selection, where the fastest-growing saplings are favored, leading to a mature forest in just 20- 30 years instead of the usual 150-200 years.

The primary objectives of Miyawaki plantation activity include:

**Biodiversity conservation:** By planting a diverse range of native plant species, Miyawaki plantations help to promote biodiversity and protect local ecosystems. This approach also helps to recreate the natural forest structure that allows for the coexistence of different species.

**Hill slope soil conservation:** The dense root network of the trees planted in Miyawaki plantations helps to stabilize the soil, reduce erosion and prevent landslides, particularly on hill slopes.

**Carbon sequestration:** Miyawaki plantations have the potential to sequester large amounts of carbon due to the density of the forests and the rapid growth rate of the trees. This can help to mitigate climate change.

**Aesthetic value:** Miyawaki plantations can be aesthetically pleasing and add beauty to the landscape, particularly in urban areas.

**Better tourist experience:** Miyawaki plantations can provide a unique and educational experience for visitors, particularly those interested in learning about the local ecosystem and biodiversity.



Overall, the Miyawaki plantation activity has gained popularity globally due to its ability to restore degraded ecosystems, promote biodiversity, mitigate climate change, and enhance the aesthetic value of an area.

GEC is awarded work for Carrying out Impact Assessment of Miyawaki Plantation activity and its impacts based on their experience and expertise. The present study will assess the Plantation area covered by the implementing agency entrusted by GSPL.

Gujarat State Disaster Management Authority (GSDMA) sanctioned and allocated the work to Gujarat State Petronet Ltd. (GSPL) to provide financial support to the Forest Creators- Restoring Ecosystem- Enviro Creators Foundation (ECF) to achieve the target of the development Miyawaki Plantation in 67597 sq. meters with a plantation of more than 2.23 Lakhs trees of 117 different species.

The Gujarat Ecology Commission (GEC) was established in 1992. GEC advocates environmental conservation & ecological sustainability. GEC is the nodal agency for implementing the Integrated Coastal Zone Management Project and preparing Gujarat's Coastal Zone Management Plan. In addition, GEC also functions as the apex entity in the field of environmental management and provides technical assistance to the Department of Forests & Environment Department, Government of Gujarat, on matters pertaining to ecology and the environment. GEC has been engaged in the ecological profiling of 59 Talukas, The comprehensive Ecological Profile, which gives equal coverage to the physical, biological, socio-economic, cultural, and built environments. The objectives of the Project are given below:

#### **Role of Gujarat State Petronet Limited**

Utilizing the innovative Miyawaki plantation method, the plantation has been carefully implemented with meticulous planning and necessary preparations. Hence GSPL has achieved the remarkable achievement of a thriving plantation of 1, 01,679 trees at Smritivan as part of their Corporate Social Responsibility (CSR) project.

The Miyawaki plantation method is known for its effectiveness in creating dense and diverse forests within a short period. It promotes the growth of native species, enhances biodiversity, and contributes to the overall ecological health of the area. GSPL's funding has been crucial in enabling the Gujarat Ecology Commission to execute to monitor its progress.

We want to acknowledge the invaluable support provided by Gujarat State Petronet Limited (GSPL) as a funding agency for assessing the Miyawaki plantation at Smritivan, Bhuj. This collaborative effort between GSPL and the Gujarat Ecology Commission has significantly contributed to the project's success. GSPL'S contribution has been instrumental in creating a greener and more sustainable environment, and it serves as an inspiration for further initiatives in the field of environmental conservation.



## Objectives

- To assess the social impact of the CSR activity- Plantation of numerous trees at Smritivan memorial, Bhuj
- To assess the plantation of trees done by ECF with the use of Miyawaki Method and analyze the impact and success of the intervention.
- To study change in life of the beneficiaries and assess the level of sustainability provided by plantation

## PROJECT DETAILS

### Project area

Bhuj is a town in the Kutch District of Gujarat, India that serves as a municipality and district headquarters. According to the 2011 census, the population of Bhuj was 213,514, with 111,146 males and 102,368 females. Bhujia Hill is situated on the eastern side of the town and is home to Bhujia Fort, which acts as a boundary between Bhuj city and Madhapar town. There are two lakes in Bhuj, Hamirsar and Deshadsar. The town has an average elevation of 110 m (360 feet) and experiences a hot desert climate (Köppen BWh) that is nearly a hot semi-desert climate (BSh). Despite this, the annual rainfall averages around 330 mm or 13 inches, with one of the highest variability in the world.

### Smritivan

Smritivan, the dream project of the honorable Prime Minister of India - Shri Narendra Modi, adorned as the largest memorial and museum ever built in modern India, covers a vast area of over 470 acres. It is situated on the mountain hills of Bhuj- Bhujiyo Dungar. It also shares the area with the Bhujia fort, which is more than 300 years old. Smritivan is a place of pilgrimage, Created for the bereaved families of earthquake victims in 2001. It is built to praise the resilience and reverence of the people of Kutch and a haven for those who find solace in nature. The memorial consists of a Sun-Point that overlooks the city, the sunrises, and the sunsets from atop the Bhujiyo Dungar.

The memorial also consists of the **world's largest Miyawaki Forest**, with over **3 lakh plants** spread across the entire memorial to create a living, breathing monument that also serves as the lungs for the city of Bhuj. A locally installed 1.1-Megawatt solar power plant powers the museum and memorial. The objective of this solar power plant is to have self-sustainable, renewable green energy that leads the way for all future establishments. The Smritivan Earthquake Memorial has 50 check-dam reservoirs that house the nameplates of almost 13,000 victims of the 2001 earthquake. Along with this, the reservoirs are carefully planned to recharge the surrounding water levels, giving life



to the surrounding forests. The rocks in these reservoirs will serve as foundations for new life to grow from within their cracks. The size of the Smritivan Earthquake Museum is 11,500 sq.m

Plantation period- A total of 6 plantation sites were developed (Zone Nos. 3, 4, 5, 6, 8 and 11) with site- specific and terrain-slope-specific strategies and composition of suitable tree species. The plantation was completed between July to October 2021, and a total of 7 CSR partners were allocated these Zones



**Aerial view of Miyawaki Forest at Bhujiyo Hill**



## CHAPTER 2 ASSESSMENT OF FLORA AND FAUNA – METHODOLOGY

### Flora

In the case of terrestrial systems, all three tiers were covered (Herbs, shrubs and trees). The size of the quadrat was fixed as  $10 \times 10$  m for trees,  $5 \times 5$  for shrubs and  $1 \times 1$  m for herbs, and a minimum of 10% of Each Zone was covered by a  $10 \times 10$  m Quadrat laid. All the species falling within the quadrat were listed, and their numbers were noted down. Standard Identification manuals and books were referred for identification.

#### DOCUMENTING PLANT DIVERSITY/DENSITY

A:  $20 \text{ m} \times 20 \text{ m}$  for trees; B:  $5 \text{ m} \times 5 \text{ m}$  for shrub layer; C:  $1 \text{ m} \times 1 \text{ m}$  for herb layer

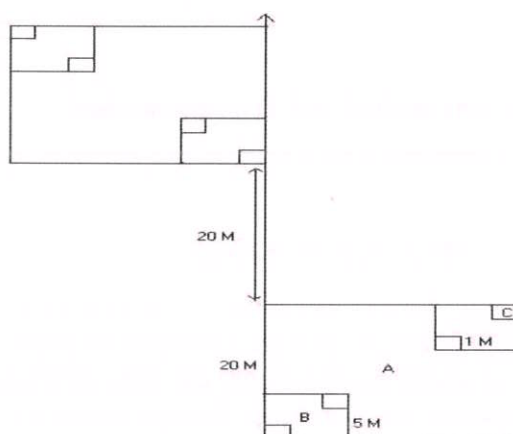
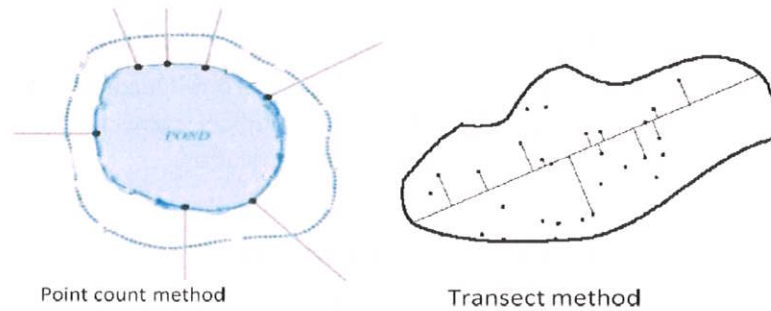


Diagram- Representation of Typical transect with quadrats.

### Fauna

Direct sightings of mammals in Point count/ transect were recorded, and night surveys were undertaken to document the presence of small mammals. Indirect indicators of the animal's presence and associated pieces of evidence were noted, such as animal burrows/holes, dung, pellets, feeding signs, tracks, etc. Reptile species present in transects were recorded.

Based on the primary data collected, the following analysis and data interpretation were done. The threatened status of the species found on the IUCN Red List (2022) Data were pooled for every zone, and various statistical analyses were performed to understand diversity, density, and abundance.



### Point count method and Transect method

#### Questionnaire Survey

Field visits to the research area were used to gather information on the taxonomy and ethno-medicine. Interviews with visitors of Smritivan were conducted to collect data on how they perceive the plantation in terms of aesthetics, importance etc. Data on botanical and traditional knowledge about the planted species was generated through secondary literature, such as published literature that details the traditional uses of different tree species.



### Selection of Species and Species Composition

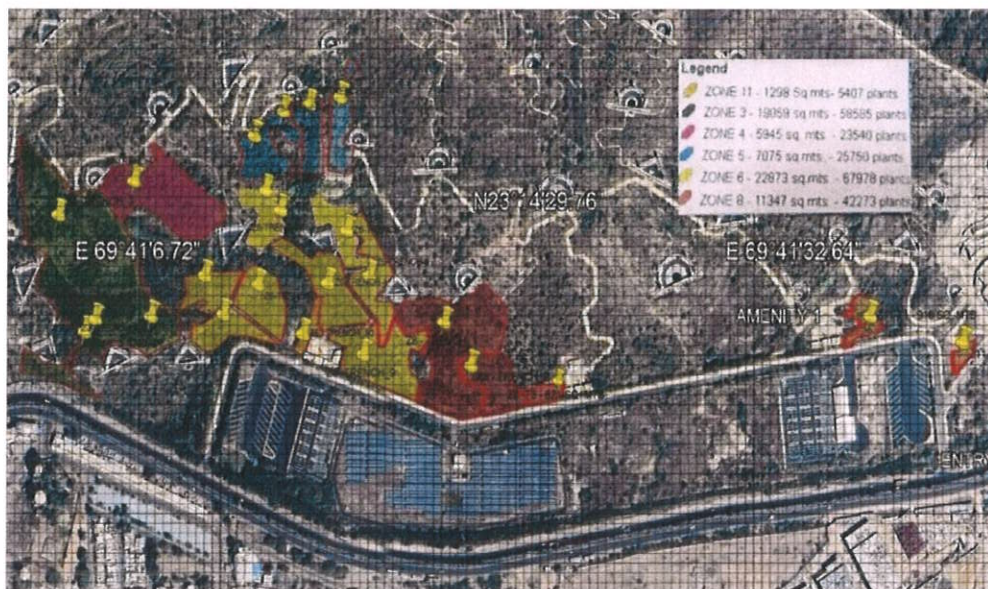
A total of 117 Tree species with 2, 23,533 saplings were planted in 6 Identified Zones/areas of Smritivan; The trees were native and adapted to the local climate; hence they were selected based on the ability of fast growth in nature, maximum fruit and flower bearing capacity. Total of four zones (Zone 3, 4, 5, 6) was planted by GSPL with 1, 75,853 trees. The native adapted to local climate trees sp. were observed as a primary composition in each zone. The following dominant plant species were planted and observed during the survey as a major composition of species:

**Table 2.1 Dominant plant species observed during the survey as a major composition of species**

| Zone No. | Q. No. Surveyed | No. of Plants Recorded in the survey | Dominant Species composition       |
|----------|-----------------|--------------------------------------|------------------------------------|
| 3        | 33              | 8360                                 | <i>Casuarina equisetifolia</i>     |
|          |                 |                                      | <i>Delonix regia</i>               |
|          |                 |                                      | <i>Azadirachta indica</i>          |
|          |                 |                                      | <i>Acacia nilotica</i>             |
| 4        | 10              | 3810                                 | <i>Casuarina equisetifolia</i>     |
|          |                 |                                      | <i>Azadirachta indica</i>          |
|          |                 |                                      | <i>Hibiscus rosa sinensis</i>      |
|          |                 |                                      | <i>Bambusa arundinacea</i>         |
|          |                 |                                      | <i>Derris indica (Lam.) Bennet</i> |
| 5        | 6               | 1795                                 | <i>Casuarina equisetifolia</i>     |
|          |                 |                                      | <i>Delonix regia</i>               |
|          |                 |                                      | <i>Bambusa arundinacea</i>         |
|          |                 |                                      | <i>Terminalia catappa</i>          |
|          |                 |                                      | <i>Azadirachta indica</i>          |
|          |                 |                                      | <i>Leucaena leucocephala</i>       |
| 6        | 11              | 2930                                 | <i>Azadirachta indica</i>          |
|          |                 |                                      | <i>Casuarina equisetifolia</i>     |
|          |                 |                                      | <i>Terminalia catappa</i>          |
|          |                 |                                      | <i>Acacia auriculiformis</i>       |
|          |                 |                                      | <i>Delonix regia</i>               |



## Plantation layout and Zones



**Table 2.2 Allocated Plantation with Zone and Species Nos. to each CSR Partner**

| ZONE                                    | TRENCH | AREA (sq. mts) | TOTAL ZONE AREA | PLANTS QUANTITY | TOTAL PLANTS IN ZONE | NUMBER OF SPRINKLERS | ALLOCATED TO | PLANTATION DATE         | PLANTATION MONTH |
|-----------------------------------------|--------|----------------|-----------------|-----------------|----------------------|----------------------|--------------|-------------------------|------------------|
| ZONE 1                                  | 1      | 1847           | 19059           | 7981            | 58,585               | 27                   | GSPL         | 06/07/2021 - 12/07/2021 | JULY             |
|                                         | 2      | 4085           |                 | 15282           |                      | 40                   | GSPL         | 06/07/2021 - 22/07/2021 | JULY             |
|                                         | 3      | 10828          |                 | 28046           |                      | 118                  | GSPL         | 06/07/2021 - 22/07/2021 | JULY             |
|                                         | 4      | 7321           |                 | 8076            |                      | 32                   | GSPL         | 06/07/2021 - 12/07/2021 | JULY             |
| ZONE 2                                  | 1      | 5945           | 5945            | 23,540          | 23,540               | 75                   | GSPL         | 01/08/2021 - 03/08/2021 | AUGUST           |
| ZONE 3                                  | 1      | 2676           | 7075            | 10,000          | 25,750               | 38                   | SOLARIS      | 28/07/2021 - 30/07/2021 | JULY             |
|                                         | 1-A    | 490            |                 | 2300            |                      | 15                   | SOLARIS      | 28/07/2021 - 30/07/2021 | JULY             |
|                                         | 2      | 1844           |                 | 6178            |                      | 37                   | GSPL         | 28/07/2021 - 30/07/2021 | JULY             |
|                                         | 3      | 2005           |                 | 7272            |                      | 32                   | GSPL         | 28/07/2021 - 30/07/2021 | JULY             |
| ZONE 4                                  | 1      | 1732           | 19040           | 8372            | 67,978               | 26                   | BKT          | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 2      | 1799           |                 | 5397            |                      | 24                   | BKT          | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 3      | 2303           |                 | 8157            |                      | 42                   | BKT          | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 4      | 3257           |                 | 10,441          |                      | 46                   | BKT          | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 5      | 1581           |                 | 5400            |                      | 26                   | GSPL         | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 6      | 195            |                 | 940             |                      | 3                    | GSPL         | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 7      | 1530           |                 | 7036            |                      | 32                   | GSPL         | 22/07/2021 - 28/07/2021 | JULY             |
|                                         | 8      | 2588           |                 | 8237            |                      | 32                   | ADANI        | 01/08/2021 - 03/08/2021 | AUGUST           |
|                                         | 9      | 4287           |                 | 12688           |                      | 40                   | ADANI        | 01/08/2021 - 03/08/2021 | AUGUST           |
|                                         | 10     | 524            |                 | 9310            |                      | 12                   | GSPL         | 01/08/2021 - 03/08/2021 | AUGUST           |
| ZONE 5                                  | 1      | 8392           | 11347           | 28651           | 42273                | 91                   | ADANI        | 01/08/2021 - 03/08/2021 | AUGUST           |
|                                         | 2      | 2534           |                 | 10,629          |                      | 32                   | GSPL         | 07/08/2021 - 09/08/2021 | AUGUST           |
|                                         | 3      | 621            |                 | 2,993           |                      | 14                   | GSPL         | 24/10/2021 - 28/10/2021 | OCTOBER          |
| ZONE 6                                  | 1      | 918            | 1298            | 4,152           | 5,407                | 22                   | GSPL         | 24/10/2021 - 28/10/2021 | OCTOBER          |
|                                         | 2      | 380            |                 | 1,205           |                      | 6                    | GSPL         | 24/10/2021 - 28/10/2021 | OCTOBER          |
| GRAND TOTAL                             |        |                | 83721           |                 | 2,23,533             | 850                  |              |                         |                  |
|                                         |        |                |                 |                 |                      |                      | ALLOCATED TO | TOTAL QTY               |                  |
|                                         |        |                |                 |                 |                      |                      | GSPL         | 1,01,679                |                  |
|                                         |        |                |                 |                 |                      |                      | BKT          | 30,167                  |                  |
|                                         |        |                |                 |                 |                      |                      | SOLARIS      | 10,000                  |                  |
|                                         |        |                |                 |                 |                      |                      | ADANI        | 41,336                  |                  |
|                                         |        |                |                 |                 |                      |                      | GSPL         | 25,713                  |                  |
|                                         |        |                |                 |                 |                      |                      | ADANI        | 41,336                  |                  |
|                                         |        |                |                 |                 |                      |                      | GSPL         | 25,713                  |                  |
|                                         |        |                |                 |                 |                      |                      | GRAND TOTAL  | 22,353                  |                  |
| Last revised and reviewed on 31/12/2021 |        |                |                 |                 |                      |                      |              |                         |                  |



**Table 2.3 Plantation Assessment**

| <b>Zone</b>                                     | <b>Zone 3</b> | <b>Zone 4</b> | <b>Zone 5</b> | <b>Zone 6</b> | <b>Total</b>  |
|-------------------------------------------------|---------------|---------------|---------------|---------------|---------------|
| <b>Quadrats sampled</b>                         | 33            | 10            | 6             | 11            | <b>60</b>     |
| <b>Total Areas in Mtr Sq.</b>                   | 3300          | 1000          | 600           | 1100          | <b>6000</b>   |
| <b>Number of Plants Recorded in Survey area</b> | 8365          | 3750          | 1740          | 2870          | <b>16725</b>  |
| <b>Density per Mtr Sq.</b>                      | 2.5           | 3.8           | 2.9           | 2.6           | <b>2.8</b>    |
| <b>Area of Zones in Mtr Sq.</b>                 | 19059         | 5945          | 7075          | 22873         | <b>54952</b>  |
| <b>Total Plants Recorded in Zone</b>            | 48312         | 22294         | 20518         | 59678         | <b>150801</b> |
| <b>Total Plants Planted in Zone</b>             | 58585         | 23540         | 25750         | 67978         | <b>175853</b> |
| <b>Survival Rate %</b>                          | 82.5          | 94.7          | 79.7          | 87.8          | <b>86.2</b>   |

- **Zone 3:**

A total of 33 quadrats were sampled, covering an area of 3300 square meters. The number of plants recorded in this zone was 8365, resulting in a density of 2.5 plants per square meter. The overall area of Zone 3 is 19,059 square meters. The number of plants recorded in this zone was 48,312, and the number of plants actually planted was 58,585. The survival rate in Zone 3 was 82.5%.

- **Zone 4:**

There were 10 quadrats sampled, covering an area of 1000 square meters. The number of plants recorded in this zone was 3750, resulting in a density of 3.8 plants per square meter. The overall area of Zone 4 is 5945 square meters. The number of plants recorded in this zone was 22,294, and the number of plants actually planted was 23,540. The survival rate in Zone 4 was 94.7%.

- **Zone 5:**

A total of 6 quadrats were sampled, covering an area of 600 square meters. The number of plants recorded in this zone was 1740, resulting in a density of 2.9 plants per square meter. The overall area of Zone 5 is 7075 square meters. The number of plants recorded in this zone was 20,518, and the number of plants actually planted was 25,750. The survival rate in Zone 5 was 79.7%.

- **Zone 6:**

There were 11 quadrats sampled, covering an area of 1100 square meters. The number of plants recorded in this zone was 2870, resulting in a density of 2.6 plants per square meter. The overall area of Zone 6 is 22,873 square meters. The number of plants recorded in this zone was 59,678, and the number of plants actually planted was 67,978. The survival rate in Zone 6 was 87.8%.



Overall, the Miyawaki plantation assessment at Smritivan has recorded a total of 16725 plants in the sampled quadrats. The total area covered by the plantation is 6000 square meters, with a density of 2.8 plants per square meter. The total number of plants recorded in all zones is 150,801, and the number of plants actually planted is 175,853. The overall survival rate for the plantation is 86.2%. Total 116 plant species were observed during the baseline survey out of 117 planted tree species the list of plants is given in the table:

**Table 2.4 Total plant species observed during the Baseline survey out of 117 planted tree species**

| Sr. No. | Scientific Name                 | Common Name        | Habit | Family         |
|---------|---------------------------------|--------------------|-------|----------------|
| 1       | <i>Phyllanthus emblica</i>      | Amla               | Tree  | Phyllanthaceae |
| 2       | <i>Plumeria pudica</i>          | Nag Champa/ Champa | Tree  | Apocynaceae    |
| 3       | <i>Azadirachta Indica</i>       | Neem               | Tree  | Meliaceae      |
| 4       | <i>Alstonia scholaris</i>       | Saptaparni         | Tree  | Apocynaceae    |
| 5       | <i>Delonix regia</i>            | Gulmahorr          | Tree  | Fabaceae       |
| 6       | <i>Terminalia bellirica</i>     | Baheda             | Tree  | Combretaceae   |
| 7       | <i>Casuarina equisetifolia</i>  | Saru               | Tree  | Casuarinaceae  |
| 8       | <i>Cassia fistula</i>           | Garmalo            | Tree  | Fabaceae       |
| 9       | <i>Neolamarckia cadamba</i>     | Kadamb             | Tree  | Rubiaceae      |
| 10      | <i>Cassia siamea</i>            | Kaasid             | Tree  | Fabaceae       |
| 11      | <i>Dalbergia letifolia</i>      | Shisham            | Tree  | Fabaceae       |
| 12      | <i>Morus nigra</i>              | Setur, Setu        | Tree  | Moraceae       |
| 13      | <i>Melia azadericta</i>         | Bakan              | Tree  | Meliaceae      |
| 14      | <i>Justicia adhatoda</i>        | Adulsi             | Shrub | Acanthaceae    |
| 15      | <i>Psidium guajava</i>          | Jamfal             | Shrub | Myrtaceae      |
| 16      | <i>kigelia pinnata</i>          | Kigelia            | Tree  | Bignonaceae    |
| 17      | <i>Thespesia Populnea</i>       | Paraspipalo        | Tree  | Malvaceae      |
| 18      | <i>Magnifera indica</i>         | Mango              | Tree  | Anacardiaceae  |
| 19      | <i>Jacaranda mimosifolia</i>    | Jacaranda          | Tree  | Bignoniaceae   |
| 20      | <i>Dendrocalamus strictus</i>   | Vaas               | Grass | Poaceae        |
| 21      | <i>Amaranthus viridis</i>       | Saag               | Herb  | Amaranthaceae  |
| 22      | <i>Putranjiva Roxburghii</i>    | Putranjeeva        | Tree  | Euphorbiaceae  |
| 23      | <i>Samanea Saman</i>            | Lal Shirish        | Tree  | Fabaceae       |
| 24      | <i>Punica Granatum</i>          | Dadam              | Shrub | Lythraceae     |
| 25      | <i>Vachellia nilotica</i>       | Bangali Bavad      | Tree  | Fabaceae       |
| 26      | <i>Anacardium occidentale</i>   | Kaju               | Shrub | Anacardiaceae  |
| 27      | <i>Terminalia catappa</i>       | Badam              | Tree  | Combretaceae   |
| 28      | <i>Bixa Orellana</i>            | Sindoor            | Shrub | Bixaceae       |
| 29      | <i>Bauhinia variegata</i>       | Kachnar            | Tree  | Fabaceae       |
| 30      | <i>Citrus aurantifolia</i>      | Limbu              | Tree  | Rutaceae       |
| 31      | <i>Nyctanthes arbor-tristis</i> | Parijat            | Shrub | Oleaceae       |
| 32      | <i>Caesalpinia pulcherrima</i>  | Galtoro            | Shrub | Fabaceae       |



|    |                                       |                                           |       |               |
|----|---------------------------------------|-------------------------------------------|-------|---------------|
| 33 | <i>Callistemon citrinus</i>           | Bottle Brushes                            | Tree  | Myrtaceae     |
| 34 | <i>Pithecellobium dulce</i>           | Goras Imli                                | Tree  | Fabaceae      |
| 35 | <i>Magnolia champaca</i>              | Golden Champa                             | Shurb | Magnoliaceae  |
| 36 | <i>Eugenia Uniflora</i>               | Liso Bavar                                | Tree  | Myrtaceae     |
| 37 | <i>Cordia dichotoma</i>               | Gunda                                     | Tree  | Boraginaceae  |
| 38 | <i>Bignonia megapotamica</i>          | Megapotamica                              | Tree  | Lamiaceae     |
| 39 | <i>Bauhinia acuminata</i>             | Safed Kachnar                             | Tree  | Fabaceae      |
| 40 | <i>Bauhinia Purpurea</i>              | Jambali Kachnar                           | Tree  | Fabaceae      |
| 41 | <i>Bauhinia Tomentosa</i>             | Pilo Kachnar                              | Tree  | Fabaceae      |
| 42 | <i>Spathodea campanulata</i>          | Spathodea Yellow/ Yellow<br>African Tulip |       | Bignonaceae   |
| 43 | <i>Spathodea campanulata</i>          | Spathodea Orange/ Orange<br>African Tulip |       | Bignonaceae   |
| 44 | <i>Swietenia macrophylla</i>          | Mahogany                                  | Tree  | Meliaceae     |
| 45 | <i>Sterculia foetida</i>              | China Badam, Jungli<br>Badam              | Tree  | Malvaceae     |
| 46 | <i>Ficus retusa</i>                   | Ficus Panda                               | Shrub | Moraceae      |
| 47 | <i>Ficus benamina</i>                 | Black Ficus, Jungli Ficus,<br>Weeping Fig | Tree  | Moraceae      |
| 48 | <i>Millingtonia hortensis</i>         | Aakash Limdo                              | Tree  | Bignoniaceae  |
| 49 | <i>Couroupita guianensis</i>          | Kailashpati, Canonball,<br>Naglinga       | Tree  | Lecythidaceae |
| 50 | <i>Tabebuia rosea</i>                 | Rosy Trumpet                              | Tree  | Bignoniaceae  |
| 51 | <i>Tabebuia impetiginosa</i>          | Purple Trumpet                            | Tree  | Bignoniaceae  |
| 52 | <i>Citrus medica</i>                  | Dabbakaya, Bijoru                         | Tree  | Rutaceae      |
| 53 | <i>Melia dubia</i>                    | Malbar Neem                               | Tree  | Meliaceae     |
| 54 | <i>cucurbita ficifolia</i>            | Pumpkin Teak                              | Tree  | Cucurbiteceae |
| 55 | <i>Limonia acidissima</i>             | Kot                                       | Tree  | Rutaceae      |
| 56 | <i>Artocarpus heterophyllus</i>       | Fanas                                     | Tree  | Moraceae      |
| 57 | <i>Gliricidia sepium</i>              | Giripushp                                 | Tree  | Fabaceae      |
| 58 | <i>Crescentia cujete</i>              | Kamandalu Tree                            | Tree  | Bignoniaceae  |
| 59 | <i>Grivillea robusta</i>              | Silver Oak                                | Tree  | Proteaceae    |
| 60 | <i>Elaeocarpus ganitrus</i>           | Khoto Rudraksh                            | Tree  | Malvaceae     |
| 61 | <i>soursop graviola<br/>guanabana</i> | Lakshman Fal                              | Tree  | Annonaceae    |
| 62 | <i>Impatiens mohana</i>               | Sujana Pink                               | Tree  | Balsaminaceae |
| 63 | <i>Impatiens sp.</i>                  | Sujana White                              | Tree  | Balsaminaceae |
| 64 | <i>Cymbopogon</i>                     | Lilichai Lemon Grass                      | Tree  | Poaseae       |
| 65 | <i>Plumeria rubra</i>                 | Champo                                    | Tree  | Apocynaceae   |
| 66 | <i>Lagerstroemia indica</i>           | Crape Myrtle Purple                       | Tree  | Lythraceae    |
| 67 | <i>Dalbergia letifolia</i>            | Kalo Shirish                              | Tree  | Fabaceae      |
| 68 | <i>Prunus padus</i>                   | Bird Cherry                               | Tree  | Rosaceae      |
| 69 | <i>Murraya koenigii</i>               | Mitho Limdo                               | Tree  | Rutaceae      |
| 70 | <i>Bombax ceiba</i>                   | Safed Shimdo                              | Tree  | Bombacaeae    |



|     |                                       |                                               |       |                 |
|-----|---------------------------------------|-----------------------------------------------|-------|-----------------|
| 71  | <i>Annona reticulata</i>              | Ramphal                                       | Tree  | Annonaceae      |
| 72  | <i>Artocarpus altilis</i>             | Bread Fruit, Curryjack                        | Tree  | Moraceae        |
| 73  | <i>Tabebuia heterophylla</i>          | Gulabi Tabubia                                | Tree  | Bignoneace      |
| 74  | <i>Erythrina indica</i>               | Pangara, Indian Coral Tree, Panervo, Pandarvo | Tree  | Fabaceae        |
| 75  | <i>Pterocarpus Marsupium</i>          | Malabar Kino, Vijayasar, Yegisa Wood, Biyo    | Tree  | Fabaceae        |
| 76  | <i>Madhuca Longifolia</i>             | Mahoda                                        | Tree  | Sapotaceae      |
| 77  | <i>Ocimum sanctum</i>                 | Tulsi                                         | Tree  | Lamiaceae       |
| 78  | <i>Monoon longifolium</i>             | Aasopalav                                     | Tree  | Annonaceae      |
| 79  | <i>Hibiscus rosa</i>                  | Jasud                                         | Tree  | Malvaceae       |
| 80  | <i>Ophioglossum pendulum</i>          | Pendulum                                      | Tree  | Ophioglossaceae |
| 81  | <i>Peltophorum pterocarpum</i>        | Traad Singi                                   | Tree  | Fabaceae        |
| 82  | <i>Withania somnifera</i>             | Ashwagandha                                   | Tree  | Solanaceae      |
| 83  | <i>Ficus benghalensis</i>             | Vad                                           | Tree  | Moraceae        |
| 84  | <i>Citrus nobilis</i>                 | Kinno Orange                                  | Tree  | Rutaceae        |
| 85  | <i>Gmelina arborea</i>                | Savan                                         | Tree  | Verbenaceae     |
| 86  | <i>Jasmiun officinale</i>             | Jasmine                                       | Tree  | Oleaceae        |
| 87  | <i>Pterocarpus santalinus</i>         | Chandan                                       | Tree  | Fabaceae        |
| 88  | <i>Nerium Oleander</i>                | Karen                                         | Tree  | Apocynaceae     |
| 89  | <i>Terminalia catappa</i>             | Badam                                         | Tree  | Combretaceae    |
| 90  | <i>Pterocarpus santalinus</i>         | Rakt Chandan                                  | Tree  | Fabaceae        |
| 91  | <i>Syzygium cumini</i>                | White Jamun                                   | Tree  | Myrtaceae       |
| 92  | <i>Bambusa vulgaris</i>               | Green Bamboo                                  | Tree  | Poaseae         |
| 93  | <i>Ficus benamina</i>                 | Lovely Ficus                                  | Tree  | Moraceae        |
| 94  | <i>Dypsis lutescens</i>               | Bottle Palm (Areca Palm)                      | Tree  | Arecaceae       |
| 95  | <i>Ocimum tenuiflorum.</i>            | Lakshmi Tulsi                                 | Tree  | Lamiaceae       |
| 96  | <i>Ocimum tenuiflorum</i>             | Krishna Tulsi                                 | Tree  | Lamiaceae       |
| 97  | <i>Ocimum tenuiflorum.</i>            | Kashi Tulsi                                   | Tree  | Lamiaceae       |
| 98  | <i>Ocimum tenuiflorum.</i>            | Kasturi Tulsi                                 | Tree  | Lamiaceae       |
| 99  | <i>Sapindus mukorossi</i>             | Aritha                                        | Tree  | Sapindaceae     |
| 100 | <i>Cedrus deodara</i>                 | Devdar                                        | Tree  | Pinaceae        |
| 101 | <i>Syzygium cumini (L.) Skells</i>    | Black Jamun                                   | Tree  | Myrtaceae       |
| 102 | <i>Casuarina equisetifolia</i>        | Saru                                          | Tree  | Casuarinaceae   |
| 103 | <i>Tamarindus indica L.</i>           | Ambali, Emali, Khati Amli                     | Tree  | Caesalpiniaceae |
| 104 | <i>Terminalia bellirica</i>           | Behda                                         | Tree  | Combretaceae    |
| 105 | <i>Annona squamosa L.</i>             | Sitafal                                       | Shrub | Annonaceae      |
| 106 | <i>Derris indica (Lam.) Bennet</i>    | Karanj                                        | Tree  | Fabaceae        |
| 107 | <i>Moringa concanensis Nimmo</i>      | Kharo Saragvo                                 | Tree  | Moringaceae     |
| 108 | <i>Manilkara hexandra (Roxb.) Dub</i> | Rayan Plant, Khirni                           | Tree  | Sapotaceae      |



|     |                                             |                                          |       |               |
|-----|---------------------------------------------|------------------------------------------|-------|---------------|
| 109 | <i>Dalbergia sissoo</i> Roxb.               | Sesam                                    | Tree  | Fabaceae      |
| 110 | <i>Ficus racemosa</i> L.                    | Umarejo Zad, Umber,<br>Cluster Fig, Umro | Tree  | Moraceae      |
| 111 | <i>Butea monosperma</i> (Lam.)<br>Taub.     | Kesudo, Palash, Modhua                   | Tree  | Fabaceae      |
| 112 | <i>Aegle marmelos</i> (L.) Corr.            | Bili Patra, Bili, Bili Jo Zad            | Tree  | Rutaceae      |
| 113 | <i>Terminalia arjuna</i> (Roxb.)<br>W. & A. | Arjun Sadad, Arjun                       | Tree  | Combretaceae  |
| 114 | <i>Ficus religiosa</i> L.                   | Piparo, Piparejo Zad,<br>Peepal          | Tree  | Moraceae      |
| 115 | <i>Prosopis cineraria</i>                   | Dasarni, Dasan, Shami,<br>Khijdo         | Shrub | Anacardiaceae |
| 116 | <i>Phoenix dactylifera</i> L.               | Kharekdi, Khajuri, Date<br>Palm          | Tree  | Arecaceae     |

**Out of 116 Plant sp. Mentioned above following 84 Plant species were recorded with considerable numbers**

**Table 2.5 Plant species recorded with considerable numbers**

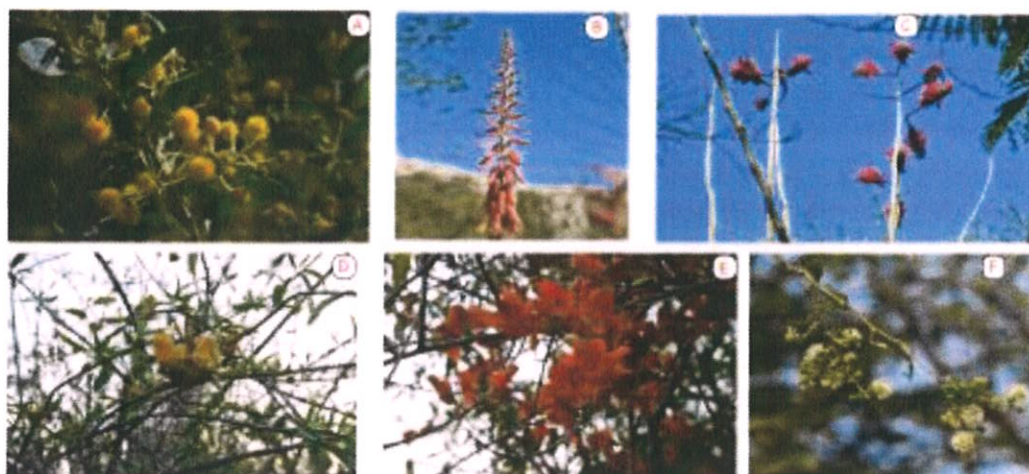
| No. | Species Name                            | Comman Name   |
|-----|-----------------------------------------|---------------|
| 1   | <i>Abutilon indicum</i>                 | Kashki        |
| 2   | <i>Acacia auriculiformis</i>            | Bangali Bavad |
| 3   | <i>Acacia juliflora</i>                 | Gando Bavad   |
| 4   | <i>Acacia nilotica</i>                  | Desi Bavad    |
| 5   | <i>Agave cantala</i>                    | Rambaan       |
| 6   | <i>Ailanthus excelsa</i> Roxb.          | Moto Arduso   |
| 7   | <i>Albizia lebeck</i>                   | Shirish       |
| 8   | <i>Aloe vera</i>                        | Kuvarpatho    |
| 9   | <i>Alstonia scholaris</i>               | Saptarni      |
| 10  | <i>Amaranthus viridis</i>               | Saag          |
| 11  | <i>Anacardium occidentale</i>           | Kaju          |
| 12  | <i>Annona reticulata</i>                | Sitaphal      |
| 13  | <i>Annona squamosa</i> L.               | Sitaphal      |
| 14  | <i>Artocarpus heterophyllus</i>         | Jackfruit     |
| 15  | <i>Azadirachta Indica</i>               | Neem          |
| 16  | <i>Bambusa arundinacea</i>              | Bamboo        |
| 17  | <i>Bambusa vulgaris</i>                 | Green Bambu   |
| 18  | <i>Bauhinia variegata</i>               | Kachnar       |
| 19  | <i>Bixa orellana</i>                    | Sindoor       |
| 20  | <i>Butea monosperma</i> (Lam.)<br>Taub. | Palash        |
| 21  | <i>Caesalpinia pulcherrima</i>          | Galtoro       |
| 22  | <i>Callistemon citrinus</i>             | Bottle Brush  |



|    |                                           |                                    |
|----|-------------------------------------------|------------------------------------|
| 23 | <i>Calotropis procera</i>                 | Akdo                               |
| 24 | <i>Cascabela thevetia</i>                 | Pili Karen                         |
| 25 | <i>Cassia auriculata</i>                  | Avad                               |
| 26 | <i>Cassia fistula</i>                     | Garmado                            |
| 27 | <i>Cassia siamea</i>                      | Kassid                             |
| 28 | <i>Casuarina equisetifolia</i>            | Saru                               |
| 29 | <i>Ceasalpinia pulcherrima</i>            | Gultaro                            |
| 30 | <i>Ceiba pentandra</i>                    | Cotton Tree                        |
| 31 | <i>Citrus aurantifolia</i>                | Limbu                              |
| 32 | <i>Cordia Dichotoma</i>                   | Gunda                              |
| 33 | <i>Cymbopogon</i>                         | Lemon Grass                        |
| 34 | <i>Dalbergia melanoxylon</i>              | Kado Sis                           |
| 35 | <i>Dalbergia sisso</i>                    | Seesam                             |
| 36 | <i>Datura stramonium</i>                  | Dhaturo                            |
| 37 | <i>Delonix regia</i>                      | Gulmohar                           |
| 38 | <i>Derris indica (Lam.) Bennet</i>        | Karanj                             |
| 39 | <i>Eucalyptus globulus</i>                | Nilgiri                            |
| 40 | <i>Ficus elastica</i>                     | Rubber Plant                       |
| 41 | <i>Ficus racemosa L.</i>                  | Umaro                              |
| 42 | <i>Ficus religiosa L.</i>                 | Piparo, Piparejo Zad,<br>Peepal    |
| 43 | <i>Ficus retusa</i>                       | Ficus Panda                        |
| 44 | <i>Gliricidia sepium</i>                  | Giri Pusp                          |
| 45 | <i>Grewia villosa</i>                     | Lusca                              |
| 46 | <i>Hibiscus rosa sinensis</i>             | Jasud                              |
| 47 | <i>Holoptelea integrifolia Roxb.</i>      | Kanji                              |
| 48 | <i>Kijella pinnata</i>                    | Topgolo                            |
| 49 | <i>Lantana camara</i>                     | Gandhari                           |
| 50 | <i>Leucaena leucocephala</i>              | Liso Bavad                         |
| 51 | <i>Mangifera indica</i>                   | Mango                              |
| 52 | <i>Manilkara hexandra (Roxb.)<br/>Dub</i> | Ran Jo Zad, Rayan<br>Plant, Khirmi |
| 53 | <i>Moringa concanensis<br/>Nimmo</i>      | Kharo Saragvo                      |
| 54 | <i>Morus nigra</i>                        | Setur                              |
| 56 | <i>Nerium indicum</i>                     | Lal Karen                          |
| 57 | <i>Nerium oleander</i>                    | Gulabi Karen                       |
| 58 | <i>Nyctanthes arbor-tristis</i>           | Parijat                            |
| 59 | <i>Ocimum sanctum</i>                     | Tulsi                              |
| 60 | <i>Peltophorum pterocarpum</i>            | Tamarparni                         |
| 61 | <i>Phoenix dactylifera</i>                | Kharek                             |
| 62 | <i>Phyllanthus emblica</i>                | Amla                               |
| 63 | <i>Pithecellobium dulce</i>               | Goras Imli, Mithi<br>Ambali        |



|    |                                    |                      |
|----|------------------------------------|----------------------|
| 64 | <i>Plumeria obtusa L.</i>          | Champa               |
| 65 | <i>Polyalthia longifolia</i>       | Aasopalav            |
| 66 | <i>Prosopis juliflora</i>          | Gando Bavad          |
| 67 | <i>Psidium guajava</i>             | Jamfal               |
| 68 | <i>Punica Granatum</i>             | Dadam                |
| 69 | <i>Quercus Agrifolia</i>           | Live Oak             |
| 70 | <i>Salvadora persica</i>           | Peludi               |
| 71 | <i>Sapindus mukorossi</i>          | Aritha               |
| 72 | <i>Spathodea campanulata</i>       | Orange African Tulip |
| 73 | <i>Swietenia macrophylla</i>       | Mahogany             |
| 74 | <i>Syzygium cumini (L.) Skells</i> | Jamuda               |
| 75 | <i>Tabebuia rosea</i>              | Rosy Trumpet         |
| 76 | <i>Tamarindus indica</i>           | Khati Ambli          |
| 77 | <i>Tecoma stans</i>                | Soneri               |
| 78 | <i>Terminalia arjuna</i>           | Arjun                |
| 79 | <i>Terminalia catappa</i>          | Badam                |
| 80 | <i>Thespesia Populnea</i>          | Paras Pipdo          |
| 81 | <i>Thuja orentalis</i>             | Thuja                |
| 82 | <i>Withania somnifera</i>          | Ashwa Gandha         |
| 83 | <i>Ziziphus mauritiana</i>         | Moti Bordi           |
| 84 | <i>Ziziphus nummularia</i>         | Nani Bordi           |

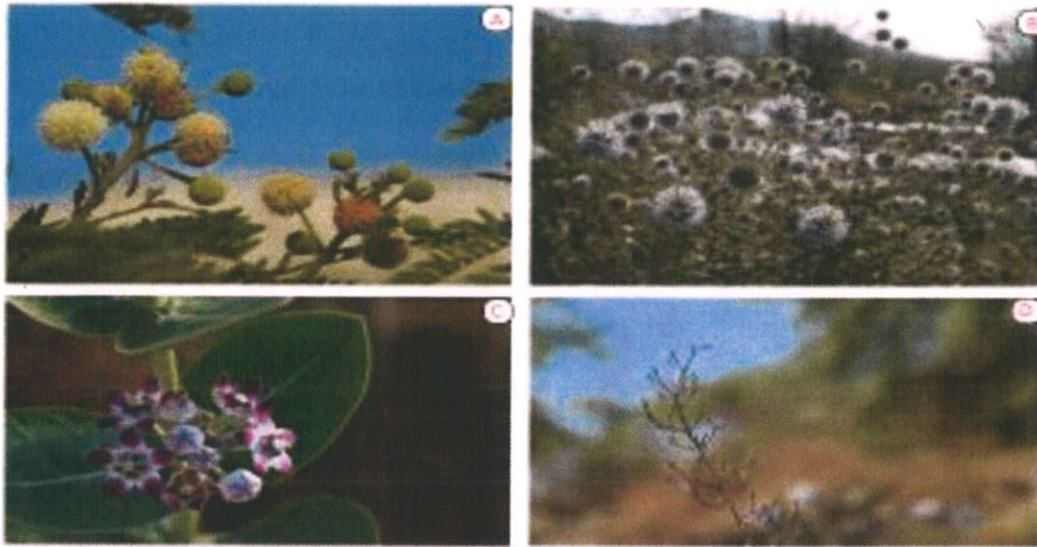


|                                                         |                                                         |                                                         |
|---------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|
| A. Golden Wreath Wattle ( <i>Acacia saligna</i> )       | B. Kuzwarpethu ( <i>Aloe vera</i> (L.) Burm. f.)        | C. Indian Coral Tree ( <i>Erythrina suberosa</i> Roeb.) |
| D. Desert Teak ( <i>Tecomella undulata</i> (Sm.) Seem.) | E. Desert Teak ( <i>Tecomella undulata</i> (Sm.) Seem.) | F. Goras Ambli ( <i>Pithecellobium dulce</i> )          |

#### Floral diversity recorded in the study area



|                                                  |                                                        |                                                        |
|--------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|
| A. White Mulberry ( <i>Morus alba</i> L.)        | B. Ashwagandha ( <i>Withania somnifera</i> (L.) Dunal) | C. Ashwagandha ( <i>Withania somnifera</i> (L.) Dunal) |
| D. Indian Jujube ( <i>Ziziphus jujuba</i> Mill.) | E. Karanj ( <i>Cassia indica</i> )                     | F. Mantes Cotheca on <i>Acacia</i> species             |



|                                                              |                                                            |
|--------------------------------------------------------------|------------------------------------------------------------|
| A. Burma Ironwood ( <i>Xylocarpus granat</i> (Roxb.) Teubl.) | B. Indian Globe Thistle ( <i>Echinops echinatus</i> Roxb.) |
| C. Aakda ( <i>Calotropis procera</i> )                       | D. Pericled Poldwing ( <i>Diclptera paniculata</i> )       |

#### Morphometric measurements to assess the plant growth





## CHAPTER 3- FAUNAL DIVERSITY

### INSECTS

Total 28 Butterfly Species were observed during the Survey, the list of Butterflies observed is given below

Table 3.1 Total Butterfly Species observed during the Survey

| NO | Common Name             | Sci.name                        | Host plants                     |                                |                              |                             |
|----|-------------------------|---------------------------------|---------------------------------|--------------------------------|------------------------------|-----------------------------|
| 1  | Pioneer white           | <i>Belenois aurota</i>          | <i>Cadaba fruticosa</i>         | <i>Capparis baducca</i>        | <i>Capparis decidua</i>      | <i>Jasminum multiflorum</i> |
| 2  | Spotted Joker           | <i>Byblia illithyia</i>         | <i>Tragia involucrata</i>       | <i>Tragia plukenetii</i>       |                              |                             |
| 3  | Blue Pansy              | <i>Junonia orithya</i>          | <i>Acanthus</i>                 | <i>Barleria</i>                | <i>Hygrophila auriculata</i> | <i>Justicia micrantha</i>   |
| 4  | Yellow Pansy            | <i>Junonia hierta</i>           | <i>Asystasia</i>                | <i>Barleria</i>                | <i>Eremomastax</i>           | <i>Ruellia</i>              |
| 5  | Small Salmon Arab       | <i>Colotis amata</i>            | <i>Toddalia asiatica</i>        | <i>Azima tetracantha</i>       | <i>Salvadora oleoides</i>    | <i>Salvadora persica</i>    |
| 6  | Plain Tiger             | <i>Danaus chrysippus</i>        | <i>Asclepias curassavica</i>    | <i>Calotropis gigantea</i>     | <i>Calotropis procera</i>    | <i>Cryptolepis dubia</i>    |
| 7  | Large Salmon Arab       | <i>Colotis fausta</i>           | <i>Capparis spinosa</i>         | <i>Maerua cylindrocarpa</i>    | <i>Maerua oblongifolia</i>   |                             |
| 8  | Little Orange-Tip       | <i>Colotis etrida</i>           | <i>Cadaba fruticosa</i>         | <i>Maerua oblongifolia</i>     | <i>Salvadora persica</i>     |                             |
| 9  | Common Rose Swallowtail | <i>Pachliopta aristolochiae</i> | <i>Aristolochia bracteolata</i> | <i>Aristolochia griffithii</i> | <i>Thottea siliquosa</i>     | <i>Dioscorea wallichii</i>  |
| 10 | Little Tiger blue       | <i>Tarucus balkanica</i>        | <i>Ziziphus jujuba</i>          | <i>Ziziphus nummularia</i>     |                              |                             |
| 11 | Danaid Eggfly           | <i>Hypolimnasia misippus</i>    | <i>Asystasia gangetica</i>      | <i>Barleria cristata</i>       | <i>Justicia betonica</i>     | <i>Ipomoea carnea</i>       |
| 12 | Bright Babul Blue       | <i>Azamas ubaldus</i>           | <i>Acacia leucophloea</i>       | <i>Acacia nilotica</i>         |                              |                             |
| 13 | Tropical fritillary     | <i>Argynnis hyperbius</i>       | <i>Lobelia sp.</i>              | <i>Viola sp.</i>               |                              |                             |
| 14 | Painted Lady            | <i>Vanessa cardui</i>           | <i>Argemone mexicana</i>        | <i>Artemisia vulgaris</i>      | <i>Laggera alata</i>         | <i>Chrysanthemum</i>        |
| 15 | Red Tip                 | <i>Colotis danae</i>            | <i>Cadaba fruticosa</i>         | <i>Capparis divaricata</i>     | <i>Maerua cylindrocarpa</i>  |                             |
| 16 | Angled Castor           | <i>Ariadne ariadne</i>          | <i>Ricinus communis</i>         | <i>Tragia hispida</i>          | <i>Tragia involucrata</i>    |                             |
| 17 | Spotless Grass Yellow   | <i>Eurema laeta</i>             | <i>Cassia fistula</i>           | <i>Chamaecrista pumila</i>     |                              |                             |



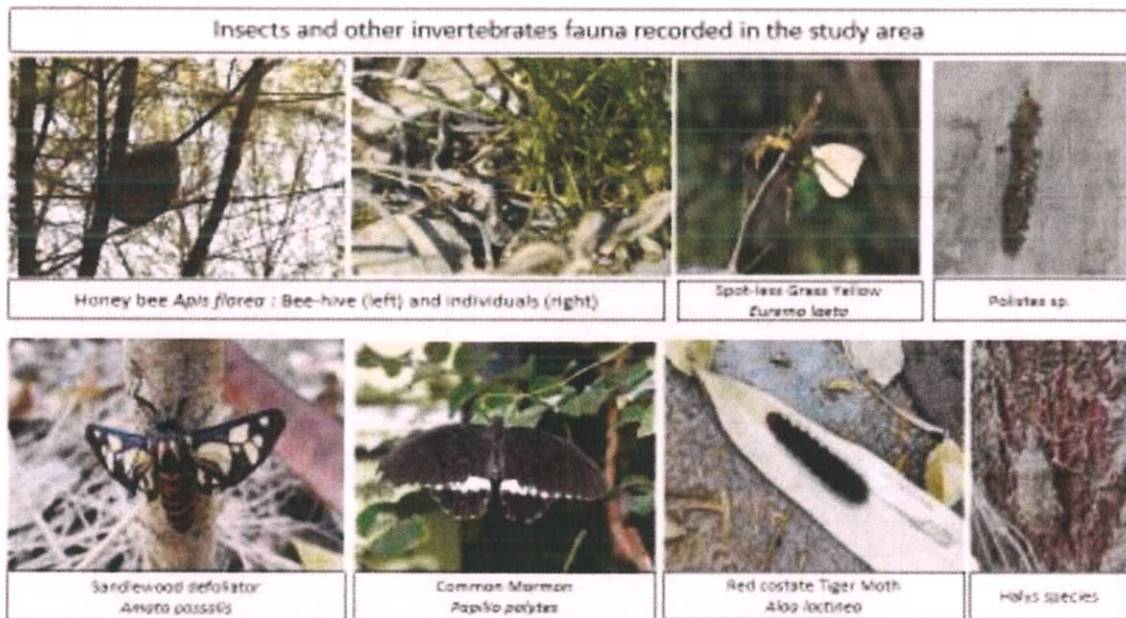
|    |                     |                            |                               |                            |                               |                                |
|----|---------------------|----------------------------|-------------------------------|----------------------------|-------------------------------|--------------------------------|
| 18 | Jwelled Grass Blue  | <i>Freyeria putli</i>      | <i>Heliotropium strigosum</i> | <i>Trichodesma indicum</i> | <i>Crotalaria hebecarpa</i>   | <i>Pisum sativum</i>           |
| 19 | Dull babul Blue     | <i>Azamas uranus</i>       | <i>Acacia catechu</i>         | <i>Acacia farnesiana</i>   | <i>Acacia senegal</i>         | <i>Acacia nilotica</i>         |
| 20 | Common Grass Yellow | <i>Eurema hecabe</i>       | <i>Aeschynomene americana</i> | <i>Albizia procera</i>     | <i>Caesalpinia mimosoides</i> | <i>Peltophorum pterocarpum</i> |
| 21 | Peacock Pansy       | <i>Junonia almana</i>      | <i>Hygrophila auriculata</i>  | <i>Mimulus gracilis</i>    | <i>Oryza sativa</i>           | <i>Pennisetum glaucum</i>      |
| 22 | Great Eggfly        | <i>Hypolimnas bolina</i>   | <i>Sida rhombifolia</i>       | <i>Portulaca oleracea</i>  | <i>Solanum torvum</i>         | <i>Elatostema cuneatum</i>     |
| 23 | Dark grass blue     | <i>Zizeeria karsandara</i> | <i>Amaranthus spinosus</i>    | <i>Amaranthus tricolor</i> | <i>Amaranthus viridis</i>     | <i>Oxalis corniculata</i>      |
| 24 | Gram Blue           | <i>Euchrysops cnejus</i>   | <i>Acacia caesia</i>          | <i>Butea monosperma</i>    | <i>Cajanus cajan</i>          | <i>Desmodium oojenense</i>     |
| 25 | Zebra Blue          | <i>Leptotes plinius</i>    | <i>Abrus precatorius</i>      | <i>Albizia lebbeck</i>     | <i>Dalbergia lanceolaria</i>  | <i>Sesbania bispinosa</i>      |
| 26 | Mottled Emigrant    | <i>Catopsilia pyranthe</i> | <i>Senna auriculata</i>       | <i>Cassia fistula</i>      | <i>Cassia javanica</i>        | <i>Sesbania sesban</i>         |
| 27 | Black Rajah         | <i>Charaxes solon</i>      | <i>Dalbergia sissoo</i>       | <i>Moullava spicata</i>    | <i>Pithecellobium dulce</i>   | <i>Tamarindus indica</i>       |
| 28 | Indian Skipper      | <i>Spialia galba</i>       | <i>Glycine max</i>            | <i>Alcea rosea</i>         | <i>Sida rhombifolia</i>       | <i>Melochia corchorifolia</i>  |

#### Other insects observed during Survey

**Table 3.2 Insect List- Smritivan Bhuj and surrounding area**

| Order      |    | Species                         | Common name                      |
|------------|----|---------------------------------|----------------------------------|
| Orthoptera | 1  | <i>Poecillocerus pictus</i>     | Painted Grasshopper              |
|            | 2  | <i>Parasanaa donovani</i>       | -                                |
|            | 3  | <i>Cyrtacanthacris tatarica</i> | Brown-Spotted Locust             |
| Coleoptera | 4  | <i>Hycleus bindulatus</i>       | Blister Beetle                   |
|            | 5  | <i>Anthia sexguttata</i>        | Six-Spot Ground Beetle           |
|            | 6  | <i>Digitonthophagus gazella</i> | Gazelle Scarab Beetle            |
|            | 7  | <i>Gametis versicolor</i>       | Indian Flower Chafer Beetle      |
|            | 8  | <i>Sternocera chrysis</i>       | Jewel Beetle                     |
|            | 9  | <i>Hydrophilus sp.</i>          | Water Scavenger Beetle           |
|            | 10 | <i>Heliocopris sp.</i>          | Giant Dung Beetle                |
|            | 11 | <i>Paederus sp.</i>             | Whiplash Beetle                  |
|            | 12 | <i>Lema sp.</i>                 | Shining Leaf Beetle              |
|            | 13 | <i>Cheilomenes sexmaculata</i>  | Six-Spotted Zigzag Ladybird      |
|            | 14 | <i>Stromatium barbatum</i>      | Teak Trunk Borer Beetle          |
|            | 15 | <i>Anthelephila sp.</i>         | Ant-Like Flower Beetle           |
|            | 16 | <i>Chiloloba acuta</i>          | Flower Chafer Beetle             |
|            | 17 | <i>Gymnopleurus cyaneus</i>     | Dung Beetle Sp.                  |
| Odonata    | 18 | <i>Ischnura senegalensis</i>    | Common Bluetail/ Marsh Blue Tail |
|            | 19 | <i>Diplacodes trivialis</i>     | Chalky Percher/Ground Skimmer    |
|            | 20 | <i>Brachythemis contaminata</i> | Ditch Jewel                      |
|            | 21 | <i>Trithemis pallidinervis</i>  | Dancing Dropwing                 |

|             |    |                                  |                       |
|-------------|----|----------------------------------|-----------------------|
| Hemiptera   | 22 | <i>Crocothemis servilia</i>      | Scarlet Skimmer       |
|             | 23 | <i>Orthetrum sabina</i>          | Slender Skimmer       |
|             | 24 | <i>Ceragrion coromandelianum</i> | Coromandel Marsh Dart |
|             | 25 | <i>Ischnura nursei</i>           | Pixie Dartlet         |
|             | 26 | <i>Corodius ianus</i>            | Red Pumpkin Bug       |
|             | 27 | <i>Ococephalus sp.</i>           | Assassin Bug          |
|             | 28 | <i>Prostemma carduelis</i>       | Damsel Bug            |
|             | 29 | <i>Prismatocerus apicicornis</i> | Leaf-Footed Bug       |
|             | 30 | <i>Apis dorsata</i>              | Giant Honey Bee       |
| Hymenoptera | 31 | <i>Philanthus sp.</i>            | Beewolves             |
|             | 32 | <i>Dorylus sp.</i>               | Driver Ant            |
|             | 33 | <i>Paratrechina longicornis</i>  | Longhorn Crazy Ant    |
|             | 34 | <i>Apis florea</i>               | Red Dwarf-Honey Bee   |
|             | 35 | <i>Ctenonomia sp.</i>            | -                     |
|             | 36 | <i>Pheidole sp.</i>              | Big-Headed Ant        |
|             | 37 | <i>Camponotus compressus</i>     | Indian Black Ant      |
|             | 38 | <i>Tapinoma melanocephalum</i>   | Ghost Ant             |
|             | 39 | <i>Stizina sp.</i>               | Sand Wasp             |





# • FISH, AMPHIBIANS AND REPTILES ASSOCIATED WITH WATERBODIES



Fish and Amphibians recorded in the study area



## REPTILES

Total 21 Species of reptiles were observed during survey

Table 3.3 Total Reptile Species observed during survey

| #  | Common Name                               | Scientific Name                   | IUCN Status |
|----|-------------------------------------------|-----------------------------------|-------------|
| 1  | Bengal Monitor lizard                     | <i>Varanus bengalensis</i>        | LC          |
| 2  | Bronze skink/ Mabuya                      | <i>Eutropis macularia</i>         | NE          |
| 4  | Brooke's Gecko/Spotted Indian house gecko | <i>Hemidactylus brookii</i>       | NE          |
| 5  | Checkered keelback                        | <i>Xenochrophis piscator</i>      | LC          |
| 6  | Common Indian Toad                        | <i>Duttaphrynus melanostictus</i> | LC          |
| 7  | Common Wolf snake                         | <i>Lycodon aulicus</i>            | LC          |
| 8  | Garden lizard                             | <i>Calotes versicolor</i>         | NE          |
| 9  | Indian Bullfrog                           | <i>Hoplobatrachus tigerinus</i>   | NE          |
| 10 | Indian Cobra                              | <i>Naja naja</i>                  | NE          |
| 11 | Indian flapshell turtle                   | <i>Lissemys punctata</i>          | VU          |
| 12 | Indian fringe toed lizard                 | <i>Acanthodactylus cantoris</i>   | LC          |
| 13 | Indian Krait                              | <i>Bungarus caeruleus</i>         | NE          |
| 14 | Indian Rat snake                          | <i>Ptyas mucosa</i>               | NE          |
| 15 | Marbled Toad                              | <i>Duttaphrynus stomaticus</i>    | LC          |
| 18 | Sawscaled viper                           | <i>Echis carinatus</i>            | NE          |
| 20 | Yellow-green House Gecko                  | <i>Hemidactylus flaviviridis</i>  | LC          |
| 21 | Fan-throated Lizard                       | <i>Sitana spinaecephalus</i>      | NE          |



Fan-throated Lizard *Sitana spinaecephalus*



Oriental Garden lizard *Calotes versicolor*



Bronze skink *Eutropis macularia*



Common House Gecko *Hemidactylus frenatus*



Common Indian wolf snake  
*Lycodon aulicus*



Red Sand Boa *Eryx johnii*



## BIRDS

79 Species of Birds were observed during survey

Table 3.4 Total Birds Species observed during survey

| No | Scientific Name                  | Species                   | Migratory Status | Status as per IUCN Category |
|----|----------------------------------|---------------------------|------------------|-----------------------------|
| 1  | <i>Accipiter badius</i>          | Shikra                    | R                | LC                          |
| 2  | <i>Acridotheres ginginianus</i>  | Bank Myna                 | R                | LC                          |
| 3  | <i>Acridotheres tristis</i>      | Common Myna               | R                | LC                          |
| 4  | <i>Acrocephalus agricola</i>     | Paddy Field Warbler       | R                | LC                          |
| 5  | <i>Acrocephalus stentoreus</i>   | Clamorous Reed Warbler    | R                | LC                          |
| 6  | <i>Aegithina nigrolutea</i>      | Marshall's Iora           | R                | LC                          |
| 7  | <i>Alcedo atthis</i>             | Common Kingfisher         | R                | LC                          |
| 8  | <i>Ammomanes phoenicurus</i>     | Rufus Tailed Lark         | R                | LC                          |
| 9  | <i>Aquila nipalensis</i>         | Steppe Eagle              | M                | EN                          |
| 10 | <i>Ardeola grayii</i>            | Indian-Pond Heron         | R                | LC                          |
| 11 | <i>Argya caudata</i>             | Common Babbler            | R                | LC                          |
| 12 | <i>Athene brama</i>              | Spotted Owlet             | R                | LC                          |
| 13 | <i>Bubo bengalensis</i>          | Indian Eagle-Owl          | R                | LC                          |
| 14 | <i>Bubulcus ibis</i>             | Cattle Egret              | R                | LC                          |
| 15 | <i>Burhinus oediceramus</i>      | Indian Thick-Knee         | R                | LC                          |
| 16 | <i>Centropus sinensis</i>        | Greater Coucal            | R                | LC                          |
| 17 | <i>Circaetus gallicus</i>        | Short-Toed Snake-Eagle    | R                | LC                          |
| 18 | <i>Columba livia</i>             | Blue Rock Pigeon          | R                | LC                          |
| 19 | <i>Copsychus saularis</i>        | Oriental Magpie Robin     | R                | LC                          |
| 20 | <i>Coracias benghalensis</i>     | Indian Roller             | R                | LC                          |
| 21 | <i>Corvus macrorhynchos</i>      | Large-Billed Crow         | R                | LC                          |
| 22 | <i>Corvus splendens</i>          | House Crow                | R                | LC                          |
| 23 | <i>Dendrocitta vagabunda</i>     | Rufous Treepie            | R                | LC                          |
| 24 | <i>Dicrurus macrocercus</i>      | Black Drongo              | R                | LC                          |
| 25 | <i>Elanus caeruleus</i>          | Black Winged Kite         | R                | LC                          |
| 26 | <i>Eremopterix griseus</i>       | Ashy-Crowned Sparrow lark | R                | LC                          |
| 27 | <i>Eudynamis scolopacea</i>      | Asian Koel                | R                | LC                          |
| 28 | <i>Francolinus pondicerianus</i> | Grey Francolin            | R                | LC                          |
| 29 | <i>Galerida cristata</i>         | Crested Lark              | R                | LC                          |
| 30 | <i>Galerida deva</i>             | Tawny Lark                | R                | LC                          |
| 31 | <i>Halcyon smyrnensis</i>        | White-Throated Kingfisher | R                | LC                          |
| 32 | <i>Hirundo rustica</i>           | Barn Swallow              | M                | LC                          |
| 33 | <i>Hirundo smithii</i>           | Wire-Tailed Swallow       | R                | LC                          |
| 34 | <i>Lanius meridionalis</i>       | Southern Grey Shrike      | R                | LC                          |
| 35 | <i>Lanius schach</i>             | Long-Tailed Shrike        | R                | LC                          |
| 36 | <i>Lanius vittatus</i>           | Bay-Backed Shrike         | R                | LC                          |



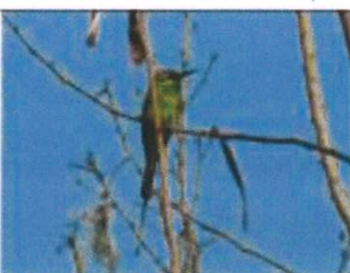
|    |                                   |                             |   |    |
|----|-----------------------------------|-----------------------------|---|----|
| 37 | <i>Euodice malabarica</i>         | Indian Silver bill          | R | LC |
| 38 | <i>Luscinia svecica</i>           | Blue Throat                 | M | LC |
| 39 | <i>Psitopogon haemacephala</i>    | Coppersmith Barbet          | R | LC |
| 40 | <i>Merops orientalis</i>          | Asian Green Bee Eater       | R | LC |
| 41 | <i>Milvus migrans</i>             | Black Kite                  | R | LC |
| 42 | <i>Motacilla alba</i>             | White Wagtail               | R | LC |
| 43 | <i>Nectarinia asiatica</i>        | Purple Sunbird              | R | LC |
| 44 | <i>Neophron percnopterus</i>      | Egyptian Vulture            | R | EN |
| 45 | <i>Oenanthe deserti</i>           | Desert Wheatear             | M | LC |
| 46 | <i>Oenanthe picata</i>            | Variable Wheatear           | M | LC |
| 47 | <i>Oriolus oriolus</i>            | Golden Oriole               | R | LC |
| 48 | <i>Orthotomus sutorius</i>        | Tailor Bird                 | R | LC |
| 49 | <i>Passer domesticus</i>          | House Sparrow               | R | LC |
| 50 | <i>Pastor roseus</i>              | Rosy Starling               | M | LC |
| 51 | <i>Pavo cristatus</i>             | Indian Peafowl              | R | LC |
| 52 | <i>Pericrocotus cinnamomeus</i>   | Small Minivet               | R | LC |
| 53 | <i>Pernis ptilorhynchus</i>       | Oriental Honey-Buzzard      | R | LC |
| 54 | <i>Phylloscopus collybita</i>     | Common Chiffchaff           | R | LC |
| 55 | <i>Ploceus philippinus</i>        | Baya Weaver                 | R | LC |
| 56 | <i>Prinia buchanani</i>           | Rufous Fronted Prinia       | R | LC |
| 57 | <i>Prinia gracilis lepida</i>     | Delicate Prinia             | R | LC |
| 58 | <i>Prinia hodgsonii</i>           | Grey Breasted Prinia        | R | LC |
| 59 | <i>Prinia inornata</i>            | Plain Prinia                | R | LC |
| 60 | <i>Prinia socialis</i>            | Ashy Prinia                 | R | LC |
| 61 | <i>Prinia sylvatica</i>           | Jungle Prinia               | R | LC |
| 62 | <i>Pseudibis papillosa</i>        | Red Naped IBIS              | R | LC |
| 63 | <i>Psittacula krameri</i>         | Rose-Ringed Parakeet        | R | LC |
| 64 | <i>Pterocles exustus</i>          | Chestnut-Bellied Sandgrouse | R | LC |
| 65 | <i>Ptyonoprogne concolor</i>      | Dusky Crag-Martin           | R | LC |
| 66 | <i>Pycnonotus cafer</i>           | Red-Vented Bulbul           | R | LC |
| 67 | <i>Pycnonotus leucotis</i>        | White-Cheeked Bulbul        | R | LC |
| 68 | <i>Saxicoloides fulicatus</i>     | Indian Robin                | R | LC |
| 69 | <i>Streptopelia decaocto</i>      | Eurasian Collared Dove      | R | LC |
| 70 | <i>Streptopelia senegalensis</i>  | Laughing Dove               | R | LC |
| 71 | <i>Streptopelia tranquedaria</i>  | Red Collared Dove           | R | LC |
| 72 | <i>Sturnus pagodarum</i>          | Brahminy Starling           | R | LC |
| 73 | <i>Sylvia crassirostris</i>       | Eastern Orphee Warbler      | M | LC |
| 74 | <i>Tephrodornis pondicerianus</i> | Common Woodshrike           | R | LC |
| 75 | <i>Upupa epops</i>                | Eurasian Hoopoe             | R | LC |
| 76 | <i>Vanellus indicus</i>           | Red-Wattled Lapwing         | R | LC |
| 77 | <i>Zosterops palpebrosus</i>      | Oriental White-Eye          | R | LC |
| 78 | <i>Currucur curruca</i>           | Lesser Whitethroat          | M | LC |
| 79 | <i>Cecropis daurica</i>           | Red-rumped swallow          | M | LC |



### Avifauna recorded in the study area



White-eared Bulbul  
*Pycnonotus leucotis*



Green Bee-eater  
*Merops orientalis*



Rose-ringed Parakeet  
*Pittacula krameri*



Oriental Honey Buzzard  
*Perisoreus philorhynchus*



White-tailed Iora  
*Aegintha nigrolutea*



Asian Koel *Eudynamis scolopacea*



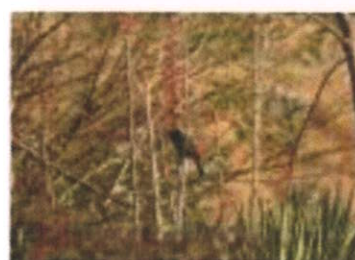
Indian Robin *Copsychus saularis*



Rock Pigeon *Columba livia*



Laughing Dove  
*Spatolopelia senegalensis*



Red-vented Bulbul *Pycnonotus cafer*



Dusky Crag Martin  
*Ptyonoprogne concolor*



Red-rumped Swallow  
*Cecropis daurica* nest



White-throated Kingfisher *Halcyon smyrnensis*  
nesting activity



Purple Sunbird *Cinnyris asiaticus* nesting activity



## MAMMALS AND OTHER ORGANISMS

Total 9 Species of Mammals were observed during survey

Table 3.5 Total Mammals Species observed during survey

| Sr. No. | Name of Species          |                                | Conservation Status |      |
|---------|--------------------------|--------------------------------|---------------------|------|
|         | Scientific Name          | Common Name                    | IWPA-1972           | IUCN |
| 1       | Nilgai                   | <i>Boselaphus tragocamelus</i> | Schedule-III        | LC   |
| 2       | Indian Jackal            | <i>Canis aureus</i>            | Schedule-II         | LC   |
| 3       | Jungle cat               | <i>Felis chaus</i>             | Schedule-II         | LC   |
| 4       | Palm squirrel            | <i>Funambulus pennanti</i>     | Schedule-IV         | LC   |
| 5       | Common Grey mongoose     | <i>Herpestes edwardsi</i>      | Schedule-II         | LC   |
| 6       | Indian Hare              | <i>Lepus nigricollis</i>       | Schedule-IV         | LC   |
| 7       | Indian Flying Fox        | <i>Pteropus giganteus</i>      | Schedule-V          | LC   |
| 8       | House rat                | <i>Rattus rattus</i>           | Schedule-V          | LC   |
| 9       | Greater Mouse-tailed Bat | <i>Rhinopoma microphyllum</i>  | Schedule-V          | LC   |



## CHAPTER 4 -SOIL CHARACTERISTICS



**Table 4.1 Results of various tests conducted on the soil samples**

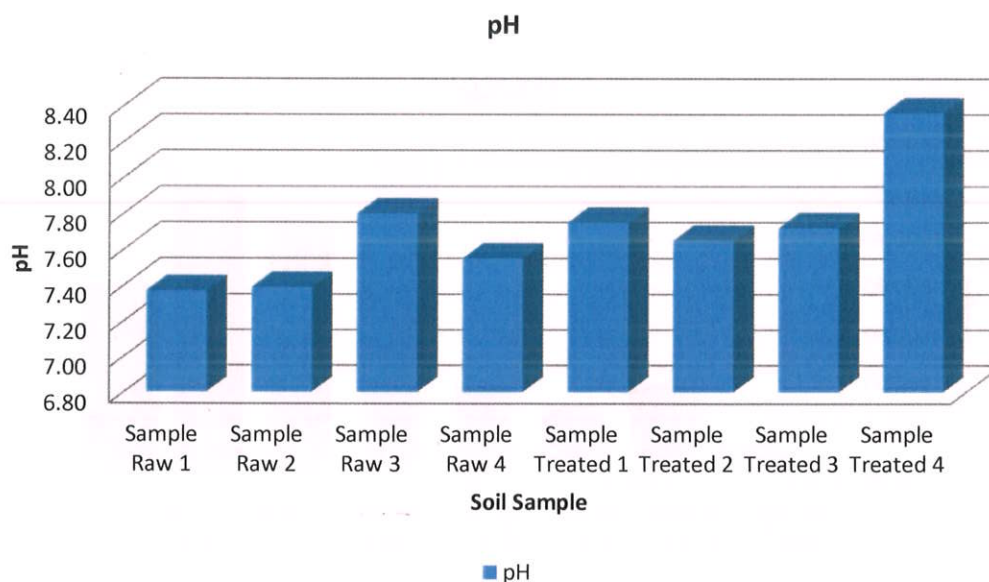
| Tests                   | Units            | Test method               | Results |        |        |        |         |         |         |        |
|-------------------------|------------------|---------------------------|---------|--------|--------|--------|---------|---------|---------|--------|
|                         |                  |                           | 1       | 2      | 3      | 4      | 1       | 2       | 3       | 4      |
|                         |                  |                           | Raw     |        |        |        | Treated |         |         |        |
| pH                      | -                | Gupta, 2009               | 7.37    | 7.39   | 7.80   | 7.55   | 7.75    | 7.65    | 7.72    | 8.36   |
| Electrical Conductivity | $\mu\text{S/cm}$ | Gupta, 2009               | 136.9   | 141.3  | 168.3  | 236    | 793     | 507     | 785     | 654    |
| Soil Moisture           | %                | Gupta, 2009               | 3.22    | 3.87   | 1.25   | 4.99   | 16.37   | 11.95   | 3.78    | 15.09  |
| Bulk density            | $\text{gm/cm}^3$ | Saxena (1987)             | 1.69    | 1.25   | 1.56   | 1.33   | 1.25    | 1.17    | 1.36    | 1.25   |
| Chloride                | mg/kg            | Gupta, 2009               | 48.21   | 337.48 | 241.06 | 337.48 | 1108.87 | 1108.87 | 1253.51 | 819.60 |
| Salinity                | ppt              | Gupta, 2009               | 0.087   | 0.609  | 0.435  | 0.609  | 2.003   | 2.003   | 2.264   | 1.480  |
| Soil texture - Sand     | %                | Gupta and Ghil Dyal, 1998 | 42.8    | 45.5   | 25.9   | 51.1   | 75.6    | 71.0    | 37.6    | 72.2   |
| Soil texture - Silt     |                  |                           | 20.4    | 30.6   | 37.2   | 27.2   | 14.3    | 19.1    | 30.6    | 13.6   |
| Soil texture - Clay     |                  |                           | 36.8    | 23.9   | 36.9   | 21.7   | 10.1    | 9.9     | 31.8    | 14.2   |
| Nitrogen (Available)    | mg/kg            | Kjeldahl method           | 61.64   | 84.06  | 72.85  | 95.26  | 69.24   | 84.06   | 95.26   | 67.24  |
| Phosphorus (Available)  | mg/kg            | Gupta, 2009               | 15.04   | 21.74  | 10.67  | 19.71  | 12.29   | 28.35   | 18.39   | 13.13  |
| Potassium               | mg/kg            | Gupta (2009)              | 16.42   | 24.56  | 7.51   | 30.96  | 22.82   | 24.97   | 19.86   | 36.80  |
| Total organic carbon    | %                | Gupta, 2009               | 0.39    | 0.75   | 0.39   | 0.72   | 0.96    | 0.63    | 0.9     | 0.99   |

The table provides the results of various tests conducted on the soil samples; Here Raw samples of the natural untreated soil were collected from the nearby grids of each plantation zone of Bhujio Hill whereas Treated Samples were collected from the Plantation area- one Sample from each Plantation Zone. The tests include pH, electrical conductivity, soil moisture, bulk density, chloride, salinity, soil texture (sand, silt, and clay), nitrogen, phosphorus, potassium, and total organic carbon. pH, Electrical Conductivity, Soil Moisture, Chloride, Salinity, Phosphorus (Available), Potassium, and Total organic carbon of the soil Samples were analysed using the Gupta, 2009 method. The Bulk density was analysed by Saxena (1987), and Nitrogen (Available) was analysed by the Kjeldahl method. The Soil texture – Sand, Soil texture – Silt, Soil texture – Clay was studied using Gupta and Ghil Dyal, 1998 method.

The results are obtained using different test methods and units, which are mentioned in the table.

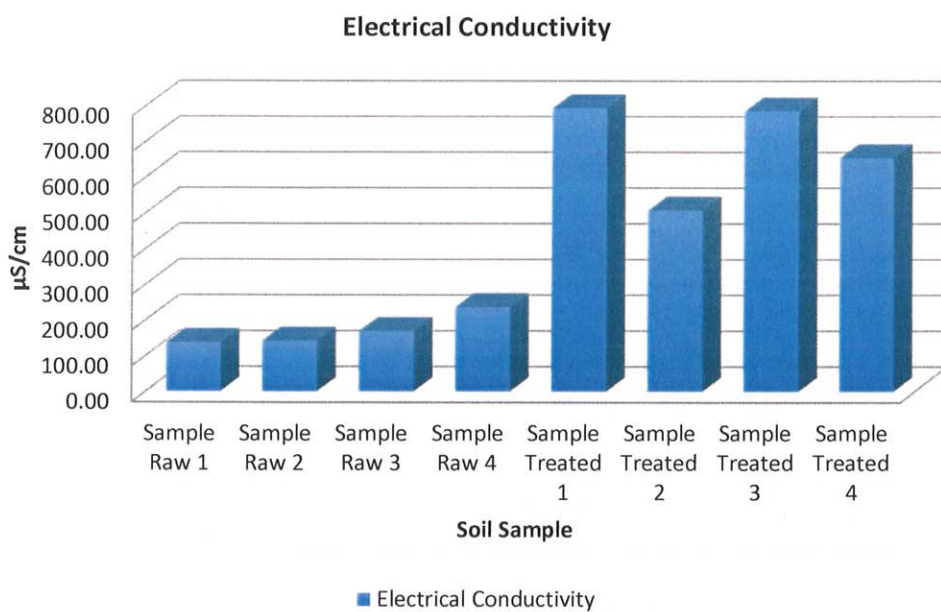
- The pH of the soil samples ranges from 7.37 to 8.36.
- The electrical conductivity of the soil samples ranges from 136.9 to 793  $\mu\text{S}/\text{cm}$ .
- The soil moisture content ranges from 1.25% to 16.37%.
- The bulk density of the soil samples ranges from 1.17 to 1.69  $\text{gm}/\text{cm}^3$ .
- The chloride content ranges from 48.21 to 1253.51  $\text{mg}/\text{kg}$ .
- The salinity of the soil samples ranges from 0.087 to 2.264 ppt.
- The percentage of sand in the soil samples ranges from 25.9% to 75.6%, silt ranges from 13.6% to 37.2%, and clay ranges from 9.9% to 36.9%.
- The available nitrogen content ranges from 61.64 to 95.26  $\text{mg}/\text{kg}$ .
- The available phosphorus content ranges from 10.67 to 28.35  $\text{mg}/\text{kg}$ .
- The potassium content ranges from 7.51 to 36.80  $\text{mg}/\text{kg}$ .

**Chart 4.1 pH of soil samples**





**Chart 4.2 Electrical Conductivity of soil samples**



**Chart 4.3 Chloride content of soil sample**

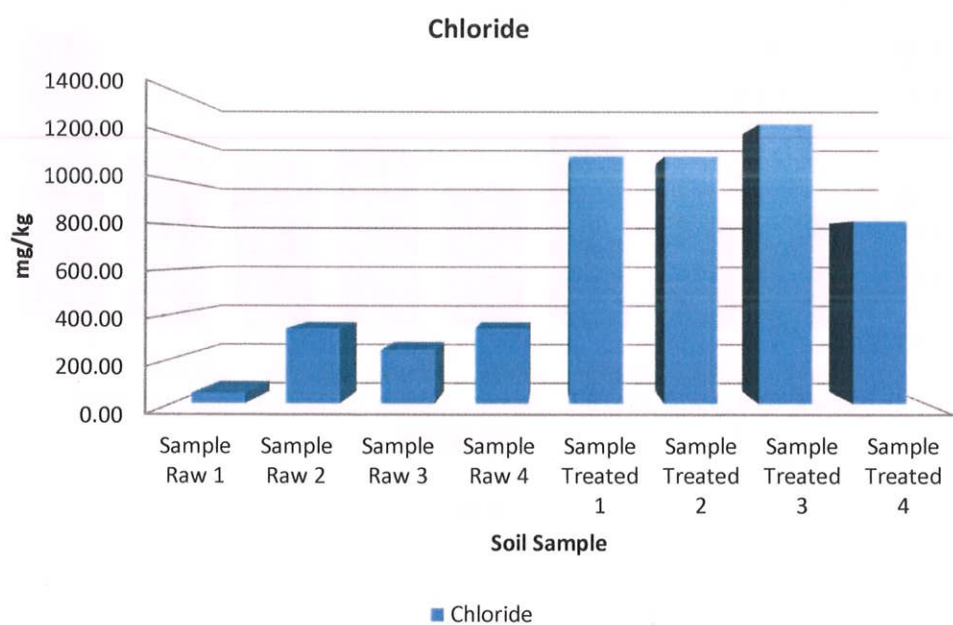




Chart 4.4 Bulk Density ranges of soil samples

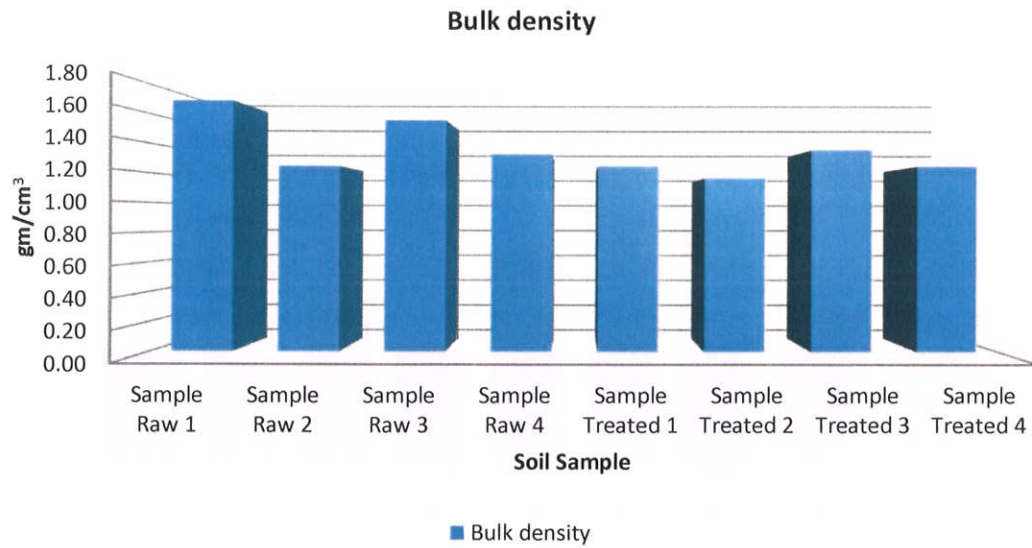
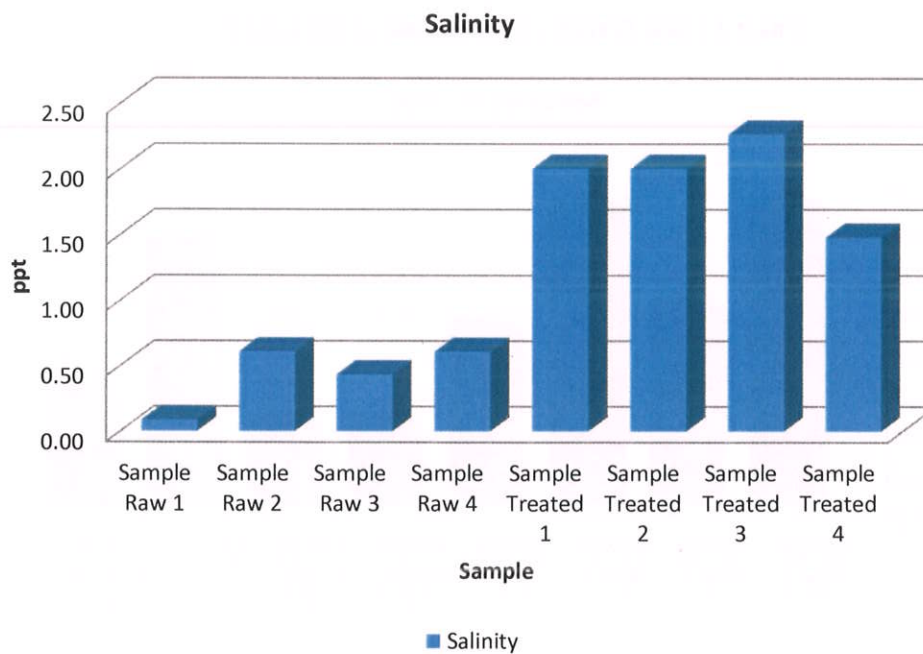
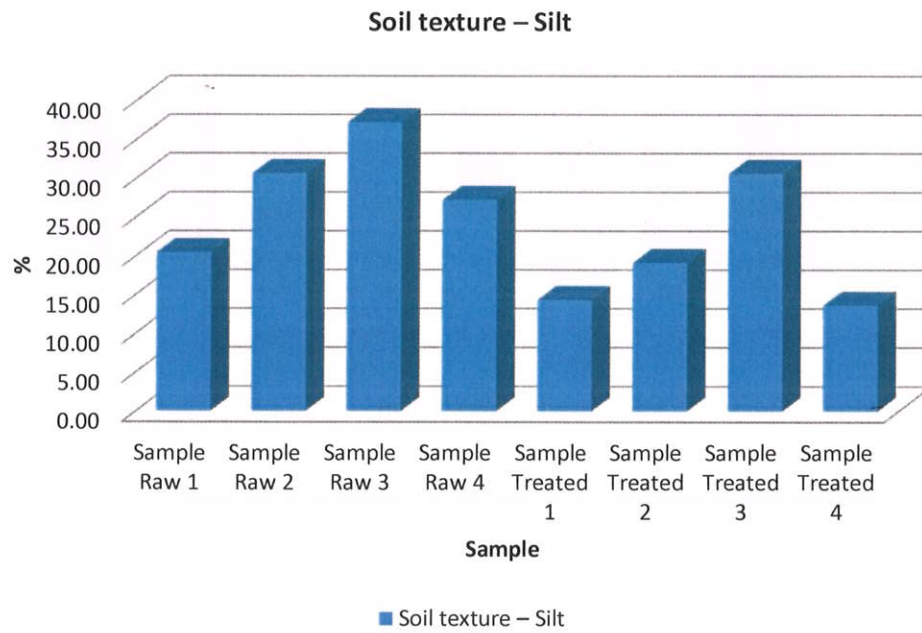


Chart 4.5 Salinity content of soil samples

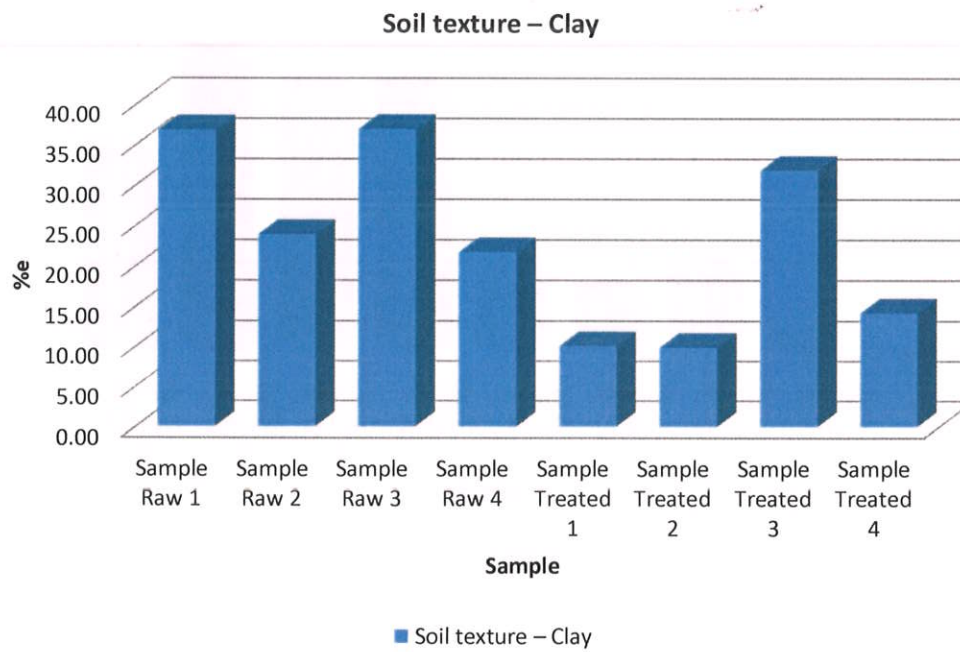




**Chart 4.6 Soil Texture- silt content of soil samples**

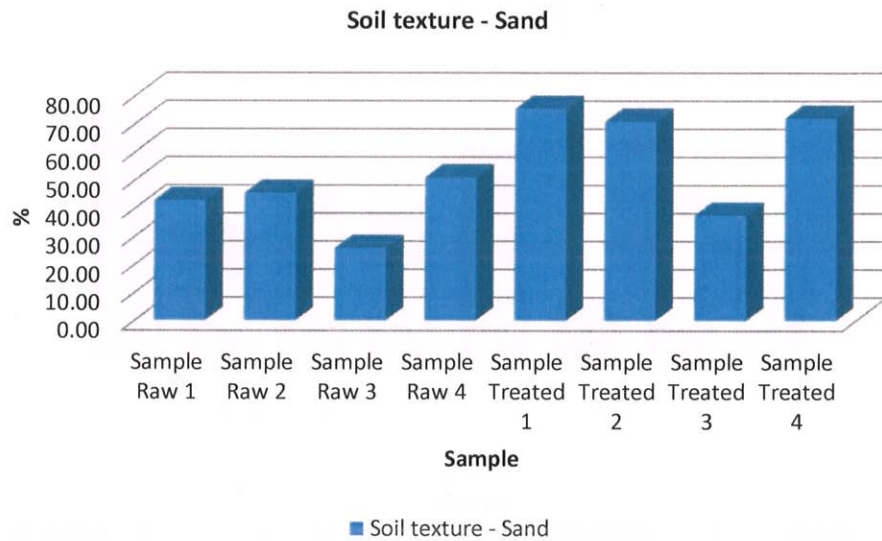


**Chart 4.7 Soil Texture - Clay content of soil samples**





**Chart 4.8 Soil Texture -Sand content of soil samples**



**Chart 4.9 Moisture content of soil samples**

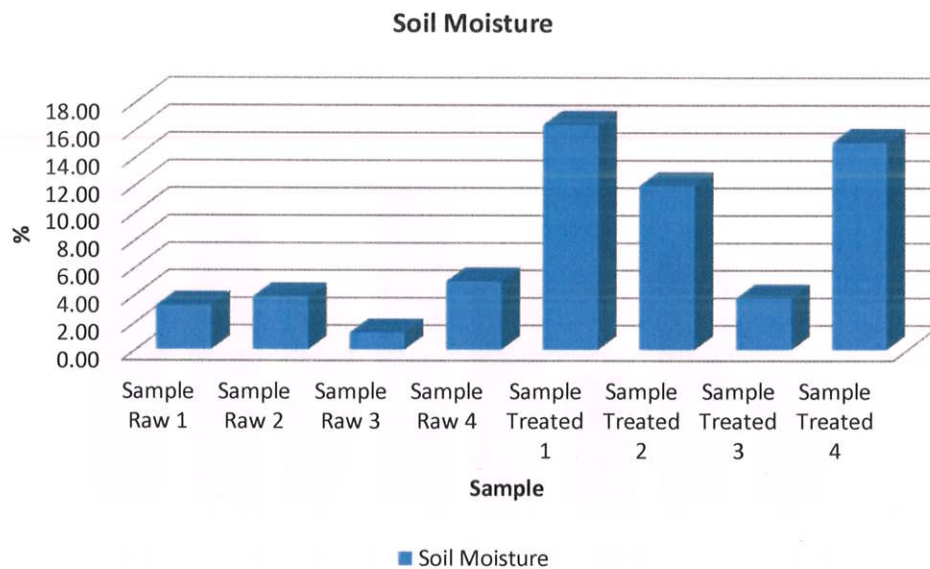




Chart 4.10 Potassium content of soil samples

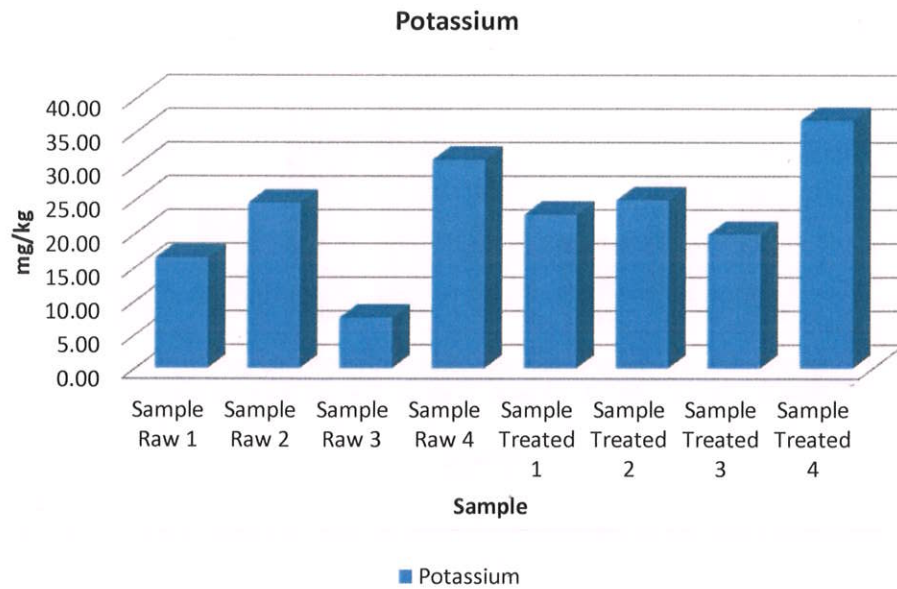
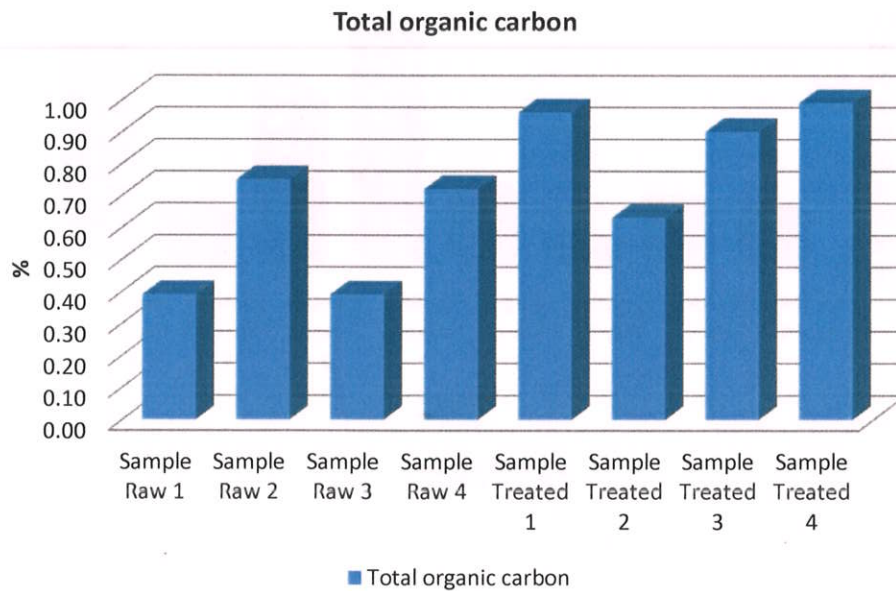


Chart 4.11 Total Organic Carbon content of soil samples



The data suggest that the soil has varying characteristics important for plant growth. The varying soil parameters may require specific soil management practices to optimize plant growth and yield. The soils with high chloride content and salinity may require special management practices such as leaching to reduce the harmful effects of salt on plants. Similarly, soils with low nitrogen, phosphorus, and potassium content may require the addition of fertilizers or organic matter to improve soil fertility and enhance plant growth. The soil texture analysis indicates that the soil has varying amounts of sand, silt, and clay, which can influence water-holding capacity, nutrient availability, and soil structure. Therefore, understanding soil characteristics and their interactions is crucial for sustainable soil management.

The soil collected from plantation area has a higher pH compared to the control soil, with a pH value of 8.36. This indicates that the treatment has increased the alkalinity of the soil. However, the pH values for both the control and treated soils are within the acceptable range for most crops, which is between 7.37 to 8.36. The total organic carbon (TOC) content of the treated soil is higher than the control soil, with values ranging from 0.39 to 0.99%. This suggests that the treatment has improved the organic matter content of the soil. Organic matter plays a crucial role in maintaining soil fertility and improving its physical properties such as water holding capacity, nutrient availability, and soil structure.

It is recommended to continue monitoring the soil quality over time to assess the long-term effects of the treatment on the soil. In addition, the application of organic matter such as compost or manure may help maintain or increase the organic matter content of the soil. Regular soil testing can also help determine the appropriate application rates of fertilizer and lime, which can help maintain a favourable pH level for plant growth. It is recommended that soil management practices such as soil amendments, irrigation and drainage management, reduced tillage, and adequate nutrient management should be implemented to optimize plant growth and yield in this soil. Additionally, regular soil testing and monitoring should be conducted to evaluate soil fertility and salinity levels and adjust management practices accordingly.

Soil sample collection using standard method





## **Chapter 5 Assessment of Tangible and non-tangible benefits and outcomes of the plantation activity**

### **Tangible Benefits**

#### **Reducing Soil Erosion:**

Implementing mulching techniques and the dense plant canopy after the Miyawaki plantation has effectively reduced soil erosion. By preventing the exposure of the top soil layer to rain and heavy winds, the plantation has helped protect the soil. Signs of soil runoff were not observed near slopes and rivulets, indicating the success of erosion control measures.

#### **Increasing Moisture Retention Capacity of Soil:**

The densely planted trees, mulching, coco-peat, and soil treatment methods have contributed to an improvement in the soil's water retention capacity. The presence of moist soil and leaf litter covering the forest floor creates a thick layer of humus, providing suitable conditions for soil microbes, fungi, and a variety of invertebrates such as insects, mites, spiders, millipedes, centipedes, snails, and earthworms. These organisms play a crucial role in nutrient cycles of the soil.

#### **Increasing Nutrient Capacity of Soil:**

The Miyawaki plantation has positively impacted the nutrient capacity of the soil. The reduced soil erosion, along with the presence of moist soil and dry leaf litter adding biomass, creates suitable conditions for nutrient accumulation in the soil. This enhances the soil's nutritional value and supports healthy vegetation growth.

### **Non-Tangible Benefits**

#### **Providing Suitable Microclimatic Conditions for Invertebrate and Small Vertebrate Species:**

The Miyawaki plantation creates microclimates that offer favourable conditions for various invertebrates and small vertebrates. These microclimates, formed by dense vegetation and leaf litter, provide shelter, moisture, and food sources for these species, promoting their presence and diversity.

#### **Initiating Natural Food Web:**

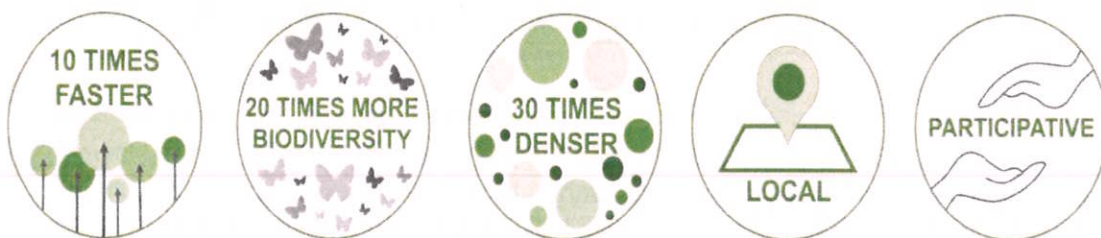
The diverse ecosystem created by the Miyawaki plantation sets the stage for the initiation of a natural food web. As the flora and fauna flourish within the plantation, a complex network of interactions and dependencies among different species begins to develop, leading to a more balanced and self-sustaining ecosystem.



### **Providing Micro and Macro Habitats to Enhance Floral and Faunal Biodiversity:**

The Miyawaki plantation acts as a haven for a wide range of plant and animal species, providing micro and macro habitats. The dense vegetation, leaf litter, and overall ecological structure created by the plantation support the growth and survival of diverse floral and faunal communities, enhancing biodiversity in the area.

By comprehensively assessing the tangible and non-tangible benefits of the Miyawaki plantation at Smritivan Bhuj, it becomes evident that this approach has brought about significant positive changes to the ecosystem, including erosion control, improved soil moisture retention, increased nutrient capacity, the promotion of diverse species, and the establishment of a natural food web.





## Chapter 6 Assessment Cultural, Aesthetic and Recreational value

### Outcomes of the Questionnaire survey and Stakeholder suggestions

Table 6.1 Data of total visitors participated in the survey at Smritivan, Bhuj

| No                                                                        | Visitors Participated in Survey from Different places of Gujarat at Smritivan | Total | Visitors Participated in Survey from Different places of India at Smritivan |     |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------|-----------------------------------------------------------------------------|-----|
| 1                                                                         | Ahmedabad                                                                     | 1     | Gujarat                                                                     | 210 |
| 2                                                                         | Bhuj                                                                          | 178   | Bihar                                                                       | 3   |
| 3                                                                         | Jamnagar                                                                      | 1     | Uttar Pradesh                                                               | 3   |
| 4                                                                         | Junagadh                                                                      | 2     | Maharashtra                                                                 | 4   |
| 5                                                                         | Madhapar                                                                      | 19    | NA                                                                          | 15  |
| 6                                                                         | Mehsana                                                                       | 2     |                                                                             |     |
| 7                                                                         | Nakhatrana                                                                    | 1     |                                                                             |     |
| 8                                                                         | Panchmahal                                                                    | 1     |                                                                             |     |
| 9                                                                         | Rajasthan                                                                     | 1     |                                                                             |     |
| 10                                                                        | Somnath                                                                       | 2     |                                                                             |     |
| 11                                                                        | Sukhpar                                                                       | 2     |                                                                             |     |
| <b>Total Visitors Participated in the survey at Smritivan, Bhuj = 235</b> |                                                                               |       |                                                                             |     |

The questionnaire survey gathered data from participants regarding their demographics, frequency of visits to Smritivan, reasons for visiting, awareness about positive environmental changes due to the Miyawaki Forest and Plantation Method, awareness about the role of CSR partners and their contribution to one of the Largest Miyawaki forest of Asia, and the improvement of ecology and socio-economic conditions.

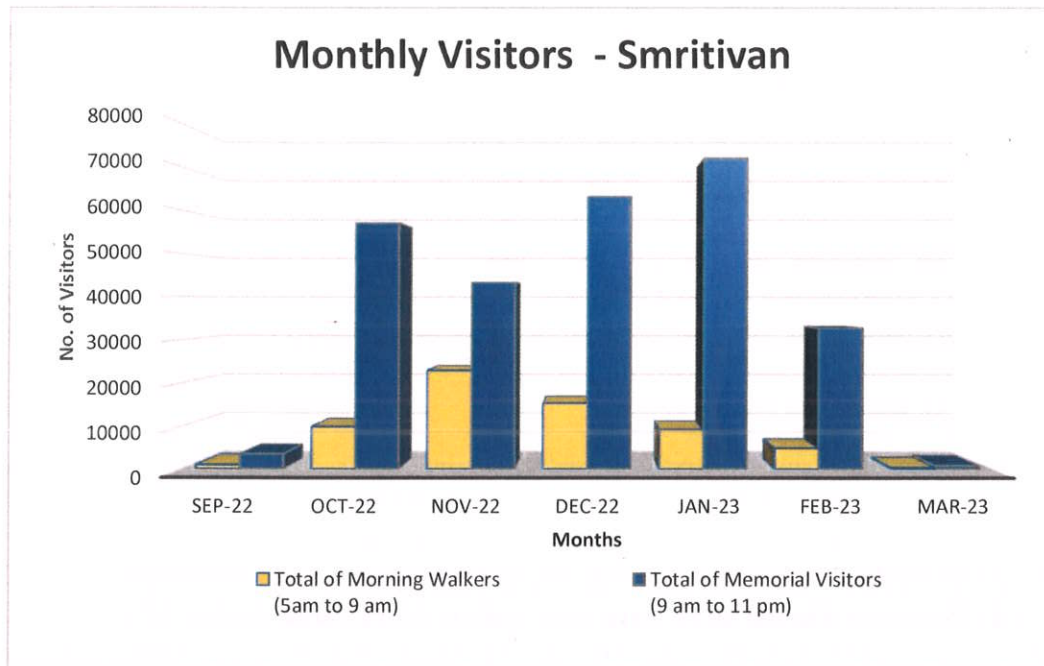
Based on the data of the Miyawaki plantation assessment at Smritivan Bhuj, the following key findings have emerged from a questionnaire survey conducted with a total of 230+ respondents

1. Appreciation for the Plantation: All respondents expressed appreciation for the Miyawaki plantation.
2. Awareness and Outreach Programs: The survey highlights the need for awareness and outreach programs to further educate the public about the importance and benefits of the plantation.
3. Highlighting Area Biodiversity: Respondents suggested the installation of awareness posters about plants and animals to highlight the rich biodiversity present in the area.
4. Maps and Infographics: Visitors expressed the need for maps and plant-related Infographics to enhance their understanding of the plantation and educate them about the various plant species present.
5. Waste Management: The survey indicates the requirement for proper waste management practices within the plantation to maintain cleanliness and sustainability.



6. Public Facilities: Respondents requested the provision of public facilities such as bio toilets and drinking water facilities to enhance the visitor experience and ensure their comfort during their visit to the plantation.

**Chart 6.1 Monthly visitors at Smritivan**



From the official figures of visitors collected by GSDMA from September 2022 to March 2023, a total of 160 days following information can be summarized:

The data for morning walkers and memorial visitors in 2022 and 2023 reveals intriguing trends. In 2022(September to December), there were 49,191-morning walkers, with an average of 492 walkers per day. Additionally, the sum of memorial visitors during this year reached 1, 67,385.

However, the following year, 2023, January to March data indicates following trend. The total number of morning walkers was recorded at 14,424, with an average of 240 daily walkers. Similarly, the sum of memorial visitors was 1, 05,859. These figures indicate a noticeable shift in behaviours and engagement of people visiting the memorial in 2023. The reasons behind the change in visitor numbers could be attributed to various factors, such as changes in community preferences, environmental consciousness of citizens, external events, or even fluctuations in season and local conditions and many other reasons. The Systematic data collection provides essential statistical data to analyze the trend of visitors at Miyawaki Forest at Smritivan

The survey involved 235 participants, with 140 males and 95 females. Regarding the frequency of visits to Smritivan, 30 participants visited daily, while 178 visited once a week, and 27 visited once a month.



The primary reason for visiting Smritivan was to enjoy the green ambience, as reported by 221 participants. Only 2 participants mentioned paying homage to the deceased, and 12 participants visited to participate in CSR activities.

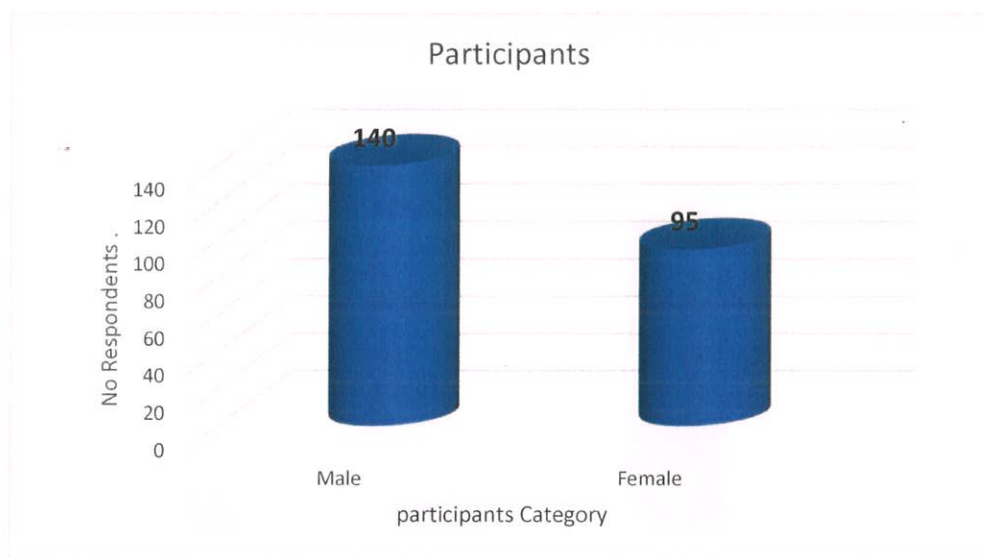
Regarding the impact of the Miyawaki plantation on the environment, 222 participants reported positive environmental changes due to the growing Miyawaki Forest, while only 13 participants did not observe any such changes. In terms of awareness about the role of CSR partners and their contribution, 39 participants were aware, while a majority of 196 participants lacked awareness about the contribution of CSR partners to build the Miyawaki forest at Smritivan. Hence it is recommended that the role of CSR partners in developing the Miyawaki Forest at Smritivan area should be highlighted through increasing awareness among the visitors.

Regarding the improvement of ecological and socio-economic conditions, 228 participants believed there had been positive changes in air quality, water availability, aesthetics, biodiversity, and the local area's economy. However, 7 participants needed clarification about these improvements.

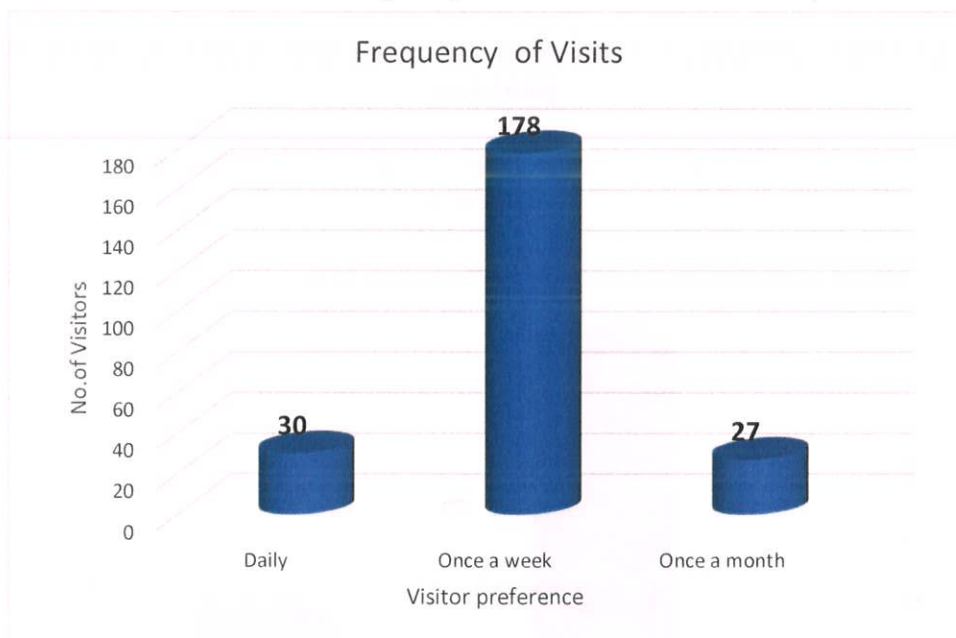
The survey data highlights a significant interest in Smritivan, with participants regularly visiting to enjoy the green ambience. The majority acknowledged the positive environmental changes resulting from the Miyawaki Forest, but a few participants needed clarification about the Miyawaki method. Awareness about the role of CSR partners, their contributions, and the Miyawaki Plantation Method could have been higher, with a large number of participants needing more knowledge in this area. Overall, the survey indicates that Smritivan attracts visitors for its natural beauty, and efforts to promote environmental sustainability and awareness should be made to maximize its impact on the community and visitors.



**Chart 6.2 Participants of the Survey-Gender**



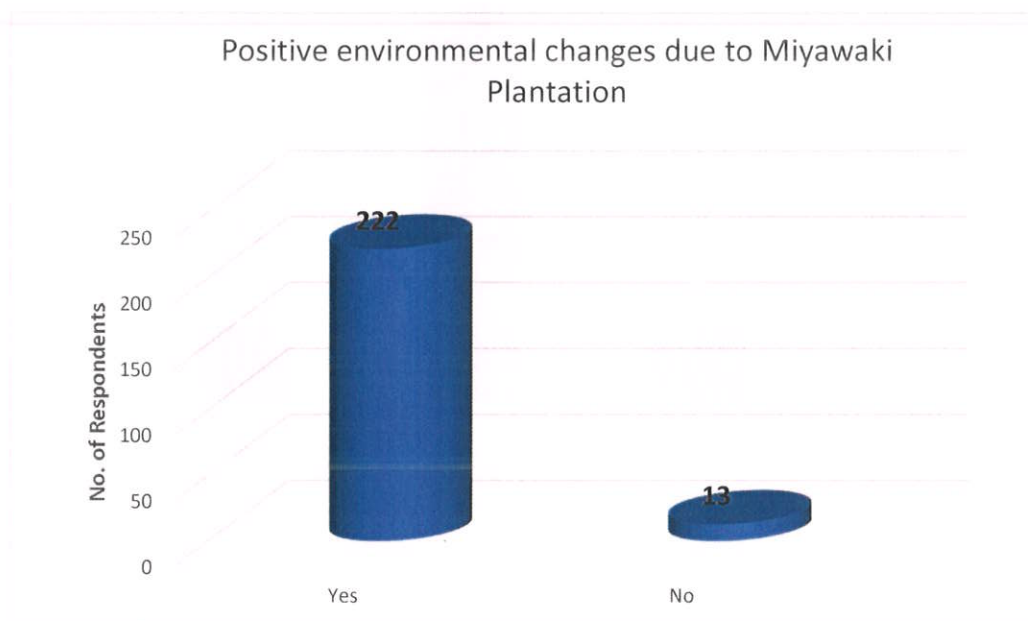
**Chart 6.3 Frequency of visits of Visitors**



**Chart 6.4 Reason to visit Smritivan**

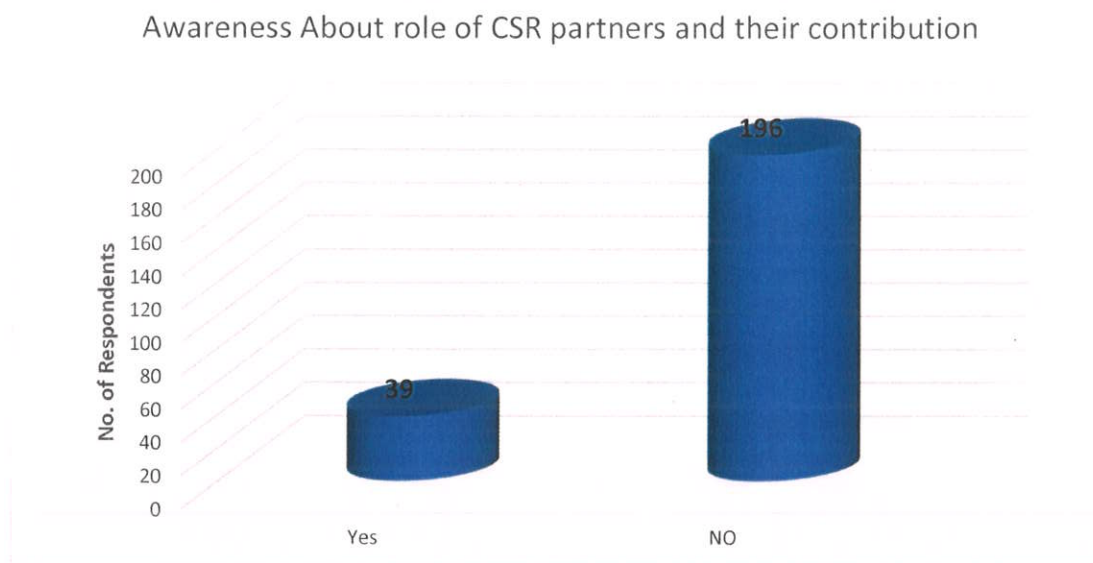


**Chart 6.5 Visitor perception towards positive environmental changes due to Miyawaki plantation**

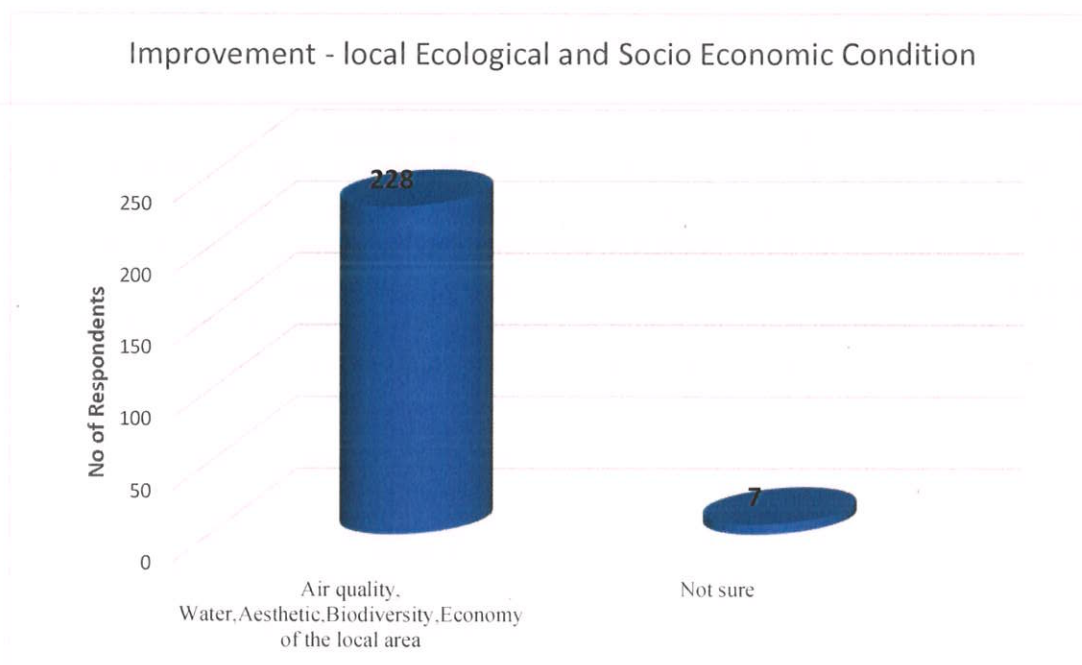


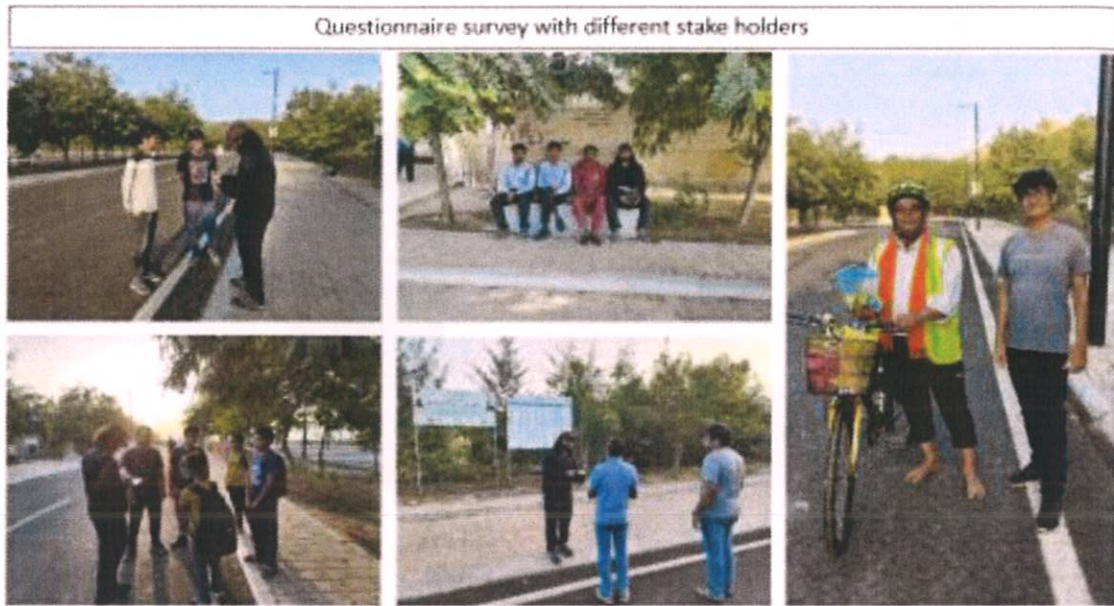


**Chart 6.6 Visitors awareness about role of CSR partners and their contribution in Miyawaki plantation**



**Chart 6.7 Perception of visitors towards the Improvement of local Ecological and Socio-Economic Condition**





- **Strengthening Cultural Social Value**

Smritivan at Bhujio Dungar has become a significant socio-cultural centre, attracting visitors from Bhuj and beyond. Its lush green environment has made it popular among morning walkers, tourists, yoga practitioners, children, and students. The increased footfall has created economic opportunities for local businesses, contributing to the socio-economic development of Bhuj and its surrounding areas. Smritivan serves as a venue for community events, festivals, and celebrations, fostering unity and a sense of belonging. It has become a symbol of cultural heritage and environmental consciousness, enriching the local culture of Bhuj.



## **Chapter 7 Conclusion and Way- Ahead**

### **Smritivan - An Urban Oasis of Bhuj**

The Miyawaki plantation project undertaken by CSR partners at Smritivan Bhuj has proven successful in establishing an urban oasis within the city.

The suitable methodology employed, including soil treatment and watering plants at specific intervals, has contributed to an average % survival rate of 86% for the planted species. However, to further enhance the survival rate of the plants, it is recommended to prioritize the plantation of native species. This will increase the plant's ability to thrive in its natural environment and promote biodiversity and ecological balance.

One crucial aspect highlighted by the project is the need to monitor plant mortality, water and nutrition requirement; re-plant dead plants, and water plants according to plant requirements and seasonal changes. Dried plant leaves can indicate water requirement to the plants. These efforts will help increase the overall density and diversity of the Miyawaki plantation, contributing to a healthier and more resilient ecosystem within Smritivan Bhuj.

Additionally, Smritivan Bhuj acts as a heat trap and helps to regulate the temperature of Bhuj City. The Miyawaki forest serves as the city's lungs and has provided a much-needed refuge for flora and fauna within the urban environment. The project has successfully increased the attachment of the local community to the wilderness landscape, creating a sense of pride and ownership among the residents.

Furthermore, the project has played a vital role in raising awareness and building the capacity of youth and students. By involving them in the plantation process and educating them about the importance of biodiversity and environmental conservation, the project has fostered a sense of environmental stewardship among the younger generation.

In conclusion, the Miyawaki plantation project at Smritivan Bhuj has demonstrated its effectiveness in establishing an urban oasis, promoting biodiversity, and creating a refuge for flora and fauna within the city. The project's success can be attributed to implementing suitable methodologies, including soil treatment and regular watering, resulting in an average % survival rate of 86%. To further enhance the project's impact, it is recommended to prioritize the plantation of native species, monitor plant mortality, and undertake re-plantation efforts. The project has also raised awareness and built the capacity of youth and students, fostering a sense of environmental responsibility in the community. Smritivan Bhuj is a shining example of the positive outcomes that can be achieved through collaborative efforts in environmental conservation.



## **Recommendations**

The objective of the project "Assessment of Plantation at Smritivan Earthquake Memorial" is to evaluate and maintain the plantation's biodiversity, health and ecological services at Smritivan, Bhuj. The project aims to implement regular monitoring for seasonal comparative management, particularly emphasizing plant and faunal diversity maintenance. Plantation of native trees with an adaptation to survive in the climatic conditions of Bhuj (Kachchh) area, Mono-species reduction and removal of invasive species like *Prosopis juliflora* should be considered as a priority that requires continuous monitoring. Removal of insect infestation or plant disease in early plant growth stages is crucial to ensure the plant survival.

Additionally, satellite-based monitoring can be utilized to understand Miyawaki forest ecological services and their economic benefits and role in the urban ecosystem after 5 years of plantation.

### **Long-term Documentation and Carbon Credit Assessment**

To ensure the best results of the plantation efforts by GSPL, there is a requirement to establish long-term documentation and monitoring protocols for biodiversity. This documentation will help track changes in plant and faunal diversity over time. Moreover, a carbon credit assessment should be conducted at intervals every 3-5 years along with Biomass estimation to evaluate the environmental benefits of the plantation and its contribution to carbon sequestration process and soil quality improvement.

### **Capacity Building and Training**

To effectively carry out the documentation and long-term monitoring process, capacity-building activities should be conducted to train staff members. The training will focus on techniques for monitoring protocols, data collection, and biodiversity assessment. This will enhance the staff's skills and enable them to participate in the project's implementation activities.

### **Stakeholder-specific Tours/ Events and Citizen Science Activities**

Smritivan has the potential to become an Eco-Education Site, providing guided tours for different stakeholders on Important Environmental Day events a trained person can deliver customized tours to various groups, such as Students, Senior Citizens, Medical practitioners, Government officers, media personnel, and NGOs working to improve the Environment. These tours can showcase the Miyawaki forest's biodiversity, ecological services, faunal diversity and the importance of conserving natural habitats. Furthermore, the memorial site can be promoted as an urban hotspot for bird watching activities, attracting enthusiasts and nature lovers. Incentivizing entry fees as a reward for bird watching participants can generate awareness for the project.

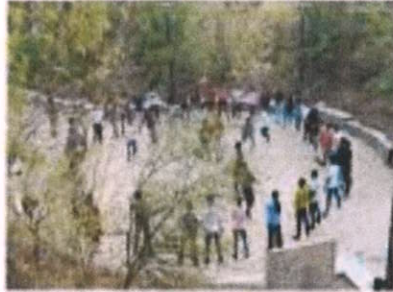


The project implementation agencies can organize nature education workshops, Nature walks on pre-established nature trails to sensitize the citizen about the significance of ecological conservation and sustainable practices. Hence Visitors can contribute to the generation of local employment opportunities



A) Termite on neem tree trunk      B) Broken plant due to Nilgai Movement





Discussion with the visitors to about Miawaki plantation at Smritivan and Mission LIFE followed by questionnaire survey and feedback session.

②



**Gujarat Ecology Commission**  
Government of Gujarat

## **Gujarat Ecology Commission**

Block No. 18/1, Udhyog Bhavan,

Sector-11, Gandhinagar

Contact No.: 23257656, Fax: 23257657

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