CHAPTER 3

Research Methodology and Methods of Study

Research Methodology includes the framework associated with a particular set of paradigmatic hypotheses based on scientific study and analogies that are used to conduct a research, i.e. scientific method, action research, etc. *Methods* refer to the techniques used to collect data, i.e. interviewing, area surveying, etc. Tools are the devices used to collect data, i.e. questionnaires, observation checklists, interviews etc. The *Methodological design* includes the plan for conducting the study.

The method employed in this research work is primarily based on Area study and Field Survey. It involves simple random sampling and various form of mixed sampling like stratified sampling and cluster sampling. The write ups, based on scientific study and interpretation are being supplemented by visual data, photographs, charts, graphs, diagrams, maps and sketches.

The research involved different techniques and methods. Field visits have been undertaken by the Researcher seasonally along with collection of field data and samples. The analyses and interpretation have been undertaken by leading Research Institutes and results obtained were procured from the Institutes by the researcher and thus presented in the following thesis.

3.1. Selected Areas

As mentioned in Chapter 1, the researcher has selected two culturally significant sites and one significant natural heritage site of West Bengal for research. This includes the Victoria Memorial Hall, Kolkata and Temples of Bishnupur, Bankura on one hand and one Natural heritage site- Sundarbans National Park, 24 Parganas South. To pursue the research work, comparative studies have however been made with heritage sites and monuments of other states of India to highlight the significance of the study.
3.2. Research Methodology

The entire Methodology of Research is divided into two main parts:

I. Based on Analysis and Interpretation

1. Non-Analytical Part:

The first part of the research work carried out is non-analytical, i.e. it covers a detailed study of the History and Architectural features (in case of Cultural Heritage Sites) and Environmental details of the heritage site as per the observations of the researcher and extensive literature study with the help of Datasheets.

Research Tools used for Non-Analytical Part:

a) Pencil, Pen, Eraser
b) Sketches
c) Datasheets
d) Binocular – Olympus (8 x 40 DPS I, Field 8.2 degrees)
e) Digital camera - Canon S3IS Powershot of Optical zoom - 6x
f) Handycam - Sony of 40 x zoom

2. Analytical Part:

The second part is analytical. It involves Field study of abiotic and biotic components by using different techniques. The Samples collected have been analysed from leading Research Institutes after preliminary treatment by the researcher at the Departmental Laboratory of Department of Museology at the University of Calcutta.

Research Tools used for Analytical Part:

a) Floral samples- Leaves and twigs in some cases
b) GPS to obtain latitude and longitude of each and every study site
c) String
d) Nail - 4 pcs
e) Ruler of 30 cm
Chapter 3

f) Measuring Tape
g) Sample Bottles - 1 litre
h) Thermometer
i) Spade for soil collection
j) Zipper bags
k) Graph Paper (mm)
l) Measuring balance
m) SEM with EDAX facility
n) Compact Disks, Pen drives, DVD
o) pH indicator papers

II. Based on Type of Data

The research work is based on both primary and secondary data.

a) Primary Data:
   Primary data is obtained through repeated field visits in different seasons at each of the sites of West Bengal selected for the research, i.e., Victoria Memorial Hall, Kolkata, Bishnupur Group of Temples, Bankura district and Sundarbans National Park and Biosphere Reserve as a whole.

b) Secondary Data:
   Unpublished manuscripts and published Books, reports, journals, dissertations, etc. have been consulted for secondary data. Correspondence with Institutions like Archaeological Survey of India (Kolkata Circle), National Library, Kolkata Department of Forest, Botanical Survey of India, Indian National Trust for Art and Cultural Heritage- Kolkata Chapter (INTACH-KC), National Research Laboratory for Conservation of Cultural Property (NRLC), Lucknow, West Bengal Pollution Control Board, West Bengal Biodiversity Board, Kolkata, Salarjung Museum Library, Hyderabad, have been undertaken for supplementing the primary data.

3.3. Research Design

A step-by-step overview of the method of study undertaken is:
Field study and survey of both natural and cultural heritage sites. This includes both Baseline survey and Comprehensive survey of the existing biodiversity in and around the heritage sites. *(Plate: 4a-e)*

For Victoria Memorial Hall, survey of the flora, fauna, the four water bodies and soil pattern has been conducted.

For the Bishnupur group of temples, survey has been done in and around the temples as well as few *bandhs* located close to the temples studied.

Sundarbans is one of the largest delta characterized by dense mangrove forest. For Sundarbans area, survey has been undertaken in the Sundarbans Biosphere Reserve which includes the National Park. It includes both terrestrial and aquatic flora and fauna.

**Details of Field Study:**

1. Study of morphology, habit, habitat of the biocomponents affecting the heritage sites in details.
2. Studies have been conducted covering the 4 dominant seasons of the year, viz. Winter (Dec.-Feb), Summer (Mar.-May), Monsoon (Jun.-Aug.), and Post-Monsoon (Sep.-Nov.).
3. Collection, identification and laboratory analysis of selected specimens.
4. Identification of factors responsible for bringing about deterioration of the monument as well as the surrounding biodiversity as a whole.
5. Formulation of strategies for improving biodiversity status.
6. Analyzing and suggesting effective measures for preventive conservation.

**3.4. Methodology Carried Out For Field Surveys**

During the survey work, the researcher has studied the morphology, habit, habitat of the biocomponents affecting the heritage sites in details as well as those that help in preservation of the heritage sites.
Ground work has been undertaken through literature reviews. The different abiotic and biotic components that probably affect a site have firstly been identified.

Field survey has been carried out to identify which particular components exists in that particular site. Total Documentation of those biotic and abiotic components of the surrounding garden has been undertaken.

3.4.1. Non-Analytical Study Of Heritage Sites Through Datasheets

Format of Datasheet:

Datasheets have been prepared for each and every site selected for the study. It includes historical description of each of the sites, objective of site inspection, location, construction material (for cultural heritage properties), surrounding biodiversity status, damage and deterioration of the surrounding biota and their causes, etc. Intensive detailed photography has been done highlighting the biodiversity pattern, monument architecture, visible damages to the structure as well as surrounding environment.

Initial survey of all the sites has been made with the help of these datasheets where the information have been filled up after proper inspection of the sites. (Survey Sheets 1-3)

3.4.2. Analytical Study: Sample Collection And Sample Analysis

- **Samples From Victoria Memorial Hall, Kolkata –**

  I. **Leaf:**
  - **Collection and Preparation:**
    A) Preparation of a List enlisting names of Trees/shrubs concerned with preservation of the Heritage Site with reference to Victoria Memorial Hall, Kolkata. The List has been prepared with the help of various literatures, including the List of Plants suggested for Green Belt Development by Central Pollution Control Board (CPCB) (1999-2000) and those
suggested by National Environmental Engineering Research Institute (NEERI) as a part of their Survey in the year 2007\(^2\) and in 2013\(^3\).

B) Identifying the existence of those trees/shrubs in different directions of the Garden, i.e. North, South, East or West.

C) Collection of leaf samples from each tree species from different directions at different heights, i.e., 5 ft, 10 ft and 15 ft.

D) Leaf area was calculated by the Graph paper method. Leaves were traced out on mm graph paper and then their total area was determined.

E) Leaves were placed inside Zipper bags. Labels were attached on the bags and taken for identification of particulates using SEM in Technology Campus, Calcutta University. (Plate: 5a-c)

- **Analysis:**
  - **Using SEM images**
    For each and every leaf at the three heights, i.e., 5 ft, 10 ft and 15 ft, SEM microimages were taken for the zones in two different magnifications- 100X and 500X.
    - Leaf tip
    - Middle of leaf across midrib
    - Lower portion of leaf

    The dust particles of various sizes have been located and photographs have been taken. Measurements have been taken for the smallest and the largest particle at different zones of the leaf.

    For larger leaves, pieces were scrapped out from different zones - tip, middle and lower part and analyzed.

  - **Using SEM-EDX:**
    The leaves showing greatest amount of particulates were analyzed with the help of SEM-EDX technique for identification of the various elements present.
Method:

1. Dried leaf samples were taken to the SEM-EDX Laboratory of Centre for Nanoscience & Nanotechnology at Jadavpur University.
2. The Samples were cut into small pieces and mounted on their lower surfaces onto aluminium 10-mm diameter SEM stubs.
3. The specimens were coated with a thin conductive film of palladium in an ion sputter coater (Hitachi E-1010).
4. Coated specimens were examined and photographed under a scanning electron microscope (Hitachi S-3400N) at an accelerating voltage of 15 kV. The stubs were loaded into a JEOL 5900LV SEM with an Oxford Instruments INCA analysis system. Preliminary SEM studies were necessary to establish the optimal operating conditions to obtain images of the leaf surfaces for subsequent image analysis (for the physical characterisation of surface materials) and for elemental analysis.
5. Elemental analysis was done taking the graphical representations through Line scan method. (Plate: 6a-d)

Lichen Collection:

Lichen samples were collected from Trunk of various trees and the samples were kept in zipper bags before sending the samples for identification. (Plate: 7a-b)

II. Water:

- Sample collection: Victoria Memorial Ponds:

The researcher has collected water samples from various water bodies within the Memorial complex. Water was collected from the five different water-bodies inside Victoria Memorial Hall premises. Before pouring the water in the bottles, water temperature and pH have been measured with the help of Alcohol Thermometer and pH indicator paper respectively. The mouths of the bottles were sealed with tape and handed over to West Bengal Pollution Control Board for analysis of various parameters which are: (Plate: 8a-f)
1. Turbidity
2. Conductivity
3. Hardness (as calcium carbonate)
4. Phosphate
5. Nitrate
6. Sulphate
7. Total Suspended Solids (TSS)
8. Total Dissolved Solids (TDS)
9. Total Fixed Solids (TFS)

Analysis was done by West Bengal Pollution Control Board.

III. Soil (Plate: 9a-i)

- **Collection and Preparation:**
  1. Soil samples were collected from different zones of Victoria Memorial Hall considering their variations, in zipper bags.
  2. Soils were subjected to air-drying.
  3. Then each of the samples was crushed to powder form using mortar and pestle.
  4. pH of soil samples were measured using pH indicator paper.

  **Method of measuring ph:**
  4 grams of soil, weighed by pan balance, was dissolved in 20 ml of Distilled water. The solution is stirred and allowed to settle down for a minute. A pH paper is inserted in the solution and the colour change is noted.

  5. The powdered samples were air-dried and examined.

- **Samples from Bishnupur Temple Areas –**

  **I. Leaf Samples:**
  Leaves have been collected from different heights of selected shrubs and trees. SEM analysis has been done in the same way as mentioned above.

  **II. Water Sample:**
  Water samples have been collected from selected *bandhs* which are located close to the temples. Water temperature has been detected through an
alcohol thermometer and pH has been detected by using a pH indicator paper. For rest of parameters as mentioned above, the water samples were collected in sample bottles of 1 litre each and brought to Central Pollution Control Board for further analysis.

**III. Soil Sample:**

Soil was collected from few places and treated as mentioned above. Then they were further analysed.

- **Samples from Sundarbans National Park Area** –
  Literature review has led to gathering of information regarding soil, water samples in the Sundarbans region. The researcher has further visited Sajnekhali Mangrove Interpretation Centre, Bhagabatpur Interpretation centre and other tourist places to analyze the modes of creating awareness on fauna and flora of Sundarbans. Floral samples were collected and Herbaria of twigs of mangroves were prepared for identification from experts. *(Plate: 10a-i)*

**3.5. Comparative Method:**

Comparative studies has been made with some prominent natural and cultural heritage sites within India with special reference to the management strategies in respect to conservation and protection of the respective sites. Various factors responsible for declining or improving biodiversity status of each of the sites under study have been identified subsequently.

The write ups have been supplemented with visual data like photographs, graphs and sketches, etc.

The researcher carried out research analysis and interpretation work with the help of the following Research Laboratories:
Table 3.1: List of Institutes for Research Analysis

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Names of Institutes</th>
<th>Materials Analysed</th>
<th>Type of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Laboratory of Department of Museology, University of Calcutta</td>
<td>Leaf Soil</td>
<td>Dry weight &amp; pH</td>
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<td></td>
<td></td>
<td></td>
<td>Grinding soil &amp; pH</td>
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<td>2.</td>
<td>West Bengal Pollution Control Board, Kolkata</td>
<td>Water samples</td>
<td>Physical &amp; Chemical</td>
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<td></td>
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<td></td>
<td>parameters</td>
</tr>
<tr>
<td>3.</td>
<td>Technology Campus, University of Calcutta, Salt-Lake</td>
<td>Leaf Lichen</td>
<td>Scanning Electron Microscopy</td>
</tr>
<tr>
<td>4.</td>
<td>Centre for Nano-Science &amp; Nano-technology, Jadavpur University, Kolkata</td>
<td>Leaf Lichen Soil</td>
<td>SEM-EDX</td>
</tr>
<tr>
<td>5.</td>
<td>Botanical Survey of India, Kolkata</td>
<td>Lichen</td>
<td>Identification of Genera</td>
</tr>
</tbody>
</table>

REFERENCES:
Plate 4: Field Survey and Recording Observations

4a-b: Survey of Biodiversity Status in Sundarbans

4c: Collection of Lichen

4d: Survey of Temples of Bishnupur

4e: Survey of Herbs
Plate 5: Collection and Preparation of Leaves For Analysis

5a: Leaves from selected species collected from different heights of the tree, placed inside zipper bags and labelled

5b: Labels stating Name, Height and Place of Collection from the Tree

5c: Graphical method of finding Leaf Area
Plate 6: Preparation of Leaves for Analysis Using Scanning Electron Microscopy

6a-b: Removal of leaf tip and a portion from middle of a Leaf

6c: Removal of unwanted matter from cut portion of the Leaf by a blower

6d: SEM Micro-image and EDAX reading of a part of leaf
Plate 7: Procedure of Collection of Lichen for Analysis

7a: Measurements before scrapping out the Lichen from Tree Trunk

7b: Peeled lichen placed inside Zipper bag and labelled before identification
Plate 8: Procedure of Collection of Water Sample

8a: Water body
8b: Collection of water
8c: Pouring collected water in sample bottle
8d: pH of water measured by a pH paper
8e: Measuring temperature of collected water
8f: Sample bottles sealed and labelled before Analysis
Plate 9: Procedure of Collection and Analysis of Soil Samples

9a: Digging of soil
9b: Measuring Soil temperature
9c: Soil placed in zipper bags before drying
9d: Air drying
9e: Soil sample ready for Grinding
9f: Measurement of dry weight of Soil
9g-i: Grinding soil sample and finding out the pH using pH paper
Plate 10: Herbarium Preparation for Identification of Mangroves

10a: Field Press

10b: Pressing the collected specimens

10c: Drying the pressed specimens
10d: Dried specimen

10e: Drying the specimen in a blotting paper

10f: Dried specimen ready for mounting
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10g: Herbarium label

10h: Herbarium sheet

10i: A Complete Herbarium sheet with specimen, label, field tag
SURVEY SHEET:1

Format of Datasheet for Study of Victoria Memorial Hall, Kolkata

1. Name of Monument/Museum:
2. Objective of inspection:
3. Location:
   a) distance from nearby town
   b) Direction of site where located
   c) Latitude/Longitude
   d) Accessibility
4. Description:
   a) Description of monument- structural & material condition
   b) Different phases of construction
   c) Any peculiarities
   d) Environmental context of surroundings
   e) Garden
   f) Materials used in construction
   g) Limit of protection
   h) Encroachment
5. Brief History:
6. Garden history and present status:
   a) Trees
   b) Shrubs
   c) Herbs
   d) Weeds
   e) Cryptogamic growth: algae/fungi/lichen
   f) Moss
7. Surrounding Water bodies:
8. Conservation Problems:
   a) Damages to building & surrounding biota:
   b) Causes of damages, deterioration & decay:
9. General assessment:
   a) Visitor Amenities
   b) Provision of notice boards/Signage
   c) Awareness creation regarding protection of the site as well as surrounding

Prepared and compiled by Ishani Chatterjee, UGC -JRF, Dept. of Museology, C.U.
**SURVEY SHEET: 2**

Format of Survey Sheet for conducting study at Bishnupur Group of Temples

<table>
<thead>
<tr>
<th>Composing material</th>
<th>Terracotta (Present/absent)</th>
<th>Visible alterations</th>
<th>Visible deterioration on important carving</th>
<th>Surrounding cleanliness</th>
<th>Water body</th>
<th>Type of damage to monument</th>
<th>Damage to surrounding biota</th>
<th>Visible traces of human vandalism</th>
<th>Abandoned/worshipped</th>
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</table>
Chapter 3

Garden surrounding the Temples

Trees:

Shrubs:

Herbs:

Hedges:

Prepared and compiled by Ishani Chatterjee, UGC -JRF, Dept. of Museology, C.U.
### SURVEY SHEET:3  Format of Checklist of Flora at Sajnekhali / Suddhanyakhali / Dobanki / Bhagabatpur, Sundarbans

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Local Name</th>
<th>Flower</th>
<th>Fruit</th>
<th>Root type</th>
<th>Associated flora</th>
<th>Associated fauna</th>
<th>Status</th>
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<td>Rhizophora apiculata</td>
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<td>R. mucronata</td>
<td>Garjan/Khamu</td>
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<td>3</td>
<td>Bruguiera gymnorrhiza</td>
<td>Kankra</td>
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<td>4</td>
<td>B. sexangula</td>
<td>Kankra</td>
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<td>B. cylindrica</td>
<td>Bakul kankra</td>
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<td>B. parviflora</td>
<td>Bakul kankra</td>
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<td>7</td>
<td>Ceriops decandra</td>
<td>Jele goran</td>
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<td>Associated flora</td>
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