CHAPTER - 3
MATERIALS AND METHODS

This is a study based on the data collected and analysed as follows.

3.1 Construction of map of the study area:

For construction of map of the study area ‘Arc GIS 9.3’ and ‘ERDAS Imagine 9.1 software’ were employed using the satellite image of ‘IRS P6 LISS IV Mx’ of December, 2013 and Survey of India (SOI) topographical sheets.

3.2 Fish diversity study:

For investigating the fish diversity in the wetland, random sampling of fish from the fish catch of the wetland during two consecutive years 2010 – 2011 and 2011 – 2012 were conducted. Sampling was done twice a month personally to ensure collection of data from all the six fish landing stations of the wetland.

For identification of fish species, specimens of small and moderate fishes falling under minor and intermediate groups were collected and preserved in 10% Formaldehyde solution following the standard preserving technique. For large growing fishes falling under major group, on the spot identification was done and photographs were taken using 12.1 Mega Pixel Sony Cyber Shot Camera.

The identification and confirmation of the species were done consulting taxonomic literatures of Talwar and Jhingran (1991), Jayaram (1999) and Vishwanath et al. (2007, 2014). Species nomenclature was followed by consulting the California Academy of Sciences (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp)
The numerical relative abundance (RA) of fish species was calculated after Lakra *et al.* (2010) with the help of the following formula:

\[
RA = \frac{\text{Numbr of Specimens of particular species}}{\text{Total Number of specimens of all species}} \times 100
\]

The analysis of Diversity Indices was performed using the Past3 (Paleontological Statistics Version 3) statistical software. The software generated the data of diversity indices after Harper (1999) in terms of Dominance index, Simpson’s index, Shannon-wiener index, Margalef index and Evenness index. The formulae employed in generating the values of the Diversity Indices are shown as follows.

**Dominance index:**

The dominance index ranges from ‘0’ to ‘1’ and it shows the level of dominance in a community of a particular habitat.

\[
D = \sum \left( \frac{n_i}{N} \right)^2
\]

Where, \(n_i\) = the number of individuals of taxon ‘i’

and \(N\) = the total number of individuals in the sample

**Simpson index:** Simpson (1949) formulated the index that gives the probability of any two individuals drawn at random from an infinitely large community belonging to different species. The Simpson index is therefore expressed as follows.

\[
D_s = 1 - D \quad \text{or} \quad D_s = 1 - \sum \left( \frac{n_i}{N} \right)^2
\]

**Shannon-Wiener Index:** Shannon and Wiener (1949) independently derived the function which has become known as Shannon index of diversity. Shannon’s index measures both species richness and evenness, or how evenly individuals are distributed.
among species. This indeed assumes that individuals are randomly sampled from an independently large population. The index also assumes that all the species are represented in the sample.

\[
H = - \sum_{i} P_i \ln P_i
\]

Where, \( P_i = \frac{n_i}{N} \) i.e. (the proportion of species ‘i’ in the assemblage)

**Margalef index:** Margalef's index (Margalef, 1958) is used to measure species richness. It is calculated by the following formula,

\[
D = \frac{(S - 1)}{\ln N}
\]

Where, \( S = \) Species number and \( N = \) Number of individuals

**Evenness \( e^{H/S} \):** The Evenness index (Pielou, 1966) measures the relative diversity of an ecosystem. It is calculated from the value of Shannon index. It shows how the fish is evenly distributed among the observed species. Thus higher the value of Shannon index, higher is the Evenness index. Its value ranges from 0 – 1. It is calculated with the help of the following formula,

\[
J' = \frac{H'}{H_{\text{max}}}
\]

Where, \( H' = \) Shannon index

\( H_{\text{max}} = \ln(S) \); here \( \ln = \) Natural log

\( S = \) Number of species.

**The conservational statuses** of the recorded species are ascertained with the help of The IUCN Red List of Threatened Species 2014.3 (www.iucnredlist.org/search) and C.A.M.P. Report (Molur and Walker, 1998).
3.3 Fish production potential:

For the study of fish production, the fish biomass data were collected from the daily catch statistics provided by the auction mahaldar (Head of Auction Market) of all the six landing sites of the wetland during two consecutive years (April 2010 to March 2011 and April 2011 to March 2012). All the landing sites were visited randomly twice a month during the fish landing times (morning 6 AM to 8 AM and afternoon 4 PM). The auction mahaldars were supplied in advance with blank data sheets for daily fish catch data. The fishes were categorised into three groups: Major group, Intermediate group and Minor group as defined below (Goswami et al., 1994) and the data were collected in terms of each such group.

**Major group:** Large growing fishes were considered as Major group.

**Intermediate group:** In adult stage, if the size of the fish was equivalent to pre-juvenile to post juvenile size of large growing fish or Major group fish, it was considered as Intermediate group.

**Minor group:** If the adult was fingerling size of the large growing fish (or even smaller), it was considered as Minor group.

Data obtained from the landing stations (individual study sites of the wetland) were tabulated. Simple percentages were calculated and tabular analyses were done using Microsoft Excel. Statistical analyses were under taken by using Graph Pad Instat (Demo Version) Software wherever found necessary.

The unpaired t – test was conducted between the monthly catch statistics data (in kg) during the two consecutive years to know whether there is any significant difference
between the means of the two samples using the Graph Pad Instat (Demo Version) software.

The seasonal study of fish production was based on four seasons following Dey (1981).

Pre monsoon season: March, April and May.

Monsoon season: June, July and August.

Post monsoon season: September, October and November.

Winter season: December, January and February.

The Commercial value of the recorded fish species were considered in view of food value, ornamental value and other available values. The food value was recorded on the basis of consumer preference, market demand and size-taste-nutrition. The ornamental value of fishes was recorded following Das and Biswas (2008).

The price of the fishes were randomly examined during 2010 -2011 and 2011 – 2012 in landing stations and fish markets through physical observations and their averages were calculated.

3.4 Impact of fish production on the socio-economy:

For investigating the impact of fish production on the socio-economy of the fisher community it was required to enquire the socio-economic status of the target population first. For that purpose, a survey was made targeting 43 fulltime fisher families in two predominantly inhabited villages Kachuarkhas Pt. I and Dharmasala under Dharmasala Gaon Panchayat to interview their family bread earners.
For selecting fulltime fisher WorldFish and FAO (2009) was followed according to which a fulltime fisher receives at least 90 percent of their livelihood from or spends at least 90 percent of their working time on fishing.

Interviews could be made in 40 fulltime fisher families out of the 43 families in the two villages with the help of a pre constructed Interview Schedule (Annexure - I). The schedule was prepared in the line of the ‘Primary Data Sheet’ employed for WFP Project No. 2750.01 (Goswami et al. 1996) with some of the minor modifications to suit the local conditions of space and time along with due consideration of the aim of the present study.

The data were collected under the following broad headings:

3.4.1 Particulars of fisher:

The data of different parameters under this head were tabulated; simple percentages were calculated and graphically represented with the help of Microsoft Excel.

The association between two qualitative attributes, the ‘family type’ and ‘family size’ were statistically analysed using Yule’s Coefficient of Association (Q). The Yule’s Coefficient of Association not only determines the nature of association i.e whether the attributes are positively associated, negatively associated or independent, but also determines the degree or extent to which the two attributes are associated.

For dealing with statistics of attributes the classification of data is done on the basis of presence or absence of particular attribute or characteristic. The coefficient is calculated with the help of the following equation (Gupta, 2012).
Yule’s Coefficient of Association (Q) = \frac{AB \times ab - Ab \times aB}{AB \times ab + Ab \times aB}

Where, A = Family size ≤ 5 numbers.
    a = Family size > 5 numbers.
B = Nuclear family.
b = Extended family.
AB = Nuclear family with family size ≤ 5 numbers.
ab = Extended family with family size > 5 numbers.
Ab = Extended family with family size ≤ 5 numbers.
aB = Nuclear family with family size > 5 numbers.

3.4.2 Particulars of respondents’ household amenities, sanitation condition and social involvement:

The data of all the parameters were tabulated, simple percentages were calculated and graphically represented using Microsoft Excel.

3.4.3 Particulars of household economy:

Data concerning different parameters of household economy were tabulated, simple percentages were calculated and graphically represented using Microsoft Excel.

A Stepwise Multiple Regression analysis was conducted between the dependent variable: ‘Household average saving’ and independent variables: ‘Household average income’ and ‘Family size’ using the statistical software SPSS (Ver. 16.0) to know the probable association between the variables.

A test of significance (z – test) with the null hypothesis (H₀ = ‘there is no significant difference between the two ways of livelihood: the ‘fishing’ and ‘other’’) was
performed. The test evaluates whether the difference between the means of the income data arising out of the two different modes of livelihoods (the ‘fishing’ and ‘other’) is significant or not. The value of ‘z’ was calculated with the help of the following formula.

$$z = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{(\sigma_1)^2}{n_1} + \frac{(\sigma_2)^2}{n_2}}}$$

Where,

$$\bar{x} = \text{Mean of data set -1}$$

$$\bar{y} = \text{Mean of data set -2}$$

$$\sigma_1 = \text{Standard deviation in data set -1}$$

$$\sigma_2 = \text{Standard deviation in data set -2}$$

$$n_1 = \text{Sample in data set -1}$$

$$n_2 = \text{Sample in data set -2}$$

Again to enquire about the probable association between the two attributes viz., ‘the age’ and the ‘occupation’ the test of association with the help of Yule’s Coefficient of Association (Q) is carried out with the help of the equation as mentioned earlier.

$$\text{Yule’s Coefficient of Association (Q)} = \frac{AB \times ab - Ab \times aB}{AB \times ab + Ab \times aB}$$

Where, A = ≥ 35 years.

a = <35 years.

B = Fishing.

b = Other.

AB = Fisher with ≥ 35 years.

ab = Other with <35 years.
Ab = Other with ≥ 35 years.

aB = Fisher with <35 years.

Again the impact of possessing and non possessing of own fishing equipment (Nets / Boat) seperately on the income of the fishers were analysed by adopting the Yules’ Coefficient of Association (Q) evaluating the association between the two attributes viz., Monthly per capita income (< Rs. 3000 and ≥ Rs. 3000) and Fishing equipment (Own and hired).

Yule’s Coefficient of Association (Q) = \( \frac{AB \times ab - Ab \times aB}{AB \times ab + Ab \times aB} \)

Where, A = ≥ Rs. 3000.

a = < Rs. 3000.

B = With own net.

b = With hired net.

AB = Income ≥ Rs. 3000 with own net.

ab = Income < Rs. 3000 with hired net.

Ab = Income ≥ Rs. 3000 with hired net.

aB = Income < Rs. 3000 with own net.

Similarly,

Yule’s Coefficient of Association (Q) = \( \frac{AB \times ab - Ab \times aB}{AB \times ab + Ab \times aB} \)

Where, A = ≥ Rs. 3000.

a = < Rs. 3000.

B = With own boat.

b = With hired boat.

AB = Income ≥ Rs. 3000 with own boat.
\[ ab = \text{Income} < \text{Rs. 3000 with hired boat.} \]
\[ Ab = \text{Income} \geq \text{Rs. 3000 with hired boat.} \]
\[ aB = \text{Income} < \text{Rs. 3000 with own boat.} \]

3.4.4 Particulars of fishing economics:

For evaluating the fishing economics 100 random observations were made to record the data of fish catch from two different fishing nets viz., Encircling nets (Pashil Net and Mushori Net) and Entangling nets (Conventional Fashi Net and Karent Fashi Net) during 2010 – 2011 and 2011 – 2012 to calculate the CPGH of the net types.

The fishing outcome was calculated from the data of fish catch in respect of the net types with due consideration of the prevailing Lessee – Fisher share and Fish sale rate at the landing stations. The data so generated are employed in different statistical analyses described as follows.

Coefficient of Correlation was conducted between the variables (Dependent: ‘Pecuniary share of fisher in Rs.’ and Independent: ‘Fish Catch in kg.’) using the SPSS (Ver.16.0) software to know degree of association between the two variables. The Coefficient of Correlation (r) shows the directional relationship between the two variables. The value of ‘r’ falls within -1 to +1.

Multiple Regression Analyses were undertaken with the help of the SPSS (Ver. 16.0) software. The analysis helps in using several independent variables to make better prediction equation. The Coefficient of Determination \(R^2\), generated in the analysis, represents the percentage of variation in the dependent variable being explained by the independent variables. The Stepwise Multiple Regression Analysis determines the
highest variation caused in dependent variable by the independent variable individually first as well as the variation caused by the independent variables together and jointly.

Stepwise Multiple Regression analysis was undertaken between the variables: Pecuniary share of the fisher in Rs. (Dependent variable), Fish catch in kg (Independent variable – 1) and Average fish sale rate (in Rs.) at the landing station (Independent variable – 2) using the SPSS (Ver. 16.0) software.

To know the role of fish catch composition on the Fisher’s income, a Stepwise Multiple Regression analysis was performed taking ‘Fisher’s Income (in Rs.)’ as Dependent variable and ‘Catch of Major Fish’, ‘Catch of Intermediate Fish’ and ‘Catch of Minor Fish’ in kg as three Independent Variables respectively using SPSS (Ver. 16.0) software.

Curve fit analysis was conducted to generate the regression line in respect of the Dependent variable (Pecuniary share of fisher in Rs.) and Independent variable (Fish catch in kg) using the SPSS (Ver. 16.0) software. Here the dependent variable is ‘Y’ and the independent variable is ‘X’. The Regression equation of ‘Y’ on ‘X’ is expressed as follows.

\[ Y = a + bX \]

Here ‘a’ an ‘b’ are numerical constants. ‘a’ denotes the ‘Y-intercept’ whose value is the point at which the regression line crosses the Y – axis. Again ‘b’ is the ‘slope’ of the line. It represents change in ‘Y’ variable for a unit change in variable ‘X’.
Another curve fit analysis was conducted to generate the regression line in respect of the Dependent variable (Pecuniary share of fisher in Rs.) and Independent variable (Fish sale rate at landing station) using the SPSS (Ver. 16.0) software.

Runs tests were conducted for the above two curve fit analyses to evaluate the linearity of the data in the Regression line using the Graph Pad Instat (Demo Version).

A Regression analysis as well as the Curve fit analysis was conducted taking the ‘Annual per capita fishing income’ as Dependent variable and the ‘Annual fishing days’ as the Independent variable employing the SPSS (Ver. 16.0) software.

3.5 Factors affecting the health of the wetland:

Data have been collected with the help of interviews with the respondents regarding the problems faced by the wetland and the presence / absence of some of the key factors affecting the health of the wetland and subsequently the data so acquired were verified by personal observations.