CHAPTER 3

RESEARCH METHODOLOGY
RESEARCH METHODOLOGY

Research methodology is a detailed action plan or investigation. This chapter narrates the methods and procedures of investigations used during the entire course of study and presented under following heads.

3.1 Research method related to Independent parameter
3.2 Research method related to demography parameter
3.3 Measurement of available water holding capacity measurement
3.4 Selection of the GIS techniques and their measurement

3.1 Research method related to Independent parameter
3.1.1 Location of study
3.1.2 Sample and sampling procedure
3.1.3 Operationalisation of variables and their measurement
3.1.4 Type of data
3.1.5 Instrument used for data collection
3.1.6 Method of data collection
3.1.7 Statistical methods used for analysis

3.1.1 Location of study

Bilaspur district was taken as a locale of the present study. The total geographical area of the district is 8568.85 sq. km. The total population of the district was 19,98,355 as per census 2001. Out of total population the percentage of male and female population were 50.73 and 49.27 respectively. The total literacy percent of the district were 63.68, out of which male literacy (78.98 percent) and female literacy (48.08 percent) are there. The sex ratios of the district were 971 per 1000 male. The forest area of the district was 46.85 percent. The total geographical area of Bilaspur district were 8,56,885 hectare. Out of total population the ST population is 19.87 percent and SC population also 19 percent. Total net sown area is 58.35 percent, out of which double cropped area
is 29.73 percent. Total irrigated area is 34.32 percent and paddy production area is 64.72 percent.

3.1.2 Sample and sampling procedure

3.1.2.1 Selection of blocks: There are ten blocks in Bilaspur district namely Belha, Masturi, Marwahi, Gourella, Kota, Thakatpur, Lormi, Mugali, Pendra, and Pateria. For the study purpose, all blocks were selected for the collection of field-related data for the study.

3.1.2.2 Selection of Village: Two villages selected from each block on the basis of a sizeable number of farmers having distances of 15 kilometers from the block headquarters, as per the random sampling technique. In this way, a total of twenty villages were selected for the study.

3.1.2.3 Selection of respondents: For the study purpose, 10 respondents from each village were selected randomly. Thus, the total respondents from each village is 10 and a total of 20 respondents in each block. The farmer was selected through the help of random number sampling technique. All the selected farmers represented the four categories viz., big, medium, small, and marginal farmers. The entire farmer enlisted as per proportion and then using the random number table for selection of respondents. Through the use of random sampling technique, ten farmers were selected from each village. So in total, twenty villages, two hundred respondents were selected for the study purpose.
3.1.3 Operationalisation of variables and their measurement

3.1.3.1 Independent Variable
Education
Caste
Size of land holding
Irrigation facility
Family income
Location of house
Credit acquire
Extension contact
Type of enterprises
Allocation of time
Training need of respondent
Animal possession
Cropping intensity
Mass media utilization

3.1.3.2 Dependent Variable
Land utilization pattern

Operationalisation of Independent Variable

Education:
The formal education level of respondents was recorded and it was
categorized as under:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>0</td>
</tr>
<tr>
<td>Up to Middle School</td>
<td>1</td>
</tr>
<tr>
<td>Up to High School</td>
<td>2</td>
</tr>
<tr>
<td>Up to Higher Secondary</td>
<td>3</td>
</tr>
<tr>
<td>Up to Graduate/ Post graduate</td>
<td>4</td>
</tr>
</tbody>
</table>
Caste:
The caste of the respondents was categorized as follows:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled Caste/Tribe</td>
<td>1</td>
</tr>
<tr>
<td>Other back ward</td>
<td>2</td>
</tr>
<tr>
<td>General</td>
<td>3</td>
</tr>
</tbody>
</table>

Size of Land holding:
It is operationally define as the actual land holding of the family of respondent at the time of investigation. The categorization of the response was done as follows:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal Framers (Up to 1 ha)</td>
<td>1</td>
</tr>
<tr>
<td>Small Farmer (1.1 to 2 ha)</td>
<td>2</td>
</tr>
<tr>
<td>Medium Farmer (2.1 to 4.0 ha)</td>
<td>3</td>
</tr>
<tr>
<td>Big Farmer (above 4 ha.)</td>
<td>4</td>
</tr>
</tbody>
</table>

Irrigation Facility:
The extent of availability of irrigation resources with the farmers may affect the adoption of different improved agricultural technology and farming practices. The respondent were asked to specify the availability and non – availability of irrigation sources. On the basis of extent of availability of irrigation the respondents were classified as follows:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>0</td>
</tr>
<tr>
<td>Low (up to 25 percent of land)</td>
<td>1</td>
</tr>
<tr>
<td>Medium (up to 25.1 to 50 percent of land)</td>
<td>2</td>
</tr>
<tr>
<td>High (up to 50.1 to 75 percent of land)</td>
<td>3</td>
</tr>
<tr>
<td>Very High (above 75 percent of land)</td>
<td>4</td>
</tr>
</tbody>
</table>
Family Income:

In this study on the basis of classification done by the Government of India, the respondent was categorized according to the income segmentation: Total family income form all the available sources of respondent were calculated and then the respondents were categorized in the following manner:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below poverty line (Up to Rs. 25,000/-)</td>
<td>1</td>
</tr>
<tr>
<td>Low Income Group (Rs. 25,001- Rs. 50,000/-)</td>
<td>2</td>
</tr>
<tr>
<td>Medium Income Group (Rs 50,001/- to Rs 75,000/-)</td>
<td>3</td>
</tr>
<tr>
<td>Higher Income Group (Above Rs. 75,000/-)</td>
<td>4</td>
</tr>
</tbody>
</table>

Location of House:

In this study the respondent were categorized according to the location of house. The location play the important role in acquiring information, create competition between neighbors. According to situation of house the respondent were categorized into three categories in the following manners:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Located in Individual</td>
<td>1</td>
</tr>
<tr>
<td>Located in hamlets /cluster</td>
<td>2</td>
</tr>
<tr>
<td>Located in center of village</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Acquire:

The availability of credit needed to purchase the required input may influence the adoption behavior of farmer. The adoption of improved agricultural technology required more investment of capital in farming to purchase the input like fertilizer, pesticide, improved seeds etc. So a question was asked to each respondent to know the sources from where they get loan and how easily they could get it. The availability of credit identified by the farmers was then measured on a four point scale as follows:
Categories
Nil  0
Short term credit  1
Medium term credit  2
Long term credit  3

Extension Contact:
This is operationally defined as the frequency with which a respondent come in contact with the extension personnel's, agricultural offices, shopkeepers and, big farmer scientist etc with in a specific period of time. On the basis of frequency of contact with the extension personnel's the farmers were categorized as under:

Categories  Score
Nil contact  0
Low level contact  1
Medium level contact  2
High level contact  3

Type of Enterprises:
It refers to combined influence of level of two or more enterprises on family income, occupation, farm power and socio-economic status of the respondents. It was measured on the basis of enterprises adopted by respondent. The respondent were categorized into three categories, which are:

Categories  Score
One enterprises  1
Two or three enterprises  2
More than three enterprises  3

Allocation of Time in Agricultural:
The allocation of time in agricultural, as one enterprises are directly, affect the extent of adoption of improved agricultural technology. The respondent was
asked to specify the time allocation to agriculture and other adopted enterprises. On the basis of extent of time allocation to agricultural the respondent were categorized as follows:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 25 percent occupational time</td>
<td>1</td>
</tr>
<tr>
<td>In between 25 to 50 percent occupational time</td>
<td>2</td>
</tr>
<tr>
<td>More than 50 percent occupational time</td>
<td>3</td>
</tr>
</tbody>
</table>

Training Need of Respondents:

Training plays the important role in adoption of innovative technology in the occupational sector as well as in the socio economic status of farmer. The education level of farmer may also affect the training need. According to need perception of farmers related to operation and use of innovative technology the respondent were categorized into three categories in the following manners:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>0</td>
</tr>
<tr>
<td>Less</td>
<td>1</td>
</tr>
<tr>
<td>Some extent</td>
<td>2</td>
</tr>
<tr>
<td>More extent</td>
<td>3</td>
</tr>
</tbody>
</table>

Animal Possession:

Dairy keeping is the most common enterprises between the farmers because it is related with the agriculture. The waste product of dairy animal is completely used in the farming. Increasing the rate of industrialization, affect the labour and animal population. The non availability of fodder and less production of crops is increasing the problem food availability for animals. The agricultural draught animal of the area is reducing day by day in developing state of India. But it increases the cost of production of small and marginal farmers. So as per the animal possession by the respondents were categorized into three categories:
Categories
Nil
One to two cattle
Three to six cattle
Six or more

Score
0
1
2
3

Cropping Intensity:

This independent variable directly related with the crop production and
cropping pattern follows by the farmers. The extent of cropping intensity were
calculated through following procedure:

Total cropped area in a year
Cropping Intensity = -------------------------- X 100
Net sown area

Through the using of the formula the respondent were categorized into
three categories –

Categories
Nil
Less
Some extent
More extent

Score
0
1
2
3

Mass media utilization

Sources credibility refers that makes people believe or trust them of
information regarding innovative technology. Scoring was done on the three
point continuum i.e. low, more and very more. Thus total score for each individual
respondent was calculated and this was considered as individual sources of
information score. The respondent were categorized with the help of mean (X) and SD. The categories are as follows:-

<table>
<thead>
<tr>
<th>Categories</th>
<th>Range</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>(&lt;(X-SD))</td>
<td>1</td>
</tr>
<tr>
<td>More</td>
<td>((X+SD))</td>
<td>2</td>
</tr>
<tr>
<td>Very more</td>
<td>(&gt;(X+SD))</td>
<td>3</td>
</tr>
</tbody>
</table>

Dependent variable:

Land Utilization Pattern:

It has been operationally defined as the position of individual respondents occupies with reference to the prevailing average standard of utilization pattern of their land. The respondent was categorized on the basis of their two year pattern of land utilization, previous utilization method, thinking about land utilization pattern are incorporated for development of scale for land utilization pattern. Thus total score for each individual respondent was calculated and this was considered as individual land utilization pattern score. The respondent were categorized with the help of mean (X) and SD. The categories are as follows:-

Out of total score, the farmers were categorized into three point scale.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Score range</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper class</td>
<td>33-40</td>
<td>5</td>
</tr>
<tr>
<td>Upper middle class</td>
<td>26-32</td>
<td>4</td>
</tr>
<tr>
<td>Middle class</td>
<td>19-25</td>
<td>3</td>
</tr>
<tr>
<td>Lower middle class</td>
<td>12-18</td>
<td>2</td>
</tr>
<tr>
<td>Lower class</td>
<td>less than 11</td>
<td>1</td>
</tr>
</tbody>
</table>
3.1.4 Type of Data

The following type of data was obtained from the respondent keeping in view the objective of the study.

1. Data pertaining to socio-personal, namely Education, Caste, Family Income, Location of house, Crop and cropping pattern, Cropping intensity, Size of land holding, Irrigation facility and sources credibility were obtained from the respondents as primary data.

2. Data regarding to the land utilization patterns abetted from primary sources.

3. Data pertaining in the change in land utilization pattern, experienced by respondents during crop production.

4. Data regarding to the respondents suggestion for development of new strategies for better use of land.

5 Some secondary data were also collected from the tehsil, district and state headquarter of different organization.

3.1.5 Instrument Used for Data Collection

Keeping in view the objective and variables of the study, a structured interview schedule was developed, by reviewing the journal, text books, previous research works and consulting the professional workers. Simultaneously, the instruments developed by the other research workers and used for this investigation, were carefully examined and discussed. An interview schedule consisting of various types of question related to the objectives of the study was, therefore developed. Initially the schedule was developed in English and was than translated to local language in Hindi.

To facilitate the respondents the interview schedule was discussed with expert before testing the interview schedules, pre testing of schedule was carried out in the non sample area and necessary corrections were made.
3.1.6 Reliability:

Reliability of an interview schedule refers to its consistency or stability in obtaining information from the respondents. The test - retest method of estimating reliability of an interview schedule was followed in this study. Ten respondents of each tehsil Kota, Pendra, Lormi, Belha and Masturi, were selected randomly through using random number table. The entire selected respondent interviewed personally and record all the information in the prepared questionnaire. After 15 days using the same questionnaire and again interviewed as procedure as followed at the first time of interview schedule was ensured.

3.1.6.1 Validity:

Validity refers to "the degree to which the data collection instrument measure what it is suppose to measure rather than something else". The validity of interview schedule used for the study was maximized, the following steps enumerated as:

1. The interview schedule was thoroughly discussed with the scientists and their suggestions were incorporated.
2. Pre testing of interview schedule provided an additional check for improving the instruments.
3. The relevance of each question in terms of objectives of the study, their logical order and wording of each question was checked carefully.

3.1.6.2 Method of Field Data Collection:

Respondent were interviewed through personal interview technique, prior to interview, the respondents were taken into confidence by revealing the actual purpose of the study and also full care was taken to develop a good rapport with them.
3.1.7 Statistical method are used in the analysis of the field data:

The data collected during the courses of investigation were tabulated in the coding sheets and then appropriate analysis of data was made according to the objective. The statistical applied were percentage, frequency, mean, SD, coefficient of correlation and regression etc. The analysis was carried out with the help of statistician.

3.1.7.1 Tabular analysis:

For comparison and interpretation of various aspects for assessing the extent of knowledge, skill, adoption, and constraints responsible for technological skill gap, tabular analysis was used.

3.1.7.2 Percentage:

This was used for making simple comparison. To calculate the percentage, the frequency of a particular cell was multiplied by 100 and divided by the total number of respondents in that particular category.

3.1.7.3 Mean:

The simplest and most important measures used in the present study were arithmetic and weighted means. The formula used to estimate these averages were as under:

\[
\text{Arithmetic average} = \frac{\sum X}{N}
\]

Where, 

\(X = \text{Variable score}\)

\(N = \text{Number of observation}\)
3.1.7.4 **Standard Deviation:**

Standard Deviation is the most commonly used indicator of the degree of dispersion and is the most dependable source of estimation of the variability in the population from which the samples are drawn. The formula used was:

\[ \text{S.D. of } \sigma = \sqrt{\frac{\sum fd^2}{n} - \left(\frac{\sum fd}{n}\right)^2} \times i \]

Where,

- **S.D. or } \sigma** = Standard deviation
- **i** = Size of class interval
- **\Sigma** = Summation
- **f** = Frequency
- **d** = Deviation from coded value
- **n** = Number of sample

3.1.7.5 **Person's Product moment Correlation:**

This measure was used to find out the relationship between the land utilization patterns by varying categories of farmers. Coefficient of correlation's were also found out between the independent and dependent variable (land utilization pattern). The formula used for calculating correlation coefficient values was as below:

\[ r = \frac{N \Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{(N \Sigma X^2 - (\Sigma X)^2)(N \Sigma Y^2 - (\Sigma Y)^2)}} \]

coefficient. Thus, the score for each skill was found out and summed up to get total scores of farmers towards knowledge, skill and adoption. Since the maximum score on knowledge, skill and adoption obtained by a respondent
could be 200, the overall knowledge, skill and adoption scores were divided into three categories. According to obtained score and S.D. was calculated.

3.2 Selection of demography parameter:

In the study of population distribution it is necessary to identify the factors which determine the way in which it is distributed within an areas or a region. These factors provide the necessary explanation for particular patterns of population and are generally grouped into three categories. (A) Geographical factors (B) Socioeconomic factors and (C) Demographic factors. More or less these factors are affecting the distribution of population of the district.

(A) Geographic factors:

Physical conditions such as climate, land forms in terms of altitude, the quality of soil, mineral resources are the important factors. In the high altitude and the hilly areas are sparsely populated of the district because of physical conditions. The climate also affect the distribution of population, the northern part areas is sparsely populated. On the other part of the district where physical conditions are suitable due to fertile soil and suitable climate are thickly populated.

(B) Socio-economics factors:

The social and economic factors affecting population distribution are (i) the type of economic activity (ii) type of technology employed and (iii) social policy.

(i) The economic activity:

In the rural areas of the district, most of the people support themselves through agriculture and other activities on surrounding land. On the other hand, in urban areas, people depend upon services of government, non-government sectors, business, finance, trading, manufacturing, retail trade etc. but not depends on land for their subsistence. The economic activity of urban areas is different from rural areas.
(ii) Type of technology:

When the government takes any step to set up any industry it has influenced on population distribution such examples is N.T.P.C. at Seepat and SECL at Bilaspur etc.

(iii) Demographic factors:

Though demographic variables like fertility, mortality and migration are themselves determined by social, economical and geographic factors it is possible to consider them in the light of their influence on population distribution. There are total 37 demographic parameter, out of these 6 parameter such as literacy, agricultural labour, cultivator, ST/SC/OBC population, land size and herd size will be selected purposely.

3.3 Measurement of available water holding capacity measurement:

The available water refers to the amount of moisture that can be easily absorbed by the plant from the soil for its optimum vegetative growth. In general, it is considered as the amount of water is held by the soil between field capacity (FC = 33 kPa) and permanent wilting point (PWP = 1500 kPa), and is expressed as the available water capacity (AWC) of soils.

The amount of water held depends upon the porosity and pores size distribution and the capillary pressure of the water in the soil. The force by which the water is held by the soil (soil water suction/tension) is the force that the plant roots have to overcome for extracting water retained by soil. It is expressed in the unit of pressure. Earlier, it was generally expressed in bars (or atmospheres) but is now expressed in Pascals (Pa). The relationship between the various units i.e. as follows (HBA-2006):

\[
\begin{align*}
1 \text{ bar} &= 1020 \text{ cm of water column}^* \\
1 \text{ atm} &= 1,030 \text{ cm of water column} \\
1 \text{ bar} &= 105 (\text{power}) \text{ Pa} = 100 \text{kPa} = 0.1 \text{ MPa} \\
* \text{Pressure exerted by a column of water 1,020 cm high.}
\end{align*}
\]
Conventionally, the soil-water potential is expressed in terms of hydraulic head, i.e., soil water potential is expressed in terms of height of water column. For example, if the soil water tension is 1 bar (soil water potential of 1 – bar), in terms of water column height it will be 1000 cm or 10 bar would be 10000 cm. Since these are fairly large numbers and holding such numbers is cumbersome, use of ‘pF’ was suggested, which was defined as the logarithm of negative pressure (tension or suction) head expressed in centimeter of water column. A tension head of 10 cm of water would be pF of 1, tension head of 1000 cm would be ‘pF’ of 3.

3.3.1 Field capacity (FC):

The amount of water retained after gravity drainage has been ceased off in saturated soils is called FC. At FC the soils remain moist at a tension of k Pa. The value of the FC varies from soil to soil. In black soils, the moisture at FC is held at about 1 kPa tension.

3.3.2 Permanent wilting point (PWP)

Removal of water from the soil by plant roots causes the water film that surrounds the soil particles to become progressively thinner and thinner, and the most of the water content in the edges between the soil particles get disappear. The micro pores whose capillary tension is high hold the remaining water molecules more tenaciously. Finally the condition is reached where the water is held so tightly by the soil particles that the roots cannot extract the sufficient water for meeting the physiological demand. When this condition is reached, the soil is stated to have reached at permanent wilting point (PWP). At this point soils retain moisture under a tension of about 1500 kPa. In black soil, the wilting point is reached at about 800 to 1000 kPa tension. The available water capacity depends on the soil texture and mineralogy.
3.4 Selection of the GIS technique and their measurement

Several remote sensing and GIS techniques have been employed for the completion of present work using software like ERDAS 8.6, and ARC GIS. In the present study both spatial as well as collateral data have been used. The spatial data consist SOI toposheet and satellite imagery. Before processing, spatial data are georeferenced then image registration is performed with reference to geo referenced data. After registration and georeferencing the toposheet act as a raw data for digitalization of forest boundary and then the projection is converted into polyconic. Similarly the satellite image is used for mapping of the forest types. Forest areas were studied through various digital image processing techniques to obtain valuable information related to study and also to identify the classes and features. The techniques used are PCA, IHS, NDVI, classification.

Now by combining both toposheet and satellite processed image, digital base map is created which consist several layers. A layer provides means of further information and spatial analysis.

Collateral data consist of census data contour data and block data. Primary analyses of these data were performed. Now linkages of statistical and digital data base has been done for visualization of data in spatial domain.

The methodology flow chart depicting various processes used in the work is given below:
Figure 1: Methodology flow chart depicting various processes used in the work.
3.4.1 Monitoring of changes in land use/land cover using multi-sensor satellite data:

Raster module of ERDAS Imagine software has been used for on-screen digitization and to obtain the boundary of study area from the map of Chhattisgarh state. By using this as raster mask, LISS-III imageries of the study area have been extracted.

3.4.2 Preparation of Multi-date Land Use/Land Cover Maps:

For monitoring the change in the pattern of land utilization, preparation of multi-date land use/land cover maps are necessary. These maps are also required for ensuring planned development of any region. After the registration of digital images of the Bilaspur city, the field samples for each land use and land cover class are collected from LISS-III imageries. Limited field visits have been undertaken for collecting the field samples. The various land use/land cover classes selected include built-up, agriculture, sand, water, scrub and open/barren land. The multi-spectral classification was carried out using supervised classification techniques with maximum likelihood classifier. The overall accuracy of the classification is finally obtained through the computation of confusion matrix to assess the reliability of the prepared maps.

3.4.3 Digital Image Processing:

The remotely sensed data from the satellites are analysed for extracting information on surface feature and deducing their properties or for identifying objects on the earth based on the observation made on the reflected/scattered energy from the earth in different spectral bands.

Prior to data analysis initial processing on the raw data is carried out to calibrate the image radiometry and correct the geometric distortions. The data is available in a standardized format, each with different levels of processing and location accuracies, either in the form of hard copy photographic prints/diapositives or in the digital form. The photographic products are available
in the form of black and white or colour transparencies / print at different scales. The digital data is available in the form of computer tapes, cartridges of floppy diskettes.

The format of data in the digital form on CCTs differs from sensor to sensor. It also depends on the standards adoption by the agency or receiving station supplying the data. The digital data are normally stored in one of the following three formats (1) Band Interleaved by pixel (VIP) in which data for each pixel element in all the bands is return squintly. (2) Band interleaved by line (BIL) where the data for all the bands are return line by line and (3) Band sequential (BSQ) where all the data for each band is return as one file and stored squintly. In order to standardize the CCT format for the present generation satellite, a new format termed as super structure format is being used universal.

Identification of object and their classification visually from the hard copy. Photographic print based on the image characteristics such as shape, size, tone, texture, shadow and aspect is commonly known as visual interpretation. Digital image processing involves the manipulation and interpretation of image obtained in the digital form with the add of computer. The digital data can be treated with various algorithm for enhancing the ground feature for better interpretability and analysis. Initial understanding of the image data is obtained by displaying the satellite data on the interactive display monitor, either by generating a the band colour composition called as facts colour composite (FCC) or displaying each spectral band data in black and white.

Alternatively the single band data can be viewed in pseudocolour by colour slicing of the image data with respect to intensity values. Various processing techniques are available for image analysis. Viz radiometric geometric correction, data presentation and compression image enhancement for presentation of results.

3.4.4 Digital Image Analysis:

The computer system commonly referred to as Digital Image Processing System comprises hardware and software element which help the analyst in
extracting meaningful information from the data. The basic of system component include input devices. These systems are capable of processing large volumes of data at a very fast rate. The speed of operation of paramount importance in digital image processing as some of the image analysis techniques likes classification rectification, spatial filtering etc are highly computation bound. A vital device which an analyst / investigator utilize for interaction with the computer system is an interactive device called the display system. Normally a colour scrolling display system with a capability to zoom shrink and pan is provided.

The display area could be either 512 pixel X 512 pixel scan lines, 1024 pixel X 1024 pixel lines or even more in the case of higher resolution display system. The state of art display system are microprocessor controlled and provide a wide range of image analysis capabilities at increased speed. This system can be used as slandered image processing system or connected to the main computer system as a powerful workstation for image analysis.

Finally the analyzed output is required to be stored or depicted in a form which aids further analysis for the user. Out put can be either(1) computer compatibility tapes /cartridges, grey scale maps on line printer or colour plotter output, photograph of colour TV displays or (2) high precision film output/ imagery. Various levels of digital Image Processing system are available.

3.4.5 Liner Contrast Stretching

Liner contrast stretching increase the original input brightness values to the total range of the output devices. The analyst examines the image histogram and determines the minimum and maximum brightness values in the image which helps in generating and appropriate output image using the equation for linear stretching (Jenson 2004).

Piece wise linear contrast stretching is a special case of the above mentioned technique which is useful in stretching the data having multimodal histogram. A typical example can be an image data having three major types of terrain classes like ocean, urban area, desert and thick vegetation patches. In
such cases, a simple liner stretching of the data may enhance some features but saturate and degrades some other.

Histogram equalization, nonlinear contrast enhancement technique is a most commonly used technique. This is implemented by redistributing the image pixel values in to output dynamic range (9-255) such that the frequency of occurrence of grey value range is almost the same throughout the dynamic range. Histogram equalization applies the greatest enhancement to the most population range of the brightness values in the image (Jenson 2004).

3.4.6 Edge Enhancement

For many earth sciences applications, it is important that the land structure should be highlighted. Tropical geometrically shaped edges are of great interest in geo-scientific application. The edge enhancement in one such operation, which help the analyst in achieving edge highlighted image. The edge enhancement operation delineates the edges and thereby makes the shapes and details comprising the image more conspicuous and perhaps easier to analyse (Jenson 2004). Edge can be enhanced using linear or non-linear techniques. A simply typical linear edge enhancement technique is the running difference method. That is by convolving the original data with a weighted mask or window. The window size can be selected by taking into consideration the surface roughness and sun angle characteristics at the time of data collection. Depending on the size of the window chosen (3 X3, 5 X 5, or 7X7 etc) various coefficient can be placed in it to convulse with the data to highlight surface structure especially for earth sciences studies.

Non liner edge enhancement is performed using nonlinear combination of pixel. Sobel edge operator, Robert edge detector and Kirsch non linear edge enhancement are the widely used operators. Robert sedge operator works on a 2 X2 window. It is computed in two diagonal directions to highlight the edge s in both directions. Sobel and Kirsch nonlinear edge enhancement work on a 3 x 3 window by calculating the gradient for the middle pixel location of every moving
window. Kirsch operator computer the maximal compass gradients magnitude about input image point (Jenson 2004).

In general, it has been observed that 3 x 3 filters do not produce shift in pixel because of the computation being effected to the middle pixel of the window. The edge boundaries produced by the larger window are not as sharp as those produced by the 2 x 2 windows.

3.4.7 Spatial Filtering

Spatial filtering is yet another method by which the image contrast can be improved this also work on a pixel –by pixel transformation of image data. The transformation not only depends on the grey level of the pixel being processed, but also the neighbor pixels. Spatial filtering as a context dependent operation that alters the grey level of the pixel being processed but also the neighborhood pixels. Spatial filtering is a context dependent operation that alters the grey level of a pixel according to its relationship with grey levels of other pixels in the immediate vicinity. A characteristic of randomly sensed images is a parameter called spatial frequency defined as the number of changes in brightness values per unit distance for any particular part of an image (Jenson 2004). In the changes in brightness values over the area are smaller in number then it is a low frequency area. On the other hand, if drastic changes occur in brightness values over a very short distance, it is known as a high frequency area. Low pass filtering produce the grey level range while a high pass filter enhances the image details and changes the original radiometry drastically.

Typical example of low filter can be mean and median filter. In both the cases, the window move the entire image by either calculating average or median value of the filter window respectively. This nullifies, the average or median value of the filter window. Respectively, this null fillies the effect of high frequency noise present in input image and produce a smooth image plate 3 show the use of low pass filter (Mean and Median filter). High pass filtering produces image which retain few frequently changing component and retain only the high frequency location variation (Jenson 2004). Typical high pass filter which
produce sharp image with linear future and edges highlighted are essentially convolution techniques (Laplacain filters).

Fast Fourier Transforms (FFT) is also using in processing digital data. The manor use of the Fourier transforms in remote sensing is in frequency domain filtering. There is wide application of this technique like characterization of a particular terrain type measure of heterogeneity in the neighborhood, clear-cut analysis of low frequency component (gradually changing features). Appropriate filter can be used for noise removal of improving quality of data using FFT techniques.

3.4.8 Image Manipulation

The manipulation techniques enable us to do certain transformation to generate images of great importance and useful information. The basic arithmetic operators, like addition, subtraction, multiplication and rationing are of great use in image processing. Additional and subtraction of images are particularly useful in change detection studies. Cultural features extracted from the topographic maps will have to be added into the thematic map for geo referencing of the final output.

3.4.9 Vegetation index image generation

The most commonly used techniques by vegetation scientists are computation of ration images using data in infrared and visible bands of the electromagnetic spectrum. Taking advantages of spectral behavior of vegetation in the 1 R and visible regions very good correlation has been derived which gives a clear indication of the photosynthetic activity and vigor in green biomass. Spectral responses characteristics of healthy vegetation, dead or senescent vegetation and dry soil can easily be characterized in the different parts of the electromagnetic spectrum. Healthy vegetation reflects 40 to 50 percent of the incident NIR (0.7 to 1.1mm) energy with the chlorophyll absorption being 80 to 90 percent of the incident energy in this visible band (0.4 to 0.7mm) (Jenson 2004). The first successful vegetation index images based on band rationing
Difference over the sum of IR and VIS was called normalized difference vegetation index (NDVI) which can be expressed as . Segmentation of NDVI images aids in differentiation forest cover density and helps in understanding and interpreting health of the green biomass. A lot of work has been done round the globe in the fields of agriculture and forestry using this technique on RS data from various satellites. Plate 5 shows the generation of NDVI image using IR and VIS channels.

3.4.10 Other Indices

Tasselled cap (Kauth–Thomas) transformation is another transformation which helps in deriving brightness greenness yellowness and no such indices using multi-spectral data of Land sat. These images are derived using linear band combination of already deserved coefficients and input band data. The justification for this operation is that the areas will provide a consistent, physically based coordinate system for interpretation of images of an agricultural area obtained at different stages of the growth cycle of the crop.

3.4.11 Decorrelation Techniques

Multi spectral digital data normally exhibit with degree of correlation among some spectral channels. Due to this reason separation of certain features, while working with color composites, become extremely difficult. And band of contrast stretching of the data will not be able to produce an improved result as the data tend to concentrate along the diagonally the three dimensional axis. Hence to improve the interpretability and data quality, it is required to reduce the correlation between the spectral channels so that the data gets spread in the three dimensional axis to all the corners. The operations involved in achieving the aforesaid end results are collectively known as decorrelation techniques. Principal Component Analysis and Hue, Saturation, Intensity (HIS) transformation are some of the commonly used tools of the decorrelation techniques.
3.4.12 Principal Component Analysis (PCA)

This most widely used and popular technique among the digital image enhancement techniques. The technique is nothing but deriving eigen values and associated eigen vector and using in linear combination with original data to produce PCA output. The ultimate effect to the coordinate system with respect of the original system PCA factor or Karhunen-Loeve analysis has proven to be of significant value in the analysis of remote sensed digital data (Jenson, 2004). PCA image often result in better interpretable images compared to the original data and it is also used as a data compression technique. For example, if four multi spectral bands are used in input to derive PCA images then the first PCA (PCI) contains maximum information completed from all spectral channels, and the rest will have lesser information in decreasing order. The technique allows reducing correlation between PCs, and increasing variance with in each spectral channel which is directly proportional to information content in the image. Plate 6 shows the principal components generated using multi spectral input data.

3.4.13 HIS Technique

This is yet another decorrelation technique which works in a three dimensional axis to produce an output which has similar characteristics as a PC image. The Red, Green, Blue (RGB) input can be manipulated by a three dimensional transformation to obtain. Saturation the degree of in colour and intensity-the brightness of dullness of colures. This enhancement is particularly useful in deriving better perceptible and interpretable images. HIS image after stretching can be transformed back to RGD space to work in the normal color composite mode for better differentiation of objects.

3.4.14 Geometric Rectification

Remotely sensed data cannot be used directly for resource information due to inherent distortions in the image data. Some of the basic correction is generally carried out. For the final use of the image data it is necessary to correct the image data with respect of the map. The transformation of a remotely sensed
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spectral signatures by using various kinds of clustering techniques (grouping of homogenous pixels into a unique group). Decision rules are then applied based on available ground information or otherwise using the spectral statistics generation after clustering on the image to derive a classified map. This will generally need a post-classification verification.

3.4.16 Supervised Classification

Multi spectral classification is an automatic decision making process based on a priori probabilities derived from training set data. Training set data is nothing but ground truth information delineated on the digital image. Spectral statistics are computed for all the specified classes which will in turn help in deriving probabilities depending on the classification algorithm. Pixel-by-pixel assignment into one of the many specified classes is performed using the decision rules with respect to the classification algorithm (Lillesand and Kefter, 1979). Maximum likelihood classification deals with classification the data pixel by pixel, based on a priori probability, with respect to maximum- probability rule. A reflect threshold is set whereby pixels which do not qualify for any of the defined classes are grouped as reflect class.

3.4.17 Accuracy Assessment

Accuracy assessment is a must for any classified output. Accuracy assessment has to be done at two stages, (1) training set data and (2) final classified maps. Training set data is evaluated by computing confusion matrix divergence and ellipsoidal plotting. Final classification is evaluated by selecting random samples all over the image followed by post – classification ground verification. This helps in accuracy evaluation of the classification results.

3.4.18 Data Integration

The image processing software and hardware in general provide a most conducive environment for manipulating spatial data in general. In order to achieve more effective information extraction from the remotely sensed data it
has been found necessary to combine spatial data acquired from various other sources with additional environmental data sets. One such tool for realization of the above is the Geographic Information System (GIS). GIS facilitates integration of data from various sources, such as maps, aerial photographs, satellite images, socio-economic data and other tabular statements into a format that allows the data to be compared and interrelated for extraction of information to make decisions about the real world.

Essential features of any GIS could be categorized into (1) Data Acquisition/Encoding, (ii) Data storage (iii) Data manipulation, (iv) Data retrieval and (5) Data presentation. All the geographic data that is stored in the GIS will have both location (x y) and non-location (attribute) characteristics. There are four fundamental types of geographic data to be stored in a GIS point. Lines, polygons, surfaces and attribute data in additional, attributes at the location can be monitored over time, these data can be stored either in from of Cartesian coordinates (vector coding) or in a grid format (raster coding). Data can be digitized/encode using either manual digitizers or automatic scanners. GIS data on various themes (geology, soil and use etc) is synthesized in different layers. Each GIS layer is stored as a geographically referenced plane in the GIS data base. The data base can contain any type of information that is spatially distributed, ranging from socio-economic, climatologically to fundamental biophysical variables. A number of manipulation and analysis function can be performed on these layers, viz. map overlay, map dissolve polygon overlay for area calculation, proximity searches, etc. The output from GIS operations may be a spatial distribution of important thematic information on a line plotter, display on the graphics terminal or a listing of statistics. It is also possible to use know relationship across different layers in conduction with attributes data to model geographically the outcome of a set of condition. A number of GIS packages are available commercially on different computer platforms.
3.4.19 Digital Analysis

The techniques of image processing so far discussed deal with deriving end result in the form of classified maps and enhance image and associated statistics which can be correlated with available conventionally generated thematic maps. There are many procedures in satellite image processing which have already been automated, especially under pattern recognition techniques. However, effort are in progress to find new technique which consume lesser amount of time, do better integration of data from various sources have better automation capabilities and are simple to use. Some of the technique which has made a big impact in the present day data processing is:-

- Expert System / Artificial Intelligence
- Contextual Classification

The spectral classification of remotely sensed data in the parametric approach depends more on the spectral statistics and related signatures. The spectral knowledge is alimenting factor with respect to the given image. Generation of scene independent spectral knowledge is a critical element in the development of Expert system. Expert system generally require knowledge base, a rules interpreter (or rule base) and a working memory. The spectral knowledge based computer systems are designed to avoid the need for scanned based parameter optimization. It is classification decisions, based on the knowledge of spectral relationships which and between the classes to be categories, given that the relationship are stable over a period of a time. There are many example about the use of expert systems in remote sensing context based classification algorithms are gaining momentum in the present day image processing. Contextual classification is mainly based on categorization of the image data with respect to the context of the particular pixel in consideration. The rules that are used to accept or reject the classification decision at a given level depend upon the local contextual interpretation associated with the pixel under consideration.
There are hybrids methods by which useful result are obtained in image processing. Temporal image are classified using parametric methods over two seasons. (Example: Rabi and Kharif) Specific knowledge bases are used to refine parametric classifications with respect to the behavior of the features in a particular season. Then, another knowledge base is used to compare two time parametric classification (already refined) to show constant and changing areas over the period. In addition to this, stratification information is superimposed from available thematic maps (i.e. forest boundaries are extracted and classified on the final product). This kind of hybrid methods not only improve upon the classification performance, but also go a long way in deriving newer technique of image processing to achieve better end results.

Future trends of the remote sensing and image processing are generation of data base and development of National network for information exchange which finally will lead to the operationalization of National Resources Information exchange which finally will lead to the operationalization of National Resources Information System (NRIS) in India.

3.4.20 Geographic Information System

Geographic Information System (GIS) emerged out of the need to evaluate the different aspects of the earth's surface in an integration multidisciplinary way, realizing that they do not function independently of each other. This was achieved initially by overlaying transparent copies of the different resource maps and identifying the places where the various attributes on the maps coincide. This technique was then adapted to the emerging computer technology. Simple maps were prepared by using the overprinting of line printer characters for generation of suitable grey scales, which represented the attributed values in what was known as a grid cell or raster system. However, these methods were not accurate and not accepted by the cartographers. The re of computer map – making improved by late 1970s with the development of various software programs for cartographic application. At the same time advances were being made in a number of related fields like remote sensing soil
science surveying, etc and the potential for linking different ends of spatial data was recognized. The needs to access, organize, update and analyze the geographic information, and to utilize it in an option always led to the concept of the Geographic Information System.

Geographical information System can be defined as a set of tools for collecting, storing, retrieving, transforming and displaying geographically referenced spatial data with its corresponding attribute information to meet a specific requirement. The distinguishing factor which separates GIS from other information storage and retrieval system is the use of the location of features in a coordinate space as the fundamental referencing principle and as important variables in quantitative analysis. The spatial data is generally in the form of maps which could be topography, geology, soil types, forests, land cover, water availability, etc. and stored as layers in a digital form in the computer. There are essentially two kinds of data bases: one the computer characteristics of a location (e.g., its slope, soil type, rainfall, etc.) called as spatial data as mentioned earlier, and the other attribute data (e.g., statistics or written text, table, and lists of data). New maps can be generated precisely by easily integrating innumerable layers of data. Thus a GIS has a database of multiple information layers that can be manipulated to evaluate relationships among the chosen elements in the different layers that can be manipulated to evaluate relationship among the chosen element in the different layers under consideration. The data analysis in GIS is supported by computer aide mapping and data base management.

3.4.21 Components of GIS

Any Geographical Information System comprises three major components viz., computer hardware, application software, and a proper organizational context. Following sections briefly describe these components. The hardware components include several specialized peripherals, such as digitizer of scanner for converting the resource maps into digital form for storage in the computer, a plotter for graphical representation of the maps generated, and a visual color graphics, display unit (work station) on which the spatial data editing
and display can be performed by the user, in addition to a central processing unit and standard computer peripherals.

The software component is primarily designed to perform five major functions.

(1) Data input, (2) Data storage and based management (3) Data processing, (4) Data analysis and modeling, and (5) Data presentation /output.

3.4.22 Data Input

An important sources of geographically referenced data in the spatial from, collected by aerial photograph and satellite imagery are presented in from of photograph of digitals image. Another source of geographic information is the non – spatial data, such as soil properties, vegetation types, weather station observation, customer lists water samples, socio – economic survey data, etc. These data bases are often geographically referenced it is possible to transformation and integrated this information into thematic data which can then be processed in the GIS. Data input involves the conversion of the data from the above mentioned different source spatial and non- spatial into compatible from, and linking the two. There are various ways to accomplish this depending on the requirements for accuracy and consistency. One way of achieving this is by using manual digitizers wherein the operators follow the lines carefully using the cursor pad and ensuring that lines are not double digitized and intersections are carefully closed. This mode of entry is tedious time consuming and the automated digitizing systems such as scanners replace the manual work of following the lines and thus ensure consistent repeatable results, each time the map is scanned Scanners though expensive are very effective in high volume application but limited to only good quality maps. The quality of the GIS product is the sophistication of its hardware and software.
3.4.23 Data Storage and Data Base Management

The data storage and base management are the function of the data management system of the GIS. They are concerned with the way the data is structured handled accessed and perceived by the user of the system. Effective data management include all aspects related to data security, data integrity ensures security against modification of GIS or access of data to unauthorized user. Data Integrity defines the ability of the system to protect data from accidental loss or from contamination by extraneous data. Filling and accessibility provides an authorized user to organize the data into categories direction study area etc. Data maintenance provides the authorized user with the ability to update, delete or add data to the GIS database.

3.4.24 Data Processing

Data processing operations are those performed on the data to produce information. It includes removal of errors and updating or matching them to other data. Errors can arise during the encoding and inputting of spatial and non-spatial data which can either incomplete or double, in the wrong place at the wrong scale distorted or linded to the wrong non-spatial data. Besides data may be over defined and may need to be reduced in volume. Data editing is interactively performed to ensure that all the errors corrected, data updated and properly verified to achieve the required accuracy which are vital to analysis.

3.4.25 Data Analysis and modeling

Data conversion is only part of the input phase of GIS. What are required next are the ability to interpret and to analyze quantitatively and qualitatively the information that has been collected. Spatial analysis tools are used to model made predictions and reach conclusion about the problems of interest. Such analysis involves combining data from multiple spatial data categories and performing analytical/statistical measurement and other operations on the GIS data sets to transform the data into information suitable for a given application. Typical operation include overlaying different thematic maps
computing areas, performing proximity searches, buffer zone creations, performing logical operations, scale changing, etc. Other techniques are relations of 3-dimensional perspective view using elevation data and generation of slope maps, network analysis, costing, etc. Give in brief are few illustrations of some of these techniques.

3.4.26 Overlay

Features from different layers can be combined to form a new map by overlaying the layers. Selecting overlay of polygons, lines and points enables the user generate a map containing features and attributes of interest extracted from different themes or layers.

3.4.27 Buffer Generation

One important class of spatial operations concerns the determination of areas and features which fall within a specified distance of interest by generating buffer zones. Such buffer zones can be generated around points, lines, or polygons. These zones are always polygons which are created as a separate layer. Distance buffering enables specifying different buffer distances for feature attributes.

3.4.28 Proximity Search

Proximity analysis enables to derive the spatial suitability based on neighborhood analysis techniques. It presents various options such as user defined locations to point features, lines, features, polygons, etc.

3.4.29 Modeling

As it is possible to analyze spatial information to extract knowledge, it is also possible to use known relationships to model geographically the outcome of a set of conditions. In other words, a GIS model is to determine the best solution for a given problem, based on a set of criteria.
3.4.30 Data Presentation/Output

Data presentation deals with the way the information is the user. It can be either as a visual display or hard copy in the form of printed maps drawn using a plotter, where the geographical entities are represented as a series of points, lines and symbols.

3.4.31 Data Structure

Data structure basically refers to the way in which the data is organized in a computer. This is a very vital component for consideration in the development of any GIS as the efficiency and case in data manipulation and analysis are to a large extent, dependent on the type of structure adopted. All geographical data are basically represented on two dimensional maps as points, lines and areas, there are two ways of representing the information, either as a mosaic of interconnecting lines and points which represent the location and boundaries of entities of by applying a grid structure of variable dimension and representing an entity by its presence or absence within a specific grid cell. These two distinct approaches can be referred to as the vector and grid data models respectively. Within each data model there are many methods of structuring data for efficient and effective manipulation by the computer which are referred to as Data Structures,

The most common method for representing spatial data is the vector method in which the fundamental building blocks are co-ordinate pairs from which points, lines and areas (polygons) are represented by single X, Y co-ordinate pair, lines and polygons is composed of straight line segments joining two co-ordinate pairs. Spatial relationships are established through the use of topological arc-mode representation and attribute values are stored independent of the spatial representation.

The grid data models are either raster data structure wad tree structure of octree structure. In a raster system, the geographical data is represented by a geometric array of rectangular of square cells. The resolution is determined by the size of cell. The smaller the grid size the greater is the resolution and
precision as also the volume of data to be handled. In this structure the points are represented as individual cells, and lines and polygons as clusters of cells.

Each cell will have an assigned value for the given attribute. However by using the Run Length Coding (RLC) technique the volume of data storage can be considerably reduced.

The quad tree data structure is a hierarchical grid based structure which improves the storage efficiency of the both the raster and vector systems, and works in the principle of recursive decomposition of space. This structure is developed by dividing the map layer into regular spatial unit, s unite each unit is occupied by entities with similar attributes. The number of divisions increases with the complexity of the map. The octree is an extension of quadtree concept to handle 3D space, which has a Z dimension.

3.4.32 Comparison of Data Structures

Certain factors influence the choice of one data model over the other which include data volume, topology and spatial query, analytical capability, accuracy and precision, etc. For example, in the grid model the quadtree data structure usually means a substantial reduction in the information stored compared with a raster file for the same ration and the magnitude of saving reduces with increasing complexity of the surface. In the vector model, storing the topological relationship between geographical entities greatly increases the data storage requirements of a map layer. Topology is an important component of a data model as it is linked with the ability to query which a very important prerequisite to any GIS. Data structures with the vector model containing topological links between entities, either fully or partially, have been mainly chosen for the above mentioned purpose. Whiten the grid model development of quadtree structure has led to improved method of geometric referencing, because every node in the quadtree is given a unique index, and its precise geographical location, associated attributes information and neighborhood can be easily identifying the nearest neighbor of a given point and identifying the area in which a point is located (Point in polygon search). The availability to perform
analysis efficiently is another key factor which is considerably different in both vector and grid models. Network analysis is straightforward and simple using the vector model, which in the grid model, it involves more complex operation since the linkage between cells are more difficult to determine. On the other hand, analysis function like overlaying multiple data entities is simpler in the grid model than in the vector model. Hence it may be seen that their circumstances under which one approach is better suited than the other recognition of this fact has led to the development of hybrid model switch transcended the boundaries imposed by the grid and vector model.

Toward establishing the above information system efforts are under way for generation of appropriate Digital Cartography Date base (DCDB) and geographical system (GIS) in various organization in the country like Department of Space, Department of Science and Technology, Survey of India, Forest Survey of India, National Wasteland Development Board a few. Keeping in view the various the various indigenous Development in Computer Technology as well as the availability of High resolution remotely sensed data, efforts are on to ensure inter compatibility of various sources of data in commonly agreed format, the access to the data by the user agencies in an operational mode.

The geographical information system (GIS) as a tool for deriving management related information pertaining to various resources has been the backbone of the above information system being plane in the country. While remote sensing derived information on various natural resources, such as forest, crop, wasteland, landuse, minerals, water resources, geology, soils topography and other terrain conditions may provide major inputs the socio economic indicators will be added to the information to make it very useful in developing resources utilization plans.

DOS has parallel initiated development of such tools indigenously to meet the specific requirement of the remote sensing community in order to achieve the ultimate goal of optimum resources management.
3.4.33 Data Used

Remote Sensing

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Sensor</th>
<th>Time of data acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS IC</td>
<td>LISS-III</td>
<td>May 2005</td>
</tr>
</tbody>
</table>

Collateral Data

Survey of India topographic maps on 1:50,000 scale of Bilaspur


Village boundary map

Contour map

Software used for study

ERDAS 8.6

ARC GIS