Chapter - 2

MATERIALS AND METHODS

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2.1 MORPHOMETRY OF RESERVOIR

The Almatti reservoir under study is one of the major perennial reservoirs located at about 28 km away from the taluk Basavana-Bagewadi and 63 km away from the district Bijapur between North latitude 160°-19" and East longitude of 75°-53' 15". From this reservoir, the water is supplied to Basavana Bagewadi, Bijapur, Kolhar and rehabilitation centers like Baluti, Siddanath, Rolli, Gani, Chimmalagi, Almatti and Sitimani for drinking purpose. For irrigation purpose, water is supplied to Narayanpur Left Bank Canal (NLBC), Narayanpur Right Bank Canal (NRBC), Alamatti Left Bank Canal (ALBC), Alamatti Right Bank Canal (ARBC), Mulawad Lift Irrigation Canal (MLIC), Rampur Left Irrigation Scheme (RLIS) and also supplied to the village Marol. Hence, it becomes more pertinent to assess the utility of reservoir. The river Krishna is the second biggest river in peninsular India. It originates in the Western Ghat at an altitude of 1338.00 m (4385 ft) above mean sea level near Mahabaleshwar in the Maharashtra state and flows across the peninsula from West to East for a length of about 1392 km (870 miles) through Maharashtra, Karnataka, and Andhra Pradesh before it drains into the Bay of Bengal. The river Krishna enters Karnataka at its 304 km and passes through the state for 480 km and finally joins Bay of Bengal near Bapatla in Andhra Pradesh. The river basin is 2.57 lac. Sq. km. Maharashtra contributes 68,800 Sq. km. (26.8%), Karnataka 1,12,600 (43.8%) and Andhra Pradesh 75,600 Sq. km. (29.4%). The main tributaries of river...
Krishna in Karnataka are Bhima from the north, Ghataprabha, Malaprabha, Tungabhadra and Vedavati from the South. The total length of the dam is about 1,564.83 M and the catchment area of the river Krishna is 35,926 Sq. Km. (13,871 Sq. Miles). The water spread area is about 487.87 Sq. Km with a maximum depth of water 30.342 mts. The head reaches of the catchment area lie in Western Ghats where the average rainfall is heavy and is nearly 635 cm (250 inches) per annum. The rainfall gradually decreases to 51 cm (20 inches) as it approaches the dam site i.e. in the area of Bijapur, Gulbarga, and Raichur districts. The suitability of the water of river Krishna for the purpose of irrigation has been studied. The water of Krishna river has a constantly good quality during the rainy season i.e. from June to August. The water in some of the non-monsoon months contain slightly higher sodium percentage. This is not as bad to make the water unsuitable for irrigation. Moreover, the construction of Dam leads to mixing of non-monsoon flows with water already existing in the reservoir and all the chemical contents get diluted.

2.2 METEOROLOGICAL DATA

The data of atmospheric temperature, humidity and rainfall were collected from Gauging Sub-division Office, Navanagar, Bagalkot during the study period. The climate of the region is dry and the year can be distinctly classified into three seasons such as rainy (June to September), winter (October to January) and summer (February to May) seasons. The day length varies between 10 to 12 hours. The soil of this region is similar to other semi-arid areas of central India. Depending on the depth for agricultural purpose, the soil is grouped into four types viz.
1. Deep to very deep soil (The depth of soil is more than 90 cm)
2. Moderate deep soil (20% of the command area with the depth of soil varies from 22.5 to 90 cm)
3. Coarse to medium textured red soil (15% of the command area with variable depth from 22.5 to 90 cm)
4. Shallow deep soil (The depth of the soil is less than 22.5 cm)

2.3 SAMPLING STATIONS

Water samples were collected monthly basis for two years. For the present study five sampling points in the reservoir were selected with an approximate distance of 0.8 km between each point taking into account the human activities such as washing, bathing, fishing etc. The outlets, inlets morphometric features and growth of aquatic vegetation etc, are other important factors considered during the selection of the sampling sites. The first sampling point (S1) was on the South West side of the reservoir, S2 and S3 were located near the outlet. S4 is selected at the downstream of the reservoir and S5 is selected towards the northern side of the reservoir (Plate I) respectively. Samples from these pre-fixed points were collected (between 6 and 9 a.m.) once in a month for two years. The procedures for collection, storage and analysis of samples were followed as described in standard methods (APHA, 1991).

2.4 ECOLOGICAL PARAMETERS

2.4.1 PHYSICAL AND CHEMICAL PARAMETERS OF WATER

The different sites of the Almatti reservoir was visited monthly for a period of two years (February, 2003 to January, 2005) to study the various ecological parameters such as rainfall, humidity, air and water temperature, pH, electrical conductivity, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness,
calcium, magnesium, chloride, nitrate, phosphate, sulphate, bicarbonate and total dissolved solids. Surface water was collected from all the five sampling points. Collections were made using plastic containers of 2 liter capacity. The plastic containers were rinsed thoroughly with sampling water before using them. After filling the containers they have been sealed. The collected water samples were transferred to the laboratory for the estimation of various physical and chemical parameters by following standard methods (APHA, 1991).

Water temperature at each sampling point was recorded on the spot using centigrade thermometer. The hydrogen ion concentration (pH) was measured using pH meter (Systronics).

Electrical conductivity was measured at 25°C in the calibrated conductivity bridge (Systronics-304). Calculation was made using cell constant 1.03. Water samples were taken carefully into 250 ml reagent bottles avoiding air bubbles. The samples collected were fixed separately by using Winkler’s method in the field itself for estimation of dissolved oxygen. Alkali-iodide azide and manganese sulphate reagents were added soon after the collection of water samples and the bottles were transported to the laboratory for further estimation. Later the D.O. was estimated in the laboratory dissolving the precipitate by adding concentrated sulphuric acid and then by titrating the samples against sodium thiosulphate (0.025N) solution using starch as an indicator and the result has been expressed in mg/l.

Carbon dioxide (CO₂) was estimated by titrating samples against 0.041N Sodium hydroxide using phenolphthalein as an indicator.
Total alkalinity of the samples were estimated by titrating against 0.02N sulphuric acid using phenolphthalein and methyl orange indicators and thus the bicarbonate alkalinities were calculated. Chloride was estimated by Argentometric method. Samples were titrated against silver nitrate and potassium chromate was used as an indicator.

Total hardness of the water samples were determined by titrimetric method with EDTA (0.01N) as titrant and Erichrome Black-T as an indicator. From the same method calcium and magnesium contents were also calculated and the results are expressed in mg/1.

Nitrate (NO\textsubscript{3}-N) was determined colorimetrically by phenol disulfonic acid method. 50 ml of water sample was taken in a conical flask and added an equivalent amount of silver sulphate solution. Heated slightly and filtered the precipitate of AgCl\textsubscript{2}. Evaporated the filtrate, dissolved the residue in 2 ml phenol disulfonic acid and diluted the contents to 50 ml. Added 6 ml of liquid ammonia to develop a yellow colour. The intensity of colour was measured at 410 nm. The amount is expressed as mg/L.

Phosphate (PO\textsubscript{4}-P) was estimated colorimetrically by stannous chloride method. 100 ml of water sample was taken in a conical flask and 4 ml of molybdate reagent and 0.5 ml stannous chloride was added to develop blue colour. The intensity of colour was measured at 690 nm. The amount is expressed in mg/L.

Sulphate ion was precipitated in a HCl medium with BaCl\textsubscript{2} and the suspension so formed was measured by using colorimeter at 420 nm and the sulphate content of the samples was determined by comparison of the reading with a standard curve.
Bicarbonate was estimated by titrimetric method and expressed in mg/l.

Total dissolved solids of the water samples were estimated by evaporation method and expressed in mg/l. All chemical analyses were completed on the day of sample collection.

2.4.2 PHYSICAL AND CHEMICAL PARAMETERS OF SEDIMENT

Sediment samples were collected from S1, S4 and S5 sites. Collections of the sediment samples were made by using plastic bags and were brought to the laboratory then stored in petri plates. Later kept them in the oven (100°C) for drying. The dried sediment was grinded until they pass through a 2 mm sieve before the estimation was carried out. Analyses of samples were followed as described in Jackson (1962).

2.4.2.1 pH

In 100 ml capacity beaker 20 gm of sieved dry soil sample was taken and 50 ml distilled water was added and stored the suspension for one hour. Finally pH of water suspension was recorded by calibrated pH meter (Systronic pH meter).

2.4.2.2 ELECTRICAL CONDUCTIVITY (EC)

After recording the pH the same soil suspension was kept overnight in order to settle suspended particles at the bottom. Then the EC was measured at 25°C in the calibrated conductivity bridge (Systronics-304). Calculation was done using cell constant 1.03.
2.4.2.3 ORGANIC CARBON (OC)

10 gm sieved soil sample was taken in 500 ml flask and to this 10 ml of 1N \( \text{K}_2\text{Cr}_2\text{O}_7 \), 20 ml conc \( \text{H}_2\text{SO}_4 \) were added and mixed by gentle swirling. The mixture was allowed to stand for 30 minutes. A blank without soil was prepared in the same way then 10 ml of 85 percent \( \text{H}_3\text{PO}_4 \), 0.59 of \( \text{NaF} \) and 1 ml of diphenylamine indicators were added and then titrated against ferrous ammonium sulphate (0.4 N) solution till dull green color changed to brilliant green. The amount of organic carbon of the sediment samples were calculated by using the following formula.

\[
\text{OC\%} = \frac{(B - T) \times N \times \text{Ferrous ammonium sulphate} \times 0.003}{\text{Wt of Soil (g)}} \times 100 \text{ (g)}
\]

\( B = \) Blank titrate value, \( T = \) Actual titrate value

One ml of 1N Potassium dichromate is equivalent to 3 mg of carbon (0.0003 g)

2.4.2.4 ESTIMATION OF SODIUM AND POTASSIUM

The estimation of sodium and potassium was carried out by using flame photometer. Values are expressed as mg/l.

20 gm of 2 mm Sieved soil was taken in a conical flask and 100 ml of ammonium acetate (0.1 N \( \text{NH}_4 \text{AOC} \)) was added and kept overnight and stirring was done for half an hour. Then it was filtered through Whatmann no. 44 filter paper. The concentration of \( \text{K} \) and \( \text{Na} \) in the extract was read in the flame photometer (Systronics digital unit 125).

\[
\text{Na OR K mg/kg} = \text{PPM of Na OR K from standard curve} \times \text{dilution}
\]
2.4.2.5 TOTAL NITROGEN (TN)

a) Digestion

5 g of air dried 0.15 mm sieved soil sample was taken into the Kjeldhal digestion flask and then 20 gm of mixture of 50 ml of water and 35 ml of concentrated H$_2$SO$_4$ containing salicylic acid were added. The content was mixed and heated (410°C) continuously on the digestion stand in a fuming chamber until the digest was cleared and cooled by adding 50 ml distilled water.

b) Distillation

The content was transferred to distillation flask (Kjeldhal distillation assembly) and washed the residue 3-4 times with a little of distilled water (30 ml in each time) and a few glass beads were added to the flask in order to prevent jumping of the boiling sample. Then 25 ml of boric acid mixed red indicator was taken in 400 ml beaker and was kept below the receiver tube. 100 ml distilled water and 40% NaOH were added to the distillation flask to make the mixture completely alkaline. Then the flask was heated. Distillate was collected till the volume of the distillate in beaker as 150 ml and titrated against standard H$_2$SO$_4$ or HCl (0.1 N) till colour was changed from green to pink. The total nitrogen was calculated by using the following formula.

\[
\text{Total Nitrogen mg/kg} = \frac{\text{T.V. X N.H}_2\text{SO}_4 X 0.014}{\text{Wt of soil (g)}} X 100 \text{ (g)}
\]

2.4.2.6 AVAILABLE PHOSPHOROUS (P$_2$O$_5$)

Available phosphorous was estimated by Bray’s method 5 gm of 2 mm sieved soil sample was taken in a 250 ml flask and 50 ml of extract was added and was
shaken for 5 minutes on a mechanical shaker. Then filtrated and 5 ml of filtrate was taken in a 25 ml volumetric flask followed by 4 ml chloromolybdic acid solution. Then 1 ml stannous chloride was added to develop the colour. The colour intensity was read at 660 nm. The amount of phosphorous was calculated by referring to the standard curve. The graph was plotted by using standard solution of potassium dihydrogen phosphate (KH$_2$PO$_4$).

The phosphorous was calculated by using the following formula.

\[
P_{2}O_{5} \text{ mg/kg} = \frac{\text{PPM Vol. of extract}}{1000} \times \frac{\text{Vol. made Wt. of Sample (g)}}{\text{Ailquat taken}} \times 1000 \text{(g)}
\]

2.4.2.7 AVAILABLE POTASSIUM (K$_2$O)

Available potassium was determined by flame photometric method as described for water.

Soil extract was prepared by leaching with 1N ammonium acetate solution to find out the concentration of potassium following flame photometric method as described for water analysis. If soluble fraction was very less do not apply the alcohol washings for the extraction. Then ammonium acetate solution was added directly to the soil extract. Later the readings were taken by using flame photometer. The amount of potassium was calculated by following formula.

Potassium mg/kg = \[
\frac{\text{mg/kg/l of soil extract x V}}{10 x S} \times 10
\]

where, \( V = \) Total volume of soil extract prepared (500 ml in this case)  
\( S = \) weight of soil taken (50 gm in this case)
2.4.3 BIOLOGICAL PARAMETERS

2.4.3.1 PHYTOPLANKTON

Phytoplankton samples were collected monthly for 2 years. Phytoplankton material at different sampling point was collected by filtering 200 ml of water through the nylon bolting cloth (mesh 25 nm). Plankton samples were kept for about 24 hours to settle. Samples were stored in small vials and diluted to 50 ml with distilled water. The diluted samples were used for further investigation. For microscopic observation one ml sample was taken on “Sedgewick Rafter Cell”. The average of 5 to 10 counts were made for each sample and the results are expressed in numbers of organism per litre of sample.

2.4.3.2 ZOOPLANKTON

For the study of zooplankton, samples were collected monthly using plankton net made of bolting nylon cloth (Mesh 25 nm) by sieving a known volume of water sample. The plankton samples were fixed in 4% formalin and preserved in 100 ml polythene bottles. The pressured samples were diluted to 40 ml with distilled water. For their taxonomic study and numerical estimation, the organisms were observed under light microscope using “Sedgwick Rafter Cell” as per the procedure given in standard methods (APHA, 1991). Average of 5 to 10 counts for each sample were taken into account and results are expressed in number of organisms/ litre.

2.4.3.3 STUDY OF MACROFLORA AND MACRO FAUNA

During every visit aquatic macrophytes were collected from littoral zone of the reservoir and the list of aquatic plants were noted.
Aquatic insects were collected from each site with the help of planktonic net and hand picking.

Molluscans were collected in winter and summer season, but in rainy season reservoir is completely full, thus there was no availability of peripheral region and collect molluscans. Collections were made from these spots (S1, S4 and S5). Live ones and molluscan shells were collected by hand. The live ones were preserved in 4% formalin. All the collected molluscan species brought to the laboratory for identification.

Fishes were collected with the help of fisherman and a general survey of them was done. Collected fishes were brought to the laboratory for identification. This provides the check list of fishes available in the reservoir.

2.5 STATISTICAL ANALYSIS

The statistical analysis like mean (\( \bar{X} \)), standard error (SE) were calculated by using the following formula.

\[
\text{Mean (} \bar{X} \text{)} = \frac{\sum X}{N}
\]

\[
\text{Standard Error (SE) (} \bar{X} \text{)} = \sqrt{\frac{\sum (X-\bar{X})^2}{n(n-1)}}
\]

Simple Correlation coefficient test was performed between some selected physico-chemical parameters, phytoplankton and zooplanktons. The simple correlation coefficients (r) was calculated and denotes only linear relationship between the two variables. The inter relation between two factors was calculated by using the formula.
\[ r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\left\{ N \sum X^2 - (\sum X)^2 \right\} \left\{ N \sum Y^2 - (\sum Y)^2 \right\}}} \]

Correlation coefficient was tested further significance using 't' test at 1% and 5% level.

\[ t = \frac{r \sqrt{n-2}}{\sqrt{1-r^2}} \quad \text{OR} \quad t = \frac{r}{\sqrt{1-r^2}} \sqrt{n-2} \]
Table 2.1 MORPHOMETRY OF ALMATTI RESERVOIR

A. GENERAL FEATURES

1. Location : Between village Almatti of Bagewadi Taluk, Bijapur district and Sitimani village of Bagalkot Taluk, Bagalkot District
   : Latitude, 16° 19" N
   : Longitude, 75° 53'E

2. Means of access : 1. 1.2 km (6 furlongs) from Almatti Railway Station on Sholapur Hubli Section of South Central Railway
   2. 28 km from B. Bagewadi and 63 km from Bijapur on NH-13 connecting Solapur-Chitradurga

B. GEOGRAPHICAL FEATURES

1. Catchment area : 35,926 Sq.Km. (13,871 Sq.Miles)
2. Nature of Catchment : The upper most reaches are in hilly and forest area, while the lower reaches are in moderate country. It has many tributaries
3. Climate : Moderate (tending to hot)
4. Annual mean temperature : 76.4° F
5. Mean annual precipitation : Varying from 635 cms (250") at the source to 50 cms (20") at the dam site
6. Geological features at dam site : Hard granite rock (coarse grained) exposed at bed and quartzites in the flanks

C. TECHNICAL DETAILS OF DAM

1. River portion : RL. 529.24 M
2. Right Bank : RL. 528.756 M
3. Left Bank
   Earthen embankment : RL. 528.756 M

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4. Lowest bed level of River : RL. 489.258 M
5. Full reservoir level : RL. 519.60 M
6. Maximum water level : RL. 519.80 M
7. Water Spread area : 487.87 Sq.Km.
8. Total length of dam : 1564.83 M
   (Including Earthen dam, Masonry Spillway & Masonry Non-Spillway)
9. Maximum height of dam above the lowest foundation level : 49.29 M
10. Height of dam above the lowest river bed level : 40.30 M
11. Top width of dam : 7.50 M
12. No. & size of Spillway Crest Gates : 26 Nos. of 15 M X 15.24 M

D. DETAILS OF SUBMERGENCE
1. Submergence area : 48787 Ha (including Stage-I)
3. Population affected : 1,30,000 (approximate)

E. CANALS OF ALMATTI AND NARAYANPUR
1. Narayanpur Left Bank Canal (NLBC)
2. Almatti Left Bank Canal (ALBC)
3. Narayanpur Right Bank Canal (NRBC)
4. Almatti Right Bank Canal (ARBC)
5. Mulwad Lift Scheme
6. Indi Lift Scheme
7. Rampur Lift Scheme
## IRRIGATION ASPECTS

**Irrigable Command Area (ICA)**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NLBC</td>
<td>4,087,400 Ha</td>
</tr>
<tr>
<td>2.</td>
<td>ALBC</td>
<td>20,235 Ha</td>
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<tr>
<td>3.</td>
<td>NRBC</td>
<td>84,000 Ha</td>
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<td>4.</td>
<td>ARBC</td>
<td>16,100 Ha</td>
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<td>5.</td>
<td>Mulwad LIS</td>
<td>30,850 Ha</td>
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<td>6.</td>
<td>Indi LIS</td>
<td>41,900 Ha</td>
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<td>7.</td>
<td>Rampur LIS</td>
<td>20,235 Ha</td>
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<td>8.</td>
<td>Total GCA</td>
<td>6,22,060 Ha</td>
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## Table 2.2 Meteorological data of study area during investigation period 2003-2005

<table>
<thead>
<tr>
<th>Month</th>
<th>Rain Fall (mm)</th>
<th>Air Temp. (°C)</th>
<th>Humidity (%)</th>
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<td>26.6</td>
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<td>March</td>
<td>7.20</td>
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<td>April</td>
<td>23.9</td>
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<td>May</td>
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<tr>
<td>June</td>
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<td>May</td>
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<td>June</td>
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<tr>
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Fig. 2.1 Map of study area