CHAPTER - III

EXPERIMENTAL METHODS AND COLLECTED DATA

(A) SAMPLING OF WATER

Water samples were generally collected at depths varying from 0.25 - 5 metres and about 5 metres away from the bank of the river from 10 a.m. to 3 p.m. The samples were collected with the help of Vandron's water sampler which consists of a glass bottle and a cord tied to a lid. The whole assembly was lowered into water to the desired depths and the cord of the lid was pulled and released. Only when displaced air bubbles ceased to come to the surface, the whole assembly was withdrawn and the water was then transferred into pre-cleaned polythene bottles. Water for the analysis of the dissolved oxygen was collected in BOD bottles and the oxygen was fixed on the spot. Temperature and pH of the water were recorded on the spot. Preservatives were added wherever necessary to keep the samples healthy till estimation in the laboratory*. The samples were collected for a period of two years (1986 to 1987) in an interval of one month on a particular date from each of the five monitoring spots. The physico-chemical parameters were determined and recorded according to the standard methods of examination of water and waste water and the procedure reported in ADV (SPADF).

(B) PHYSICO-CHEMICAL PARAMETERS AND THEIR ANALYSIS

1. TEMPERATURE: - The temperature is basically important for

*P.G. Dept. of Chemistry, Sambalpur University.
its effects on the organisms in water. A rise in the temperature of water leads to the speeding up of the chemical reactions in water reduces the solubility of gases and amplifies the taste and odour. Water in the temperature range of 7°C to 11°C has a pleasant taste and is refreshing. At higher temperature with less dissolved gases, the water becomes tasteless and even does not quench the thirst. At elevated temperatures metabolic activity of organisms increases, requiring more oxygen but at the same time the solubility of oxygen decreases. Temperature is also very important in the determination of various other parameters such as pH, conductivity, saturation level of gases and various forms of alkalinity etc. Data on temperature are also required by the industries in heat transmission calculations, cooling towers and process use etc.

For determination of surface temperature, water samples were collected in suitable containers. Soon after collection of sample, a mercury thermometer was inserted into the sample and reading were noted. The thermometer used was graduated upto an accuracy of 0.1°C and was of small thermal capacity to attain equilibrium rapidly.

2. pH (Potentia hydrogenii):- pH is the measure of the intensity of acidity or alkalinity and measure the concentration of hydrogen ions in water. It does not measure total acidity or total alkalinity. Any solution whether acidic, alkaline or neutral, contains both \( \text{H}^+ \) and \( \text{OH}^- \) ions which of these two ions is present in larger concentration determines the acidity or alkalinity.

\[ \text{pH} \text{ is generally measured on a 'log' scale and it is equal to the negative log}_10 \text{ of hydrogen ion concentration} \]
pressed in moles per litre. The mathematical relation is as follows:

\[
pH = -\log[H^+]
\]

\[
= \log_{10} \frac{1}{[H^+]}
\]

As the ionic product of water is \(1 \times 10^{-14}\) at 25°C, therefore, a neutral solution will have \(1 \times 10^{-7}\) ions of \(H^+\) and \(OH^-\) each. pH scale ranges from 0 to 14 with 7 as neutral point, below 7 being acid and above 7 as alkaline.

pH can be measured by calorimetric method using various indicators or paper strips. However, the use of calorimetric methods are less convenient and less accurate. For accurate measurement of pH, electromeric methods are used employing the hydrogen ion sensitive electrodes. These apparatus are known as pH meters. In the present study soon after the collection of the water sample pH has been measured by a portable Griph pH meter No.323 Systonic make operated by battery. The accuracy of this pH meter varies from 0.01 to 0.1.

3. CONDUCTIVITY:- Conductivity is the measure of capacity of a substance or solution to conduct electric current. In water, it is the property caused by the presence of various ionic species.

It is generally measured with the help of a conductivity meter having a conductance cell containing electrodes of platinum coated with platinum black or carbon. These electrodes are mounted rigidly and placed parallely at a fixed distance. Conductance of the sample when measured between the electrodes having a surface area of 1 cm\(^2\) and placed at a distance of 1 cm
apart is called electrical conductivity and it is the property of the water sample. The conductivity is generally reported in m, mho or \(\frac{1}{\text{mho}}\) or Siemens (s). Conductivity is highly dependent upon temperature and therefore, is reported normally at 25°C to maintain the comparability of the data from various sources. It has got no health significance as such. Conductivity is, however, an important criterion in determining the suitability of water and waste water for irrigation.

Water samples were collected from different sites in sampling bottles and taken to the laboratory, where conductivity of those samples were measured using a Systronics-303 direct reading conductivity meter having an accuracy of ± 1% and the results has been reported in m mho cm\(^{-1}\).

4. **DISSOLVED CARBON DIOXIDE:** The acidity of neutral water is due to the presence of carbon dioxide. It forms a very unstable weak acid with water, namely carbonic acid. Its amount in water should be determined as it causes corrosion and enhances the rate of some chemical and biochemical processes. Carbon dioxide has been determined on the spot as soon as the sampling is done by titrating the sample with carbonate free NaOH solution using phenolphthalein as indicator.

The final expression for calculation of CO\(_2\) in water is given below.

\[
\text{CO}_2 \text{ in mg/l} = \frac{(\text{ml} \times N) \text{ of NaOH} \times 1000 \times 44}{\text{Volume of sample in ml}}
\]

where 'N' is the normality.

5. **DISSOLVED OXYGEN (DO):** Dissolved oxygen is one of the most important parameter in water quality assessment and ref-
elects the physical and biological processes prevailing in the water. Its presence is essential to maintain the higher forms of biological life in the water. The analysis of DO plays a key role in water pollution control activities and waste treatment process control. Winkler Iodometric method is commonly used for the determination of dissolved oxygen in water samples.

The water sample (100 ml) was taken in a glass stoppered bottle (BOD bottle). To it 1 ml each of MnSO₄ and alkaline KI solutions were added (when volume is less than 300 ml) by two separate pipettes and was well mixed by thorough shaking. It was kept for some time (about 5 minutes). Then 1-2 ml of concentrated H₂SO₄ or HCl was added and then whole content was titrated against standard sodium thiosulphate solution using starch as indicator. The reagents used were prepared as per the specification.

Calculations:

When whole contents have been titrated

Dissolved oxygen in mg/l = \( \frac{(ml \times N) \text{ of thiosulphate x 1000 x 8}}{\text{Volume of water sample taken}} \)

where 'N' is the normality of thiosulphate solution.

Winkler's Method: The manganous sulphate reacts with the alkali (KOH or NaOH) to form a white precipitate of manganous hydroxide which in presence of oxygen gets oxidised to a brown coloured Mn⁺³ compound. In acid medium manganic ions are reduced by iodine ions which get converted to iodine equivalent to the original concentration of oxygen in the sample. The iodine can be titrated against thiosulphate using starch as an indicator.

1) \( 2\text{KOH} + \text{MnSO}_4 \rightarrow \text{Mn(OH)}_2 + \text{K}_2\text{SO}_4 \)

ii) \( 4\text{Mn(OH)}_2 + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{Mn(OH)}_3 \)
iii) $4\text{Mn(OH)}_3 + 12\text{HCl} + 4\text{KI} \rightarrow 4\text{MnCl}_2 + 4\text{KCl} + 12\text{H}_2\text{O} + 2\text{I}_2$

iv) $2\text{Na}_2\text{S}_2\text{O}_3 + \text{I}_2 \rightarrow 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6$

6. **CHEMICAL OXYGEN DEMAND (COD):** Chemical oxygen demand (COD) is the measure of oxygen consumed during the oxidation of the oxidizable organic matter present in a fixed volume of sample by a strong oxidizing agent. This is a satisfactory method for determining the organic load of a water body, which is preferable to the biochemical oxygen demand (BOD). It is a rapidly measurable parameter to be known for industrial waste studies and control of water treatment plants. The method is based on the chemical oxidation of materials in the presence of potassium dichromate and 50% sulphuric acid. If say, formaldehyde is present in the sample the chemical reaction can be represented by the following equation.

$$3\text{CH}_2\text{O} + 16\text{H}^+ + 2\text{Cr}_2\text{O}_7^{2-} \rightarrow 4\text{Cr}^{3+} + 3\text{CO}_2 + 11\text{H}_2\text{O}$$

or,

$$3\text{CH}_2\text{O} + 8\text{H}_2\text{SO}_4 + 2\text{K}_2\text{Cr}_2\text{O}_7 \rightarrow 2\text{Cr}_2(\text{SO}_4)_3 + 2\text{K}_2\text{SO}_4 + 3\text{CO}_2 + 11\text{H}_2\text{O}$$

The sample is refluxed with $\text{K}_2\text{Cr}_2\text{O}_7$ and $\text{H}_2\text{SO}_4$ in presence of mercuric sulphate to neutralise the effect of chlorides and silver sulphate (catalyst). The excess of potassium dichromate is titrated against standard ferrous ammonium sulphate using ferroin as indicator. The amount of $\text{K}_2\text{Cr}_2\text{O}_7$ consumed is proportional to the oxidizable organic matter present in the sample. A small trace of organic matter in glassware may contribute a significant error hence a blank experiment is always run to minimise it.

**Procedure:** 20 ml of sample was taken in a 250-500 ml conical
flask with ground glass joint to be fitted to a upright condenser. To it 20 ml 50% H$_2$SO$_4$, 10 ml of 0.025N K$_2$Cr$_2$O$_7$ solution, ½ gm Ag$_2$SO$_4$ and ⅔ gm HgSO$_4$ were added and refluxed for 2 hours on water bath. Then it was cooled, diluted to about 100 ml with distilled water and titrated the excess of K$_2$Cr$_2$O$_7$ with 0.01N ferrous ammonium sulphate solution using 2-3 drops of ferroin indicator.

The final expression for calculation is as follows:

COD in mg/l = \(\frac{(b-a) \text{ml} \times N \text{ of ferrous ammonium sulphate} \times 1000 \times 8}{\text{Volume of water sample}}\)

where

\[a = \text{ml of ferrous ammonium sulphate consumed},\]
\[b = \text{ml of ferrous ammonium sulphate consumed with blank experiment}.\]

7. **BIOCHEMICAL OXYGEN DEMAND (BOD):** Biochemical oxygen demand (BOD) is the measure of the degradable organic material present in a water sample and can be defined as the amount of oxygen required by the microorganisms in stabilizing the biologically degradable organic matter. On an average basis, the demand for oxygen is proportional to the amount of organic matter to be degraded aerobically. Hence BOD value can be used as a measure of waste strength.

The principle of the method involves measuring the difference of the dissolved oxygen concentration of the sample and after incubating it for 5 days at 20°C.

**Procedure:** Since dissolved oxygen is likely to be exhausted, it is necessary to prepare a suitable dilution of the sample. Dilution of water sample was done by bubbling compressed air for 30 minutes. A blank experiment was also started with dis-
tilled water after suitable dilution.

To each litre of dilution water 1 ml of each of phosphate buffer, magnesium sulphate (M/3), calcium chloride (M/4), and ferric chloride (M/1000) solutions were added and mixed thoroughly and pH was adjusted to 7.0 by adding 1(N) NaOH or H₂SO₄ as the case may be. Phosphate buffer was prepared by dissolving each of 8.5g KH₂PO₄, 21.75g K₂HPO₄, 33.4g Na₂HPO₄·7H₂O and 1.7g NH₄Cl in distilled water to prepare 1 litre of solution and pH was adjusted to 7.2. Two sets of BOD bottles were filled with diluted sample and distilled water. One set was kept in BOD incubator for 5 days at 20°C and the DO of other set was measured immediately. After completion of 5 days incubation DO of this set was determined.

BOD can be calculated as follows:

BOD in mg/l = \((D₀ - D₅) \times \text{dilution factor}\).

\(D₀\) = Initial DO in the sample.

\(D₅\) = DO after 5 days incubation.

8. **TOTAL ALKALINITY:** The total alkalinity is a measure of the capacity of the water to neutralize a strong acid. The alkalinity in the water is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, borates, silicates etc. together with the hydroxyl ions in free state. However most of the waters are rich in carbonates and bicarbonates with little concentration of other alkalinity imparting ions.

Total alkalinity and alkalinites due to carbonates, bicarbonates can be estimated by titrating the sample with a strong acid (HCl or H₂SO₄), first to pH 8.3 using phenolphthalein as an indicator and then further to pH between 4.2 and 5.4 with
methyl orange or mixed indicator. In the first case the value is called as phenolphalein alkalinity (PA) and in the second case, it is total alkalinity (TA).

Procedure: - 100 ml of sample was taken in a Erlenmayer flask and 2 drops of phenolphthalein indicator was added to it. If there is no development of pink colour, the phenolphthalein alkalinity is zero. If colour development is there, then PA was determined by titrating it with a strong mineral acid (e.g. 0.1N HCl) till it becomes colourless. Then to the same solution 2 drops of methyl orange indicator was added and again titrated with 0.1N HCl until the yellow colour changed to pink. The alkalinity is usually expressed in terms of mg of CaCO₃ per litre.

For calculation the expressions are as follows:

\[
\text{PA as CaCO}_3 \text{ in mg/l} = \frac{(X \times N \text{ of HCl}) \times 1000 \times 50}{\text{Volume of sample in ml}}
\]

\[
\text{TA as CaCO}_3 \text{ in mg/l} = \frac{(Y \times N \text{ of HCl}) \times 1000 \times 50}{\text{Volume of sample in ml}}
\]

where 'X' = ml of HCl used till pink colour of phenolphthalein is decolourised.

'Y' = ml of HCl consumed in both steps.

'N' = Normality of HCl.

PA = Phenolphthalein alkalinity.

TA = Total alkalinity.

9. (a) TOTAL SOLIDS (TS): - Total solids present in a water sample is estimated by weighing the residue left after evaporation of the unfiltered sample.

Procedure: - 500 ml of the sample was taken in a previously cleaned and weighted porcelain basin. Then the sample was evaporated on water bath till it was dry. It was further dried
in an oven for an hour at a temperature of 103-105°C. The basin was cooled and weighted till constant weight.

The total solids in gm/1 = \( \frac{(B - A) \text{ gm} \times 1000}{V} \)

where

- A = Initial weight of the basin in gm.
- B = Final weight of the basin in gm.
- V = Volume of sample taken in ml.

(b) TOTAL DISSOLVED SOLIDS (TDS):- Total dissolved solids are determined as the residue left on evaporation of a particular volume of the filtrated sample. The experimental procedure and method of calculation is exactly similar to that of total solids.

10. TOTAL SUSPENDED SOLIDS (TSS):- The difference between the total solids and total suspended solids in a sample of water is the amount of total suspended solids.

Hence, TSS in gm/1 = (TS - TDS).

11. TOTAL HARDNESS:— Hardness of water is due to the presence of dissolved calcium, magnesium, iron and aluminium compound in it which prevent soap from lathering and increase its boiling point. Calcium and magnesium salts are present mostly as bicarbonates, sulphates and chlorides. The difficulty in lather formation arises because of the fact that soaps are sodium and potassium salt of higher fatty acids and are soluble in water, but when soap is used in water containing calcium and magnesium ions insoluble soaps are formed and precipitated, thus destroy soap. As a general rule all soluble salts of heavy metals cause hardness because they form precipitate with soap. In addition to the acid radicals mentioned above nitrates and silicates also
cause hardness. Hardness is called temporary when caused by bicarbonates and carbonates which can be removed simply by boiling the water. Permanent hardness is caused mainly by sulphates and chlorides of the metals which requires chemical methods for softening.

In order to estimate the total hardness EDTA method is followed using Eriochrome Black-T as indicator. Calcium and magnesium form a complex of wine red colour with Eriochrome Black-T at pH of 10.0 ± 0.1. The EDTA has got a stronger affinity towards calcium and magnesium ions and, therefore, by addition of EDTA, the former complex is broken and a new complex of blue colour is formed. The magnesium and calcium complexes with EDTA are easily dissolvable. They are formed according to the equation given below.

\[
\begin{align*}
Ca^{+2} + Na_2H_2(C_{10}H_{12}O_8N_2) &= Na_2Ca(C_{10}H_{12}O_8N_2) + 2H^+ \\
Mg^{+2} + Na_2H_2(C_{10}H_{12}O_8N_2) &= Na_2Mg(C_{10}H_{12}O_8N_2) + 2H^+
\end{align*}
\]

The equilibria are shifted to the right at pH 10.

**Procedure:** 50 ml of water sample was taken in a conical flask and 1 ml of buffer solution prepared from prescribed amount of NH₄Cl and NH₄OH was added, followed by the addition of 1 ml of \( \frac{M}{50} \) sodium sulphide solution to minimise the interference of heavy metals, if present. Then 3-4 drops of Eriochrome Black-T indicator was added and titrated against \( \frac{M}{100} \) EDTA solution till colour changes from wine red to blue. The hardness is estimated in terms of calcium carbonates as given below.

It is known that 1 ml of 0.01M EDTA = 1.00 mg of CaCO₃.
Hardness in mg/l as CaCO₃

\[ \frac{x \times (M) \times \text{EDTA} \times 1000 \times 100.9}{V} \]

where \( x \) = ml of EDTA solution.

\( M \) = molarity of EDTA.

\( V \) = volume of sample taken.

100.9 = molecular weight of CaCO₃.

12. CALCIUM HARDNESS:- Calcium is one of the most abundant substances of the natural waters. Being present in high quantities in the rocks, it is leached from there to contaminate the water. Disposal of sewage and industrial wastes are also important sources of calcium. It has got a high affinity to adsorb on the soil particles, therefore the cation exchange equilibria and presence of other cations greatly influence its concentration in water. Presence of calcium in water is not bad for health.

With little modification the EDTA method can be used for estimation of only calcium hardness in presence of magnesium. Magnesium is precipitated in the system as hydroxide at higher pH by adding NaOH solution and murexide indicator in place of Eriochrome Black-T.

Procedure:- 50 ml of water sample was taken in a conical flask and 2 ml of normal NaOH solution was added to it. It was shaken and then followed by the addition of 100 mg of murexide indicator. A pink colour was developed. Then the content was titrated against 1/100 EDTA solution until colour changed to purple. The calcium hardness can be calculated using the following expression.
(A) Calcium hardness in mg/1 as CaCO\(_3\)
\[ = \frac{x \text{ ml} \times (M) \text{ EDTA} \times 1000 \times 100.9}{V} \]
where \('x' = \text{ml of EDTA solution.}\)
\('M' = \text{molecularity of EDTA solution.}\)
\('V' = \text{volume of sample in ml.}\)
100.9 = \text{molecular weight of CaCO}_3.

(B) Calcium hardness in mg/1 as calcium
\[ = \frac{'x' \times (M) \text{ EDTA} \times 1000 \times 40.08}{V} \]
where \('x' = \text{ml of EDTA solution.}\)
\('M' = \text{molecularity of EDTA solution.}\)
\('V' = \text{volume of sample in ml.}\)
40.08 = \text{molecular weight of calcium.}

13. **SILICA:** Silicon is the most abundant element in the earth surface after oxygen. The term silica refers to silicon in natural waters, where it is usually represented as H\(_2\)SiO\(_4\) or Si(OH)\(_4\) and silicic acid.

Despite its overabundance, it occurs in meagre quantities in water. This is due to silica sources being resistant to chemical weathering processes. The solubility of silica has been found to be more at high pH or high temperature.

Ammonium molybdate reacts with silica to form molybdo-silicic acid of yellow colour. Hence silica can be determined colorimetrically.\(^{10}\) By adding oxalic acid the molybdate phosphorous acid is destroyed while molybdate-silica acid remains unaffected. Then by adding aminonaphthosulphonic acid or "Metol" pyrosulphite solution the yellow complex is reduced to a blue compound with higher colour intensity than the yellow complex.
The colour intensity is proportional to the concentration of silica acid and is measured in a spectrophotometer Model-100-20 (Hitachi made) at absorbance maximum, 820 nm.

**Procedure:** 50 ml water sample was taken in a conical flask and to that 1 ml hydrochloric acid (1:1) was added followed by the addition of 2 ml 10\% ammonium molybdate solution. It was shaken thoroughly and allowed to stand for 5 minutes. Then 1.5 ml 10\% oxalic acid solution was added to it and mixed well. After 1 minute 2 ml 'Metol' solution was added and well shaken. After 10 minutes the absorbance was recorded by a spectrophotometer with 10 mm cuvette at 820 nm.

From sodium silicofluoride Na₂SiF₂ a standard solution was prepared. Taking different concentration of standard sodium silicofluoride a calibration curve was drawn by taking absorbances by the photometer at 820 nm following the same procedure. From the calibration curve, the concentration of silica of the unknown sample was computed.

For preparation of metol the following sequence was adopted. First 800 ml of demineralised water was heated to 40°C. Then 100-150 mg of potassium pyrosulphite, K₂S₂O₅, added therein to preserve the metol. Then 20 gm of metol was allowed to dissolve in that solution completely before 205 gm potassium pyrosulphite, K₂S₂O₅, was dissolved. After cooling the solution was diluted to 1000 ml with demineralised water.

14. **CHLORIDES:** Chloride is a common anion present in all types of water. In natural fresh water, its concentration remains quite low. The most important source of chlorides in the waters is the mixing of domestic sewage. Man and other animals
excrete very high quantities of chlorides along with nitrogenous compounds. Hence high chloride concentration in the water source indicates the pollution by sewage. Most of the chlorides of heavy metals are highly soluble in water and responsible for hardness and cannot be removed easily either chemically or biologically.

Silver nitrate reacts with chloride in solution to form very slightly soluble white precipitate of AgCl. At the end point when all the chlorides get precipitated free silver ions react with the chromate indicator to form silver chromate of radish brown colour.

Procedure:- 50 ml of water sample was taken in a Erlenmeyer flask and to that 2 ml of potassium chromate, K₂CrO₄ solution was added. Then the content was titrated against 0.02N AgNO₃ solution till the appearance of persistent red tinge. The chloride concentration can be calculated using the following expression.

\[
\text{Chloride in mg/l} = \frac{\text{ml of AgNO}_3 \text{ soln} \times N \times 1000 \times 35.5}{\text{ml of sample}}
\]

where 'N' is the normality of AgNO₃ solution.

15. PHOSPHATE:- Phosphorous in natural fresh water is present mostly in inorganic forms such as H₂PO₄⁻, HPO₄⁻², and PO₄³⁻. Phosphorous being an important constituent of biological systems, may also be present in the organic forms.

The rocks in which most of the phosphorous is bound, are generally insoluble in water and hence the phosphorous content of natural fresh waters is low and biological growth is limited due to this fact. The major sources of contaminated
phosphorus in water are due to domestic sewage, detergents, agricultural runoff and industrial effluents.

Phosphate in acid solution reacts with ammonium molybdate and forms a yellow complex heteropolyacid (Molybdo-phosphoric acid), which is reduced by 'metol' to a blue compound. This colour intensity is measured by a photometer at 820 nm.

**Procedure:** To a 50 ml water sample in a conical flask 2.5 ml of sulphuric acid (1:1), about 9M was added and followed by the addition of 10% citric acid to minimise the interference of silica. To that solution 2.0 ml of 'metol' and 10% 4.0 ml of 10% ammonium molybdate solution was added, mixed well and allowed to stand for 40 minutes. Then the absorbance was recorded at 820 nm by a spectrophotometer model-100-20 (Hitachi make). The 'metol' solution was prepared following the procedure described in silica determination.

A standard phosphate solution was prepared from potassium dihydrogen phosphate \( \text{(K}_2\text{HPO}_4) \) in demineralised water. From that stock solutions of different concentration were prepared and absorbances were recorded at 820 nm following the procedure described earlier. Then a standard graph was plotted with concentration versus absorbance. From that standard graph concentration of phosphate in the unknown sample was determined.

16. **SULPHATE:** It is a common anion occurs in all kinds of natural waters. In arid and semiarid regions, it is found in particularly higher concentrations due to accumulation of soluble salts in soils and shallow aquifers. Some mines drainage wastes and industrial effluents contribute high concentration
of sulphate to water by virtue of pyrite oxidation. Biological oxidation of reduced sulphur species to sulphate also increase its concentration. Rain water has quite high concentration of sulphate particularly in the area with high atmospheric pollution. Sulphate is an important constituent of hardness with calcium and magnesium. Excess Na$_2$SO$_4$ and MgSO$_4$ should not be present in drinking water as it interfer with normal functioning of the intestine.

Sulphate is precipitated in hydrochloric acid medium as BaSO$_4$, by the addition of 10% Barium chloride solution. The precipitation is carried out near the boiling temperature and after a period of digestion, the precipitate is filtered, washed with hot water till free from chloride ion, ignited and weighted as BaSO$_4$.

17. **NITRATE NITROGEN**:- Nitrate represents the highest oxidized form of nitrogen. The most important source of nitrate is biological oxidation of organic nitrogenous substances which come in sewage and industrial wastes. It is also added to water sources from agricultural runoff and from atmosphere through rain. High amount of nitrate are generally indicative of pollution. Excess nitrate in drinking water causes the disease 'methamoglobinemia' in blood. Due to this the skin looks blue. High concentration of nitrate in water causes diseases in animals and abortion in brood animals.

Nitrate and brucine react to produce a yellow colour, the intensity of which can be measured at 410 nm. The reaction is highly dependent upon the heat generation during the test. Hence measurement is done under controlled condition.
Procedure:— 10 ml of water sample was taken in a 50 ml test tube and placed in a cool water bath and to it 2 ml of 30% NaCl solution was added, followed by the addition of 10 ml of (4:1) H$_2$SO$_4$ and mixed thoroughly. Then 0.5 ml of brucine reagent was added with stirring and the test tube was placed in a boiling water bath for exactly 20 minutes. The content was cooled in a water bath and absorbance was recorded at 410 nm by a photometer model 100-20 (Hitachi).

100 ppm of standard nitrate solution was prepared from KNO$_3$. From this stock solution a series of solutions of different nitrate concentration were prepared by dilution. Then following the above mentioned procedure a standard curve was drawn.

From the standard curve the amount of nitrate nitrogen in the sample was evaluated.

18. NITRITE NITROGEN:— Nitrite represents an intermediate form during denitrification and nitrification (i.e. both in oxidation of NH$_3$ to NO$_3^-$ and in the reduction of NO$_3^-$) which occurs in nitrogen cycle, waste-water treatment plants, water distribution systems and natural waters. The other source of nitrite entering into the system may be due to its use as corrosion inhibitor in industrial process waters. The high concentration of nitrites can also cause the birth of blue-babies.$^3$

Nitrite forms a diazonium salt with sulphanilic acid at pH 2.0 to 2.5, which combines with a 4-naphthylamine hydrochloride to form a pinkish dye. The colour intensity so produced can be estimated spectrophotometrically.$^3$ The original samples are made colourless by treatment with activated charcoal and by filtration if required.
Procedure:- 50 ml of colourless sample was taken in a conical flask. To that 1 ml of 0.5% EDTA solution, 1 ml sulphanilic acid, 1 ml of \( \alpha \)-naphthylamine hydrochloride and 1 ml of 16% sodium acetate solution were added in sequence. The total content was shaken thoroughly. Then the absorbance was measured at 520 nm by the spectrophotometer Model 100-20 (Hitachi). The reagent used above were prepared as per the specification. A standard curve was drawn using sodium nitrite solution containing 1.232 gm/l following above procedure like other photometric methods. From the standard curve the concentration of nitrite-nitrogen of the sample was obtained matching the observed absorbance value.

(C) EXTRACTION OF ORGANIC COMPONENTS

The organic components from the water samples were collected by using plastic bottles and organic components were extracted subsequently using chloroform and benzene. Evaporation of the solvent resulted black gummy materials which were stored in the refrigerator for analysis. The extractions were carried on at the spots by collecting samples once in a month on different dates for a period of one year. The samples were collected from five locations, namely Vedavyas, Rourkela effluent sample, Deogaon, Banaigarh and Barkote. The first is in the upstream and the third one in the immediate downstream of the industrial effluent discharge point and the latter two are at distances of 50 Kms and 85 Kms downstream of Deogaon. The separation of various components were tried with Gilson automatic fraction collector (Model-201) (Illustration No.13A & B) using drop adjustment method. The detail procedure of fractionation is as follows:
FRACTIONATIONS:-

An alumina column of 20 cm long was prepared with activated alumina. Then the organic residue of one spot black gummy material was dissolved in required volume of a mixture of cyclohexane and ethyl-acetate (5:1). Then the solution was poured on the alumina column slowly followed by the solvent mixture. The eluent coming out at the bottom of alumina column was connected to the inlet of the fraction collector. By drop mode method the eluent was fractionated by this instrument into large number of fractions and collected in special type of test tubes. After evaporation of the solvent it was observed that in some test tubes appreciable deposit of organic compounds had taken place. From the IR spectra of these deposits some conclusions have been drawn regarding the functional groups of the organic compounds present in the water samples. The spectral data are presented in chapter IV. Further, the collected organic matters were characterised following the standard procedures.

CHARACTERISATION:-

Characterisation of organic matter collected at Deogaon:-

The organic matters which were extracted from the water samples of the river at Deogaon were characterised as follows:

(a) Separation and characterisation of the acidic components-

A suspension of black residue (5 gm) in \( \frac{N}{20} \) NaOH (100 ml) was magnetically stirred for 72 hours. After allowing it to settle for another day, the mother liquor was decanted
13(A). Photograph of Gilson fraction collector Model No. 201.

13(B). Fractionation in operation.
off and neutralised by conc. HCl in cold. A black viscous oil
(1 gm) with pungent smell separated. The oil was esterified
using ethanol and conc. H₂SO₄ and after usual work up it was
chromatographed through activated alumina using petroleum
ether (bp - 80°C). The eluent after evaporation of solvent
gave a sweet smelling oil. The oil gave several spots on TLC.
Further fractionation of the oil was made on alumina column
using cyclohexane ethyl-acetate (2:1) and different fractions
were collected.

Fraction-1: B.P. - 212°C (lit.¹² bp - 212°C)
Rf - 0.65
Spectrally identical to ethyl benzoate.

Fraction-2: B.P. - 228°C (lit.¹² bp - 228°C)
Rf - 0.6
Spectrally identical to ethyl p-toluate.

Fraction-3: Mixture of 3 compounds which could not be
ccharacterised. The Rf value of one spot is
identical to ethyl o-toluate (b.p. - 227°C).

Fraction-4: B.P. - 304°C (lit.¹² bp - 305°C)
Rf - 0.3
Spectrally identical to ethyl naphthoate.

Fraction-5: Mixture of a number of compounds which could
not be characterised.

(b) Separation and characterisation of phenolic components-

A suspension of black residue (3 gm) extracted from
water samples was magnetically stirred for 72 hours using N/20
NaOH solution (100 ml). After allowing it to settle, the super-
natant liquid was decanted off and a slow stream of CO₂ was
passed through the solution for one hour during which an oily material separated. It was extracted with carbon tetrachloride and derivatised by acylation using acetic anhydride and acid mixture. The product isolated as grey coloured semisolid gave several spots on TLC indicating that it is a mixture. It was further fractionated using cyclohexane-ethyl acetate (1:1) in alumina column and several fraction were collected.

**Fraction-1:** Colourless oil B.P. - 196°C (lit. bp - 196°C)

Rf - 0.61

Spectrally identical to phenyl acetate.

**Fraction-2:** Brown oil B.P. - 212°C (lit. bp - 212°C)

Rf - 0.46

Spectrally similar to p-cresylacetate.

**Fraction-3:** Thick oil, gave several spots on TLC plate and could not be characterised.

**Fraction-4:** Colourless solid, M.P. - 70°C (lit. mp - 70°C)

Spectrally identical to \( \beta \)-naphthylacetate.

**Fraction-5:** Grey powder, gave several spots on TLC plate and could not be characterised.

(c) Isolation of nitrogen containing organic compounds:

A suspension of organic extract (2 gm) was stirred with \( \frac{N}{20} \) HCl (50 ml) for 48 hours. The acid solution is slightly brown in colour was decanted off and basified with dil. NaOH and kept for two days during which oily droplets settled at the bottom. The supernatant liquid was decanted off and the oil was extracted with chloroform. Evaporation of solvent gave a syrupy brown oil (400 mg). Elemental analysis of the oil indicated the presence of nitrogen by routine test. The TLC of the material gave several spots. The separation of the components was not
successful.

(d) Isolation of neutral components:

The crude residue free from acidic and phenolic components was eluted through an alumina column using carbon tetrachloride and ethylacetate sequentially. Evaporation of the solvent gave grey paste. The TLC of material gave several spots. A part of the paste was sublimated at 150°C. A pale yellow sublimate of m.p. 210°C was isolated (about 50 mg). It was found to be aromatic in nature. Although its m.p. is same as that of anthracine, it did not show any positive test for the same. The separation of the other component was not successful.

(D) **INORGANIC POLLUTANTS**

The inorganic pollutants generally present in river are soluble and insoluble inorganic salts and complex mineral acids, finely divided metals etc. The metals are immutable. They can neither be created nor destroyed. This means that once a metal is mobilised in the environment, its total amount remain the same, regardless of form, until it is mobilised again. Some metals such as Co, Cr, Cu, Fe, Mn, and Zn are believed to be essential for human health. It is not always possible to draw a clean distinction between essential and toxic metallic elements, since all are probably toxic if ingested in sufficient amount. Non-essential metals particularly Hg, Cd, Pb are extremely toxic at relatively low concentrations, their toxic effects presumably being caused by their chemical similarity to more common available essential metals. A non-essential metal may substitute for an essential metal at
one point in a metabolic pathway and because of small chemical
differences, through further chemical reaction block the com-
plete pathway.

(i) EXTRACTION OF METALLIC RADICALS:

After removing the soluble organic matters by
chloroform and benzene successively, the mother liquor was
concentrated on sun drying. The concentrated mass was digested
with aqua regia (3 HCl : 1 HNO₃) and the sample were kept in
refrigerator for qualitative analysis.

(ii) QUALITATIVE ANALYSIS:

The digested samples were taken and the cations were
separated into respective groups using group reagents. Then the
detections were done using different test reagents for differ-
ent metal ions.

Separation of metal ions into qualitative analysis groups:

Samples were treated with dil or conc HCl in hot
condition. It was cooled. On appearance of precipitate it was
filtered.

\[
\begin{array}{c}
\text{Filtrate} \\
\downarrow \\
\text{Residue Gr I radicals}
\end{array}
\]

The filtrate was oxidised with H₂O₂ and saturated
with H₂S. A precipitate appeared. It was filtered.

\[
\begin{array}{c}
\text{Filtrate} \\
\downarrow \\
\text{Residue Gr IIA and Gr IIB radicals}
\end{array}
\]

Borate, silicate, phosphate if present in the filt-
rate are removed at this stage. Then the subsequent filtrate
was treated with solid NH₄Cl and concentrated NH₄OH till alka-
line. A precipitate appeared. It was filtered.

\[
\begin{array}{c}
\text{Filtrate} \\
\downarrow \\
\text{Residue Gr IIIA radicals}
\end{array}
\]

The filtrate was treated with conc. NH₄OH 1 to 2 ml
and saturated with $H_2S$. A precipitate was obtained. It was filtered.

To concentrated filtrate solid $NH_4Cl$, 1-2 ml conc. $NH_4OH$ and 1-2 ml saturated solution of $(NH_4)_2CO_3$ were added. White precipitate was formed. It was filtered.

The filtrate was analysed for Gr V radicals.

Following the systematic analytical procedure from different samples Pb, Cu, Hg, Fe, Cr, Al, Co, Ni, Mn, Zn, Ca and Na have been detected. In some of the samples some radicals were found in traces, some were absent and the remaining were in appreciable quantities. The presence of these basic radicals have been estimated wherever possible by the following methods. Although many basic radicals have been detected in the above qualitative analysis but except Fe, Mn, Cr, Zn, Cu and Pb others were found in traces. So their quantitative analysis have been omitted.

(iii) ESTIMATION OF METAL IONS:

The quantitative determination of metals in a water body is really a difficult task. Most of the metals are associated with organic matter and hydrous oxides of iron and manganese etc. For quantitative estimation colour photometric method has been followed in the present investigation.\(^3\)\(^7\) For different metals particular different complex has been used for colour development and absorbance has been recorded in spectrophotometer model 200-20, made by Hitachi, Japan. By comparison with the absorbance of standard solution of that metal in the same
procedure, the actual metal concentration has been calculated.  

1. **IRON:** Iron has been determined by phenanthroline method using spectrophotometer. First Fe(III) solution is reduced to Fe(II) by hydroxylamine hydrochloride and pH is adjusted to 3.2 to 3.3 by ammonium acetate buffer. It is then treated with 1:10 phenanthroline. The absorbance of resulting orange red solution is measured at 510 nm following the standard procedure.  

2. **LEAD:** Lead has been estimated in water body by the spectrophotometric dithiozone method. The interference due to tin and bismuth are eliminated by masking the sample with KCN and Na$_2$SO$_3$.  

3. **CHROMIUM:** Chromium has been estimated in water body by the spectrophotometric method. A compound of red-violet colour is formed by the reaction of dissolved hexavalent chromium with diphenylcarbazide in acid solution. Total (dissolved + particulate) chromium has been estimated after digestion of the sample with H$_2$SO$_4$ and HNO$_3$.  

4. **MANGANESE:** Waste water containing 10 to 1500 ppb of Mn is estimated by persulphate method. This method is based on the oxidation of Mn$^{+2}$ to MnO$_4$ by (NH$_4$)$_2$S$_2$O$_8$ in presence of AgNO$_3$. Following the above principle manganese has been estimated in the water body by a spectrophotometer model 200-20, Hitachi - Japan.  

5. **ZINC:** A blue complex is formed by zinc with zincon (2 carboxy 2'-hydroxy-5'sulpho-formazyl benzene) in a solution buffered at pH 9. The intensity of colour can be measured by a
The interference of other metals are suppressed by complexing with cyanide first and then zinc is made free using chloral hydrate or cyclohexanone.

6. **COPPER**: Copper(I) and copper(II) ions form in acidic solution a yellow coloured complex with the zinc salt of N,N-dibenzyl dithiocarbamate. The complex is extracted by means of carbontetrachloride. The colour intensity which is proportional to copper concentration is measured in a spectrophotometer at 438 nm.

(E) **REPORTS FROM HEALTH CENTRES AND HOSPITALS REGARDING DISEASES**

The types of diseases seen among the inhabitants settled on the banks of the river Brahmani from Vedavyas to Rengali have been collected from hospitals of the localities. From the data it appears that stomach trouble, scabbies, dysentery, diarrhoea and jaundice are very common diseases found in this area. Leprosy and T.B. cases have also been reported.

The birth of blue babies is an unusual feature at Banaigarh and Barkote area. The data collected from hospitals are given in Table-17 to 17(C).

<table>
<thead>
<tr>
<th>TABLE-17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health report from Panposh Government Hospital</strong></td>
</tr>
<tr>
<td><strong>Disease</strong></td>
</tr>
<tr>
<td>Dysentery</td>
</tr>
<tr>
<td>Diarrhoea</td>
</tr>
<tr>
<td>Gastroenterities</td>
</tr>
<tr>
<td>Fever</td>
</tr>
<tr>
<td>Stomach troubles</td>
</tr>
<tr>
<td>Scabbies</td>
</tr>
</tbody>
</table>
# TABLE-17(A)

Health report from Govt. Hospital, Banaighar during 1986-87

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>T.B. Respiratory</td>
<td>170</td>
</tr>
<tr>
<td>2.</td>
<td>T.B. Intestine Peritoneus and Mesenteric</td>
<td>36</td>
</tr>
<tr>
<td>3.</td>
<td>T.B. Bone and joints</td>
<td>33</td>
</tr>
<tr>
<td>4.</td>
<td>Syphilis</td>
<td>44</td>
</tr>
<tr>
<td>5.</td>
<td>Gonocoelic infection</td>
<td>22</td>
</tr>
<tr>
<td>6.</td>
<td>Typhoid</td>
<td>649</td>
</tr>
<tr>
<td>7.</td>
<td>Paratyphoid</td>
<td>18</td>
</tr>
<tr>
<td>8.</td>
<td>Amoebic</td>
<td>8266</td>
</tr>
<tr>
<td>9.</td>
<td>Bascillary</td>
<td>271</td>
</tr>
<tr>
<td>10.</td>
<td>Whoping cough</td>
<td>155</td>
</tr>
<tr>
<td>11.</td>
<td>Malaria</td>
<td>10737</td>
</tr>
<tr>
<td>12.</td>
<td>Helminthas infection</td>
<td>5200</td>
</tr>
<tr>
<td>13.</td>
<td>Beri Berri</td>
<td>580</td>
</tr>
<tr>
<td>14.</td>
<td>Anaemic sickle</td>
<td>5910</td>
</tr>
<tr>
<td>15.</td>
<td>Inflammatory disease</td>
<td>67</td>
</tr>
<tr>
<td>16.</td>
<td>Asthma</td>
<td>90</td>
</tr>
<tr>
<td>17.</td>
<td>Upper respiratory infection</td>
<td>8560</td>
</tr>
<tr>
<td>18.</td>
<td>Acute Bronchities</td>
<td>232</td>
</tr>
<tr>
<td>19.</td>
<td>Chronic Bronchities</td>
<td>95</td>
</tr>
<tr>
<td>20.</td>
<td>Stomach ulcer</td>
<td>896</td>
</tr>
<tr>
<td>21.</td>
<td>Infection</td>
<td>2100</td>
</tr>
<tr>
<td>22.</td>
<td>Scabbies</td>
<td>4926</td>
</tr>
<tr>
<td>23.</td>
<td>Arthritis &amp; Spondylities (Skin disease)</td>
<td>5340</td>
</tr>
<tr>
<td>24.</td>
<td>Rheumatism musculas</td>
<td>1800</td>
</tr>
<tr>
<td>25.</td>
<td>Jaundice</td>
<td>400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Children</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>34857</td>
<td>14228</td>
<td>82087</td>
</tr>
<tr>
<td>Women</td>
<td>22966</td>
<td>10036</td>
<td></td>
</tr>
<tr>
<td>Children Male</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children Female</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE-17(B)**

Disease and Health report from Govt. Hospital, Barkote during 1986-1987

People suffering from following diseases have been treated.

**Disease**

1. Diarrhoea and dysentery
2. Gastroenterities
3. Jaundice
4. Scabbies (almost 70% patients)
5. Leprosy
6. T.B. (Rare)
7. Stomach troubles
8. Round worm and Thread worm
9. Trichomons vaginalities
10. Sickle cell Amoebia

The no. of patients treated were not available from the hospital.

**TABLE-17(C)**

Report from Veterinary Hospital, Banaigarh.

Cattle suffering from the following diseases have been treated during 1986-1987.

**Disease**

1. Tympanitics | Common among all sorts of cattle.
2. Summer diarrhoea |
3. Viral diseases |
4. Contageous optha |
5. in goats.
(F) REPORT ON PERSONAL INTERVIEWS

During collection of water samples for analysis a number of people have been interviewed and firsthand information relating to their problems concerning pollution due to establishment of industries on the banks of the river Brahmani have been collected and reported below. The interview have taken in the month of September, 1987.

1. Mr Harekrishna Das, Age - 60 years
   Residence - Vedavyas
   Occupation - Temple priest

   The priest worships Lord Radhakrishna in the temple of Vedavyas, staying there since last 35 years. According to him and others, two important festivals namely, Shivaratri and Shra-vanamela are organised by the people of Vedavyas every year. Thousands of devotees gather there during these festivals. After it is over the usual tradition was not to throw the waste materials into the river Brahmani as it may pollute the water system. But now such tradition is not being followed, even the deadbodies are being thrown into the river as such or these are cremated by the side of the river bed.

2. Mr Bhola Cherketia, Age - 25 years
   Residence - Brahmanitara (near Vedavyas)
   Occupation - Steel plant worker

   According to him, before two years they were drinking the water of the river Brahmani. But now-a-days they are collecting drinking water from tubewell as water system of the river is polluted. The diseases like diarrhoea, dysentery, scabbies are common in this area.

3. Mr Akur Roul, Age - 45 years
   Forester, Panposh
According to him washeries of mines from open cast mining area are coming to the river directly, particularly in rainy season due to massive deforestation. It contributes to a major part of the river water pollution. The common trees found on the banks of the river Brahmani are Jamu, Karanja, Arjuna, Mahalim, Pashi, Simuli, Ashan (Sahaj), Putus (Latina camera) and the common shrubs are Nirgundi, Amari. Besides these, Chakundia, Eucalyptus, Akashia, Gambhari plants are available in small numbers. The employees of forest department do not use the waste water of Rourkela for the growth of plants due to its corrosive action. Plants need suitable environment for their growth like human being.

4. Dr R.K. Mishra
   S.D.M.O., Govt. Hospital, Panposh.
   He stated that people suffering from different diseases are coming for treatment to the hospital daily. Out of them people suffering from dysentery, scabbies and stomach trouble are very common. Particularly in the late summer and beginning of rainy season the number of dysentery and diarrhoea patients are more.

5. Priest, "Lord Shiva temple"
   Deogaon, Age - 60 years
   The temple is situated near the meeting point of the river Brahmani and the channel which carries the effluents of Rourkela steel plant and Fertilizer plant. The priest has been staying there since construction of the temple. According to him the channel has originated from Jhariaghati hill. Its water was very good before the construction of the steel plant. But now the same channel carries the effluents of steel plant complex.
6. Mr Tikeswar Dagh, Age - 23 years
   Mr Kailash Sahoo, Age - 40 years
   Residence - Deogaon, Shopkeepers

   They said that steel plant authority has built the reservoir to store the effluents and discharge into the main stream of the river slowly during summer. It is cleaned completely during rainy season. At the temple of the village Deogaon the effluent from steel plant and fertiliser plant are discharged into the river Brahmani. The water of the river at this zone remains muddy, oily and sticky throughout the year. Large quantities of suspended particles and heavy particles enter into the river at this point as the black pitch-like material sticks to their feet. They go somewhere to the upstream of Deogaon, even during rainy season for their bath. Almost all people of Deogaon take their bath in the river Brahmani and also use the river water for various purposes. Diseases like diarrhoea, dysentery and scabies are common in the village. The cattle and other domestic animals of this village frequently fall ill and die of drinking the river water from the place where the effluent enters into the river.

7. Mr Bhagban Dehuri, Age - 45 years
   Mechanic in Steel Plant
   Residence - Deogaon

   Before the establishment of industries at Rourkela people were using the river water comfortably for their bath and for all other purposes. Various types of fishes and prawn were available in the river. Now-a-days the availability of fishes has reduced remarkably and the river water is unsuitable for use.

8. Mr Hurdya Ranjan Sen, Age - 50 years
According to them the waste waters of mines from different nearby areas mix with the water of the Brahmani through Kusachinalla, Rangabhati nalla, Chiraur nalla, Binjhadihi nalla at different localities of Banaigarh. Due to these impurities the colour of the river water looks reddish brown in dry seasons. The water supplied to Banaigarh town is faint reddish brown in colour even after filtration. It changes the taste of cooked food materials. Tubewells have not been provided in all parts of the town.

9. Dr Narasingh Charan Behura
Veterinary Surgeon, Banaigarh

He stated that large number of animals are treated in this hospital suffering from various diseases. Tympanities is a common disease found in Banaigarh among cattle due to which they die. Summer diarrhoea is mainly seen in all kinds of animals during summer because of shortage of good quality drinking water. Viral diseases and contagious optha are common in goats of this locality.

10. Dr Niranjan Mahanty
SDMO, Banaigarh

He reported that diseases found in Banaigarh area are leprosy, sickle cell anaemia, malaria, T.B., stomach pain, skin diseases, dysentery and diarrhoea. The last two are common in rainy season. Many of the children suffer from hookworm and roundworm. Out of these diseases the dysentery, diarrhoea and skin diseases are caused due to poor water quality of the river Brahmani.
11. Mr Ramakanta Pattnaik, OAS
Additional Tahasildar, Banaigarh

He told that authority have planned through several schemes to supply good drinking water to Banaigarh town which are yet to be executed. The present system having one tank is unable to meet the entire demand. In some part of the town tube wells have been provided. The people of villages like Narandra, Twamara, Charokira, Jataikela, Jibika, Kendrikela, Baktekela, Tunkera etc. which are situated on the bank of the river Brahmani are still depending upon it for water for all sorts of uses.

12. Mr Narendra Choudhury, Age - 26 years
Shopkeeper
Residence - Tunkeraghat

He said there is no water supply in their village. They took bath in the river and use the river water for drinking and cooking purposes by settling and country filtration method when it is required. The stomach and intestinal diseases, scabbies etc are very common in this area.

13. Mr Dambaru Panthai, Age - 50 years
Mr Sashi Panthai, Age - 27 years
Occupation - Fishermen
Residence - Barkot

According to them fishes of good quality they catch from the river even now by netting. Everybody in their area use the water of the river Brahmani for bathing, drinking and cooking purposes without much purification. In some areas paddy and vegetables are grown by lift irrigation using the river water. The water system of the river in this zone is less polluted. But stomach pain, dysentery, diarrhoea and skin diseases are
very common among people from February to July every year.

14. Mr Surendra Naik, Age - 30 years
   Occupation - Fisherman
   Residence - Balita (Barkot)

   He said after the construction of Rengali dam some
   varieties of fishes are not available in plenty which they
   used to catch earlier. This may be due to the accumulation of
   various pollutants in the reservoir basin which is unsuitable
   for fish breeding of specific varieties.
References


