METHODOLOGY

The entire research work has been carried out at four major sites in trans Varuna area of Varanasi city. River Varuna is a tributary of holy river Ganga in Varanasi district of U.P. India, located at 25° 28' N latitude and 82° 24' E longitude. The whole work is centred around air, water, noise pollution including household and municipal waste pollution. Due to the anthropogenic activities, the environmental quality of trans Varuna and its adjoining areas have shown quiet deterioration, which is increasing day by day. For the present work, four major study sites have been selected in and around the trans Varuna area which are as follows-

1. Rameshwar, a pilgrimage spot, functioning as a control site.
2. Shivpur – Pandeypur.
3. Cantt. – Chaukaghat.

Out of four sites the 2nd, 3rd and 4th sites function as degraded sites.

Environmental monitoring has been done by the collection of informations about source monitoring, ambient monitoring and target monitoring.

Source Monitoring is applied for monitoring of automobiles and gen-sets exhausts, including noise level produced by automobile horns, music systems, loud speakers and generators.

Ambient Monitoring is applied to the study of concentration of
pollutants in air and water.

**Target Monitoring** is done to see the effect of pollution on plants, aquatic organisms and human beings.

**Air Monitoring—**

For the monitoring of the air pollution in respect to SPM, SO\textsubscript{2}, NO\textsubscript{x}, HC and CO, four major study sites were selected which were further divided into eleven subsites for the ambient and source monitoring of air quality and for knowing the traffic density, the number of petrol and diesel vehicles passing through these eleven sites were counted in 10 am - 11 am in day time and 5 pm - 6pm in the evening during the month of April 2000 for a week. The monitoring subsites were located at (1) Rameshwar (2) Shivpur (3) Bhojubeer (4) Pandeypur (5) Varuna Bridge (6) Varanasi Cantt. (7) Andhrapul (8) Chaukaghat (9) Alaipur (10) Bandhu kachi bag (11) Rajghat Bridge.

**Sampling for SPM—**

Sampling of air for SPM has been done by high volume air sampler using weighed whatman glass fibre filter (circle) having a diameter of 1 - 2 mm, for 2 hours. Before using, the filter was maintained at a temperature of 30° C for 24 hours at 50% relative humidity.

**Analysis for SPM—**

After sampling, the filter was removed and kept for 24 hours again at same temperature and weighed again. The difference in weight
gaves the total amount of solid present in the air sample from which the total quantity of solid per unit volume of the air was calculated.

**Sampling for Undesirable Gases**

The sampling of undesirable gases was done by a portable air quality sampler, using a suction device and the sampled air was bubbled through absorbants, sodium tetrachloro mercurate and sodium hydroxide for SO$_2$ and NO$_x$ respectively. For hydrocarbon, a liquid absorber, a high boiling petroleum distillate called 'straw' was used.

**Analysis for Undesirable Gases**

For the analysis of SO$_2$, West-Gaek's spectrophotometric method has been applied, where intensity of colour product was measured spectrophotometrically at 548 nm.

Analysis of NO$_x$ was done, after collecting samples, by spectrophotometer at 543 nm against a blank. Before analysis, the sample air which was bubbled through NaOH was subjected to a reaction with H$_3$PO$_4$ Sulphanilamide and N (1 - naphthyle) ethylenediamine dihydrochloride which develop reddish purple azo-dye colour proportional to the concentration of NO$_x$ present in the samples.

For the analysis of the hydrocarbon, air sample was collected in absorption column packed with porous styrene divinyle bezene polymer through which the air was passed. This absorption column was subsequently heated to desorb the sample. The same was subjected to gas chromatography coupled with mass spectrophotometry with flame ionization detector to obtain a spectrum showing level of hydrocarbon.
For the analysis of carbon monoxide, the analytical data has been obtained from the pollution control Board personals at different sites on making request.

**Water Monitoring—**

Water analysis has been done on four major study sites of trans Vanuna area during Jan 2001-December 2001. The water samples were collected from Vanuna river between 7am to 12 pm in eight replicates from each of the site in clean polyethylene bags, taking standard precautions as described in APHA (1992), Standard Methods for the Examination of Water and Waste Water and HACH, water analysis Handbook 1997.

The odour, turbidity and temperature of water were observed at the respective sites and water samples were immediately brought to the laboratory and kept in preservator at 4° for physico-chemical and faecal coliform analysis, using standard methods of water analysis as described in APHA and HACH. Different parameters were analysed in the following ways—

**Odour—** Odour of sample water has been detected by smelling herself.

**Turbidity** — Turbidity has been measured in cm. with the help of Secchi disc painted alternately black and white. The Secchi disc was lowered in the water body form a boat. The white and black colour of Secchi disc when became indistinguishable on reaching certain depth depending on the relative turbidity level which was measured in centimetres. Turbid water shows lesser centimetres as compare to the clear water.
**Temperature** - The measurement of temperature of water was done by °C thermometer.

**pH** - For knowing the pH of water the sample water was analysed by electronic pH meter.

**Dissolved Oxygen (DO)** - The dissolved oxygen of water samples were estimated by winkle's modified iodide-azide method. The amples were preserved with the help of magnous sulphate and alkaline iodide-azide. The developed precipitate were dissolved by adding H₂SO₄ and then titrated with 0.025N sodium thiosulphate using starch as an indicator.

**Biochemical or Biological Oxygen Demand (BOD)** - For calculation of BOD sample water was taken in two BOD bottles where one was fixed at once and other was incubated at 20°C in dark for five days. The DO difference of both the BOD bottles denoted the BOD. Here again the amount of DO was estimated with the help of winkle's modified iodide-azide method as said earlier.

**Chemical Oxygen Demand (COD)** - The COD was measured by the dichromate reflux method. 50ml of sample water was refluxed with 25ml 0.25 N K₂Cr₂O₇ (Potassium dichromate solution) and conc. H₂SO₄ for 2 hours The remaining amount of potassium dichromate after completing reflux was titrated with ferrous ammonium sulphate using ferroine indicator. The COD was calculated by using following formula-

\[
COD = \frac{(a-b) \times N \times 8000}{\text{ml sample}} \, \text{mg/l}
\]

where,
a = ml of ferrous ammonium sulphate \( \text{Fe(NH}_4\text{)}_2\text{(SO}_4\text{)}_2 \) used for blank.

\[ a = \text{ml of ferrous ammonium sulphate (Fe(NH}_4\text{)}_2\text{(SO}_4\text{)}_2) \]

\[ \text{used for blank.} \]

\[ b = \text{ml of ferrous ammonium sulphate (Fe(NH}_4\text{)}_2\text{(SO}_4\text{)}_2) \]

\[ \text{used for the sample water.} \]

\[ N = \text{Normality of (Fe(NH}_4\text{)}_2\text{(SO}_4\text{)}_2)?} \]

\[ \text{Alkalinity - For the estimation of alkalinity of water potentiometric titration method was used. 0.025 N sulphuric acid was used for the lowering of pH of water at 8.3 (phenolphthalein alkalinity) and to pH 3.7 (methyl orange alkalinity). The alkalinity of water was calculated by following formula-} \]

\[ \text{Alkalinity} = \frac{V \times N \times 50,000}{\text{ml sample}} \text{mg/l CaCO}_3 \]

Where,

\[ V = \text{ml of H}_2\text{SO}_4 \text{ used} \]

\[ N = \text{Normality of acid used} \]

\[ \text{Phosphate - The presence of phosphate in the sample water was estimated by stannous-chloride method. The sample water was mixed with ammonium molybdate solution and stannous chloride solution in glycerol. The development of blue colour indicated the presence of phosphate phosphorous. Colorimeter was used to measure the amount of phosphate in terms of optical density at 690 nm by matching colour intensity of sample water.} \]

\[ \text{Nitrate - The estimation of nitrate nitrogen was done by the phenol-di-} \]
sulphonic method. For which steamed dried water samples were dissolved in phenol di-sulphonic acid and ammonium hydroxide, a yellow colour was developed, indicating presence of nitrate-nitrogen. The colour intensity was proportional to the amount of nitrate-nitrogen in the sample water which was measured with the help of colorimeter at 410 nm in terms of optical density. A control line was kept by taking redistilled water.

**Calcium** - The presence of calcium in sample water was analysed by chemical analytical method i.e. EDTA titrimetric method. The EDTA (Ethylene Diamine Tetracetic Acid) which combined with calcium and magnesium where magnesium is precipitated at high pH using murexide i.e. ammonium perpurate and Eriochrome Blue Black R indicator and 1N NaOH. Here 50ml of sample water was taken in a flask to which 2 ml of 1N and murexide indicator were added to give a pink colour which was titrated against 0.01 M EDTA solution and the end point was seen when colour was change pink to purple. The following formula was used for calculation of calcium mg/l.

\[
Ca = \frac{\text{Volume of EDTA used} \times 400.8}{\text{ml of sample}} \text{ mg/l}
\]

**Chloride** - The chloride content of water was found out by Argentometric Method. 50ml of water sample was taken in a flask to which 2ml of 5% \(K_2Cr_2O_7\) solution was added as indicator and titrated against 0.02 N solution of silver nitrate developing red tinge at end point from redish brown colour. The following formula was used to calculate the amount of chloride in mg/l.

\[
Cl = \frac{(a-b) \times N \times 35.45 \times 1000}{\text{ml sample}} \text{ mg/l}
\]
Where,

\[ a = \text{Volume of Ag NO}_3 \text{ used for the sample.} \]

\[ b = \text{Volume of AgNO}_3 \text{ used for the blank} \]

\[ N = \text{Normality of AgNO}_3. \]

**Potassium** - For Potassium analysis of sample water flame photometer was used at a wave length of 760.5nm to take direct readings.

The **Heavy Metals** like mercury, lead, cadmium chromium, copper, zinc, iron, nickel, manganese were estimated by Atomic Absorption spectrophotometer (Perkin-Elmer).

**Detergents** - For knowing the presence of detergents in sample water, methylene blue was added, the changes in colour of sample water indicated the presence of detergents.

**Fecal Coliform** - For the counting of fecal coliform, membrane filter method was adopted by counting the colonies of fecal coliform in various shades of blue colour indicating the presence of fecal coliform densities after the development of its colonies on a filter paper by using culture media.

The procedure for membrane filtration testing is as follows-

The sample was collected from the different study sites of Varuna river which is diluted when turbidity of water was observed. Now the sample was filtered through filter paper (47 mm diameter and 0.45 \( \mu \)m pore size) under vacuum pump and sterile disposable filter unit. Then the
prior prepared medium (M-Fc Agar) was poured into petridish and then placed membrane filter in petridish which is incubated for 24 hours at 45°C. The developed coloured colonies were counted by using 15x magnification and the selected colonies were further incubated by using suitable medium and the results were recorded by using ultraviolet portable lamp. For counting the number of fecal coliform following formula was used:

\[
\text{Fecal Coliform Count} = \frac{\text{No. of Colonies}}{\text{ml Sample Poured}} \times 100
\]

Reporting unit for total fecal coliform counts is per 100 millilitre.

**Medium for Fecal Coliform**

**Formulation**

- Protease Peptone No. 3 (Difco) ......................: 5.0 g.
- Yeast extract .............................................: 3.0 g
- Lactose ......................................................: 20.0 g
- Tergitol 7 (25% solution).............................: 0.4 ml
- Polyoxyethylene ether W-1............................: 5.0 g
- Bromthymol blue ........................................: 0.1 g
- Bromeresol purple .....................................: 0.1 g
- Agar .........................................................: 15.0 g
- Distilled water ..........................................: 1.01

All ingredients dissolved in distilled water and autoclaved at 121°C.
for 15 minutes pH was adjusted to 7.4 ± 0.2 Selectivity was enhanced with the aseptic addition of 0.1 mg/l pricillin G after autoclaving.

**Noise monitoring** -

For monitoring of noise level in trans Varuna area, four major sites were selected, which were further divided into eleven subsites. The observed values were compared with the standard permissible values prescribed for the production of noise. The monitoring subsites and their names showing average sound levels in dB have been listed in the table which were taken from 15th - 21st Jan, 14th - 20th May and 15th - 21st October 2001 during heavy traffic load i.e. day (10am-11am and 5pm-6pm).

Sound level meter was used for monitoring noise levels at different monitoring subsites. The microphone was adjusted with wind screen kept at 1.2 meter above the ground level. The sampling was done during aforesaid period of 2001. The sampling period was 20 minutes at each location during day and evening.

The noise measurement may be affected by different meteorological parameters such as temperature, relative humidity and wind speed etc. Such parameters and their effects were ignored because such efforts are only effective if the distance between source and the receptor is more than a few hundred meters (Singh, 1995, Das, D.B. 1999). The instrument was moved in four directions to take care the effect of wind direction. The monitoring was done for five minutes in each direction so as to collect four sample from every location during day and evening. After every 10 seconds the values of noise level were recorded. The reading presented in the
observation table is the average for one hour. Ambient sound level was also monitored from different capacity gen-sets at and nearby area of eleven study subsites by following above method.

**Methodology for Household and Municipal Wastes**

For knowing about the status of Household and Municipal wastes in trans varuna area of Varanasi door to door personal survey was done at different eleven subsites of four major study sites and observation was done about sweeping, collection and dumping individuals of municipal body.