CHAPTER 2

REVIEW OF LITERATURE

2.1 GENERAL

Water pollution is considered to be one of the most environmental problems. It poses a major hazardous threat to our health. It will stand in the economic growth of a nation. In consequence of multi-faced industrialization, environment stands on the verge of change. The polluted environment emanates hazardous waste discharge and poisonous gas fumes. It produces smokes. Leachates from landfills and uncontrolled industrial effluents disposal cause significant deterioration in the water quality. Of course, water provides essential elements. When it becomes polluted, it brings about undesirable substance dangerous to human health. It is, therefore, absolutely essential to study effects of industrialization and pollution on water resources. In the Age of Technological Revolution, many investigations have been made to study effects, causes and consequences of bad and polluted water. Water used should be reasonably pure and drinkable. The availability of water, both in quantity and quality is one of the prime factors in deciding the growth of towns, cities and so on. The close study about the suitability of water, data interpretation using various techniques and water pollution are lucidly discussed on the following topics.

2.2 SUITABILITY OF WATER FOR DRINKING AND IRRIGATION

In respect of the prevailing bacterial contamination of groundwater in rural areas of North West Uttar Pradesh, Narain Rai and Sharma (1995)
took research. Fifteen well water samples were collected from rural areas of Bareilly and Nainital districts. THB, TC, FC and ECI were taken into account of testing. It is enumerated that Maximum THB, TC, FC and ECI were 28,800 mL, 4460, 1480 and 305 per 100 mL of water present in the water samples but a few samples were found free from ECI. However, the well water samples are reported to be unsuitable and unhealthy for drinking without treatment. The following are the causes for deterioration of water quality:

- Improper sanitation
- Protection of well with high input of nitrogenous fertilizer
- Industrial effluents overflow in the well.

When Delwar Hossain and Huda (1997) researched about the concentration of iron in groundwater of deep tube wells situated in Bangladesh, they initiated themselves to ensure whether the drinking water was suitable for our health or not. Water samples were taken from 1000 deep tube wells of the 56 districts. It covered about 86% of total area of Bangladesh. From the findings of the experimental results, it is understood that 41% and 22.5% of the studied area exceed iron concentration of 1.0 mg/L and 5.0 mg/L respectively.

Having the spot study of water quality at Bondamunda of Rourkela Industrial Complex, Shrikanta Naik and Purohit (1998) submitted their proof of identified water quality. Twenty physico-chemical parameters from fourteen sampling points of Bondamunda were continuously monitored for a period of two years. Besides, values which were obtained were compared with standards prescribed by BIS, ICMR and WHO. Findings from the result confirmed us that quality of water at Bondamunda is harmless for drinking although small deviation in pH, turbidity and BOD values were observed in some locations.
Adediji and Ajibade (2005), the Nigerian researchers examined the chemical composition/quality of well water in Ede Area of Southwestern Nigeria and took much interest to ensure whether the available water was suitable for human consumption or not. The pH, TDS and cations concentration such as Ca\(^{2+}\), Na\(^{+}\), Mg\(^{2+}\) and K\(^{+}\) of 21 well water samples were determined by pH meter, Electronic Conducting meter and Atomic Absorption Spectrometer respectively. From the study of the results, it was assured that K\(^{+}\) was the most abundant dissolved cation in the well water. All the dissolved cations such as Ca\(^{2+}\), Na\(^{+}\), Mg\(^{2+}\) and K\(^{+}\) are in conformation with the recommendations of WHO maximum limits. However, the most of the inhabitants of the area depend on well water for drinkable purposes and hence researchers recommended that waste disposal facilities should be arranged at the outskirts of the towns. In this regard, the site of the well should be at least thirty meters away from any source of contamination to make use of well water at the best of its quality.

There are a large number of marble industries at Kishangarh (Ajmer), Rajesthan. So, Madhavi Sharma et al (2005) took up the study about the groundwater quality of marble industrial area. The season-wise water quality of this area was experimented for various physico-chemical parameters like TDS, EC, T.Alk, TH, Cl\(^{-}\) and Ca\(^{2+}\). And it was experimented after adding marble slurry in different proportions. The study gave a clear scientific view that the normal groundwater at marble industrial area of Kishangarh unfit for drinking purpose. It is a naked truth that the marble slurry from the industries had affected the underground water quality.

Nagaraj et al (2005) put forth the analysis regarding the groundwater quality of Mandya taluk, Karnataka, India. The researchers applied the test about the surface and groundwater for the agricultural purposes. Water samples were collected from 70 locations and were analyzed
to determine the physico-chemical parameters including all major ions. The hydrogeochemical facies of groundwater which belong to this area, are found to be dominated by sodium bicarbonate type which indicates that the water is of recent origin. However, it has less residence time in aquifers.

Study areas selected by Agarkar and Thombre (2006) for drinking water quality test are schools of two villages in Buldana District of Maharashtra. The quality of water samples bear the best proof of unsatisfaction by means of examining various physico-chemical and microbiological parameters including pH, turbidity, odour, colour, taste, EC, TS, TDS, TH, DO, Cl⁻, F⁻, Fe³⁺, NO₃⁻, SO₄²⁻, oil & grease and MPN of coliforms. Having conducted test, it was ultimately decided that a few remedial steps should be taken to regulate the supply of the best quality water.

Das Rajib et al (2006) studied the role of electrical conductivity as an indicator of pollution in shallow lakes. Experiments carried out at Subhas Sarovar (lake) and Rabindra Sarovar (lake), Kolkata indicate that EC has a linear relationship with TDS which are validated by the findings at various other lakes throughout the world. When EC increases, there is much increase in TDS, which in turn indicated the increased concentration of sulphates and other ions.

Freeda Grana Rani (2006) selected ten villages of Thirumanur union where the people use groundwater for drinking and the water samples were systematically analysed. The studied different parameters are appearance, colour, odour, taste, turbidity, EC, TDS, pH, alkalinity, TH, Ca²⁺, Mg²⁺, Fe³⁺, Mn²⁺, Na⁺, K⁺, NH₃⁺, NO₃⁻, Cl⁻, F⁻, SO₄²⁻, PO₄³⁻ and Tidy's. The values obtained for different parameters were compared with the standard values given by ISI / ICMR / WHO and the variations were notable for the parameters like NO₃⁻ and TH for a few samples.
Freeda Grana Rani et al (2006) reported the drinking water quality in and around the villages of different panchayat unions in Perambalur district, Tamilnadu. The water quality was found to be satisfactory but the level of nitrates were considerably higher.

The researchers Lenin Sundar and Saseetharan (2006) conducted a study about the ground water quality of Noyyal river basin, Tamilnadu in India not only for establishing the quality criteria of the groundwater but also for assessing the quality in the water of the Noyyal river basin stretching from Perur tank to Sular tank. The chemical analysis for different parameters like pH, TDS, EC, TH, alkalinity, Cl⁻, Na⁺, SO₄²⁻, NO₃⁻, Ca²⁺, Mg²⁺ was carried out. The identified study area, where the pollution level stands marginalized, was investigated by imbibing values of TDS, EC, TH, NO₃⁻ and SO₄²⁻. The investigation discloses that the study area has filled with pollution because of notorious activities carried out by the people for agriculture and industries.

Murugesan et al (2006) selected Uthamapalayam for their research. Water samples were analyzed. It is found that quality of water from various sources such as well, bore well, channel, river, drinking water from lower dam water and drinking water from the river where water is pumped are said to be below the permissible limits except a few well and bore well water samples. It is noticed that water quality of well is not well in Uthamapalayam region and the well is having high amount of mineral content in it.

The Palar and Cheyyar river basins are situated in Southern India. Rajmohan and Elango (2006) researchers examined the role of water level fluctuation on major – ion chemistry of groundwater in the above mentioned rivers. It is assured that the ground water is only a major source of water for agricultural and drinking purposes in this area. Ground water samples were collected once a month from 43 wells respectively from January 1998 to June 1999. They were put into analysis of major ions. The results indicate that the
major ion chemistry of the ground water varies from space to space. The major – ion chemistry, about which the study is undertaken, comes under the control of both mineral dissolution and anthropogenic activities. When the relative contributions of mineral dissolution and anthropogenic contamination are estimated upon the stoichiometric approach, it is identified that mineral dissolution is endowed with the dominant process in the formations.

Dash et al (2007) investigated the bacteriological quality of ground and surface water in the rural areas around Angul – Talcher industrial zone, Orisa. 252 samples from pond, dug wells and tube wells spanning over seven locations in and around the industrial zone, were analyzed bimonthly from July 2001 to May 2003. The study reveals that water in pond was very bad because of microbial quality and it could not be used even for bathing purpose. On the analysis of coliform counts, the water of tube wells is found to be safer and tidier sources than dug wells.

Kumaresan and Riyazuddin (2006) reported the major ion chemistry of environmental samples around sub-urban of Chennai city. Manali, Ennore, Ambattur and Thiruvtrottiyur of North Chennai were chosen for the research areas. The groundwater samples which were collected from thirty-five stations covering the above mentioned four areas during pre and post monsoons of the year 2000–01, were put into analysis for the findings of physico-chemical characters. On the basis of hydrochemical facies, water prevailing in the study area was strongly assessed. Besides, suitability of groundwater for irrigation was acutely evaluated based on the SAR, percent sodium, RSC and the US salinity diagrams.

Similarly Prajapati and Raol (2007) deal with research about the ground water quality of Kalol, an industrial town of Gujart. The bore well water samples were collected from north, south, east, west and central zone of Kalol during summer, winter and monsoon seasons. The researchers involved
themselves in analyzing the physico–chemical and bacteriological parameters like temperature, pH, turbidity, EC, DO, free CO\textsubscript{2}, TH, Ca\textsuperscript{2+}, Mg\textsuperscript{2+}, TDS, T.Alk, Cl\textsuperscript{−}, F\textsuperscript{−}, SO\textsubscript{4}\textsuperscript{2−}, NO\textsubscript{2}−, Fe\textsuperscript{3+} and MPN of coliforms. Among these, T.Alk, TDS, Ca\textsuperscript{2+}, SO\textsubscript{4}\textsuperscript{2−}, Fe\textsuperscript{3+}, F\textsuperscript{−} and MPN count of coliforms were above the permissible limit prescribed by IS:10500, 1991. It was scientifically proved that water which was collected from Kalol town, was rated as unacceptable on account of their TH values. The bore well samples which were collected from south, east and central zones exhibited MPN count above the chosen and desirable limit of 10 coliforms/ 100ml. Therefore, the borewell samples from these zones were quite unsafe and unhealthy for drinking with respect to many parameters. It harms the health of human beings and others.

Both technical experts, Venkatasubramani and Meenambal (2007) in their analytical report about the subsurface water quality in Mettupalayam taluk, Coimbatore, Tamilnadu have assessed the suitability for drinking and irrigation. Based on world health standards, the data were specifically analyzed and it was observed that physical and chemical parameters were within the optimum permissible limits. The study reveals that Mg\textsuperscript{2+}, Na\textsuperscript{+} and Cl\textsuperscript{−} are present in the ground water according to the character of the geological formation.

### 2.3 DATA INTERPRETATION USING GIS

Alam et al (2006) made the full – length risk assessment upon the contaminated surface water system operated by Sylhet municipality. By means of GIS, the analysis of some selected water quality parameters was done. The selected parameters are DO, pH, BOD\textsubscript{5}, As and Fe\textsuperscript{3+} content of water. The DO concentration of most of the samples was more than 6 mg/L. Generally, all the samples have higher values of BOD\textsubscript{5} than 100 mg/L. In the
case of Fe³⁺ content, samples were above 0.3 mg/L. About half of the population (55.22%) comes under very high-risk zone.

Chithar River Basin, Tamil Nadu, India had become a study – centre for the research of Subramani et al (2005) to know about the quality of ground water and its suitability for drinking and agricultural use. Both physical and chemical parameters of groundwater such as EC, pH, TDS, Na⁺, K⁺, Ca²⁺, Mg²⁺, Cl⁻, F⁻, HCO₃⁻, CO₃²⁻, SO₄²⁻, NO₃⁻, B⁻ and SiO₂ were determined. The abundance of the major ions is as follows: Na⁺ ≥ Ca²⁺ ≥ Mg²⁺ > K⁺ = Cl⁻ > CO₃²⁻ > SO₄²⁻ > NO₃⁻ > CO₃²⁻. Groundwater in the area is said to be hard, fresh to brackish, high to very high saline and low alkaline in nature. With the help of GIS, the zonation maps and spatial variation maps were prepared for various water quality parameters to understand its suitability for the various purposes. High TH and TDS in a few places are identified to bring forth unsuitability of ground water for drinking and irrigation.

Regarding the spatial variation of various groundwater quality parameters and their interrelationship in lower Bhavani River basin, Tamilnadu, India, Anandakumar et al (2007) researched. Interpretation of the analytical results of fifteen groundwater samples spreading over the basin suggests that groundwater of the area is mainly alkaline and it seems to be hard in nature. Hardness in ground water becomes formed because of the magnesium embedded with sodium. Higher concentrations of geochemical parameters are sighted in the eastern part of the basin. Concentrations of geochemical parameters exceed the maximum allowable limits for drinking at a certain locations.

Nageswara Rao et al (2007) conducted the study on the hydrochemical characteristics of groundwater in Mehadrigedda watershed of Visakhapatnam district. Twenty eight samples were collected from shallow
groundwater of open wells during December, 2005. The samples were analyzed for various water quality parameters such as pH, alkalinity, EC, TH, Ca$^{2+}$, Na$^+$, K$^+$, Fe$^{3+}$, Cl$^-$, F$^-$, SO$_4^{2-}$, NO$_3^-$ and PO$_4^{3-}$. Based on the analyses, a certain parameters like TDS, Mg$^{2+}$, HCO$_3^-$, CO$_3^{2-}$, percent sodium, SAR and WQI were calculated. With the help of GIS, the spatial distribution of TDS, TH, Cl$^-$ and WQI of the area maps were generated. Through the study, one comes to understand that 7% of the area water is not suitable owing to high TDS concentration, 25% of the geographical area is having more TH and 36% of the area represents excess Cl$^-$. On the whole, 43% of the area contains the good quality of groundwater, 43% contains polluted water while 14% area water is declared unfit for domestic and other uses.

Both Ravishankar and Poongothai (2007) took much interest and research to know about the groundwater quality in the Tsunami affected coastal areas, Tamilnadu, India. The nightmarish tsunami happened on 26th December, 2004. Due to the terrible inundation of giant waves of the tsunami, water lost its original quality. It is true. Water quality in the coastal region had been highly affected. The study had been attempted to find out the source, degree, extension and nature of the groundwater pollution in the chosen research areas. Historical data about the previous groundwater quality was collected before the happening of horrible natural disaster from the year 1970 to 2000. Groundwater samples after tsunami were collected from the study areas. They were put into the scientific and technological analysis for water quality parameters. With the help of ILWIS-GIS package various maps were prepared. It was experimentally proved that major pollution prevailed due to EC, Na$^+$ and Cl$^-$. In consequence of the tsunami, there was significant degradation in the original water quality.

Vennila et al (2008) reported a detailed study on hydrochemistry of groundwater in Vattamalaikarai Basin, Tamilnadu, India. The study describes
the GIS. The motto of the research was to find out the quality of groundwater and to determine the suitability for drinking. Further, the spatial variation of various groundwater quality parameters over the basin has also been studied in the year 2008. Fifty nine groundwater samples spread over the basin have been collected from open and tube wells in the month of January 2008. The physico-chemical parameters have been compared with the standard guideline values are recommended by WHO for drinking and public health. The abundance of major ions in groundwater is present in the following order: Na$^+$ > Mg$^+$ > Ca$^+$ > K$^+$ = Cl$^-$ > SO$_4^{2-}$ > HCO$_3^-$ > NO$_3^-$ > CO$_3^{2-}$. TDS widely varied from 124 to 4270 mg/L with an average value of 1422 mg/L. But it exceeded the maximum allowable limit of 1500 mg/L at twenty four locations and led to the unsuitability of groundwater in nearly 40% of the total basin area. Groundwater of the basin belongs to hard to very hard water category since the TH exceeds the permissible limit of 500 mg/L prescribed for drinking water. NO$_3^-$ concentration present in groundwater also widely varies from 0 mg/L to 647 mg/L with an average value of 125 mg/L. Forty four well samples out of 59 exceed the maximum allowable limit of 45 mg/L (60% of the total basin area). F$^-$ is found in ground water (> 1.5 mg/L) at 17 locations, which may cause dental fluorosis.

2.4 DATA INTERPRETATION USING MULTIVARIATE STATISTICAL METHODS

Erin Carlson and Ecker (2002) applied statistical methods to derive solution about the water quality in two Iowa lakes. Two Iowa lakes, Silver Lake and Casey Lake were chosen for study by a team of biologists, chemists, earth scientists and statisticians from the University of Northern Iowa. They had such aim that they wanted to statistically compare the water quality of the two lakes yearly and probe the change in terms of water quality variables for a period from 1999 to 2000. Apart that, they invented the variables which
affected phosphorus levels in each lake in the year 2000. At last, they explored the spatial distribution of phosphorus in the sediment of each lake. From the DA and ANCOVA one can find out significant difference between the two lakes in years 1999 and 2000 and a change in Silver lake's water quality data from 1999 to 2000. From the regression analyses, one could understand that, in Silver Lake, phosphorus levels increased during the summer of 2000 while they decreased with increasing levels of surface DO and decreased as the water became less clear. The analyses also show that phosphorus levels in Lake Casey decreased as the water became less clear. A significant relationship between phosphorus in the sediment and depth exists in Lake Casey. While a significant 2-dimensional spatial correlation is not shown in Silver Lake, spatial analyses show the existence of a prominent 3-dimensional spatial correlation in Lake Casey.

Sivasankaran et al (2005) took much involvement to understand the geochemical characteristics of groundwater in Pondicherry region, India through their deep research. The research went on for three seasons during the year 1994 – 1995. Groundwater samples were collected from 42 bore wells in Pondicherry region. The collected samples were put into analysis for pH, EC and major ions (Ca$^{2+}$, Mg$^{2+}$, Na$^+$, K$^+$, Cl$^-$, HCO$_3^-$, CO$_3^{2-}$, and SO$_4^{2-}$). The distribution of major ions and their variations with seasons, inter-elemental correlation were discussed at length. The mean of dominant cations and anions of groundwater of Pondicherry region were kept in the order of HCO$_3^-$ > Cl$^-$ > SO$_4^{2-}$ and Na$^+$ > Ca$^{2+}$ > Mg$^{2+}$ > K$^+$ (meq/L) respectively. FA which was applied to widely differing sets of groundwater hydrochemical data appeared successful as statistical tool for revealing hydrochemical as well as hydrogeological features. Except a few locations, the water is found suitable for drinking and irrigational purposes in the study area.
Through Multivariate Statistical Methods i.e., CA and DA, Feng Zhou et al (2007) found that the temporal and spatial variations in the water quality of the watercourses in Northwestern New Territories, Hong Kong, for a period of five years from 2000 to 2004. Twenty three parameters at 23 different sites were applied. Total observations come to 31,740. Hierarchical CA grouped the 12 months into two periods (the first and second periods) and classified the 23 monitoring sites into three groups (group A, group B, and group C) based on similarities of water quality characteristics. DA provided good results with great discriminatory ability for both temporal and spatial analysis. DA also provided an important data reduction because it only used six parameters (pH, temperature, five-day biochemical oxygen demand, FC, Fe$^{3+}$, and Ni) for temporal analysis, affording about 84% correct assignations, and seven parameters (pH, ammonia–nitrogen, nitrate nitrogen, FC, Fe$^{3+}$, Ni, and Zn) for spatial analysis, affording more than 90% correct assignations. Therefore, DA allowed a reduction in the dimensionality of the large data set and indicated a few significant parameters that were responsible for the most of the variations in water quality. Thus, this study demonstrates that the multivariate statistical methods are useful for interpreting complex data sets in the analysis of temporal and spatial variations in water quality and the optimization of regional water quality monitoring network.

Hulya Boyacioglu and Hayal Boyacioglu (2007) found that the surface water quality assessment through research – oriented thoughts. They had handled environmetric methods. Their chosen area for research was basin of the Buyuk Menderes River and its tributaries in Turkey. Eleven variables were measured to assess the water quality at 17 sampling sites. FA was set forth to explain the correlations through keen observations in terms of underlying factors. In the results, illustration was shown that the water quality was strongly affected from agricultural uses. CA was used to classify stations with similar properties and results distinguished three groups of stations.
Water quality at downstream of the river was totally different from the other parts. Under recommendation, it was approved that there was necessary for the environmetric data treatment as a substantial procedure in assessment of water quality data.

The urban water quality evaluation submitted by Petr Praus (2007) using multivariate analysis provoked scientific thinking. There was a data set through which water quality for drinking were analyzed thoroughly. PCA reduced the data dimensionality from 18 original physico-chemical and microbiological parameters determined in drinking water samples to 6 principal components with explaining about 83% of the data variability. These six components consist of inorganic salts, nitrate/pH, iron, chlorine, nitrite/ammonium traces, and heterotrophic bacteria. By Using the PCA scatter plot and the Ward's clustering of the samples characterized by the first and second principal components, three clusters were revealed. These clusters were sorted drinking water samples according to their origin - ground and surface water. The PCA results were confirmed by the FA and hierarchical clustering of the original data.

By handling PCA Rezwanul Mahmud et al (2007) examined the irrigation water quality in an arsenic affected area, Bangladesh. The research took place in and around Budhol union in Brahmanbaria, Bangladesh and pointed out the arsenic contaminated underground water. Three were three types (surface, shallow tube well and deep tube well) of irrigation water samples which were collected for physio-chemical analyses including pH, EC, TDS, Ca$^{2+}$, Mg$^{2+}$, Na$^{+}$, K$^{+}$, Fe$^{3+}$, Zn, Cu, Mn$^{2+}$, P, B$^{-}$, As, HCO$_3^-$, CO$_3^{2-}$, Cl$^-$, SO$_4^{2-}$ and NO$_3^-$'. Comparative study was made and the distribution pattern of anionic and cationic constituents were performed for three types of arsenic contaminated irrigation water sources. Among the water sources, surface irrigation water was found less arsenic and manganese toxicity for
irrigation. On the other hand, shallow tube wells water used for irrigation purpose contain more soluble arsenic than surface water and deep tube wells. Depth of tube well was correlated with arsenic concentration of well water. In order to understand the distribution of individual geochemical variables in the irrigation water samples collected from the sites affected by arsenic toxicity, principal component analysis was performed. The results of principal component analysis showed that geochemical variables have tendency to accumulate into three distinct groups. Well depth, arsenic and Mn$^{2+}$ belonged to one group, which indicated that Well depth might have positive effect on As and Mn$^{2+}$.

Yogendra and Puttaiah (2007) made a technical survey about the water quality assessment in the Tunga River by means of FA. Variations in land-use by the human activity might have affected the river water quality. It was observed that the water quality in this river was immensely affected by the agricultural pollutants and urban wastes. Through this research, variations in the quality of water in different locations were acutely observed.

Multivariate statistical methods are based on FA, PCA and CA. The foreign researchers Hulya Boyacioglu and Hayal Boyacioglu (2008) who handled environmetric methods for the surface water quality assessment in the year 2007 took research about prevailing water pollution also in the Tahtali Basin, Turkey. They applied FA and PCA results revealed that surface water quality was mainly controlled by agricultural uses and domestic discharges. CA generated two clusters. Based on the locations of the sites consisted by each cluster and variable concentrations at these stations, it was concluded that agricultural discharges strongly affected north and northeast part of the region terribly. From these methods, one could understand complex nature of water quality issues and would allot priorities to improve water quality in prosperous way.
Najafpour et al (2008) evaluated the temporal/spatial variations and interpretation of a large complex water-quality data set of Shiroud River that discharges to southern part of Caspian Sea, Iran. Totally 16 parameters of water quality were monitored during 12 months at 8 sites in mountainous, flat and estuary areas. Through FA, one could learn that the first factor explained 25.76% of the total variance [comprise of EC, TDS, TH, Ca$^{2+}$ and water temperature levels]. As far as the second factor is concerned, the water quality indicator factor explained 13.99% [comprise of silicate, DO and pH levels]. The third factor so called phosphate pollutant factor explained 10.72% [comprise of orthophosphate and TP]. Additional factors were affected by part of nutrient, flow rate and general water quality, each of them recorded variance less than 10%. DA gave the best results about spatial and temporal analysis. It has provided an important data reduction as long as it uses only four parameters (mean river depth, DO, NH$_4^+$ and EC). DA allowed a reduction in the dimension of the large data set, explained a few indicator parameters accountable for large variations in water quality.

Sojka et al (2008) executed a few multivariate statistical techniques to evaluate the water quality in the Mała Wełna River, Western Poland. The researchers collected samples for the physico-chemical analysis at eight gauging cross-sections once a month between May and November in the year 2006. Multivariate statistical methods which consist of data analysis, viz. CA, FA, PCA and DA were handled to assess the physico-chemical composition of surface water. Having observed similarities and differences in the physico-chemical composition of water in the gauging cross-sections, it was possible to identify the water quality indicators suitable for characterizing its temporal and spatial variability, and to uncover hidden factors accounting for the structure of the data and to assess the impact of man-made sources of water pollution.
2.5 DATA INTERPRETATION USING WATER QUALITY INDEX

Chinmoy Chatterjee and Raziuddin (2002) handled the WQI to study a degraded river. The Nunia in Asansol industrial belt, West Bengal for a period of one year from May 2000 to April 2001 was chosen for the research. Six locations were selected for test and study. This investigation aimed to calculate WQI of the river and to assess the impact of industries, agriculture and human activities on the water quality. Eight physico-chemical parameters such as pH, TDS, T.Alk, TH, Cl⁻, SO₄²⁻, DO and BOD were monitored for the calculation of WQI during the summer, monsoon and winter seasons. Through the results, it was found that water at these stations was severely polluted due to the dumping of wastes and residues of industries, hospital, domestic and agricultural sources into earth. The water at all sampling stations was recorded above the upper limit in terms of WQI which indicated that the river water was not safe for human use.

Both Ibrahim Bathusha and Saseetharan (2006) threw themselves heart and soul into investigation about the WQI assessment for pre-monsoon groundwater in Coimbatore city North zone. This zone consisted of 18 wards; from each ward, two samples were collected from two different locations, totaling 36 samples. Water quality assessment was carried out for the parameters like temperature, odour, taste, colour, turbidity, pH, EC, TDS, Cl⁻, TH, T.Alk, Ca²⁺, Na⁺ and Mg²⁺. Regression equations, relating highly correlated parameters were formulated. Water quality parameters were estimated by means of regression models. Considering the observed and estimated water quality parameter values, WQI for the groundwater sampling locations was calculated. Comparison of observed and estimated values based on the water quality indices and statistical analysis revealed that the regression equations developed can be very well used for making water
quality monitoring by observing the EC alone. Of course, it is an easy and rapid method of monitoring of water quality. Definitely it becomes easy to compare the quality levels in different locations with each other and gives priority for the required treatment to any affected location.

WQI about the ground water handled by Chaturvedi et al (2008) showed its evaluation correctly. Groundwater was tested near industrial areas of Balrampur, where one of the largest sugar factories of India, i.e. B.C.M Ltd. including one distillery unit and one power plant are situated. Apart from that there are 72 small and large scale industries functioning. The groundwater samples were, at a stretch, collected from three different sites based on different depths. The physico-chemical parameters like pH, TDS, DO, TH, \( \text{SO}_4^{2-} \), \( \text{Ca}^{2+} \), \( \text{Mg}^{2+} \), \( \text{NO}_3^- \) and \( \text{Cl}^- \) were acutely analyzed and compared based on WQI. This determines the water quality for various purposes like irrigation and potable purpose. The result indicates poor status of water. Comparative study of three different sites indicates that the groundwater near industrial areas of Balrampur city is not at all healthy and unsuitable for human and animals’ consumption.

Mishra and Srivastava (2008) took the groundwater quality of Tulsipur town at Indo-Nepal border for their research. Groundwater samples were taken from hand pumps from three depths i.e. 10-12 meter, 20-25 meter and 30-35 meter. To evaluate the extent of groundwater pollution, a number of physico-chemical and biological parameters were determined by standard techniques and compared with WHO and ICMR. A new single parameter called WQI, which took into account the effect of all parameters, was also evaluated. WQI is proved to be quite capable of evaluating the suitability of a water sample for a particular use like domestic, industrial or agricultural purposes.
Through the study of literature is made to know about the worst water quality available and the best water quality changeable. One understands that water pollution has been becoming a grave problem. Researchers try hard to identify the locations and come forward to suggest alternative methods to prevent the impending danger through water. Without water, nothing can exist on the earth. It is great challenge to the scientists to put an end to the water pollution and retain the pure water all along. Water quality evaluations awaken the spirit of enquiry and curiosity in the minds of researchers to keep the human beings safe and healthy through their innovative methods in future.