2.1 Definitions and Concepts

2.1.1 Groundwater

*Definition:* “The water contained in the rock openings underneath the surface of ground”. It is regulated by the quantum and speed of rains, extent of vaporization, temperature and slope of land, dryness of air, porosity and permeability of rocks, vegetative cover and water absorbing capacity of the soil. It is also called sub-surface water since it is found below the surface of earth.

2.1.2 Water Table

*Definition:* “The water table is the imaginary surface in an unconfined aquifer at which the pressure is atmospheric or it is the surface representing the top of the saturated zone, below which all pores in the rock matrix are filled with water or it is defined by the levels at which water stands in wells that just penetrate the top of the water body” (Lohman, 1972).

The position of the water table is related to depth below the earth surface and elevation above a datum. Depth of water below the earth surface is referred to as “depth to water table or unsaturated zone thickness”. The elevation of the water table above a datum is referred to as “water-table elevation”. The datum here is mean sea level (msl). Depth-to-water value and water-table elevation are related in the following way:

\[
\text{Water-table elevation} = \text{land-surface elevation (meters above msl) – depth to water below land surface}
\]

Depth to water level (bgl) provides information about storage, recharge and discharge within an aquifer. Long-term data of groundwater level can be useful to develop groundwater models (Taylor and Alley, 2001).

2.1.3 Depth-to-Water Table Map

*Definition:* “a map of a specific region that display the spatial distribution of the depth of the water table below the ground level, also called isobath map”.
2.1.4 Water Table-Fluctuation Map

*Definition*: “a map that shows the amount of the change in water table over a period of time (such as a season or a year)”.

2.2 Long Term Groundwater Level

In this study, the geostatistical analyst in ARCGIS has been applied for analyzing spatial and temporal variations of groundwater level fluctuations. GIS has been widely used in such cases where spatial and temporal analysis is required (Chaudhary *et al.*, 1996). Sophocleous *et al.*, 1982 have applied the geostatistical analysis on water table data of observation wells in the northwest Kansas. They applied kriging method for the preparation of water table elevation and standard deviation error maps. Furthermore, they have recommended a network for groundwater management based on the standard deviation error map.

Olea and Davis (1999) have also applied the kriging method to make an approximation of the water level using the cross-validation method. Christakos, 2000 have also applied the geostatistical analysis on the water table data of seventy observation wells in Kansas. He has prepared the water table elevation maps for many years and determined the decline in groundwater level. He has also prepared the standard deviation maps and proposed new observation wells in the region with the help of standard deviation maps.

The spatial and temporal variations in the groundwater table have been investigated by many researchers. Finke *et al* (2004) and Ahmadi *et al*, 2007 used kriging for mapping of groundwater level to identify critical area. Antonellini *et al* (2008) have used kriging technique to prepare salinity and water table maps of the coastal area of the southern Po Plain, Italy to identify the causes and extent of seawater intrusion. Rakad *et al*, 2009 have applied the geostatistical approach to study the temporal and spatial variations of groundwater level fluctuations in the Amman–Zarqa basin, Jordan.

2.3 Groundwater Quality Parameters

2.3.1 Physico – Chemical Characteristics of Groundwater

*pH*

The pH value is an important index to check the acidity or alkalinity of a solution i.e., groundwater in this study. It is defined as the hydrogen ion concentration in
groundwater. The pH value varies from 0 to 14. The value 7 is neutral i.e., neither acidic nor alkaline. A value below 7 means groundwater is acidic and a value above 7 is alkaline (or basic) (U.S. EPA, 2007).

Minerals and organic substances are important factors to give the resultant pH value. These interact with groundwater and change the pH value. Acidic water can damage the pipes made of metals such as copper, lead and zinc. These metals then percolate in groundwater. They can also cause aesthetic problems like sour taste and laundry staining. (U.S. EPA, 2007). High pH value (above 8.5) in groundwater indicates that high levels of alkalinity minerals are present (Rose, 1986). High alkalinity does not cause health problems, but can cause an alkali taste to the water. According to the BIS standards, a pH level between 6.5 and 8.5 is suitable for drinking water.

**Temperature**

It is an important factor for the chemical and biological reactions of organisms in groundwater. The rise in temperature decreases the sweetness of water because at high temperatures carbon dioxide and other volatile gases, which impart taste, are expelled. High water temperature enhances the growth of microorganisms and may change taste, color and odor.

**Electrical Conductivity (EC)**

It is the ability of water to conduct electricity. It is directly proportional to the total dissolved solids.

**Total Dissolved Solids (TDS)**

TDS are expressed by the weight of the residue left when a water sample has been evaporated to dryness. It decides the quality of groundwater. The presence of excessive solids in water indicates pollution. High level of TDS may not be good for bathing and washing. The main reasons for high TDS are geological parameters and agricultural activities. The most common chemical constituents of TDS are calcium, magnesium, sodium, potassium, phosphates, nitrates, sulphates, and chlorides. Some of these chemical constituents dissolve in groundwater through the rock-water interaction. Other constituents such as nitrates and phosphates are due to agricultural activities. Higher the
TDS higher will be the Electric conductivity and water will show higher salinity. Quality of groundwater can be predicted with sufficient accuracy by EC alone:

\[ TDS = 0.64 \times EC (\mu S/cm) \]  \hspace{1cm} (2.1)

**Total Hardness (TH)**

It is used to decide the suitability of water for domestic, agricultural and industrial purposes. The hardness is due to the presence of calcium and magnesium salts, which are due to rock-water interaction. It leads to the heart diseases and kidney stone formations.

**Alkalinity**

Alkalinity measurement can be used to determine the bicarbonate and carbonate concentration of the groundwater. This is an important measurement because bicarbonate is often the dominant anion in shallow groundwater. It is due to the presence of various ions such as \( \text{OH}^{-}, \text{HCO}_3^{-}, \text{PO}_4^{3-}, \text{and BO}_3^{3-} \). Beyond the limit defined by BIS, the taste of water becomes unpleasant (sour taste and saline). A little unusual value of alkalinity is not harmful to human beings.

**Sulphate \((\text{SO}_4^{2-})\)**

It is not a major constituent of most of the rocks except some evaporate deposits like gypsum & anhydrite. Pyrite is one of the common sulphide minerals that is found extensively, although in small quantities, in most of the rocks. The excess amount of sulphate causes diarrhea. It produces unpleasant taste at 300-400 mg/l, bitter taste at 500 mg/l and laxative effect and causes gastrointestinal irritation at 1000 mg/l.

**Chloride \((\text{Cl}^{-})\)**

It occurs as a very minor constituent of rock forming minerals. There are few minerals like sodalite & chlorapatite, which are very minor constituents of rocks. Therefore it is assumed that bulk of the chloride is primarily from atmosphere, which is later concentrated due to climate influence especially in arid zones. Natural chloride is from the rock salt (NaCl). Domestic sewages can also add substantial amount of chloride to groundwater. High chloride causes corrosion of metal pipes or iron plates and harmful to agricultural crops.
Fluoride (F\(^{-}\))

It is an essential element for life. It is the most electronegative of all chemical elements. Most of the fluoride in groundwater is due to water interaction with fluoride bearing mineral rocks. The important fluoride bearing minerals are fluorite, apatite and certain amphiboles & micas. There are other sources of fluoride, such as:

- Infiltration of chemical fertilizers in agricultural areas
- Discharge from septic and sewage treatment plants in communities with fluoridated water supplies
- Toxic waste from industries

The fluoride content in drinking water below 0.5 mg/l or above 1.5 mg/l can have an effect on bone and teeth structure. Rajasthan is one of the states with highest fluoride concentration in groundwater. Many places in Rajasthan have water with fluoride up to 44 mg/l.

Nitrate (NO\(_3\)^{-})

The most common pollutant recognized in groundwater is dissolved nitrogen in the form of Nitrate (NO\(_3\)). Nitrogen is a very minor constituent of rock but is a major constituent of atmosphere. Frequent and abundant use of fertilizers due to intensification of agricultural activities, decayed vegetables and animal matters, domestic effluents, sewage, industrial discharges etc contribute to increased nitrate concentration. If nitrate in the soil is neither lost in runoff nor used by the plants or transformed to nitrogen gas, then it percolates down the earth during rainfall (Keeney, 1986). High or low water table and the rainfall are also important factors for nitrate concentrations in groundwater (Jacks et al, 1983). High nitrate in groundwater causes a disease methaemoglobinemia (a kind of anemia).

Calcium (Ca\(^{2+}\)) and Magnesium (Mg\(^{2+}\))

Both these constituents are essential elements to human health. The probable origin for calcium and magnesium is the rock – water interaction. Calcium is found in minerals like plagioclase, pyroxene & amphibole among igneous & metamorphic rocks and limestone, dolomite & gypsum among the sedimentary rocks. Magnesium is found in minerals of igneous rocks such as amphibolites, pyroxenites; volcanic rocks such as basalt; metamorphic rocks such as tremolite schist, hornblende schist and sedimentary deposits
such as dolomite. Sewage and industrial wastes can also add calcium and magnesium to the groundwater.

Calcium is an important element of bones and teeth. Similarly, magnesium plays an important role as a cofactor and activator of more than 300 enzymatic reactions (Kozisek, 2004). Studies suggest that the intake of soft water, i.e. water low in calcium, may be associated with higher risk of fracture in children (Verd et al., 1992), certain neurodegenerative diseases (Jacqmin et al., 1994) and pre-term birth (Yang et al., 2002). In addition to an increased risk of sudden death, studies (Eisenberg, 1992; Bernardi et al., 1995; Garzon et al, 1998; Iwami et al., 1994) reported that the intake of water low in magnesium seems to be associated with a higher risk of motor neuronal disease and pregnancy disorders (Melles et al, 1992).

Sodium (Na\(^+\))
Sodium salts (e.g., sodium chloride) are found in all foods and in groundwater also. The rock forming minerals bearing sodium are albite – plagioclase feldspar members, nepheline, sodalite, halite, glaucophane and aegirine. Of these the feldspars are the only commonly occurring minerals while other minerals are of minor occurrence. Apart from these rock–forming minerals, the other important sources of sodium are precipitates of sodium salts in soil and salt water lakes called ranns. Heavy concentration of sodium chloride in drinking water gives a saline taste and is generally not accepted for domestic purpose.

The spatial and temporal distribution of groundwater quality can be effectively presented with the help of GIS technologies. GIS is an effective tool for preparing maps of groundwater quality parameters. Groundwater quality maps are useful for identifying locations that have a severe contamination. The main aim of this investigation was to provide an insight of present groundwater quality corresponding to chemical constituents such as calcium, sodium, magnesium, potassium, nitrate, chloride, sulphate, fluoride, pH, EC, TDS, total hardness, and alkalinity levels. Geostatistical analysis was used to determine the spatial and temporal distribution of groundwater quality in terms of WQI in the study area.
Several ground water related studies have been carried out by many researchers to determine prospective sites for groundwater evaluation and to prepare maps of groundwater quality parameters using GIS.

Barber et al. (1996) conducted a GIS-based study to determine the effect of urbanization on the groundwater quality. They performed this study in relation to land-use changes. Ducci (1999) performed a study in Southern Italy and used GIS to produce the groundwater quality maps and suggested that the use of GIS technique is vital and enables the testing and improvement of the groundwater contamination risk assessment methods.

Asadi et al. (2007) used the remote sensing and GIS techniques for the evaluation of groundwater quality in Municipal Corporation of Hyderabad (Zone-V), India. GIS can be used as a database system to prepare water quality maps corresponding to the concentration of various chemical constituents. With the help of these maps, those groundwater quality zones can be easily located that are suitable for drinking, irrigation and domestic purposes (Yammani S., 2007). Singh and Lawrence (2007) successfully created groundwater quality maps using GIS for Chennai city, Tamilnadu, India.

Remesan and Panda (2008) conducted a study “to examine the pollution level of various contaminants in the watershed of Kapgari” and generated various maps by using GIS environment.

Nas and Berktay (2010) created the maps of urban groundwater quality using GIS in Koyna, Turkey. They also emphasized that these maps are very important to assess the groundwater quality for drinking and irrigation purposes. Ishaku et al. (2011) generated the chemical indices for the groundwater quality in Jada, Northern Nigeria. They generated the water quality maps for different parameters by using IDW interpolation technique.

2.3.2 Factors Affecting Groundwater Quality

Influence of Lithology

Rajasthan possesses a veritable range of mineral deposits such as zinc, lead, silver, cadmium, marble, tungsten, gypsum, soap-stone, rock phosphate, asbestos, clay, calcite, feldspar, copper, silica, quartz, limestone, mica, barites, fluorite, graphite etc.
Groundwater when exposed for long periods to such minerals seep out some minerals into the groundwater, thus changes the concentration of the chemical constituents.

**Influence of Climate**

The chemical concentration of the ions leached by percolating rainwater from the rock/soil forming minerals is modified in the aquifer by many other factors. One such factor is the climate. Temperature, rainfall, evaporation etc have an overall roll in modifying the chemistry of groundwater. Earlier studies in India and in World have proven that groundwater of arid and semi-arid regions are characterized by highly brackish quality as well as the individual cations and anions are also found in higher concentration (Sreenivasan, 1998 and Karanth 1989). The extreme climatic condition is an important controlling factor guiding the hydrogeochemical patterns of groundwater in Rajasthan. Very low rainfall, high temperature, evaporation and transpiration may increase the concentration of the chemical constituents in groundwater.

**Influence of Geomorphology**

Geomorphology is the combined result of many physical processes, which is controlled by the geology, intensity of weathering, soil type, slope/altitude, drainage and a number of other factors. The geomorphology/land forms of a region also control the groundwater movement and quality. Studies carried out in the semi-arid region of Bellary district, Karnataka indicated that the groundwater quality especially fluoride, is controlled by the geomorphology of the area apart from the other factors (Sreenivasan, 1998).

**Influence of Anthropogenic Activities**

Due to the increasing population growth and urbanization, human activities are continuously increasing and man is causing water pollution by these activities. Water pollution is caused by agriculture waste, effluent of chemical substances from industries and domestic disposal.

Agricultural effluents include the process of flowing of insecticides and other chemicals used in agriculture along with water. At present, fertilizers, pesticides and insecticides are being used for increasing agricultural productivity. Every industry disposes off used water either in rivers or in surrounding areas. Water disposed of by industries contains carbonic and non-carbonic elements dissolved in it and some of them are poisonous.
All such disposed waste mixes with surface water and pollutes groundwater. Water pollution on account of natural elements may be improved in a natural way, but water polluted by human activities may not be improved in any way.

### 2.3.3 Water quality standards/guidelines

Various parameters used in the study have desirable and permissible values as per the BIS standards (2012). Table 2.1 lists the standard values of these parameters for drinking purpose.

**Table 2.1: Groundwater standards of Chemical Parameters for Drinking Purpose (BIS, 2012 and WHO, 2006)**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>BIS Standards</th>
<th>WHO Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Desirable</td>
<td>Permissible</td>
</tr>
<tr>
<td>1</td>
<td>EC as µS/cm</td>
<td>750</td>
<td>3000</td>
</tr>
<tr>
<td>2</td>
<td>Total Dissolved Solids as mg/l</td>
<td>500</td>
<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>Total Hardness as mg/l</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>4</td>
<td>pH</td>
<td>6.5 – 8.5</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Sodium as mg/l</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Potassium as mg/l</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Calcium as mg/l</td>
<td>75</td>
<td>200</td>
</tr>
<tr>
<td>8</td>
<td>Magnesium as mg/l</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>9</td>
<td>Chloride as mg/l</td>
<td>250</td>
<td>1000</td>
</tr>
<tr>
<td>10</td>
<td>Sulphate as mg/l</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>11</td>
<td>Nitrate as mg/l</td>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>12</td>
<td>Fluoride as mg/l</td>
<td>1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### 2.4 Water Quality Index

Water quality of an area can be evaluated using various parameters such as physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred more than the defined limits prescribed by various agencies (BIS, WHO). Water quality monitoring and reporting the results has always been a challenge for the scientists. They generally deliver the reports concerning the water quality status and trends in terms of individual water quality variables. These reports can be easily interpreted by professionals, but the general public and the policy
makers cannot easily understand these. Political decision-makers and the general public usually have not been provided sufficient training to study and understand these reports. There is a strong need to develop tools to effectively address this problem. One of the ways to solve this problem is using Water Quality Index (WQI).

WQI reduces the data from various parameters into a single value to express data in a simplified and logical form (Babaei et al. 2011). It makes the policy makers and the general public aware about water quality of the specific area (Nasirian M. 2007). Many researchers have attempted to formulate the WQI. Initially, WQI was developed by Horton (1965) in United States using various water quality variables. Furthermore, a new WQI similar to Horton’s index has also been developed by a group with Brown in 1970 (Brown, R.M. et al 1970). It was based on the weights to individual parameters. Many modifications have been made for WQI concept by various scientists and experts (Bhargava, D.S 1998).

However, a large number of water quality indices have been formulated by several national and international organizations viz. National Sanitation Foundation Water Quality Index (NSFWQI), Weight Arithmetic Water Quality Index (WAWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), Oregon Water Quality Index (OWQI) etc.

Researchers have suggested many mathematical aggregation functions for water quality indices. The different aggregation functions can be of type additive, multiplicative, minimum or maximum. Every function is having its own advantages and disadvantages and applicable in restricted situations. A function that minimizes the overestimation (ambiguity) and underestimation (eclipsing) is the most suitable aggregation function.

WQI has been regarded as one of the most effective way to evaluate the quality of water (Tiwari and Mishra 1985 and Sinha et al 2004). Stigter et al (2006) have applied the WQI “as an assessment and communication tool in agro-environmental policies”.

Sinha and Ritesh (2006) find the WQI for drinking water at Hasanpur, J.P Nagar for 10 different sites, and concluded that the water is severely contaminated at almost all the sites of sampling. They proved WQI is an important tool for the assessment of water
quality. WQI relates a group of water quality parameters to a common scale and combines them into a single number by choosing an appropriate method (Mohsen 2007).

Yidana (2010) used water quality index and multivariate analysis for assessing the water quality and reported that 98% of the samples were good for drinking purpose. Vasanthavigar et al. (2010) applied WQI to study the groundwater quality of Thirumanimuthar sub-basin, Tamil Nadu and reported the huge seasonal variation during the pre-monsoon and post-monsoon seasons. Abdul Hameed et al (2010) made a study on application of WQI for the assessment of Dokan Lake ecosystem, Kusrdistan, Iran. Their results revealed that water quality of lake declined from good to poor from 1978 to 2009. Rizwan and Gurdeep (2010) created the WQI using 24 groundwater samples to assess spatial and temporal changes in groundwater quality in Angul-Talcher region of Orissa, India. Saeedi et al. (2010) applied eight different parameters including K, Na, Ca, Mg, SO\textsubscript{4}, Cl, pH, and TDS as the most important components of healthy water to develop a groundwater quality index in Iran.

Rita et al (2011) made a study on seasonal variation and WQI of Sabarmati River at Ahmedabad, Gujarat, India. The results of their study discovered that the quality of Sabarmati River was adversely affected by domestic, agricultural and industrial effluents. It was only because of the growing urbanization. Rajankar et al. (2011) studied the groundwater quality and water quality index at Bhandara District. This study showed that the water quality was deteriorated in the post-monsoon season. Das et al (2012) made a study of drinking water of Balasore district, Odissa, India. They evaluated the water quality using WQI. Sriniwas Rao et al (2013) applied the WQI to evaluate the groundwater quality of Greater Vishakhapatnam city.

Researchers had also generated the water quality index in the study area, but only for a small part of the state. Yadav A.K. (2010), Jajawara S. et al (2013), Ankita Mathur et al (2015) assessed the groundwater quality using WQI in Tadaraisingh Tehsil, Chandraloi river near Kota, and Jaipur district of Rajasthan respectively.

Review made in the journals and publications reveal that WQI study will be helpful for monitoring and prediction of the water quality.
2.4.1 GIS in Water Quality Index

Babiker et al. (2007) proposed a WQI method based on GIS which fused different water quality data into a single value relative to WHO standards. Singh and Khan (2011) assessed the groundwater quality of Pune, India by using a spatial interpolation technique IDW to produce the spatial distribution maps of various groundwater quality parameters and water quality index. Their results showed that the groundwater is suitable for drinking and domestic purposes. El-Hames et al. (2011) worked on a classification approach by which zones with acceptable groundwater quality for drinking were classified using water sample analysis methods and GIS capabilities, in Saudi Arabia.

Latha et.al (2012) studied the groundwater quality in Upper Pincha Basin, Chittoor District, Andhra Pradesh, India. They made use of GIS techniques for mapping the water quality indices. They generated the spatial distribution maps of different water quality parameters by using IDW technique and demarcated the areas of suitable/unsuitable water quality. Magesh et al (2013) did a case study in Virudunagar District, Tamil Nadu and suggested that WQI and GIS are promising tools to understand the spatial distribution pattern of groundwater quality.

The other main objective of the present study is to evaluate the groundwater quality of Rajasthan State by developing the water quality index and generating WQI map.

2.5 Geo-Statistical Analysis

Geo-statistical methods are good tools for water resources management and can be effectively used to derive the long-term trends of the groundwater (Reghunath R., 2005). ArcGIS Geo-statistical Analyst tool plays an efficient role in creating a continuous surface map from measured sample points. The data stored in the point layer can be depth to the water table or water table elevation or water quality data. Comprehensive set of tools provided by Geo-statistical Analyst can be used for creating surfaces and to visualize, analyze, and understand spatial phenomena.

There are two main groups of spatial modeling techniques (interpolation techniques): deterministic and geo-statistical. Deterministic techniques include IDW, global polynomial interpolation, local polynomial interpolation and radial basis functions. Geostatistical techniques include kriging / cokriging, areal interpolation and empirical
Bayesian kriging. Kriging / cokriging methods are of ordinary, simple, universal, indicator, probability, and disjunctive kriging types.

Many researchers applied geostatistical techniques for spatial distribution of groundwater parameters. The spatial distribution of groundwater constituents shows some heterogeneity and it is not feasible to collect the data of every possible location in the specified area due to the heavy cost and more time involved in data collection. Therefore, only alternative is to predict the values at unknown locations by making use of values of known locations. To perform this prediction, the geo-statistical methods such as kriging can be used.

The basic assumption in using geo-statistics is that the properties of the earth have some spatial continuity up to a certain lag distance. Kriging method considers the spatial correlation between the sample points (Ella et al, 2001). Kriging is distinguished from IDW and other interpolation methods by taking into consideration the variance of estimated parameters (Buttner et al, 1998). It is recognized that the geo-statistical approach has several advantages over the deterministic techniques (Isaaks et al, 1989; Goovaerts P, 1997). A detailed comparison of all the geostatistical methods is given in the Appendix C.

Barca et al. (2008) used disjunctive kriging to prepare nitrate hazard map in the Modena plain of Italy. Their results showed that the applied method is the suitable one to study the declining quality of Groundwater. Delgado et al. (2010) applied kriging method to prepare groundwater quality maps for various parameters in Yukatan, Mexico. On the basis of these maps, they classified the study area into different zones and demarcated the suitable zones for agriculture purpose.

Adhikary et al. (2010) assessed the groundwater pollution in West Delhi, India and analyzed spatial variability of groundwater quality. They made use of indicator kriging to generate the probability maps of groundwater contaminants. Hooshmand et al. (2011) applied kriging and cokriging methods for spatial analysis of SAR and Cl- concentration in groundwater. They found Gaussian model, the best semi-variogram model, among all the available models.

Rawat et al. (2012) have also used Kriging methods to predict spatial variability of some groundwater quality parameters in Mathura district, Uttar Pradesh, India. Gorai et al
(2013) made a study on the groundwater quality in Ranchi Municipal Corporation area. Total 65 samples were collected from different sites in the study area. The thematic maps of various parameters were prepared using geo-statistical techniques. They tested various semi-variogram models for ordinary Kriging to identify the best fitted model. The best model was selected on the basis of MSE, RMSE, ASE, and RMSSE.

Spatial and temporal behavior of groundwater level in the coastal aquifers of Minjur in Tamilnadu, India was studied using the GS+ and geostatistical module of Arc GIS 9.3 softwares. The variograms and krigged spatial maps were generated for pre monsoon and post monsoon seasons of 1999 and 2008. The spatial variability analysis of groundwater level indicated that the water level was below mean sea level. It was observed from the spatial variability maps that there was a considerable decline in the water level over a period of 10 years and groundwater level improved during post monsoon in both Aquifers (P.K. Mini, 2014).

Researchers have applied distinct interpolation method for their specific problem. A single method for specific region cannot be generalized to others. Similarly, Geostatistical Analyst offers 11 semivariogram models and sometimes difficult to chose anyone from these. Therefore, it was decided to work on all these models and the best model was selected for surface generation.

Various studies had been carried out to show the water quality status and trend in the study area. But all the reports were produced in terms of individual water quality variables. People had also generated the water quality index in the study area, but only for a small part of the state. Thus, it can be said that significant water quality information using Water Quality Index was not available for a longer duration for the groundwater quality of the entire state. For calculating WQI, the various parameters need to be assigned some relative weights. In most of the earlier studies, there was some variation in the weights assigned to the chemical parameters, since it was completely the researcher’s expert opinion. Here, some scientific and mathematical approach in calculating these weights have been structured which is independent of individual research opinion.