CHAPTER 2

LITERATURE REVIEW

This Chapter presents the Literature review of studies pertaining to rainfall, water level, remote sensing, hydrogeophysics, hydrogeochemistry, GIS technology and discuss the importance of present study.

2.1 RAINFALL AND GROUNDWATER LEVEL

Namias (1968) reported the trend of rainfall of Central Park Observatory, New York and related it to general circulation aberration. It was highly helpful in assessing the rainfall pattern of the study area.

Todd (1980) explained the groundwater levels may show seasonal variations due to rainfall. The spatial pattern of groundwater utilization shows good correspondence with dynamic groundwater level pattern in the area. A comparison of the above two parameters indicates the possibility of the presently existing groundwater and its enlargement.

Raju (1998) evaluated the rainfall, evaporation, runoff and infiltration variations in India. He reported the rainfall received and its loss in the country. Major amount of rainfall is lost by direct evaporation and runoff. The remaining amount of rainfall flows into the subsurface. This indicates the importance of the study in sub-surface features.

Nageswara Rao (2002) studied the monsoon rainfall and its variation in Godavari river basin. He reported that the basin monsoon rainfall varies from 36 % to 72 %. But the average seasonal rainfall varied from 36 % to 46 %. This indicates the importance of the rainfall study in monsoon wise.
Gurugnanam et al. (2010) studied the rainfall variation by using GIS tool in Salem district. He mapped the high and low rainfall regions of the district.

2.2 HYDROGEOPHYSICS

Bugg & Lloyd (1976), Van Overmeeren (1989), Ebraheem et al. (1997) explained the importance of the electrical resistivity method in groundwater investigation. This method has been applied successfully in delta and coastal region aquifers.

Abbi & Puranik (2000) studied geophysical characteristics of the basin. The geoelectrical survey had shown that the fractured layer was noticed in the lower gradient to plains within the basin. It provided more pronounced weathering and easy infiltration of surface water. It also noticed that the variation in yield of bore wells may be attributed to the variations in the intensity of weathering and amount of secondary openings available in the aquifer for the groundwater occurrence.

Wyns et al. (2002) reported the hydrodynamic properties of different aquifers. These are very helpful to find out the different aquifer layers thickness and resistivity spatial distribution maps (first aquifer and second aquifer, third aquifer, fourth aquifer, etc).

Vaidya et al. (2002) studied the electrical resistivity of groundwater zones. This study locates the best zones for drilling bore wells.

Khan & Mukesh Sharma (2003) discussed the isohyetal line mapping technique with electrical resistivity about the depth to bedrock, thickness of saturated zone, bedrock resistivity drop ratio in Luni block, Jodhpur District of Rajasthan.
Elijah et al. (2005) reported the geophysical method with vertical electrical soundings and the hydrochemical analysis are carried out on the sample sites to understand the quality of groundwater. By using the elucidation of vertical electrical sounding data the three geoelectric layers were described and the top of resistive bed depth map was produced to show the extent of pollution.

Suresh et al. (2008) studied the geoelectrical resistivity survey with equal grid method. This study suggested that the high resistivity of the rock formation (more than 160 Ohm.m) was very compact at the end of the fracture zone. This study is helpful in locating the subsurface groundwater potential zone.

Madan et al. (2008) studied the resistivity spatial distribution maps. These maps are helpful in locating the different depth of aquifers. This significant study indicates reliable water quality from the resistivity values.

Suresh et al. (2009) explained about multi-criteria analysis to demarcate the shallow groundwater potential zone in Upper Thirumanimuthar Sub-basin, Cauvery River, Tamil Nadu region. This analysis is highly helpful in determining the groundwater potential zone.

Mukherjee et al. (2012) studied electrical resistivity technique and suggested that it is an effective tool for evaluating the accessibility of groundwater in the rock unit.

Ebraheem et al. (2014) studied about the sites for identification of groundwater resources in different types of aquifers in the northern emirates of UAE. This study reveals that the integration of various thematic layers
including geology, hydrogeomorphology, geophysical layers and GIS applications for locating groundwater zone.

2.3 HYDROGEOCHEMISTRY

The US Salinity Research Laboratory report (1954) reported the usage of Sodium Absorption Ratio value. This recommendation was highly helpful to assess the irrigation water quality.

Karanth (1991) reported the source of chloride concentration in the groundwater. This is due to weathering of phosphate minerals and domestic sewage.

Khan & Mukeshsharma (2003), Tyagi et al. (2009) explained the effects excess concentration of Magnesium (Mg) and (Ca) Calcium in water. Excess concentration leads to the scale formation. So the water is not suitable for drinking, bathing and washing usage.

Jeelani (2005) studied the geochemical characteristics of water. Four types of water that were identified which reflect the interaction of water under different lithological conditions. The observed major cations (Ca$^{2+}$, Na$^+$, Mg$^{2+}$, and K$^+$) and anions (HCO$_3^-$, SO$_4^{2-}$, Cl$^-$ and NO$_3^-$) were within the WHO standards. Hence, the water was potable and good for domestic purposes. The four hydrochemical facies were identified as CaHCO$_3$, MgHCO$_3$ and NaHCO$_3$ and hybrid type.

Omkar Singh et al. (2005) classified the different zones based on the concentration of bicarbonate. If the bicarbonate concentration less than 1.5 m.eq/l classified as no problem area and more than 8.5 m.eq/l belongs to severe problem zone.
Bing Zhang et al. (2012) studied the geochemical characteristics of groundwater by using fuzzy membership in the region of Songnen Plain, North East China. This report was useful to find the groundwater suitability for agricultural purposes.

Tamara Markovic et al. (2013) explained the hydrochemical data model in an alluvial aquifer of Zagreb, Croatia. Further, a hydrogeological study and the interaction between the groundwater and surface water have been carried out in detail. The lithological profile observed from the well indicated that the aquifer is a single hydrological unit, but the geochemical characteristics of the aquifer observed from the well indicated stratification.

2.4 REMOTE SENSING

Fon (1991) explained the thematic map preparation details from Remote Sensing data. He had reported the past, present and future landform prediction.

Padmavathy et al. (1992) successfully utilized integrated Remote Sensing and GIS techniques to locate the groundwater potential zones. She had generated GIS theme building using satellite data in Lucknow, Uttar Pradesh.

Haridas et al. (1994) explained remote sensing usage in geomorphology and lineament studies. He used IRS-1 data in and around Kanjamalai, Salem District, Tamil Nadu.

Mahamaya Chattopadhyay et al. (1996) evaluated the groundwater resource using remote sensing thematic maps in Vamanapuram river basin. The remote sensing maps are reported the spatial variation aquifer of
thickness and resistivity. This was very useful for identifying groundwater potential resources.

Rao et al. (1996) described the use of IRS-IC data for geological and geomorphological studies.

Das et al. (1997) conducted a case study regarding hydrogeomorphological mapping in groundwater exploration using remote sensing data and stated that the obtained data could be effectively used for such studies.

Okereke et al. (1998) successfully used the combination of remote sensing and geophysical method for the investigation of groundwater in Cross River State.

Muralidhar et al. (2000) highlighted that remote sensing applications could be a very good tool for the evaluation of water resources.

Chakraborthy & Paul (2004) discussed the geomorphic features (through remote sensing) and the occurrence of groundwater prospect zones. He used remote sensing techniques for lineament analysis. This analysis was highly helpful for assessment of groundwater potential zones.

Srivastava & Battacharya (2006) studied the delineation of groundwater potential zones using IRS data. He integrated the studies on remote sensing and geophysics through GIS technology.

Prabu et al. (2008) has analyzed temporal satellite data to understand the seasonal variations in groundwater level inferred from vegetation cover and land use practice of the region.
Ratnakar Dhakate et al. (2008) identified best groundwater potential zones through hydrogeomorphology and lineament analysis by using Remote sensing techniques in the granitic region of the Andhra Pradesh.

Gurugnanam et al. (2008) discussed the use of IRS – P6 LISS IV remotely sensed data to delineate geomorphological units to identify potential groundwater resources of a terrain is simply discussed.

2.5 GEOGRAPHIC INFORMATION SYSTEM

Sharma (1992) recommended that Remote Sensing and GIS can act as a potential tool in selecting suitable sites for groundwater prospective zones. It has been suggested that various thematic maps like fracture systems, geology, lineament intersection, drainage network and dyke systems could be generated from Remote Sensing. These data could be integrated through GIS for selecting suitable sites for groundwater prospective zones.

Clark (1993) explained about the GIS applications in watershed management and development of groundwater resources. He also explained the watershed soil permeability characteristics. This study was highly helpful for assessing soil characteristics and its usage for groundwater resources development.

Eiumnoh (1993) stated that remote sensing data and GIS could be effectively used for soils, agriculture and watershed management.

Obi Reddy et al. (2000) discussed the slope, elevation, relief, depth of rock weathering, type of weathered material, thickness of sediments and the overall assemblage of different landforms. It plays an important role in defining the ground regime, especially in hard rocks and the unconsolidated sediments.
Singh & Prakash (2003), Sahu & Sahoo (2006) reported about the Remote Sensing and GIS methods usage in the groundwater. This method is used to delineate suitable groundwater prospective zones in soft rock aquifers.

Cornelis Vander Post & Margaret McFarlane (2007) worked in the Boteti area of the Kalahari region in Botswana. It was explained that Geographic information systems are more effective in integrating the multiple thematic layers. It is used to find out the groundwater potential zone and groundwater development practices implementation.

2.6 NEED FOR THE PRESENT STUDY

The Groundwater is the major source for drinking, domestic and irrigation purposes in rural and urban areas of India as well as in most of the other countries. Now a days, the overall global groundwater level is gradually decreasing and getting affected mainly due to over-extraction, industrial development and some special geological conditions. Hence, a special emphasis has to be given to study the groundwater potential and contamination in water scarce areas. The earlier studies on groundwater study of the present study area mainly focused on the quality spatial variation. In order to excellently assess the quantity and quality of groundwater, it is necessary to employ an integrated study approach. The present study completely utilized integrated study approach to analyze the quantity and quality of groundwater. In this approach, GIS technique is being used to integrate the rainfall, water level, geology, groundwater potential and groundwater quality data.
Generally, the GIS technique spatial analysis studies to be carried out by using following three methods

i) Spline interpolation method

ii) Kriging method

iii) Inverse Distance Weighted methods (IDW)

The Spline spatial analysis is a special form of interpolation method that estimates value using a mathematical function. This method is most suitable for plain areas.

Kriging is one of the geostatistical spatial methods which was used in past years in the present study area. This method is mainly suitable for coastal regions.

Inverse Distance Weighted (IDW) method is a deterministic, non-linear interpolation technique that utilizes the assigned values of a known scattered set of sample locations to identify the value of an unknown sample location.

Among the above said three methods, the first two methods were mainly used by the researchers to investigate the present study area groundwater analysis.

The present study area is an undulated area, hence, rather than the first two methods; the third Inverse Distance Weighted (IDW) method is the suitable method for the investigation. So, IDW tool is being completely utilized for the present study groundwater analysis.