CHAPTER-VII

SUMMARY AND CONCLUSION

Geology and Geomorphology

The study area constitutes a part of Mahi - Narmada interstream (Doab) region of Gujarat state. It has a distinct physiographic boundary which is bordered by the Gulf of Cambay in the West, the rocky uplands in the East, Mahi River in the North and Narmada River in the South and sprawl in about 11,000 sq km. The area lies between 72° 30' E and 73° 43' E longitudes and 21° 40' N and 22° 53' N latitudes, falling in 46/ B, C, F, G, J & K topographic sheets of the Survey of India. The alluvial tract being part of "Gujarat alluvial plains" comprises huge thickness of marine, fluvial and aeolian sediments deposited during the Quaternary period. These sediments consist of intercalations of sand, silt, clay and gravel fractions with the perceived development of clacretised bands. These unconsolidated sediments serve as repository for groundwater in unconfined, semi-confined and confined conditions. The Eastern part of the study area is covered by hard rocks consisting of Deccan Trap, Granite, Gneiss, Quartzite, Phyllite, Slate, Schist, Marble, Sandstone, Dolomite and Limestone. Detail of geological formation with relation to their hydrological characteristic is given in Table7.1.

Geomorphological attribute like landform, drainage, soil, slope etc plays an important role in controlling the overall distribution of water in terms of surface runoff and recharge. A combined effect of these geomorphic attributes greatly facilitates the investigator in delineation of suitable zones of potential groundwater source as well as demarcation of recharge boundaries. Accordingly, the study area has been divided into four distinct hydrogeomorphic classes based on the geomorphic features i.e. Coastal Plains (±2 to 15m AMSL), Central Alluvial Plains (15 - 50m AMSL), Transitional Pediment Zone (50-100m AMSL) and Highlands Zone (100-540m AMSL). The high relief areas in the eastern part have steeper topography thereby resulting in high runoff and less recharge. The general groundwater potential in such terrain is limited owing to hydrogeomorphological condition prevailing in such area. Piedmont zones have transitional type of hydrogeological properties. The vast alluvial tract have potential groundwater reservoir with varying groundwater conditions. The western part along the coast has salinity as a constraint for groundwater development. The occurrence of groundwater in different geological, geomorphic and structural setup is summarized in Table7.2.

Table-7.1 Hydrogeological Characteristic Properties of Formations in Study Area

Epoch/Age	Formation	Hydrogeological Characteristic
Holocene Recent 2000 Yrs B.P. Depth 10-25m	Surfacial Deposits River sands, gravel, Coastal mud, Beach Sand, Modern soils etc	Unconfined shallow aquifers leaky confined, confined deeper aquifer. Large to moderate yield prospects 10-141 lps, hydraulic conductivity 5 to 20m/day, and transmissivity 50 to 200m 2/day.
Sub-Recent 10,000 Yrs B.P. Depth 50-450m	Newer Alluvium Inter layering of thick sand gravel and thin clay silt with calcareous nodules	
Pleistocene 1.5 – 2 M.Y. Depth 450-750m Tertiary (<40 M.Y.)	Older Alluvium Interbedding of thick silty clay and thin gravelly sands	
Cretaceous - Eocene (40-55 M.Y.) Cretaceous (>55 M.Y.)	Deccan Trap (Basalt, Dolerites, Rhyolites etc.) Bagh Formation (Sand stone, Shale, Limestone)	Discontinous aquifers with limited thickness 50-300m. Limited yield prospect less than 15 lps. Hydraulic conductivity 2 to 10 m/day; transmissivity 50-1000 m^2/day.
---------------**Unconformity**---------------		
Precambrian (>1500 M.Y.)	Champaner Group (Aravalli Super Group) Quartzite, Phyllites, Slates and Schists ,Limestone and intrusive	Groundwater occurrence is restricted to weathered and fractured zones having secondary porosity, limited yield prospect 2 to 5 lps
Basement (>2000 M.Y.)	Unclassified Gneisses (Gneisses, Granites and Intrusives)	

The landform of the study area is shaped by the various processes of fluvial, aeolian and marine environments. The coastal tract is marked by features like estuarine river mouth, mudbanks, river bar, backshore alluvial cliffs, alluvial islands etc. while central part is a vast stretch of alluvial plains consisting of paleo channels, ravine land, recent flood plains, alluvial plains etc. The western part is characterized by pediplains of sedimentaries and metasedimentaries, deccan plateau, eroded land, dissected plateau, hills, residual hills etc. Rivers flowing through the study area has further modified the landforms by forming various featrures which in turn gave rise to conditions for groundwater occurrence and movement. The geomorphic features like alluvial fans, buried pediment, old stream channels and the deep-seated interconnected fractures are the indicators of subsurface water accumulation. These features are the natural recharge sites due to their high permeability and water holding capacity.

Table 7.2 Physiography Controlling the Hydrogeological Conditions in the Study Area.

Hydrogeological Attributes	Physiographic units			
	Highland Zone	**Piedmont Zone**	**Central Alluvium Plain Zone**	**Coastal Plain Zone**
Hydromorphology: It includes geomorphic features favouring availability of groundwater occurrence.	Ground slope >24°, Steep hilly terrain, shallow weathered zone, thin soil cover, high runoff, radial drainage pattern, mainly erosional features, dissected plateaus & hills, pediplains, residual hills, valley fills etc.	Ground slope 9-24°, this zone is marked by landforms formed due to prolonged erosion and later filled up by deposition of sediments by various processes. It has characteristic of both highland zone as well as central alluvial plain.	Ground slope 3-9°, gentle terrain, low lying plains, flood plains, river terraces, thick soil cover, sandy and influent river bed, buried river channels thick weathered profile.	Ground slope upto 3°, flat monotonous land with little or no undlulation. Major geomorphic features are mud flats, old mud flats, river mouth bars, plains and coastal sand dunes.
Hydrolithology: Variation of rock types their composition and texture in response to groundwater occurrence, distribution and total potential.	The consolidated formation lacks inherent porosity as a result water is present in secondary porosity as well as in weathered zone which is the important source of occurrence and distribution of groundwater.	Here also weathering is important source of groundwater movement. Shallower aquifers are unconfined in valley fills deposits and weathered zone. While deeper aquifers are semi-confined.	It comprises mainly of coarse sand and clay with subordinate proportion of gravel, kankar & silt. Because of intercalation of permenable and impermeable layer groundwater occurrence is in unconfined to semi-confined state.	The sediments comprises mainly of sand, silt and clay. Aquifer occurs mainly in semiconfined and unconfined state but the quality is very poor hence not much useful.
Hydrostructure: The effect of the joints, fractures, faults, folds, foliation, bedding & unconformity etc	Lineations, deep fracture & fault, fracture zone, fault & shear zone, lithological contracts, interflow surfaces, dykes & master joints, bedding planes, foliations, columnar joints, vesicular cavities, red bole layers and local fractures.	The secondary porosity like fractures, lineaments, bedding planes etc offer conduits for groundwater movement	Because of soft sediments only primary porosity is responsible for groundwater movement and occurrence.	Groundwater is confined in primary porosity of soft sediments, structural secondary porosity is absent.

Hydrogeomorphology Characterization

In order to study the subsurface geology of the Quaternary sequence some of the available bore holes logs were studied in greater detail. The subsurface geological cross-sections give a fair clue about the areas of recharge and possibility of occurrence of good quantity of groundwater.

The central and western part consists of Quaternary deposits having intercalated sediments of sand, silt and clay, which host the aquifers mainly in semi-confined and unconfined conditions and at few places in confined state. Places where clay starts immediately below the soil are not good from recharge point of view. Further, at places where the top soil is of vertisol type (black cotton soil) which impedes groundwater movement. In western and southern parts of the alluvial plains, the vertical recharge through precipitation would be almost negligible as clay layer occurs just below the topsoil. In central part, where sandy layer follows the soil layer is the zone of recharge.

Well lithologs of eastern part were also studied to know the rock type and depth of weathering. Basalt is exposed in wells from Ghanta, Gulvani, Raisingpur, Panchdevla, pipaliya, Bhaniyara, Vadiya, Laved and Kawant villages of Vadodara District. Granite rock is encountered in Vajeria and Lagmi at shallow depth while other rock types are sandstone at Sankheda and schist, phyllite from Vajaria village.

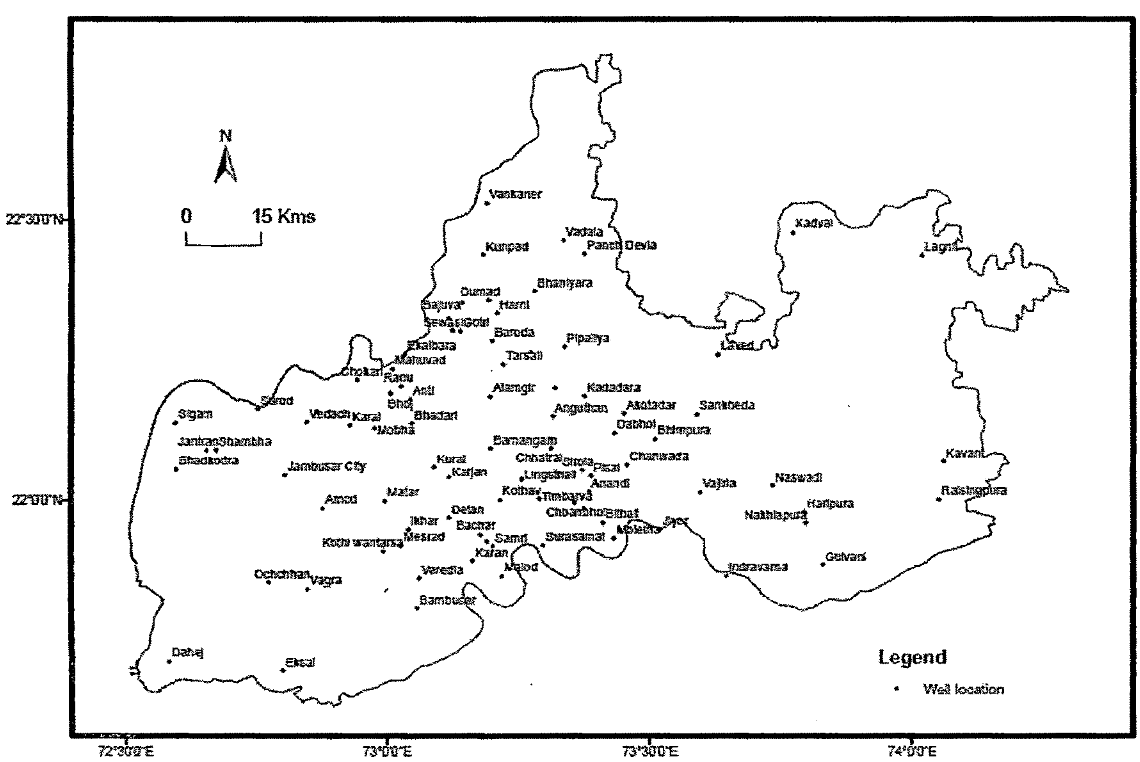

Fig-7.1 Map depicting locations of Well Lithologs.

Hydrogeochemistry

The groundwater samples were collected from four geomorphic divisions of the study area i.e. coastal plains, alluvial plains, piedmont zone and highlands. Samples were collected from shallow aquifer (hand pumps/dug well) and deeper aquifers (tube/bore wells). As the eastern highland region is rocky and predominated by phreatic aquifers samples were collected only for such aquifers. The groundwater movement direction as evident from reduced water level map indicates that highlands act as a recharge zone to the shallow and deeper aquifers. Some of these aquifers through lower aquitard layer are in hydraulic connectivity with the lower aquifers thereby gets recharged.

Geochemical analysis has established that the groundwater in the study area has high concentration of major and minor ions. These ionic concentrations tend to decrease from western coastal plain to the eastern highland parts. Some of the inland aquifers do show high concentration of ions but they are localized viz. at Falod (Waghodia taluka) village shallow aquifer is saline but deeper aquifer contains potable groundwater.

The pH level of the ground water fall in alkaline field and most of them are well within the range. The pre-monsoon 2002 samples show concentration almost within the permissible limits except at Sindhav village (Jambusar Taluka) and Ambada village (Padra Taluka).

The average range of constituent ions in groundwater samples of pre and post monsoon periods indicate minute but noticeable change in their ionic content. The average difference indicate an overall decrease in pH, TDS, Ca, Mg and Sulphate whereas increase in total hardness, chloride and nitrate concentration from pre to post monsoon season.

Level of Na^{2+} concentration is comparatively on higher side and tends to decrease towards highlands. Few aquifers from alluvial zone show exceptionally higher concentration of Na^{2+} but are of localized one. This may be due to inherent sediment salinity causing base exchange reaction between groundwater and aquifer material rich in clay content.

Overall decrease in Ca^{2+} (Calcium) content has been observed during post monsoon period that may be attributed due to rainfall recharge causing dilution. The increased in Ca^{2+} concentration from coastal and alluvial plains may be ascribed monsoonal increase in water table causing enrichments of salts. The lowering of calcium value especially in piedmont zone may be on account of flushing action as well as replacement by other ion as base exchange reactions of clay minerals.

The metamorphic rocks present in eastern highland zone consist of magnesium bearing minerals as main constituents. Therefore, groundwater is enriched with Mg^{2+}. However, few samples from coastal and eastern alluvial plains show very low concentration of magnesium. There is an overall decrease in Mg^{2+} concentration from west to east.

Potassium ion concentration in groundwater is very high especially from coastal fringes. The concentration ranges from as high as 1000 mg/l in coastal areas to as low as 0.5 mg/l in highlands. This high potassium concentration may be attributed to coastal influence, excessive use of potash fertilizers in agricultural fields, presence of connate water and also due to lower geochemical mobility of potassium.

The Bicarbonate ion concentration (HCO_3^-) in the study area fluctuates between 100 mg/l to 1000 mg/l. The year 2002 show an overall declining trend from 2003 in both pre and post monsoon seasons. This may be due to the below normal rainfall i.e. <859mm in 2000, 2001 and 2002 received by the study area and above normal rainfall (1006mm) in the year 2003, resulting into high dissolution of CO_3 during above normal rainfall.

Sulphate ion concentration in the study area tends to vary from west to east showing an overall declining trend. SO_4 concentration ranges between 100-1000mg/l in coastal plains; 100-1000mg/l in alluvial plains; and 10-1000mg/l in highlands. This observed high concentration is mainly attributed to agricultural practice apart from geochemical processes occurring in the aquifer system.

The Chloride concentration exhibit an overall decrease from west to east. In general the average concentration ranges between 19-59,189 mg/l. Higher concentration in coastal region may be ascribed to aquifers inherent salinity and direct marine influence.

In the study area the TDS concentration is on higher side as a result there is a declining trend from coast to highlands.

In the study area high fluoride (F^-) concentration beyond permissible limit has been observed from six locations during pre-monsoon period and 10 locations in post-monsoon period. Fluoride is mainly derived from rock/mineral water interaction. In the study area the highlands are having basalt and carbonate rocks consisting fluorite mineral. Most of the rivers draining the area originate from these highlands and during this process dissolution and precipitation of fluoride take place in lower reaches. As the water samples were mainly collected from wells utilized for the irrigation purpose therefore no deleterious effect on human health is observed in the study area.

Nitrate concentrations in groundwater during the pre and post monsoon seasons indicate a wide range. Exceptionally high concentration in both pre and post monsoon period has been observed in the villages viz. Keshwan (265 and 245 mg/l), Kadachhala (120 mg/l for both period) and Falod (215 and 295 mg/l). Further there has been a rise in nitrate concentration during post monsoon. The observed high concentration of nitrate ion on specific locations may be attributed to the use of inorganic nitrate fertilizers for agricultural purposes.

Chemical hydro geological investigation has been carried out with a view to characterize groundwater for its domestic and irrigation suitability. As a part of irrigation suitability the review of Ec values have established that only 6% (Pre-monsoon, 2002), 57% (Post-monsoon, 2002), 18% (Pre-monsoon, 2003) and 17% (Post-monsoon, 2003) was found to be in fresh water category. The alkali hazards as Kelley's Ratio, indicates 75% (Pre-monsoon, 2002), 43% (post-monsoon, 2002), 69% (Pre-monsoon 2003) and 69% (Post-monsoon, 2003) of the samples fall above one ratio, indicating prone to alkali hazards. Evaluation of groundwater Permeability Index has established that bad category water is almost absent except one location at Rarod village (Karjan Taluka). About 57% (Pre-monsoon, 2002), 45% (Post-monsoon, 2002), 54% (Pre-monsoon, 2003) and 53% (Post-monsoon, 2003) of groundwater fall in excellent category. The abundance of carbonate and bicarbonate ions is denoted by residual Sodium Carbonate. Most of the samples are within the safe permissible limit with more numbers of samples having negative value, indicating that the concentration of Ca^{2+} and Mg^{2+} ions exceeds far more than Carbonate and Bicarbonate values. The Schoellar Index (SI) point to the possibilities of ion exchange reaction in groundwater. The SI index for about 70% (Pre-monsoon, 2002), 79% (Post- monsoon, 2002), 77% (Pre- monsoon, 2003) and 71% (Post- monsoon, 2003) samples are in chloro-alkaline disequilibrium whereas few samples are indicative of base exchange reactions. The adsorption of sodium by soil is measured as SAR (Sodium Adsorption Ratio). The SAR values indicate that only one sample in pre-monsoon 2002 and six samples in post 2002 fall in good water category while in pre and post monsoon year of 2003 none of the samples fall in good water category. Majority of the samples fall in bad water category i.e. C4-S4 to C3-S3. Owing to high ion concentration ground water are not fit for irrigation, especially in coastal and alluvial plain regions.

Categorizing water in accordance with the drinking water standards has established that majority of samples have either one or two constituents in higher concentration making it unfit for drinking.

δ^{18} O isotopic concentration of groundwater sample shows considerable variation in stable isotopic values ranging between -3.16 to 1.06‰. The depleted values are indicating that the area is being recharged from surface water, while enriched values are from coastal plain area, which indicate salinity ingress. The coastal area has high TDS values and the correlation coefficient 'r' between Ec and $\delta^{18}O$ is positive (r = 0.34). Plot of chloride vs. $\delta^{18}O$ shows high chloride at high isotope concentration thereby indicative of long storage and no recharge, same way nitrate also gives similar correlation

Pieper's Trilinear plot has been used to determine the genetic classification of water. The mean dominant cation in pre and post-monsoon 2002 and pre-monsoon 2003 in groundwater samples are in the order of $Na^+ > Mg^{++} > Ca^{++} > K^+$, while anion shows $SO_4^{2-} > Cl^- > HCO_3^-$ dominance. Similarly in post-monsoon 2003 samples are in the order of $Na^+ > Ca^{++} > Mg^{++} > K^+$, while anions shows $SO_4^{2-} > Cl^- > HCO_3^-$ dominance respectively. Therefore, overall ground water facies is Na-Mg-Ca-K: SO_4-Cl-4CO_3 type.

Various correlation plots have established to assess the overall quality of groundwater based on geochemical processes. The Na vs. Cl plot falls on 1:1 equiline, indicative of evaporation while Na/Cl vs. Ec plot indicates that though evaporation is not a not dominating process but occurring to some extent. The plot of Na vs. Ca show depleting Ca values indicating cation exchange reactions. This is also confirmed by Schoeller Index (SI) wherein for maximum numbers of samples negative values are obtained indicating cation-anion exchange. For (Ca+Mg) vs. (SO_4+HCO_3) plot depicts almost all values fall below equiline indicating silicate weathering. Similarly the Gibb's plots indicate that evaporation is a main geochemical process occurring in the study area which is trending towards rock water interaction.

The correlation coefficient among various chemical variables shows pH –ve correlation with most of the parameters except alkalinity. The correlation between the Ec and other parameters is significantly positive except K; TDS, Na, Ca is strongly co-relatable with most of the variables except alkalinity; alkalinity is slightly negative correlatable with Mg, K, and TH, whereas significant with Ec and slightly correlatable with other parameters. Cl is significant with Ec, TDS, Na and Ca while slightly negative with pH, alkalinity; SO_4 is significant with Ec, TDS, Na, and Ca while negative with pH.

Statistical analysis of the major ionic contents with obtained trace elements has inferred that Na showing +ve correlation with all ions except silica and bicarbonates. Bicarbonate has –ve correlation with all ions except boron. Boron has –ve correlation with Si and Mg while +ve correlation with all other ions. Silica has +ve correlation with NO_3, K and Mg while –ve with all other ions. F shows –ve correlation with Mg, Si and NO_3 and +ve with other ions. Nitrate is –ve with F, Mg, Mn and HCO_3 while +ve with other ions. Sulphate shows –ve correlation with Si and HCO_3 while +ve with others. Chloride is –ve with Si and HCO_3 and +ve with all other ions.

Therefore, overall groundwater quality tends to deteriorate from eastern hilly zone to western coastal plains which follow the ground water gradient direction.

Groundwater Behaviour and Resource Potential

The study area receives rainfall due to SW monsoon and is limited to the period between June to September. The period is further extended upto November due to retreating monsoon. The rainfall data for 42 years i.e. from 1961 to 2003 from 18 rain gauge stations located within the study area is used. The average rainfall for the study area stands at 858.99 mm. The average maximum rainfall for the study area comes out to be 1699.50mm while lowest is 389.79mm. The coefficient of variation (C_V) which is a measure of variability of rainfall comes out to be 32.35% while standard deviation is 27.8. The mean annual rainfall gradually increases from west to the east. The highest rainfall recorded in the study area is at Savli station in the year 1976 with 2688.7 mm precipitation and lowest was recorded during 1968 with 101 mm at Kawant station.

The study area constitutes an interstream region of two perennial river systems the Mahi and Narmada Rivers. Therefore, it shows significant prospect of surface water resource. Other tributary streams of these two mega fluvial system although ephemeral in nature, they maintain good base flow up to November-December months that subsists the irrigation needs of the study area to an extent. Noteworthy tributary streams viz. Heran, Orsang and Dhadhar by and large covers almost 60% of the study area. Apart from river water there are some major and minor irrigation schemes in the study area. These irrigation tanks are mainly present in the Vadodara district while the western part of the study area covering four coastal talukas of the Bharuch district are devoid of it.

In case of study area water levels from the year 1993-2003 for nearly 76 wells have been studied for its pre and post monsoon fluctuations. The fluctuation values were compared with the corresponding rainfall to deduce the sensitivity of the aquifer to rainfall. As the recharge to the aquifers is rainfall dependent, overall water levels are lowest in the month of May (Pre-monsoon) whereas higher in November (Post-monsoon). In order to develop clear understanding of seasonal behavior of water levels for litho-specific aquifers, the author has constructed observation well hydrographs by considering 1993-2003 pre and post monsoon water levels. Almost all well hydrographs show strong correlation with the rainfall input.

For a better understanding water level fluctuation has been studied with reference to geomorphic division of the area. In coastal plains the average decadal pre-monsoon level is 10.8m while post-monsoon level comes out to be 8.6m with a positive average rise of 2.2m in storage having standard deviation of 1.2. At number of place an overall decline has been observed and this may be attributed to growing demand due to increase in population as well as rapid industrialization of the area. The alluvial plains consist of thick pile of flood plain deposits that are extensively utilized for agricultural purpose. The alluvial plains share large part of the study area. Well hydrographs constructed for 21 tube wells have been studied to evaluate the behavior of groundwater. The selected hydrographs of this area indicates positive trend especially from Atladra (Vadodara taluka), Dharampura (Dabhoi taluka), Chansad (Padra taluka) and Varnama (Vadodara taluka) villages while negative trend from Sinor and Chhatral village (Dabhoi taluka) has been observed. The year 1998 indicates an overall increase in water levels because of good rainfall. Further, because of lean rainfall in year 1999 & 2000 decline in groundwater levels has been recorded throughout. The average of last one decade indicates that the minimum and maximum pre-monsoon level is 8.05m & 30.11m, while that of post-monsoon is 4.48m and 28.22m respectively. Therefore, average decadal fluctuation indicates a minimum of -0.4m while maximum average fluctuation is 11.16m with a standard deviation of 2.28. The narrow piedmont zone demarcates transitional strip between highlands on the eastern side to alluvial plains on the western side. The area is dominated by thin veneer of colluvial sediments over the surface and hard rock at shallow depth. From piedmont zone, well hydrographs of 22 bore/tube wells have been studied. Most of them indicate a declining trend over the years but the pattern also indicates that the draft during pre-monsoon period and subsequent recharge in monsoon period is more or less the same. It is observed that in last ten years average pre-monsoon groundwater level is minimum at 2m and maximum at 19m while during post-monsoon minimum is at 1m and maximum at 18m. The average mean change in water level is 1.94m with a standard deviation of 1.5. The eastern highland zone is characterized by hard rock terrain signifying less population, sporadic settlements and patchy agricultural land compared to alluvial plains of the study area. In all 23 well hydrographs have been studied. The hydrographs evaluation on decadal average pre-monsoon minimum and maximum stand at 4.7m and 12.55m, while that of post-monsoon is 3.5 and 10.8m respectively. The net average change in storage is 2.5m with a standard deviation of 1.1m.

Based on Reduced Water Level map in general contours in highlands show circular patterns and radial flow. The narrow pediment zone followed by alluvium plain and coastal plain westward are characterized by unconsolidated sediments and the contour show progressive flattening indicative of reduction in gradient. Overall the groundwater gradient is: Coastal plains-1:2542; Alluvial plains-1:653; Piedmont zone-1:352 and Highlands-1:93-154.

The author, for estimation of groundwater recharge has adopted Water Level Fluctuation and Specific Yield Approach and Rainfall –Recharge empirical methods as suggested by different workers. The groundwater recharge estimated by various approaches is summarized in table given below.

Table 7.1 Comparison of Groundwater recharge in the Study Area by Various Approaches.

<table>
<tr><th>Sr No.</th><th>Approach</th><th>Rock Type</th><th>Area (km^2)</th><th>Percentage Normal Rainfall (859mm)</th><th>Recharge (MCM)</th><th>Total Recharge (MCM)</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">G'water over Exploitation Committee</td><td>Alluvial</td><td>7488.194</td><td>20</td><td>1286.472</td><td rowspan="2">1597</td></tr>
<tr><td>Hard Rock</td><td>3613.297</td><td>10</td><td>310.382</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Sukhija</td><td>Alluvial</td><td>7488.194</td><td>8</td><td>514.58</td><td rowspan="2">608</td></tr>
<tr><td>Hard Rock</td><td>3613.297</td><td>3</td><td>93.11</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Specific Yield Approach</td><td>Alluvial</td><td>7488.194</td><td>*2.1-2.7</td><td>2052</td><td rowspan="2">2261</td></tr>
<tr><td>Hard Rock</td><td>3613.297</td><td>*1.68-2.56</td><td>209</td></tr>
</table>

*Water Table Fluctuation/Specific Yield Approach

Water Table Fluctuation and Specific Yield Approach would provide the most dependable estimates on the groundwater storage. Hence, the author has considered 2261 MCM as recharge for the study area.

Remote Sensing and GIS

In the present study, integrated remote sensing and GIS techniques have been used to generate groundwater potential map and prediction of recharge zones in the study area. Various information like geology, geomorphology, soil, structures, landcover/landuse, and other relevant information have been extracted from satellite data, Survey of India (SOI) topographical sheet and aided by field checks. All the thematic information layers were digitized and analyzed in GIS environment to derive composite maps for identifying suitable zones for construction of artificial recharge structures. Thereafter, weighted indexing method has been used to identify and demarcate the suitability zones for groundwater recharge which can also be used as sites for artificial recharge. Thus, multiple thematic layers of influencing parameters like Geology, Soil, Slope, Drainage density and Land use were prepared and assigned weights as per the importance in the selection of recharge sites. These layers in turn formed the vector base which was converted into raster according to the weights. Each raster was assigned percentage influence based on its importance. Each input raster was weighted and the total influence for all raster equals 100 percent. Moreover, individual thematic layers and their classes are assigned weightage on the basis of their relative contribution towards the output. Using this suitability modeling, suitable areas were identified wherein the classes with higher values indicate the most favorable zones for natural recharge and also for artificial recharge structures.

Overall characterization of the study area based on various adopted approach it can be concluded that the poor recharge zone constitutes 26.1%, moderate zone 37.2% and good recharge zone is 36.7% of the total study area.

The area suitable for recharge as identified in GIS environ has been cross checked with the water fluctuation data. It has been found that the zones identified through GIS approach actually show increase in water table after monsoon which is quite higher from the other areas. After getting the final overlay map, the TDS contour map has been superimposed on it to identify the area suitable for groundwater development in terms of its quality also.

The result of this study is useful for identifying potential zones for recharging shallow aquifers, while for deeper aquifers further details like sub surface information and aquifer characteristics are required along with field inputs.