

## CONTENTS

CHAPTER – 1 INTRODUCTION		1 – 31
1.1	General	1
1.2	Study Area	3
	1.2.1 Location	3
	1.2.2 Physiographic	3
	1.2.3 Climate and Rainfall	4
	1.2.4 Drainage System	4
	1.2.5 Population	4
	1.2.6 Irrigation	5
	1.2.7 Industries	5
	1.2.8 Problems of the Study Area in General	5
1.3	Aim and objectives	6
1.4	Materials and Methodology	7
1.5	Organisation of Chapters	7
1.6	Previous Work	8
1.7	International Scenario	9
	1.7.1 Hydrogeology	9
	1.7.2 Geochemistry	11
	1.7.3 Geophysics	13
	1.7.4 Remote Sensing and GIS for Ground Water Studies	17
1.8	National Scenario	19
	1.8.1 Hydrogeology	19
	1.8.2 Geochemistry	20
	1.8.3 Geophysics	24

	1.8.4	Remote Sensing and GIS for Ground Water Studies	27
CHAPTER – 2 GEOLOGY AND GEOMORPHOLOGY			32 – 50
2.1	General		32
2.2	Regional Geology of Tamil Nadu		32
2.3	Geological Settings of Tirunelveli District		33
2.4	Geology of Study Area		34
	2.4.1	Charnockite	39
	2.4.2	Hornblende Biotite Gneiss	39
	2.4.3	Quartzite	40
2.5	Structure		41
	2.5.1	Foliation	41
	2.5.2	Folds	41
	2.5.3	Faults	42
	2.5.4	Joints	42
2.6	Surface Soil Texture		42
2.7	Geomorphology		44
	2.7.1	Geomorphology of the study area	46
		2.7.1.1 Structural Hills	47
		2.7.1.2 Pediment	47
		2.7.1.3 Residual Hill	48
		2.7.1.4 Pediments and Buried Pediments	49
		2.7.1.5 Flood Plain	49
CHAPTER – 3 HYDROGEOLOGY			51 – 64
3.1	General		51

3.2	Water Level		53	
	3.2.1	Pre-monsoon Water Level	54	
	3.2.2	Post-monsoon Water Level	54	
	3.2.3	Average Water Level	54	
	3.2.4	Water Level Fluctuation	55	
3.3	Rainfall		55	
3.4	Pumping Test		57	
	3.4.1	Pumping test Data Collection	57	
	3.4.2	Selection of Pump Wells	58	
	3.4.3	Empirical Measurements	58	
	3.4.4	Evaluation of Aquifer Parameters	59	
		3.4.4.1	Aquifer Transmissivity	60
		3.4.4.2	Storage Co-efficient	62
		3.4.4.3	Specific Capacity	63
CHAPTER - 4 GROUND WATER CHEMISTRY			64 – 83	
4.1	General		64	
4.2	Major ground water problems and issues of the study area		65	
4.3	Methodology		66	
4.4	Ground Water Quality Analysis for Drinking Purpose		67	
	4.4.1	Ph	67	
	4.4.2	Electrical Conductivity (EC)	68	
	4.4.3	Total Dissolved Solids (TDS)	69	
	4.4.4	Sulphate (So <sub>4</sub> )	70	
	4.4.5	Calcium (Ca)	71	
	4.4.6	Magnesium (Mg)	72	

	4.4.7	Chloride (Cl)	74
4.5	Ground Water Quality Analysis for Irrigation Purpose		75
	4.5.1	Sodium Absorption Ratio (SAR)	75
	4.5.2	Residual Sodium Carbonate (RSC)	77
	4.5.2	Total Hardness (TH)	78
4.6	Assessment Of Water Quality Index for the Ground Water in the Study Area		79
	4.6.1	Ground Water Quality in the Study area	80
CHAPTER – 5 GEOPHYSICS			84 – 111
5.1	General		84
5.2	Electrical Resistivity Survey		84
5.3	Traditional Resistivity Surveys		85
5.4	The Relationship Between Geology and Resistivity		87
5.5	Resistivity Method		89
5.6	Electrode Configuration Used		92
	5.6.1	Wenner configuration	92
5.7	Methodology		94
	5.7.1	Vertical Electrical Soundings	95
	5.7.2	Electrode Configuration	95
		5.7.2.1 Wenner Configuration	95
		5.7.2.2 Schlumberger Configuration	96
	5.7.3	Instrumentation	97
5.8	Geophysical Field Data for the Study Area		98
5.9	Interpretation of Ves Data		98
	5.9.1	Quantitative Interpretations	99
		5.9.1.1 Geohydrologic Interpretation	101

		5.9.1.2	Depth wise Behavior of Resistivities	102
	5.9.2	Qualitative Interpretation		102
		5.9.2.1	Geoelectric Parameters	102
		5.9.2.2	Hydrogeological Significance of S, T and $\lambda$	104
5.10	Results and Discussion			105
	5.10.1	Geohydrologic Interpretations		106
		5.10.1.1	Top Soil	106
		5.10.1.2	Water bearing formation	107
		5.10.1.3	Depth to Basement	108
	4.10.2	Other Geoelectric Parameters		109
CHAPTER - 6 REMOTE SENSING AND GIS				112 – 126
6.1	General			112
6.2	Remote Sensing Data			114
6.3	Drainage and Drainage Analysis			114
	6.3.1	Drainage Density		116
6.4	Lineament			116
	6.4.1	Lineament Mapping		119
	6.4.2	Lineament Of Study Area		119
	6.4.3	Lineament Density		120
6.5	Slope Analysis			121
6.6	Integration			122
	6.6.1	Metthodology		124
	6.6.2	GIS Database Development		124
	6.6.3	Weight Assignment		124
	6.6.4	Data Integration		125

	6.6.5	Assessment of Ground Water Potential Zones	125
CHAPTER - 7 SUMMARY AND CONCLUSION			127 – 136
7.1	Summary		127
	7.1.1	Geology	127
	7.1.2	Hydrogeology	128
	7.1.3	Ground Water Chemistry	129
	7.1.4	Geophysics	130
	7.1.5	Remote Sensing And GIS Integration	132
7.2	Conclusion		133
7.3	Recommendations		135
	Bibliography		
	Appendix		
	List of Publications		

## LIST OF TABLES

<b>Sl. No.</b>	<b>TABLES</b>	<b>Page / After</b>
2.1	Geological Succession Of Tirunelveli District	35
2.2	USDS – SCS soil classification in the study area	43
2.3	HSGs and their textural classes in the study area	43
2.4	Hydrogeomorphic units, their characteristics and GW potential	45
3.1	Locations for Water Level monitoring OB well in the study area	53
3.2	Water Level data for the period from 2007 to 2012	54
3.3	Actual and Normal Rainfall data of Tirunelveli District for the period from 2005 to 2014	56
3.4	Season wise Average Rainfall (10 years)	56
3.5	Locations of Pumping Test Conducted in the study area	59
3.6	Results of Pumping Test data in the study area	61
4.1	Ground Water Sampling Locations in the Study area	66
4.2	Geochemical Parameters in the Study area	66
4.3	Ground Water permissible limits prescribed by WHO	66
4.4	pH concentration of the study area	67
4.5	EC concentration of the study area	69
4.6	TDS concentration of the study area	70
4.7	So <sub>4</sub> concentration of the study area	71
4.8	Ca concentration of the study area	72
4.9	Mg concentration of the study area	73
4.10	Cl concentration of the study area	75
4.11	Sodium absorbtion ratio of the study area	76
4.12	Irrigation quality of groundwater based on RSC	77
4.13	Irrigation quality of groundwater based on Total Hardness	78

4.14	Relative weight of chemical parameters	81
4.15	Calculation of WQI for Individual Samples in the Study area	83
5.1	Resistivities of Some Common Rocks, Minerals, Chemicals and Metals (after Loke, 1997)	87
5.2	Representative resistivity values for earth materials (Mooney, 1980)	89
5.3	Hydrogeological Significance of Bulk Resistivity Values	89
5.4	Electrical Methods Employed For Common Hydrogeological Problems	95
5.5	VES Location of the Study area	98
5.6	Analysis of VES data	100
5.7	Results of Quantitative Interpretation	101
5.8	Results of Qualitative Interpretation	104
5.9	Resistivity Curve Type	111
6.1	Slope Categories and Percentage	122
6.2	Different parameters considered for groundwater prospects evaluation and their themes and class weights	123
6.3	Ground Water Potential	126



## LIST OF FIGURES

<b>Sl. No.</b>	<b>FIGURES</b>	<b>Page / After</b>
1.1	Location map of the Study Area	3
2.1	Geology map of the Study Area	34
2.2	Surface Soil Texture map of the Study Area	42
2.3	Geomorphology map of the Study area	46
3.1	Water Level monitoring location map of the Study area	53
3.2	Pre-monsoon Average Water Level Map (2007-2012)	54
3.3	Post-monsoon Average Water Level Map (2007-2012)	54
3.4	Average Water Level Map (2007-2012)	55
3.5	Water Level Fluctuation Map (2007-2012)	55
3.6	Pumping Test Location Map of the Study area	59
3.7	Transmissivity Map of the Study area	61
3.8	Storage Co-efficient Map of the Study area	62
3.9	Specific Capacity Map of the Study area	63
4.1	GW Sample Location map of the Study area	66
4.2	pH Concentration map of the Study area	67
4.3	EC Concentration map of the Study area	68
4.4	TDS Concentration map of the Study area	70
4.5	So <sub>4</sub> Concentration map of the Study area	71
4.6	Ca Concentration map of the Study area	72
4.7	Mg Concentration map of the Study area	73
4.8	Cl Concentration map of the Study area	74
4.9	SAR Concentration map of the Study area	76
4.10	RSC Concentration map of the Study area	77

4.11	TH Concentration map of the Study area	78
4.12	Water Quality Index map of the Study area	83
5.1	A Graphical Plot of the Resistivity Values of Different Types of Materials (after Loke, 1997)	88
5.2	A Conventional Four-Electrode Array to Measure the Subsurface Resistivity	90
5.3	Wenner Configuration	93
5.4	Vertical Electrical Soundings Location map of the Study area	98
5.5	Iso- Apparent Resistivity Values at 4 m depth from G.L.	102
5.6	Iso- Apparent Resistivity Values at 8 m depth from G.L.	102
5.7	Iso- Apparent Resistivity Values at 12 m depth from G.L.	102
5.8	Iso- Apparent Resistivity Values at 16 m depth from G.L.	102
5.9	Iso- Apparent Resistivity Values at 20 m depth from G.L.	102
5.10	Iso- Apparent Resistivity Values at 40 m depth from G.L.	102
5.11	Iso- Apparent Resistivity Values at 60 m depth from G.L.	102
5.12	Iso- Apparent Resistivity Values at 80 m depth from G.L.	102
5.13	Iso- Apparent Resistivity Values at 100 m depth from G.L.	102
5.14	Top Soil Thickness map of the Study area	106
5.15	Top Soil Resistivity map of the Study area	107
5.16	Water Bearing Formation Thickness map of the Study area	107
5.17	Water Bearing Formation Resistivity map of the Study area	108
5.18	Depth of Basement map of the Study area	108
5.19	Depth of Basement Resistivity map of the Study area	109
5.20	Transverse Resistance Map of the Study area	109
5.21	Longitudinal Conductance Map of the Study area	110
5.22	Anisotrophy Map of the Study area	110

5.23	Curve Type Map of the Study area	111
6.1	Landsat ETM Satellite Imagery showing the study area	114
6.2	Drainage Map of the Study area	115
6.3	Drainage Density Map of the Study area	116
6.4	Lineament Map of the Study area	120
6.5	Lineament Density Map of the Study area	121
6.6	Slope Map of the Study area	122
6.7	Ground Water Potential Map of the Study area	125

### LIST OF PLATES

<b>Sl. No.</b>	<b>PLATES</b>	<b>Page / After</b>
2.1	Charnockites Rocks in Gangaikondan in the study area	39
2.2	Unclassified Gneissic Rock in the study area	39
2.3	Quartzitic Intrusion in Gneissic Rock in the study area	40
2.4	Foliation Structure in Quartzitic Rock in the study area	40
2.5	Structural Features in Unclassified Gneissic Rocks in the study area	42
2.6	Fissures and Joints in Gneissic Rock in the study area	42
2.7	Pediments Near Reddiarpatti Village in the study area	47
2.8	Buried Pediment (Shallow) in Alangulam in the study area	47
2.9	Buried Pediments (Deep) in Seevalaperi in the study area	49
2.10	Flood Plain in Seevalaperi in the study area	49
3.1	Tamiraparani River in the study area	51
3.2	Chittar River in the study area	51

### LIST OF GRAPH

<b>Sl. No.</b>	<b>GRAPH</b>	<b>Page / After</b>
3.1	Rain fall data for the Period from 2005 to 2014	56