

CONTENTS

Acknowledgement	I
Synopsis	III
List of Tables	XIII
List of Graph	XVII
List of Figures	XI
Abbreviations	XXVII

Chapter	Title	Page
1	INTRODUCTION	1
1	Significance of Water	1
1.1	General Comparison	3
1.1.1	Statistics For World	3
1.1.2	Statistics For India	4
1.1.2.1	Population & Resources	4
1.1.2.2	Rainfall	5
1.1.2.3	Rivers	5
1.1.3	Statistics For Gujarat	6
1.1.3.1	Population & Resources	6
1.1.3.2	Physiographic of Gujarat	7
1.1.3.3	Climate of Gujarat	8
1.1.3.4	Rainfall	8
1.1.3.4	Surface Water Resources	9
1.1.3.5	Ground Water Resources of Gujarat	10
1.1.3.6	Availability of water	10

Chapter	Title	Page
1.2	About The Study Area	11
1.2.1	Location of Kutch	11
1.2.2	Administrative Subdivisions	11
1.2.3	Meteorological Parameters of Kutch	12
1.2.3.1	Rainfall	12
1.2.3.2	Wind	12
1.2.3.3	Temperature	12
1.2.3.4	Humidity	12
1.2.3.5	Cloudiness	13
1.2.4	Physical Features	13
1.2.4.1	Configuration	13
1.2.4.2	The Rann	13
1.2.4.3	Coastal Areas	13
1.2.4.4	Rivers	13
1.2.4.5	Structure And Stratigraphy	14
1.3	Problems Of The Study Area	14
1.3.1	Earthquakes	14
1.3.2	Ingress of Desert Of Kutch	14
1.3.3	Banni Grassland of Kutch	15
1.3.4	Increase in Growth Of "Gando Bawal"	15
1.3.5	Sea Water Intrusion	15
1.4	Background For Study	16
1.5	Objectives Of Study	16
1.6	Methodology Adopted	17

Chapter	Title	Page
2.	LITERATURE REVIEW	18
2.1	Historical Background	18
2.1.1	Empirical methods for estimation of runoff	18
2.1.2	Curves and table method	19
2.1.3	Runoff coefficient method	19
2.1.4	Infiltration capacity curve method	20
2.1.5	Watershed simulation method	20
2.1.6	Hydrograph method	20
2.1.7	Rainfall runoff correlation method	20
2.1.8	SCS method	20
2.1.9	Rainfall Runoff Modeling	21
2.2	Studies Carried Out at World Level	21
2.3	Studies In India	24
2.4	Studies In Kutch	25
2.5	Justification of Study	28
3	RAINFALL PATTERN & ANALYSIS	29
3.1	Rainfall data collected	29
3.2	Analysis of 130 year annual rainfall data	30
3.2.1	Analysis for Kutch district	30
3.2.1.1	Rainfall Pattern Analysis	30
3.2.1.2	Probability Analysis	31
3.2.1.3	Rainfall Distribution Analysis for District	32
3.2.2	Analysis for Anjar Taluka	34
3.2.2.1	Rainfall Pattern Analysis for Anjar	34
3.2.2.2	Probability Analysis for Anjar	34
3.2.2.2	Distribution of Rainfall for Anjar	36

Chapter	Title	Page
3.2.3	Analysis for Bhachau Taluka	37
3.2.4	Analysis for Bhuj Taluka	38
3.2.5	Analysis for Lakhpat Taluka	40
3.2.6	Analysis for Mandvi Taluka	41
3.2.7	Analysis for Mundra Taluka	43
3.2.8	Analysis for Nakhatrana Taluka	44
3.2.9	Analysis for Naliya Taluka	46
3.2.10	Analysis for Rapar Taluka	47
3.3	Analysis of 19 year annual rainfall data	49
3.4	Analysis of monthly rainfall data	51
3.5	Summary of rainfall analysis	53
3.5.1	Summary for 130 Year Annual Rainfall Data	53
3.5.2	Summary for 19 Year Annual Rainfall Data	54
4	SURFACE WATER POTENTIAL & ANALYSIS	56
4.1	Rivers Of Kutch	56
4.1.1	Major North Flowing Rivers	57
4.1.2	Major South Flowing Rivers	58
4.3	Medium Irrigation Schemes Of Kutch	61
4.4	Minor Irrigation Schemes	61
4.5	Check Dams	61
4.6	Runoff	62
4.7	Summary Of Runoff Analysis	71
4.7.1	Summary For Analysis Of Annual Runoff	71
4.7.2	Summary For Analysis Of Monthly Runoff	71

Chapter	Title	Page
5	GROUNDWATER POTENTIAL	73
5.1	Geology Of Area	73
5.2	Soils of Kutch	74
5.3	Lithology Of Area	75
5.3.1	Sub-Surface Geological Cross-Sections	75
5.4	Open Wells In Kutch	76
5.4.1	Anjar Taluka	77
5.4.2	Bhachau Taluka	77
5.4.3	Bhuj Taluka	78
5.4.4	Lakhpat Taluka	78
5.4.5	Mandvi Taluka	78
5.4.6	Mundra Taluka	79
5.4.7	Nakhatrana Taluka	79
5.4.8	Naliya Taluka	80
5.4.9	Rapar Taluka	80
5.5	Tube Wells In Kutch	81
5.5.1	Anjar Taluka	82
5.5.2	Bhachau Taluka	82
5.5.3	Bhuj Taluka	83
5.5.4	Lakhpat Taluka	83
5.5.5	Mandvi Taluka	83
5.5.6	Mundra Taluka	84
5.5.7	Nakhatrana Taluka	84
5.5.8	Naliya Taluka	84
5.5.9	Rapar Taluka	85
5.6	Groundwater Levels	85
5.7	Groundwater Withdrawal	90

Chapter	Title	Page
	5.7.1 Formations Of The Area	90
	5.7.2 Groundwater Water Extracting Mechanism	91
	5.7.3 Groundwater Withdrawal Pattern	91
	5.8 Recharge Calculations	92
	5.8.1 Recharge Due To Rainfall	93
	5.8.2 Recharge Due To Surface Storage	93
	5.8.3 Total Recharge	95
	5.9 Summary For Groundwater Analysis	95
	5.9.1 Summary For Draft Pattern	96
	5.9.2 Summary For Total Groundwater Recharge	96
6	INTER RELATIONSHIPS BETWEEN RAINFALL, SURFACE & GROUNDWATER POTENTIAL	97
	6.1 Rainfall-Runoff Relations	97
	6.1.1 Annual Relations Between Rainfall And Runoff	97
	6.1.2 Monthly Relations Between Rainfall And Runoff	102
	6.2 Rainfall-Groundwater Recharge Relations	106
	6.3 Summary	111
	6.3.1 Annual Rainfall - Runoff Relations	111
	6.3.2 Monthly Rainfall – Runoff Relations	111
	6.3.3 Rainfall – Groundwater Recharge Relations	112
7	RESULTS	113
	7.1 Rainfall Analysis For Kutch	113
	7.1.1 Analysis of Annual Rainfall for the study period of 130 years (1878 to 2007)	113
	7.1.1.1 Rainfall Analysis	113
	7.1.1.2 Results of Rainfall Distribution Analysis (1878 to 2007)	113
	7.1.1.3 Probability Analysis	114

Chapter	Title	Page
7.1.2	Analysis of Annual Rainfall for the study period of 19 years (1989 to 2007)	115
7.1.3	Analysis for Monthly Rainfall (mm) for 1989 to 2007	116
7.2	Surface Water Analysis For Kutch	116
7.2.1	Analysis of Annual Runoff (mm)	116
7.2.2	Analysis of Monthly Runoff (mm)	117
7.3	Results Of Groundwater Potential Analysis	117
7.3.1	Development of Equation for Draft	118
7.3.2	Total Groundwater Recharge	118
7.4	Results Of Inter-Relationship	119
7.4.1	Rainfall-Runoff Relations	119
7.4.1.1	Annual Rainfall - Runoff Relations	119
7.4.1.2	Monthly Rainfall – Runoff Relations	119
7.4.2	Rainfall – Groundwater Recharge Relations	120
8.	CONCLUSIONS, DISCUSSIONS & RECOMMENDATIONS	121
8.1	Conclusions & Discussions	121
8.1.1	Conclusions & Discussions for Rainfall Analysis	121
8.1.2	Conclusions & Discussions for Surface Water Analysis	121
8.1.3	Conclusions & Discussions for Groundwater Potential Analysis	122
8.1.4	Conclusions & Discussions for Inter Relationships	122
8.2	Recommendations	123
8.3	Scope For Future Study	123
	REFERENCE	124-131
	ANNEXURES	132
	Annual Rainfall Data For 1878 To 2007	132

Chapter	Title	Page
	Monthly Rainfall Data For 1989 To 2007	134
	General Details For Medium Irrigation Schemes	137
	Storage Parameters For Medium Irrigation Schemes	138
	General Details For Minor Irrigation Schemes	138
	General Details For Check Dams	142
	Groundwater Withdrawal	166