

TABLE OF CONTENTS

CERTIFICATE	i
DECLARATION BY THE CANDIDATE	ii
COPYRIGHT TRANSFER CERTIFICATE	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	vii
LIST OF FIGURES	xii
LIST OF TABLES	xvi
LIST OF ABBREVIATIONS	xix
PREFACE	xxii
CHAPTER 1: INTRODUCTION	1-36
1.1 WHAT IS REMOTE SENSING	1
1.2 TYPES OF REMOTE SENSING	3
1.2.1 Passive remote sensing	3
1.2.2 Active remote sensing	4
1.3 THE ELECTROMAGNETIC SPECTRUM	5
1.4 INTERACTION OF EMR WITH ATMOSPHERE	6
1.4.1 Scattering	6
1.4.2 Absorption	7
1.5 INTERACTION OF EMR WITH THE EARTH SURFACE FEATURES	9
1.5.1 Spectral reflectance	11
1.6 DIGITAL IMAGE REPRESENTATION	12
1.7 SATELLITE CHARACTERISTICS	13
1.8 CHARACTERISTICS OF REMOTE SENSING IMAGE	14
1.8.1 Spatial resolution	14
1.8.2 Spectral resolution	15
1.8.3 Radiometric resolution	17
1.8.4 Temporal resolution	18
1.9 THERMAL REMOTE SENSING	18
1.10 APPLICATIONS OF THERMAL REMOTE SENSING	21

1.11 SURFACE URBAN HEAT ISLANDS	21
1.12 IMPORTANCE OF LAND SURFACE TEMPERATURES ANALYSIS IN URBAN AREAS	24
1.13 RESEARCH QUESTIONS	24
1.14 REVIEW OF LITERATURE	25
1.15 MOTIVATION OF THE STUDY	31
1.16 RESEARCH OBJECTIVES	33
1.17 ORGANISATION OF THESIS	34
CHAPTER 2: MATERIALS AND METHODOLOGY	37-46
2.1 SATELLITE DATA AND ITS SPECIFICATIONS	37
2.1.1 MODIS satellite data	37
2.1.2 Landsat satellite data	38
2.2 CALCULATION OF SPECTRAL INDICES	41
2.3 CLASSIFICATION OF IMPERVIOUS SURFACE FRACTION	43
2.4 ESTIMATION OF LST FROM LANDSAT DATA	44
CHAPTER 3: DISAGGREGATION OF MODIS LAND SURFACE TEMPERATURE IN URBAN AREAS USING IMPROVED THERMAL SHARPENING TECHNIQUES	47-72
3.1 INTRODUCTION	47
3.2 STUDY AREA AND DATA USED	50
3.2.1 Study area	50
3.2.2 Data used and image preprocessing	52
3.3 METHODOLOGY	53
3.3.1 Calculation of spectral indices	54
3.3.2 Inter-calibration of sensors	54
3.3.3 Thermal sharpening technique	56
3.3.4 Validation	58
3.4 RESULTS AND DISCUSSION	59
3.4.1 Inter-calibration of Landsat and MODIS data	59
3.4.2 LST downscaling using Distrad model with different indices	61
3.4.3 LST downscaling using different robust regression techniques	64
3.5 CONCLUSION	71

CHAPTER 4: THERMAL SHARPENING OF MODIS LAND SURFACE	73-94
TEMPERATURE USING STATISTICAL	
DOWNSCALING TECHNIQUE IN URBAN AREAS	
4.1 INTRODUCTION	73
4.2 STUDY AREA AND DATA USED	76
4.2.1 Study area	76
4.2.2 Data used and image preprocessing	77
4.3 METHODOLOGY	79
4.3.1 Calculation of Spectral Indices	79
4.3.2 Inter-calibration of sensors	79
4.3.3 Statistical downscaling technique	81
4.4 RESULTS AND DISCUSSION	82
4.4.1 Downscaling of MODIS-LST using various SI employed singly	82
4.4.2 LST maps	84
4.4.3 Disaggregation of MODIS-LST using statistical-downscaling-technique	88
4.4.4 Comparative analysis of downscaling MODIS-LST in different cities	91
4.5 CONCLUSION	92
CHAPTER 5: A COMPARATIVE ANALYSIS OF DAY AND NIGHT LAND	95-121
SURFACE TEMPERATURE IN TWO SEMI-ARID CITIES	
USING SATELLITE IMAGES SAMPLED IN DIFFERENT	
SEASONS	
5.1 INTRODUCTION	95
5.2 STUDY AREA AND DATA USED	99
5.2.1 Study area	99
5.2.2 Data used and image preprocessing	99
5.3 METHODOLOGY	103
5.3.1 Classification of impervious surface fraction	103
5.4 RESULTS AND DISCUSSION	104
5.4.1 Diurnal LST variation of land cover	104
5.4.2 Relation of LST with indices and ISF	107
5.4.3 Development of model for diurnal LST	112
5.4.4 Seasonal behaviour of the developed relation of LST with combination of indices	115

5.5 CONCLUSION	119
CHAPTER 6: QUANTIFICATION OF URBAN HEAT INTENSITY WITH LAND USE/LAND COVER CHANGES USING LANDSAT SATELLITE DATA OVER URBAN LANDSCAPES	122-141
6.1 INTRODUCTION	122
6.2 STUDY AREA AND DATA USED	125
6.2.1 Study area	125
6.2.2 Data used	126
6.3 METHODOLOGY	127
6.3.1 Supervised classification and change in LULC	127
6.3.2 Calculation of normalized LST	127
6.3.3 Calculation of Urban Heat Intensity Ratio Index (UHIRI)	128
6.3.4 Computation of land cover contribution index (LCCI)	128
6.4 RESULTS AND DISCUSSION	129
6.4.1 LULC classification and changes	129
6.4.2 Long term Study on LST and quantification of urban heat intensity using UHIRI	131
6.4.3 LST dependence of each land cover	134
6.4.4 Quantifying the contribution of LULC types on LST	135
6.4.5 LULC change and its effect on LST	138
6.5 CONCLUSION	140
CHAPTER 7: ASSESSMENT OF SEASONAL AND LONG TERM QUANTIFICATION OF SURFACE URBAN HEAT ISLAND INTENSITY (SUHI): A CASE STUDY OF VARANASI CITY, INDIA	142-157
7.1 INTRODUCTION	142
7.2 STUDY AREA AND DATA USED	144
7.2.1 Study area	144
7.2.2 Data used	145
7.3 METHODOLOGY	146
7.3.1 UHI calculation and its classification into five thermal levels	146
7.3.2 SUHI intensity calculation	146
7.4 RESULTS AND DISCUSSION	147

7.4.1	Seasonal and temporal variation in vegetation covers using NDVI maps	147
7.4.2	UHI maps	150
7.4.3	SUHI intensity determination	155
7.5	CONCLUSION	156
CHAPTER 8: CONCLUSIONS AND FUTURE RESEARCH		158-160
7.1	CONCLUSIONS	158
7.2	FUTURE RESEARCH	159
REFERENCES		161-174
LIST OF PUBLICATIONS		175-176