

# TABLE OF CONENTS

	Page no
<b>ABSTRACT(English)</b>	i
<b>ABSTRACT(Arabic)</b>	iii
<b>AKLOWNEDGEMENTS</b>	iv
<b>TABLE OF CONENTS</b>	v
<b>LIST OF FIGURES</b>	xii
<b>LIST OF TABLES</b>	xiv

## **Chapter One: Introduction**

1.1 Background	1
1.2 Thesis objectives	3
1.3 Thesis outlines	4

## **Chapter Two: The Fundamentals of the Cadastral Surveying**

2.1 Classification of the cadastre	5
2.1.1 Fiscal cadastre	5
2.1.1.1 Land and property taxation	5
2.1.1.2 The creation of the fiscal cadastre	6
2.1.2 Legal cadastre	7
2.1.2.1 Methods of land transfer registration	8
2.1.2.1.1 Private conveyancing	8
2.1.2.1.2 Registration of deeds	8
2.1.2.1.3 Registration of title	9
2.1.3 Multipurpose cadastre	10
2.1.3.1 Components of the multipurpose cadastre	11

2.2 Components of the cadastral system	12
2.2.1 Adjudication	12
2.2.1.1 Sporadic and systematic adjudication	12
2.2.1.2 The adjudication process	12
2.2.2 Demarcation	14
2.2.2.1 Boundaries monumentation	14
2.2.2.2 Permanence of boundaries	15
2.2.2.2.1 Fixed boundaries	15
2.2.2.2.2 General boundaries	17
2.2.3 Survey	17
2.2.4 Registration	17
2.2.4.1 Parcel attributes	18
2.2.4.2 Parcel description	18
2.3 Summary	19

### **Chapter Three: Acquisition of Land Ownership in the Land Law of the Sudan**

3.1 Historical background	20
3.1.1 Absolute individual ownership	20
3.1.2 Private landlordism	21
3.1.3 Communal ownership	21
3.1.3.1 Village ownership	21
3.1.4 Ownership documentation	21
3.2 Beginning of systematic land registration	22
3.3 Land ownership and limitations on it	23
3.4 Types of land ownership in the Sudan	24
3.4.1 Co-ownership of undivided shares	25
3.4.1.1 Ownership of Storey in Buildings	26

3.5 Limitations on the ownership of land	26
3.5.1 Common law Limitation on ownership of land	26
3.5.2 Covenants and contractual Limitations	27
3.5.3 Customary Restrictions	27
3.5.4 Statutory Limitations	28
3.6 Modes of Acquisition of Ownership of Land	
in the Sudan	28
3.6.1 Possession	29
3.6.1.1 Hag el Gusad	29
3.6.1.2 Ownership of Islands in the River	30
3.6.1.3 Mirin	30
3.6.2 Other Modes of Acquisition of Ownership of Land	30
3.6.2.1 Gift	31
3.6.2.2 Exchange	31
3.6.2.3 Inheritance	31
3.6.2.4 Wills	31
3.6.2.5 Doweries and Khula	32
3.6.2.6 Grants by the Government	32
3.6.2.7 Partnership and Companies	32
3.6.3 Sale of Land in the Sudan	32
3.6.4 Land Settlement and Registration	33
3.6.5 The Law of Pre-emption in the Sudan	34
3.6.6 The Unregistered Land Act, 1970 and the Land Settlement and Registration Ordinance, 1925	35

## **Chapter Four: The Role of Surveying and Mapping in the Cadastre**

4.1 Survey coordinate systems	37
-------------------------------	----

4.1.1 The geodetic coordinate system	38
4.1.1.1 Definition of terms	39
4.1.2 The astronomical coordinate system	39
4.1.3 The three dimensional rectangular Cartesian coordinate systems	40
4.1.3.1 The geocentric rectangular Cartesian coordinate system	40
4.1.3.2 The topocentric rectangular cartesian coordinate system	41
4.1.4 The two dimensional plane Cartesian coordinate system	41
4.1.5 The levelling datum	42
4.1.6 Advantages of the coordinate systems	42
4.1.7 Establishment of the coordinate systems	42
4.2 Field survey measurement techniques	43
4.2.1 Plane table	44
4.2.2 Chain surveying	45
4.2.3 Electromagnetic distance measurements (EDM)	46
4.2.4 Photogrammetry	47
4.3 Cadastral mapping	47

## **Chapter Five: The Impact of GPS in Georeferencing Cadastral Surveys and Maps**

5.1 Introduction	51
5.2 Components of GPS System	52
5.2.1 The space segment	52
5.2.2 The control segment	53
5.2.3 The user segment	54
5.3 Surveying with GPS	56
5.3.1 Techniques of GPS observations	56
5.4 GPS accuracy	57
5.4.1 GPS sources of errors	57

5.4.1.1 Ionospheric and atmospheric delays	58
5.4.1.2 Satellite and receiver clock errors	58
5.4.1.3 Multipath errors	59
5.4.1.4 Dilution of Precision	59
5.4.1.5 Selective Availability (S/A)	60
5.4.1.6 Anti-Spoofing (A-S)	60
5.5 Application of GPS in the proposed cadastral system	60

## **Chapter Six: Basic Concepts of Geographic Information Systems (GIS)**

6.1 Introduction	62
6.2 Components of GIS	63
6.2.1 Hardware	63
6.2.2 Software	64
6.2.3 Data	65
6.2.3.1 Spatial data	66
6.2.3.1.1 Raster data model	66
6.2.3.1.2 Vector data model	67
6.2.3.2.1.1 Topology	67
6.2.3.2 Attributes	68
6.2.3.2.1 Attribute data models	69
6.2.3.2.1.1 Tabular model	69
6.2.3.2.1.2 Hierarchical Model	69
6.2.3.2.1.3 Network model	69
6.2.3.2.1.4 Relational model	70
6.2.3.2.1.5 Object oriented model	71
6.2.4 People or live ware	71
6.2.5 Procedures	71

6. 3 Functionalities of GIS	72
6.3.1 Data acquisition	73
6.3.2 Preliminary data processing	74
6.3.3 Data storage and retrieval	74
6.3.4 Spatial search and analysis	76
6.3.4.1 Containment search within a spatial region	76
6.3.5 Proximal search	77
6.3.6 Phenomenon based search and overlay processing	77
6.3.7 Interpolation and surface modeling	78
6.3.8 Best path analysis and routing	78
6.3.9 Spatial interaction modeling	78
6.3.10 Correlations, associations, patterns and trends	79
6.3.11 Map algebra with girded data	79
6.3.12 Graphics and interaction	80

## **Chapter Seven: The Design of the Proposed Cadastral System**

7.1 Introduction	81
7.2 Area of study	83
7.3 The structure of the proposed cadastral system	88
7.3.1 The graphical data	88
7.3.1.1 The residential parcels layer	88
7.3.1.2 Services' parcels layer	90
7.3.1.3 Geodetic control points layer	91
7.3.1.4 Contour map layer	92
7.3.2 The attributes	93
7.3.2.1 The attributes of the residential parcels layer	94
7.4 Generalization of the model	97

7.5 Relocation of ground points from the coordinates of the digital map	98
7.6 Data security	99
7.7 Execution of the proposed model	100
7.7 Summary	107

## **Chapter Eight: Tests and Results**

8.1 Test of total station observations accuracy	108
8.2 Test of ground setting out accuracy of the existed system	109
8.3 Test of digital map georeferencing accuracy	109
8.4 Comparison of location accuracy between existed and proposed system	111
8.5 Analysis of the results	112

## **Chapter Nine: Conclusions and Recommendations**

9.1 Conclusions	114
9.2 Recommendation	115
<b>References and Bibliography</b>	116
<b>Appendix A</b>	118
<b>Appendix B</b>	124

## LIST OF FIGURES

Figure	page
4.1 Relationship between the topographic surface of the earth, the geoid and the reference ellipsoid	37
4.2 The geodetic coordinates	38
4.3 Cartesian coordinates ( $x, y, z$ ) of point P ( $\varphi, \lambda$ ) on the spheroid	40
4.4 The topocentric rectangular Cartesian coordinate system	41
4.5 Cadastral plan showing bearings and distances of sides, areas and plot numbers.	48
4.6 Part of a residential cadastral map in the Sudan	49
5.1 Components of GPS receiver	55
6.1 Layers of GIS spatial data	65
6.2 Relationship between GIS functions	72
6.3 Storage of vector data model	75
6.4 Spatial containment search with a rectangular window	76
6.5 Spatial containment search based on existing object	76
7.1 Map of the Sudan	84
7.2 Map of part of Khartoum state	85
7.3 Map of location of Alazhari district in Khartoum	86
7.4 Map Of Alazhari district	87
7.5 Map of block 5	87
7.6 Block 5 map before transformation	89
7.7 Block 5 residential parcels after transformation	90
7.8 Block 5 service parcels after transformation	90
7.9 Geodetic control points of block 5	91
7.10 Contour map of block 5	92
7.11 Combined layers of block 5	93
7.12 Structure of the proposed cadastral system	96



7.13 Maps of three blocks from different districts referred to the same coordinate system	97
7.14 Stones in the corners of the block of adjacent parcels	98
7.15 Smart station	99
7.16 Preparation of the digital map of the block	101
7.17 Preparation of the contour map of the block	101
7.18 Georeferencing block 5 layers	102
7.19 Editing attributes of the parcels	103
7.20 layers of the block saved in mxd file	103
7.21 Entering the password of the published map file	104
7.22 Layers of the block opened in ArcReader software	105
7.23 Using Find tool to view the plot data	105
7.24 Choosing Zoom To tool to view the plot map	106
7.25 The attributes of the plot are viewed using identify tool	106

## LIST OF TABLES

<b>Table</b>	<b>page</b>
7.1 Source and destination block 5 corners coordinates	89
8.1 Corners coordinates by total station	108
8.2 Block 5 sides map and ground distances	109
8.3 Total station and GPS coordinates of block 5 corners	110
8.4 Residuals of transformed corners coordinates	110
8.5 Residuals of other transformed points coordinates	111
8.6 Displacement of the block corners	112