

**APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM
FOR
LAND CLEARANCES IN THE CITY OF COLOMBO SRI LANKA**

M. Sc. Full Time (Research)

H. H. LEELANANDA

**DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF MORATUWA
SRI LANKA
MARCH 2005**

**APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM
FOR
LAND CLEARANCES IN THE CITY OF COLOMBO SRI LANKA**

**by
HEWA HEENIPALLAGE LEELANANDA**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE
(RESEARCH) FULL TIME**

March 2005

**Supervised by Prof. N. T. S. Wijesekera
Dr. T. A. Peiris**

**DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF MORATUWA
SRI LANKA**

DECLARATION

I certify that this thesis does not incorporate any material previously submitted for any degree or diploma in any university and to the best of my knowledge and belief it does not contain any material previously published or written or orally communicated by another person except where due reference made in the text.

Date :

H. H. Leelananda

To the best of my knowledge above particulars are correct.

Prof. N. T. S. Wijesekera

Department of Civil Engineering

University of Mortuwa

Dr. T. A. Peiris

Department of Civil Engineering

University of Mortuwa

ABSTRACT

The study aims to improve land clearance processes in Urban Development Authority (UDA) with the support of Geographic Information Systems. The objective is realized through the conduct of geographical analysis, query, and modeling. The study takes Thimbirigasyaya Ward in the City of Colombo as a case for developing the land clearance system.

UDA is the main Government Agency dealing with physical planning in Sri Lanka. The primary activity of the UDA is the preparation, implementation, and maintaining of National Physical Plans, Regional Structure Plans, and Local Development Plan within its declared areas.

A study is done to understand the context of land clearance processes in UDA and to develop a digital system for land clearances. The study takes a critical look at how UDA practices land clearances and monitoring, and applies information technology tools to support such functions. It reviews UDA regulations and identifies issues in land clearances and database management.

The method that has been exercised in developing a Land Information System (LIS) is basically in three forms. They are (1) Identifications of shortcomings in the present system. (2) Identifications of targets. (3) Finding ways in reaching the targets. Collection of data is first subjected to detailed study in order to find its accuracy and a database has been developed using data layers and attributes by converting analog maps and statistical data into digital form. Then land information were tested and verified for its accuracy.

Selection of the study area was done through a suitability analysis and availability of updated data. A model was then developed using GIS tools, its data accuracy was checked and found that the results had been in proper order. The developed LIS was compared with the existing processing system and was proved effective.

The accuracy of the data is very important in the process of developing a good LIS. In this study checks were carried out to ensure data accuracy. Numerical checks including stepwise calculations and field measurements were done to verify the model. The system developed using GIS has a significant advantage over the existing system. Clear improvements were visible in the area of labour and time saving and also in the provision of alternative solutions. System output identified the present distribution and use of land parcels. This gives rise to the need of establishing norms for rational decision making. UDA is basically benefited by this system on followings. (1) Serve as platform to integrate data and facilitate data exchange, (2) provide immediate access to data, (3) spatial analysis for selection of alternative sites, and (4) easy decision-making.

ACKNOWLEDGEMENT

I would like to extend respect and appreciation to the Director Human Resources & Management Urban Development Authority Mrs. G. D. K. Gunasekara, who had provided great support & encouragement for my postgraduate study.

Many people helped me in making this thesis possible, and special thanks are to;

My two supervisors, Prof. N. T. S. Wijesekera and Dr. T. A. Peiris, and Mr. P. K. S. Mahanama, who guided me to complete this work adhering to required standards.

I thankfully acknowledge, the officers of the Urban Development Authority especially the Directors Mrs. Shirani Ariyathilaka, Mr. Hematha Jayasundara, Mr. L. H. Indrasiri, and Deputy Directors Mrs. Pushpa Gamage, Mrs. D. Jayasundara, Miss. Mangalika Ekanayake for the support in approving study leave and data collection programmes. The UDA also assisted this work by providing 1:1000 digital map data.

I am sincerely grateful to the officials and staff of Colombo Municipal Council, especially the Deputy Commissioner Mr. N. S. Jayasundara, Director Planning Miss. N. P. Herath, Deputy Director Mr. T. A. Gamage, Senior Draftsman Mr. S. M. Vignarajha. The Colombo Municipal Council supported this work by granting permission to use the Land Parcels map information.

My sincere gratitude goes to the International Centre for Geoinformatics Applications and Training (ICGAT), University of Moratuwa for providing me space and its resources to successfully complete my research. I also like to remember all the assistance given by the staff of the ICGAT who provided great support to complete the work in time.

Finally, I specially wish to thank my wife Sumedha and my son Nandinu.

TABLE OF CONTENTS

ABSTRACT.....	i
ACKNOWLEDGMENTS.....	ii
TABLE OF CONTENTS.....	iii
LIST OF FIGURES.....	v
LIST OF TABLES.....	vii
ABBREVIATIONS.....	viii
1. INTRODUCTION.....	1
1.1. BACKGROUND.....	1
1.2. THE PRESENT STATUS.....	3
1.3. STATUS IMPROVEMENT.....	6
1.4. MERIT OF GIS.....	6
1.5. OBJECTIVE OF THE PROJECT.....	7
1.6. STUDY AREA.....	8
1.7. EXISTING PLANNING APPROVAL PROCESS.....	11
2. LITERATURE REVIEW.....	14
2.1. LAND DEVELOPMENTS.....	14
2.2. LAND USE.....	15
2.3. LAND REGISTRATION SYSTEM.....	16
2.4. LAND INFORMATION SYSTEM.....	16
2.5. DIGITAL MAPPING AND LAND INFORMATION SYSTEM.....	17
2.6. STARTING THE INFORMATION SYSTEMS DEVELOPMENT PROCESS.....	17
2.7. GEOGRAPHIC INFORMATION SYSTEM.....	18
2.8. IMPORTING DATA INTO A GIS.....	18
2.9. GIS MODELING.....	19
2.10. CREATING A GIS DATABASE.....	19
2.11. ZONING REGULATIONS FOR CITY OF COLOMBO	20
3. METHODOLOGY.....	22
3.1. DEVELOPMENT OF DATA LAYERS AND ATTRIBUTES.....	24
3.2. DEVELOPMENT OF SEQUENCE OF COMPUTATIONS.....	25
3.3. IDENTIFICATION OF DATA COLLECTION METHODS.....	25
3.4. SEQUENCE OF STUDY AREA SELECTION.....	28

4. ANALYSIS.....	31
4.1. CASE STUDY AREA SELECTION.....	31
4.2. LAND CLEARANCE SYSTEM DEVELOPMENT.....	36
4.2.1. SYSTEM STRUCTURE AND FUNCTIONALITIES.....	36
4.2.2. MODEL OUTLINE.....	37
4.2.3. MODEL DEVELOPMENT.....	40
4.2.4. MODEL CHECKING.....	42
4.2.5. MODEL OUTPUTS.....	55
5. RESULTS.....	58
5.1 LAND SUBDIVISION QUALIFICATIONS.....	58
5.2 MANAGEMENT OF DEVELOPMENT INFORMATION.....	59
5.3 COMPARISON OF EXISTING WITH PROPOSED SYSTEM.....	64
5.4 IDENTIFICATION OF ALTERNATIVE SITES.....	68
6. DISCUSSION.....	71
6.1. DATA ACCURACY.....	71
6.2. SYSTEM ACCURACY.....	72
6.3. SYSTEM BENEFITS.....	72
6.4. MANAGEMENT OF GeoLIS.....	73
7. CONCLUSIONS.....	75
REFERENCES.....	76
8. APPENDICES.....	78
APPENDIX A: Duplicate Error.....	78
APPENDIX B: Land Parcels Lengths Accuracy.....	81
APPENDIX C: Extent Distribution Patterns.....	84
APPENDIX D: Alternative Site Selections.....	89
APPENDIX E: Zoning Regulations.....	96
APPENDIX F: Land Subdivision Limitations.....	103
APPENDIX G: Land Parcels Extent Accuracy.....	105
APPENDIX H: Gazette Notification.....	112

LIST OF FIGURES

1-1	Existing Preliminary Planning Clearance System	5
1-2	Location of Study Area	9
1-3	Population Distribution of Colombo City.....	10
1-4	Planning Approval Process.....	12
3-1	Research Methodology adopted for the study.....	22
3-2	Methodology for Development of GeoLIS for Land Clearances.....	23
3-3	Data Processing Methodology.....	26
3-4	The MOSAIC of Scanned Images of Land Parcels map	27
3-5	Selection Criteria using Themes.....	30
4-1	Slums & Shanty distribution pattern.....	32
4-2	Low Slums & Shanty distribution pattern.....	32
4-3	Population Density distribution pattern.....	33
4-4	Low Population Density distribution pattern.....	33
4-5	Common to Slums & Shanty & Population Density.....	33
4-6	Plot Coverage distribution pattern.....	33
4-7	Low Plot coverage distribution pattern.....	33
4-8	Common to Plot Coverage Others.....	33
4-9	Floor Area distribution pattern.....	34
4-10	Low Floor Area distribution pattern.....	34
4-11	Common to Slums, Pop, Plot & Floor Themes.....	34
4-12	Vacant Lots distribution pattern.....	34
4-13	High Vacant Lots distribution pattern.....	34
4-14	Two Municipal Wards Finally Selected.....	34
4-15	Zones in Thimbrigasyaya Ward.....	35
4-16	Flow Chart shows Proposed System Analysis.....	41
4-17	Field Length measured in Sakvithi Lane.....	45
4-18	Digital Length measured in Sakvithi Lane.....	45
4-19	Extent measured at eight different locations.....	46
4-20	Mean Absolute Error Ratios.....	47

4-21	Addresses Geocoded Attribute Table1.....	53
4-22	Address Locations in Road Theme.....	53
4-23	Address Geocoded Attribute Table2.....	54
4-24	Address Location in Land Parcels Theme.....	54
4-25	GIS for Accessing Data.....	56
5-1	Floors Distribution Pattern in Thimbrigasyaya Ward.....	60
5-2	Use of Buildings in Thimbrigasyaya Ward.....	60
5-3	Land Parcels Distribution Pattern.....	61
5-4	Floor Distribution pattern in three Zones.....	61
5-5	Uses of Buildings in three Zones.....	62
5-6	Age of Buildings in three Zones.....	62
5-7	Land parcels extent distribution pattern in three Zones.....	63
5-8	Land parcels distribution pattern in three Zones.....	63
5-9	Existing Preliminary Planning Clearance Processing System.....	64
5-10	Proposed Processing System.....	65
5-11	Best Locations for the Non-Residential Developments.....	70

LIST OF TABLES

1-1	Preliminary Planning Functions and Responsible Persons involved in Clearance Process.....	13
2-1	Permissible Development Activities.....	21
3-1	Development of Data Layers and Attributes.....	24
3-2	Theme Classifications.....	29
4-1	Theme Categorization.....	35
4-2	Existing and Proposed Changes for Land Clearance System.....	36
4-3	Total Error Calculations in different four locations.....	47
4-4	Land Parcels Attribute Table.....	49
4-5	Buildings Attribute Table.....	50
4-6	Comparison of Preliminary Planning Clearance Applications Results.....	51
5-1	Floors Distribution pattern in Thimbrigasyaya Ward.....	59
5-2	Usage of Buildings in Thimbrigasyaya Ward.....	60
5-3	Land Parcel distribution pattern in Thimbrigasyaya Ward.....	60
5-4	Floor Distribution pattern in three Zones.....	61
5-5	Uses of Buildings in different Zones.....	62
5-6	Age of Buildings in three Zones.....	62
5-7	Land parcels extent distribution pattern in three Zones.....	63
5-8	Preliminary Planning Clearance Process.....	66
6-1	Competitions of Application Processing Days.....	73
6-2	Staff Reduction Comparison.....	74

LIST OF ABBREVIATIONS

UDA	Urban Development Authority
CMC	Colombo Municipal Council
SLLR & DC	Sri Lanka Land Reclamation & Development Corporation
NHDA	National Housing Development Authority
ULAs	Urban Local Authorities
LA	Local Authority
GIS	Geographic Information System
LIS	Land Information System
SPRZ	Special Primary Residential Zone
PRZ	Primary Residential Zone
MDZ	Mixed Development Zone
MRAE	Mean Ratio of Absolute Error
GPS	Global Positioning System
GCPs	Ground Control Points
LCS	Land Clearance System
IS	Information System
IT	Information Technology
NGOs	Non Government Organizations
PPC	Preliminary Planning Clearance