Gis Based Analysis For Suitability Location Finding In The Residential Development Areas Of Greater Matara Region

H.K.G.M Madurika, G.P.T.S Hemakumara

Abstract: Urban Planning and Land utilization for the Residential is one of crucial factors in high density Cities. Many theories in Planning explain the Residential areas are moving to periphery areas in cities by its commercial development. Martara is one of developing city in Southern Sri Lanka and Residential land value are comparative high in city sub urban areas. In this study it is examined that where is the best locations for residential development in Grater Matara Region by using **five criteria**. GIS based Multi Criteria Method (MCE) method have been applied to find the suitable locations. The results of analysis have been shown that there are 5378.99 hectares area suitable within study area and however extremely importance areas only 1.40 hectares accordingly given criteria but very strongly importance and importance category have 1560.51 and 2468.22 respectively.

Key words: Urban Planning, GIS Model Builder, Suitability Analysis, Housing Demand, Residential Development, GIS, Land use

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1. INTRODUCTION

Land is an area of earth and it is natural resource to beneficial all citizens. As a factor of production land has an economic value, because of high demand for space many purposes, such as housing, education, public services, agriculture, mining, business, transport and recreation. Thus land is a scare resource especially in urban area, because more than half of world population lives in urban areas and half of world population in developing countries also live in urban areas. In today's increasingly global and interconnected world, over half of world's population (54%) lives in urban areas although there is still substantial variability in the levels of urbanization across countries. The continuing urbanization and overall growth of the world's population is projected to add 2.5 billion people to the urban population by 2050, with nearly 90% of the increase concentrated in Asia and Africa. Between 2011 and 2050, the world population is expected to increase by 2.3 billion, passing from 7.0 billion to 9.3 billion. The rate of urbanization in developed countries much higher than the urbanization of developing counties. In 2030 the population will increase 83.7% in more developed region and 57.3% in less developed region. [1] Basically, the urban population in developing countries is increasing day by day as a result of push and pull factors. Therefore residential land development plays a major role in the urban development. Due to the scarcity of land, real estate developers are concern on vertical development rather than horizontal development. Most of real estate developers try to maximum their profit margin and pay less attention for selecting best locations. [2] However, Sri Lanka similar to most other developing countries also has been experiencing a slow growth and a low level of urbanization as well for a long time. Considering the level of urbanization the last century, in 1891 it was 10.6% and 21.5% in 1981 and 14.6% in 2001 [2]. The urban population in Sri Lanka was reported as 3,118,603 in 2010 [13] UDA was declared a municipality in 2002 and recorded immense growth with the higher infrastructure development projects.

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Economically, the urban area is the most important industrial, commercial and administrative centre in Sri Lanka. It has the largest employment density and is the major distribution centre for imports as well as exports. Thus majority of people like to living close proximity to city center, because many facilities and services are available in core area. A residential area is a land use in which housing predominates, as opposed to industrial and commercial areas. Therefore the urbanization rate is growing annually and generating high demand of residential land. Planners and Policy makers need to prepare proper guidelines for suitable location for residential development.

1.2 Problem Statement

Although high level of urbanization are positively correlated with high level of economic development and positively correlated with reduce poverty. But urbanization developed underserved settlements. Still, available evidence indicates that substandard living conditions in underserved settlements have become a pressing issue in Colombo. [16]. The urbanization in Sri Lanka expected to increase from 20% in 2000 to 60% in 2030, perpetual gridlock, polluted waterways, and smoggy skies could all be potential side effects [14] Therefore providing better living condition is a critical issue in the country. However, Managing Cities for Sri Lanka Green Growth, organized by the UDA and attended by representatives from all major cities (including Matara) taught me some ways we may mitigate some of the negative effects and create a sustainable urban development through innovative locally driven initiatives [15]. Basically the urban areas consisting lots of commercial activity and industrial activities. Other hand general public want their residential places within close proximity to urban fragile. The residential activities are impossible in the core urban areas because of the zoning regulations. Therefore essential to find some suitable location nearby urban centers. Hence this study attempts to identify and evaluate the suitability location for residential development using a scientific methodology. Geographical Information System (GIS) and Multi Criteria Evaluation (MCE) can be used as a tool to analysis suitability location for residential development. When town planners choose sites for new residential developments, they must determine not only the sites that meet basic criteria, but also the areas that would make a new development successful. A

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potential site must be located in a residentially zoned area and in an area that is available for new growth. There are certain factors that make a site more appealing to a planner, such as land slope and distance from existing groundwater supplies. A successful development, however, requires more than this to attract new residents. Potential residents would be concerned with distance from amenities such as roads and schools, which they would want at a minimum. They would also prefer greater distances from features such as landfills and major polluters, as they would likely not want to live near these locations. The purpose of this project was to look at characteristics of the environment and existing infrastructure that a town planner would consider when siting a new housing development, especially in Greater Matara Region. These characteristics were used to determine the "most suitable" areas for residential development, based on weighting of the factors examined.

1.3 Objectives of this study

The main objective of this study to find the best locations for the residential housing scheme in Greater Matara Region. To achieve this main objective, following objectives were developed.

i.   To overview the existing residential land in Greater Matara   Region.
ii.   To find the vacant land availability for residential development.
iii. To find the suitable residential areas using GIS model.

2 METHODOLOGY

Basically, three types of data are used for this research; primary data, secondary data and literature. Primary data was collected only field observation. Existing and proposed housing units was collected from field survey in Greater Matara Region only selected area and sort out general view in day to day activities of the study area. Many literature reviews were collected using internet, others were collected by books and reports and all literature categorized according this research topic. The secondary data was consisting census data and digital data. Census data; land value data, samurdhi data, housing data. That data was collected by Matara Secretariat Division and Urban Development Authority in Matara and Colombo. Methodology was developed as step by step process and it is explained below:

2.1 Define Criteria

Criteria is a general category of information concerning the site being evaluated. The criteria often considered in land suitability studies include natural environment factor like slope, soil type geologic hazards present, land cover, etc., Build environment factors like existing land use, planned land use, accessibility to roads, availability of utilities, etc., Economic factors like land value, tax rate, etc. and social factors like population present, job present, historical features present, etc. In this study criteria were selected using the literature reviews of internal and external references, field observation and availability of data from Urban Development Authority (UDA) in Colombo. Criteria mean a standard of judgment, principle for evaluating or testing something. All data were collected and then define main and sub criteria. They are physical and social factors.

Elevation
Population density

Land use
Land use zoning
Available Facility (Accessibility roads, Hospital, School)

The land suitability assessment is the selection of the influencing factors since there are too many criteria affecting the land suitability. The selection of influencing criteria should also consider the objective of suitability analysis. Therefore, criterion was selected to easy to finding suitable residential locations in Greater Matara Region. As well as, Model builder used to define criteria. Model Builder is a visual programming language for building geoprocessing workflows. Geoprocessing models automate and document your spatial analysis and data management processes.

2.2 Using Model builder for define criteria

Model Builder is a visual programming language for building geoprocessing workflows. Geoprocessing models automate and document your spatial analysis and data management processes. Create and modify geoprocessing models in Model Builder, where a model is represented as a diagram that chains together sequences of processes and geoprocessing tools, using the output of one process as the input to another process. Besides, ModelBuilder is an application you use to create, edit, and manage models. Models are workflows that string together sequences of geoprocessing tools, feeding the output of one tool into another tool as input. ModelBuilder can also be thought of as a visual programming language for building workflows. While ModelBuilder is very useful for constructing and executing simple workflows, it also provides advanced methods for extending ArcGIS functionality by allowing you to create and share your models as tool. Model Builder can even be used to integrate ArcGIS with other applications.

The benefits of Model Builder can be summarized as follows:
Model Builder is an easy-to-use application for creating and running workflows containing a sequence of tools.
Can create own tools with Model Builder. Tools you create with Model Builder can be used in Python scripting and other models.
Model Builder, along with scripting, is a way for you to integrate ArcGIS with other applications.

2.3 Prioritize Criteria based on AHP

Data was collected for prioritizing criteria from field observation conducted existing and proposed housing units based on AHP. The Analytic Hierarchical Process (AHP) is one the methodological approaches that may be applied to resolve highly complex decision making problems involving multiple situations, criteria and factors. Thomas L. Saaty (1970) constructs a ratio scale associated with the priorities for the various items to be compared. In his initial formulation of AHP, Saaty proposed a four step methodology comprising modeling, valuation, prioritization and synthesis. At the modeling stage, a hierarchy representing relevant aspects of the problem (criteria, sub-criteria, attributes and alternatives) has been constructed. The goal concerned in the problem is placed at the top of this hierarchy. Other relevant aspects (criteria, sub criteria, attributes, etc.) are placed at remaining levels. In the AHP method, obtaining the weights or priority vector of the alternatives or the criteria is required. The AHP method

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commonly used in multi-criteria decision making experiences was found to be a useful method to determine the weights, compared with other methods used for determining weights. When applying AHP, constraints are compared with each other to determine the relative importance of each variable in accomplishing the overall goal.

2.4 Preparing Criteria map
Based on the given priority preferences five criterion were identified and five criterion maps were developed. They are, Elevation map, Population density map, Land use map, Land use zoning map, Available Facility map (Accessibility roads map, Hospital map, and School map) Criteria maps are prepared by using GIS that is a computer based system that is used to store and manipulate geographic information. This technology has developed so rapidly over the past two decades and it is now accepted as an essential tool for the effective use of geographic information.

2.5 Given weights for criterion map
Weighting in suitability analysis refers to assigning a numeric value to each factor in order to recognize its relative importance, and usually express in percent format (Pease and Coughlin, 1996). For an example, there are just three factors to be considered in selecting a site for a subdivision of single family homes: Slope of terrain, land price and availability of utilities. You assign weights to these factors to reflect the relative importance you attach to each. The slope might be given a weight of 0.3: land price 0.5: and availability of utilities 0.2. The weights represent the relative importance of each factors attribute. The weight value for the suitability of one factor used in this research was based on interpretation of published materials as well as several experts. The weights can be determined through method such as Delphi and the pairwise comparison pioneered in the Analytic Hierarchy Process (AHP) method. Calculation of weights for criterion maps was based on the multi criteria evaluation. Saaty's Analytic Hierarchy Process was applied for that. Based on that pair – wise comparison matrix was prepared according to AHP scales. For determining the relative importance of the criteria the pair wise comparison matrix using Saaty's nine point weighting scale has been applied. In AHP, all identified factors are compared against each other in a pair wise comparison matrix which is a measure of relative preference among the factors. Therefore, numerical values expressing the relative preference of a factor against another. Saaty (1977) suggested a scale for comparison consisting of values ranging from 1 to 9 which describe the intensity of importance, by

Table 1: Nine point weighing scale for pair wise comparison

Description of preference		Scale
I.	Equally	1
II.	Equally to moderately	2
III.	Moderately	3
IV.	Moderately to Strongly	4
V.	Strongly	5
VI.	Strongly to very Strongly	6
VII.	Very Strongly	7
VIII.	Very Strongly to extremely	8
IX.	Extremely	9

which a value of 1 expresses equal importance over another factor. As shown in Table 1, the factors were pair wise compared. In order to compare criteria with each other, all values need to be transformed to the same unit of measurement scale.

After standardization all criteria and sub criteria were weighted using pair wise comparison method. Then the pairwise AHP calculates the weights values and build the estimation matrix for the influencing factor.

2.6 Calculate composite weights & develop suitability map
Calculate composite weights, based on main criterion weights and each sub criterion weights. The suitability value elevation, land use, land use zoning, population density, available facility in Greater Matara Region area and the criterion for each land mapping unit is determined through the maximum limitation method that affects the land use. The above five natural physical characteristics are used the sub criteria under facilities available criteria. Before applying weighted linear combination equation to calculated suitability index, these calculated scores are standardized to the measured scale 9 (Very high suitability), 7 (High), 5(Medium), and 1(Low) Actually, Calculated final composite weights were used to develop suitability criterion such as not suitable, less suitable, moderately suitable and highly suitable. After weighting the criteria, as regards the relative importance of each criterion as well as suitability index, all the criterion maps were overlaid and final suitability map was prepared. Suitability map s resulting from Multi Criteria Evaluation (MCE)

3 STUDY AREA
Greater Matara Area was selected as the case study area due to high demanded for residential uses, highly populated area and most housing requirement area. UDA was proposed to extend GMR that is the key component of this task since the model output similarly displays the trend of urbanization in future. Greater Matara project area is comprising six DSD. Such as, Matara, Weligama, Thihagoda, Malimbada, Donra and Welipitiya and there are around 303665 population. Greater Matara Development project has been introduced by UDA for the enhancement of environmental condition education level, institute development, commercial development and housing development for the area of Matara. Because GMR has lot of reborn development. As a regional center of southern province proposed GMR plan has been introduce to making a better planning has enable to overcome issues. From the big project such as southern expressway and protecting of the natural resources especially in the kirala kele etc. Therefore UDA understood that instead of the Matara MC area. It is more powerful to introducing more expential area of GMR.

Table 2: Population and Number of Housing units in GMR in 2012

DSD Name	Population	Number of Housing units
MataraFour Gravets	115805	27325
Weligama(part off)	72511	17360
Devinuwara(PartOff)	42003	11656
Thihagoda (Part Off)	28916	8434
Malimboda Part Off)	24967	8899
Welipitiya (Part Off)	33970	12778

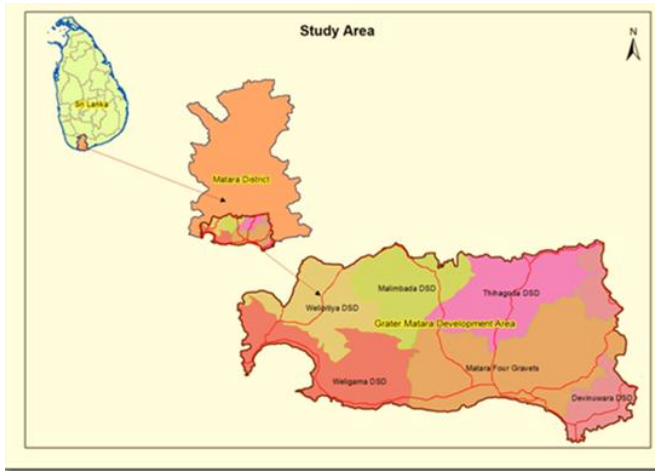Source: Divisional Secretariat, Matara, 2012

Figure 1: Greater Matara Region Area

Source: Urban Development Authority, Colombo

4 ANALYSIS

This chapter provides details of the final outputs in the study and discussing about the reasons behind the specific outcome using GIS and AHP Application. The AHP considers basically, seven of evaluation criteria based on data availability.

1. Physical suitability for development Elevation
2. Population density
3. Legal restrictions, government regulations (Land Use Zoning Regulation)
4. Existing Land Use patterns
5. Access, including proximity to Roads, Schools, Hospitals

GIS was using for analysis criterion weights and preparation final output. Because GIS, it is shown that the approaches commonly used in vector and raster systems typically lead to different solutions. Specially Model builder tool was supported criteria ranking, assign weights and making maps.

4.1 Criteria Development Based on AHP

Criteria must be define according to data availability. Therefore give weights using saaty's model AHP and criteria have categorized five classes.

1. Population Density
2. Elevation
3. Land Use (Scrubs, Vacant land, Unimproved open space, Plantation, Residential)
4. Land Use Zoning (New Housing, Residential Zone High Density, Residential Zone Low Density, Mixed Development Zone, Utilities Zone)
5. Availability facility (Accessibility, schools, Hospitals)

4.2 Suitability analysis using Model builder Tool

The ArcGIS 10.3 Model Builder tool was use for the preparation final results of land suitability for the residential development in GMR. Because the specific tool is help process a large number of layers in an automated fashion. As described prior sections many factors effecting the residential development and AHP combine the criteria with scores (Standards) and finally assigned weights for criteria in each factors. The process of the study is complex analyses by each of single layer. Therefore the ArcGIS 10.3 Model Builder tool
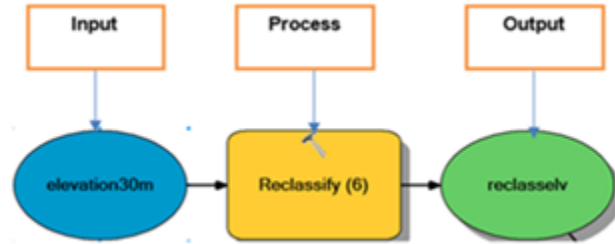
was using for the study.

Figure 2: Process of model builder

Table 4: Summary of Matrix (Assign weights for main criteria)

Criteria	Sub- criteria	Standards adopted	Weights
	Population Density	245 - 730	9
		731-1141	5
		1142-2298	3
		2299-4063	2
		4064-15230	1
	Elevation	0 -9	9
		9-21	5
		21-37	3
		37-56	2
		56-109	1
	Land Use	Scrubs	9
		Vacant land	5
		Unimproved Open Space	3
		Plantation	1
		Residential	1
	Land use zoning	New Housing	9
		Residential Zone High Density	7
		Residential Zone Low Density	5
		Mixed Development Zone	3
		Utilities Zone	1
	Available Facilities	100 - 200	9
		200 - 400	5
		400 - 600	3
		600 - 800	2
		800 - 1000	1

The figure 2 shown the process of the model which was apply to the study and completed process mentioned in the end of paper. After studying several literature suggested the factors effecting the residential development in project area include;

• Elevation, Land use zoning, Land use, Population density (Main criteria)
• Available Facility -School, Hospital and Accessibility- (Sub Criteria)

The ArcGIS 10.3 Weighted Overlay tool was using extracted final results, therefore all the layers which are in vector format should be converted to raster format. Except Elevation layer (already raster layer) other layers are converted to Raster using ArcGIS Polygon to Raster tool. Afterward ArcGIS Reclassify tool is using for all the layers for reclassify values in

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specific raster in order to AHP standards. Finally combine all reclassified raster layers using Weighted Overlay tool and apply common measurement scale and weights each according to its importance (Table 3). Then ArcGIS Raster to Polygon tool was using for extracted that output in vector format. Next step was using the ArcGIS Buffer tool and generate 200m buffers around the water bodies. Finally ArcGIS Erase tool was using erase reservation of water bodies and then extracted suitable Area for Residential development. (Figure 10)

Table 3: Factors influence for Weighted Overlay

Factor	AHP Weight Influence (%)
Elevation	44
Land Use	25
Population density	16
Land use Zoning	9
Available Facility	6
Total	100

4.3 AHP Application for Residential Development in Greater Matara Region

According data availability and ground condition, AHP application was used for finding suitability residential areas in GMR. Therefore, mainly define main and sub criteria. Criteria are mentioned in methodology.

4.4 Weighted matrix for main and sub criteria.

Criteria define based on availability of data & information especially spatial data... Using AHP application and give weights for each main and sub criteria. Then, make a matrix for main (table 4) and sub criteria (table 5) using Microsoft excel 2010.

Table 5: Sub criteria matrix

Sub - criteria	Criteria	Weights
Accessibility to main roads(Available facilities)	100 - 200	9
	200 - 400	5
	400 - 600	3
	600 - 800	2
	800 - 1000	1
Schools (Available facilities)	500 - 1000	9
	1000 - 1500	5
	1500 - 2000	3
	2000 - 2500	2
	2500 - 3000	1
Hospitals(Available facilities)	1000 - 2000	9
	2000 - 4000	5
	4000 - 6000	3
	6000 - 8000	1
	8000 - 9000	1

Finding suitable residential location, it used least population area. Finally, it was used to define most suitable residential location and prepared population density map (figure 3) in GM using ARC GIS10.3
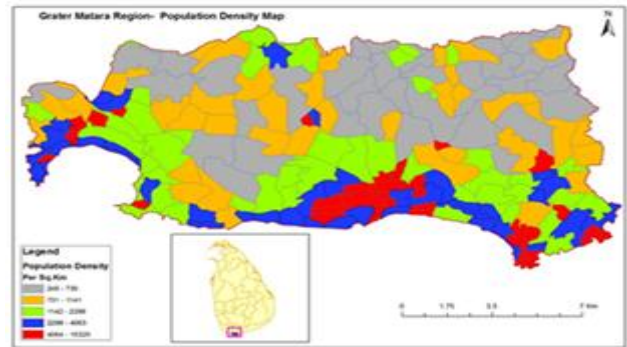

Figure 3: population density map after given weights

According to above (table 4), this research used most suitable population likely within 245-730 and 731-1141 that are Standards adopted. Finding suitable residential location, it used least population area. Finally, it was used to define most suitable residential location and prepared population density map (figure 4) in GM using ARC GIS10.3 According to above (table 4), this research used most suitable elevation likely within 0 -9 and 9-21 that are standards adopted. It was used to define most suitable residential location and prepared elevation map (figure 4) in GMR using ARC GIS 10.3.
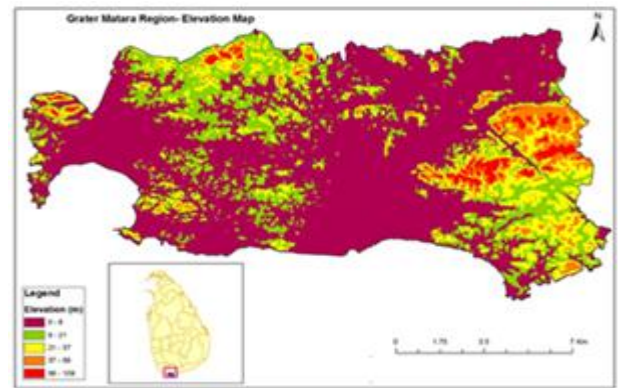

Figure 4: Elevation map after given weights

The main criteria matrix (table 4) is indicating scoring of land use. Scrubs and vacant land are most suitable for residential because that places are not used human beings for their activities. Finally, it was used to define most suitable residential location and prepared land use map (figure 5) in GMR using ARC GIS 10.3.
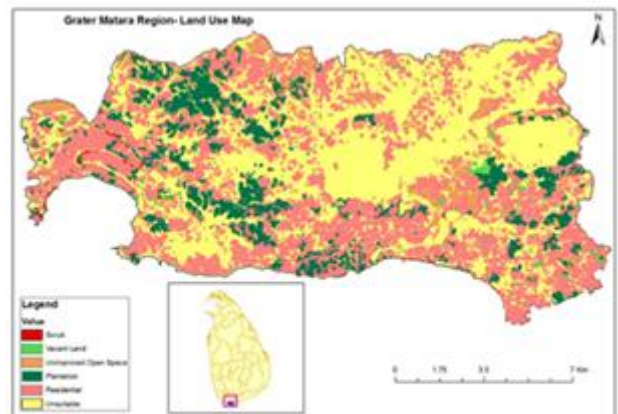

Figure 5: Land use map after given weights

For this study land use zoning is very important factor because it helps to finding best residential areas with development control. So, land use zoning categorized standards adopted and then give weights (table 4) using AHP Application. However, Finding suitable residential location, it used least land use zoning area for residential. New housing, residential zone high density are most suitable for residential. Finally, it was used to define most suitable residential location and prepared land use zoning map (figure 6) in GMR.
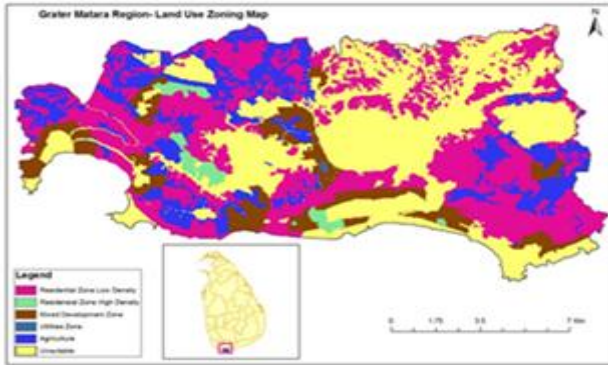

Figure 6: Land use zoning map after given weighs

According to Availability facility matrix (table 5) this research used most suitable land likely availability facility within 100-200 and 200-400 that are standards adopted. Finding suitable residential location, it used least availability facilities area for residential. Then, three sub criteria, they are school, hospitals and accessibility to main roads that are categorized and then give weights using AHP Application.
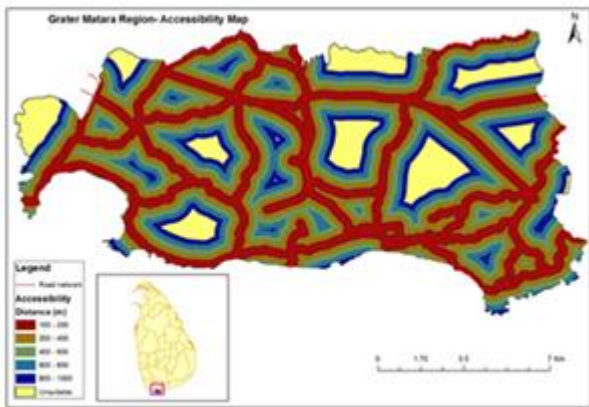

Figure 7: accessibility road map after given weighs

According to above (table 5), this research used most suitable accessibility to main roads likely within 100-200 and 200-400 that are standards adopted. Finding suitable residential location, it used least accessibility to main roads area for residential development. Maximum accessibility to main roads facility area are not used for residential development. Finally, it was used to define most suitable residential location and prepared accessibility to main roads criteria map (figure 7) in GMR using ARC GIS 10.3
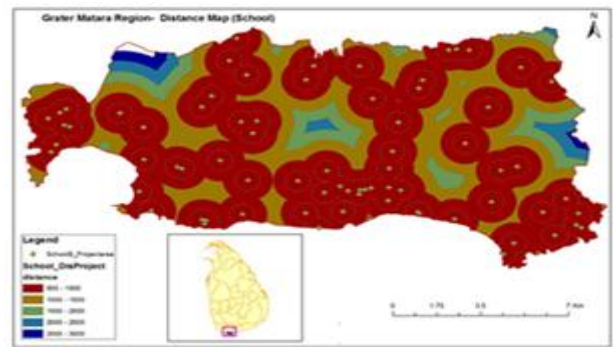

Figure 8: School map after given weights

According to above (table 5), this research used most suitable hospitals likely within 1000-2000 and 2000-4000 that are standards adopted. Finding suitable residential location, it used least hospitals area for residential development. A large number of hospitals areas are not used for residential development. Finally, it was used to define most suitable residential location and prepared hospital criteria map (figure 8) in GMR using ARC GIS 10.3

Figure 9: Distance map o Hospital

According to above figure 9, this research used most suitable hospitals likely within 1000-2000 and 2000-4000 that are standards adopted. Finding suitable residential location, it used least hospitals area for residential development. A large number of hospitals areas are not used for residential development. Finally, it was used to define most suitable residential location and prepared hospital criteria map (figure 9) in GMR using ARC GIS 10.3
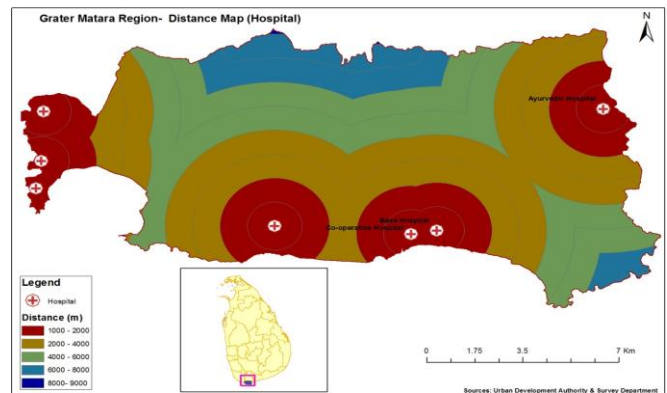
5.5 Calculation of score value for each criterion.

The suitability value for main and sub criteria in GMR and each land mapping unit is determined through the maximum limitation method that affects the land use. The score is the numerical total of the calculated land suitability when the ratings and weights for all factors are considered. As described in pererira and Duckstein (1993), each thematic layer represented an evaluation criterion and cells were valued according to their quality for a particular land use. The first steps, initially suitability class value and weight are assigned to individual land characteristic and then calculated the suitability score. The score for an individual site is used as a basis for comparing its suitability with other sites.

4.5.1 Calculation of score value for population density criteria

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Table 6: Calculation of population density criteria

Class	245-730	731-1141	1142-2298	2299-4063	4064-15230	Sum	Score
245-730	155.000	266.400	465.000	1075.500	1395.000	3356.900	0.4411
731-1141	86.111	148.000	258.333	597.500	775.000	1864.944	0.2451
1142-2298	49.333	84.600	148.000	341.700	444.000	1067.633	0.1403
2299-4063	34.444	59.200	103.333	239.000	310.000	745.978	0.0980
4064-15230	26.556	45.560	79.667	184.000	239.000	574.782	0.0755
						7610.238	1

Population density criteria are categorized standards adopted in five classes. Then, calculate sum and score value (table 6) for each class. Thus, in the elevation classes sum is 7610.238. Each class score value total should be 1.

4.5.2 Calculation of score value for elevation criteria

Table 7: Calculation of elevation criteria

Elevation	0 - 9	9 -21	21 - 37	37 - 56	56 - 109	Sum	Score
0 - 9	222.000	399.600	684.000	1998.000	1998.000	5301.600	0.457
9 -21	120.000	216.000	370.000	1080.000	1080.000	2866.000	0.247
21 - 37	72.000	129.600	222.000	648.000	648.000	1719.600	0.148
37 - 56	48.000	86.400	148.000	432.000	432.000	1146.400	0.099
56 - 109	24.000	43.200	74.000	216.000	216.000	573.200	0.049
						11606.800	1

Elevation criteria are categorized standards adopted in five classes. Then, calculate sum and score value (table 7) for each class. Each class score value total should be1.Thus, in the elevation classes sum is 11606.800

4.5.3 Calculation of score value for land use criteria

Table 8: Calculation of land use criteria

Class	Scrub	Vacant land	Unimproved Open Space	Plantation	Residential	Sum	Score
Scrub	125.000	225.000	375.000	1125.000	1125.000	2975.000	0.475
Vacant land	53.333	125.000	208.333	625.000	625.000	1636.667	0.261
Unimproved Open Space	41.667	75.000	125.000	375.000	375.000	991.667	0.158
Plantation	13.889	25.000	41.667	125.000	125.000	330.556	0.053
Residential	13.889	25.000	41.667	125.000	125.000	330.556	0.053
					Total	6264.444	1

Land use criteria are categorized standards adopted in five classes. They are Scrubs, Vacant land, Unimproved Open Space, Plantation and Residential. Then, calculate sum and score value (table 8) for each class. Thus, in the five classes sum is 6264.444. Each class score value total should be 1.

4.5.4 Calculation of score value for land use zoning criteria

Table 9: Calculation of land use zoning criteria

Class	New Housing	Residential Zone Low Density	Residential Zone High Density	Mixed Development Zone	Utilities Zone	Sum	Score
New Housing	205.000	263.571	369.000	1407.000	1845.000	4089.571	0.3426
Residential Zone Low Density	159.444	205.000	287.000	1094.333	1435.000	3180.778	0.2664
Residential Zone High Density	113.889	146.429	205.000	781.667	1025.000	2271.984	0.1903
Mixed Development Zone	68.333	87.857	123.000	469.000	615.000	1363.190	0.1142
Utilities Zone	52.111	67.000	93.800	351.000	469.000	1032.911	0.0865
						11938.435	1

Land use zoning criteria are categorized standards adopted in five classes. They are, New Housing, Residential Zone Low Density, Residential Zone High Density, Mixed Development Zone, and Utilities Zone. Then, calculate sum and score value (table 9) for each class. Thus, in the five classes sum is 11938.435. Each class score value total should be 1.

4.5.5 Calculation of score value for availability facility criteria

Table 10: Calculation of availability facility criteria

Available Facility	Accessibility	Hospital	School	Sum	Score
Accessibility road	27.000	34.714	48.600	110.314	0.429
Hospital	21.000	27.000	37.800	85.800	0.333
School	15.000	19.286	27.000	61.286	0.238
				257.400	1

Available Facility criteria are categorized standards adopted in three sub criteria they are, Accessibility roads, Hospitals, Schools. Then, available facility calculate sum and score value (table 10) for each sub criteria. Thus, all sub criteria sum is 257.400. Each class score value total should be 1.

4.6 Final suitability map for residential area

Final suitability map for residential development has been extracted using weighted overlay techniques in ArcGIS 10.3. As described previous section, application of GIS and AHP in the process of find the suitable area for residential development an effective way for the study. AHP tool is used to combine attributes score with weight value calculation and Model builder tool in ArcGIS 10.3 support to obtain the final suitability map.

Table 11: Land suitability for residential development in GMR

Land suitability Class	Area Extent (ha)	Area (%) _Suitable area	Area (%)_ Total area
Extremely Importance	1.40	0.03	0.01
Very Strongly Importance	1560.51	29.01	8.95
Strongly Importance	2468.22	45.89	14.15
Moderately Importance	1190.29	22.13	6.83
Equally Importance	158.48	2.95	0.91
Extent of suitable area	5378.89	100.00	30.85
Not Suitable	12058.56		69.15
Total Extent of GMR	17437.45		100.00

The final output has been shown in (table 11) as could be seen the study area was divided in to five categories, such as Extremely Importance, Very Strongly Importance, Strongly Importance, Moderately Importance, and Equally Importance. The core divided by these five levels of suitability are 9, 7, 5, 3 and 1 respectively. Absolute values of suitable area for residential is covers 5378.89 ha of land and accounts for 30.85 percent of that study area and covers 12058.56ha or 69.15 percent of geographical area recorded as a not suitable category. Out of total suitable area, Extremely Importance category is covers geographical area of 1.4 ha of land it accounts 0.03% of total land extent from suitable land area. The total land area of that category surrounded by Residential Zone Low density, Residential Zone High Density and Mix Development Zone. Very Strongly Importance category is covers 1560.51ha of land extent it accounts 29.01 percent from suitable land area. The total land extent is surrounded by Residential Zone Low density. Strongly Importance category is covers 2468.22ha of land it accounts 45.89 percent out of total extent of suitable area, surrounded by Residential Zone Low density and Mix Development Zone. Moderately Importance category is covers 1190.29ha of land it accounts 22.13 percent out of suitable land extent and Most of the area surrounded by Residential Zone Low density and Agriculture zone.
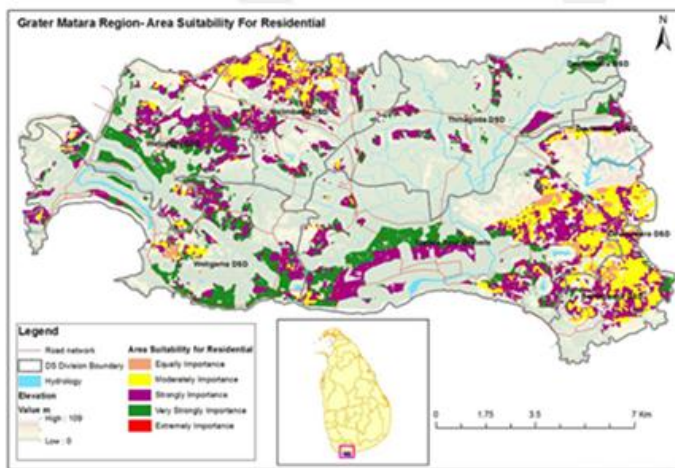
Figure 10: Final suitability map

Finally Equally Importance category is covers 158.48ha of land it accounts 2.95 percent out of suitable land extent and most of the area surrounded in Agriculture zone. As a summary, geographic area of Extremely Importance, Very Strongly Importance and Strongly Importance categories are compatible with the Zoning regulation which is introduce by UDA. (Figure 11)
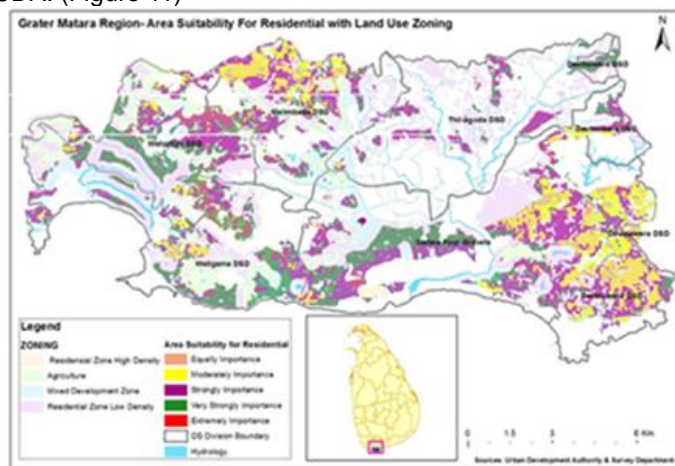

Figure 11: Area suitability for residential with Land Use zoning

5 Conclution

In this research an attempt was made to investigate and entrance the appropriateness of utilizing the loose-coupling approach for modeling future planning actions. The whole process of this study has gone to achieved main objective. There is the finding suitability land for residential development. Hence the study explores how land suitability evaluation and GIS for finding suitability land by using AHP Application in Greater Matara Region. This research presents a multi criteria framework for suitability analysis of residential development. It considered resident' perspectives and GIS assisted Multi Criteria Evaluation Techniques were used for the analysis. The suitability analysis has been carried out for GMR to evaluate feasibility of existing residential use and potential lands without considering the social and environmental constraints as evaluation parameters. Final map shows suitability locations for residential development. The analysis of this study mainly focused on highly demand of Suitability areas as these areas have highest potential for residential land use. AHP method commonly used in multi criteria decision making exercises was found to be a useful method to determine the weights. The GIS is found to be a technique that provides greater flexibility and accuracy for land suitability analysis in urban areas. Although urban planners have conducted similar exercises in the past using manual methods, The GIS can perform these tasks much faster. The combination of AHP method with GIS is a new trend in land use planning exercises and this study confirms that the findings of other researchers could be powerful combination to apply for land suitability analysis. This analysis can be useful in decision making process for land use planning and can also help in sustainable urban development of GMR. It is very important for planners to decide whether land should be developed immediately or to be conserved for future development. This model can help to prepare the strategic urban land development framework and the short term land use policies can be formulated. The approach, therefore, can help the planers and policy makers to monitor the urban land development for formulating urban growth policies and strategies for a city. As well as, many stakeholders are trying to understand the nature of residential property market that follows the property development. This will be useful for the people who are looking for the suitable and profitable places to purchase the residential properties and to identify the development level of the area. Finally, Output of this paper suitable area for residential is covers 5378.89 ha of land and accounts for 30.85 percent and the equally Importance category is covers 158.48ha of land it accounts 2.95 percent out of suitable land extent and most of the area surrounded in Agriculture zone and the final suitability map have presented suitability locations for residential land in GMR. Confidently, AHP is an effective method for the formulate urbanization policies in Sri Lanka.

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Annex 1: process of the model which was apply to the study