MEASURING THE SUITABILITY OF URBAN RESIDENTIAL ZONES IN GALLE CITY: A GIS ANALYSIS

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Abstract

Urbanization is an unending process because increasing numbers of people are attracted to urban areas in the hope of finding better and more convenient living conditions. As a result, the demand for residential land in the areas surrounding cities has become very high. In fact, urban sprawl is a universal phenomenon that exists in most developed and developing countries today. Due to this, most cities now face the very challenging task of providing habitable land with better infrastructure to fulfill the residential demand.Under the prevailing situation though, most of the areas demarcated for residential use are unable to provide better facilities and living conditions for those wishing to move in there. This is a common problem in Galle, which is the Capital of the Southern Province and a densely populated city.

According to the proposed zoning plan (2008-2025) of the Urban Development Authority, eight Primary residential zones have been demarcated within the Galle Municipal Council limits. This paper evaluates the prevailing challenges confronting these primary residential zones by measuring their suitability levels using four key criteria, which are, level of infrastructure, land value, road accessibility and proximity to town center. GIS based weighted overlay analysis has been applied to measure the level of suitability of each residential zone. Results of the analysis have shown that 0.41% of the land is highly suitable, 31% of land is moderately suitable, 63% of land is barely suitable, while 5% is quite unsuitable for residential use. Knowing this can help the planners and policy makers to monitor the urban land development process and formulate appropriate urban growth policies and strategies for the city. Apart from that, many stakeholders are trying to understand the nature of the residential property market that follows in the immediate wake of property development. This will be useful for the people who are looking for suitable and profitable places to purchase their residential properties and to identify the development level of the area.

Keywords: Urbanization, Residential zoning, Residentialand suitability, Geographic Information System, Weighted overlay analysis

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1.0. INTRODUCTION

At present, more than one half of the world's population resides in urban areas, with United Nations projections suggesting that this number will swell to about 60% by 2030;the trend will continue and more than 6 billion people, or almost 66% of the world population will be living in urban areas by 2050 (United Nations, Department of Economic and Social Affairs, 2014). Where Sri Lanka is concerned, urban areas are home to 20% of the population now, but urban dwellers are expected to grow to 40% in 2030 and 50% by 2050 as people search for a better quality of life (Central Bank of Sri Lanka, 2014).

A significant feature of third world urbanization is the concentration of urban population in and around the mega cities. Due to the high demand for residential properties, the population is unevenly scattered near the urban edges of the metropolitan areas. Therefore, citiesare faced with the most challenging task of providing land with better infrastructure to meet the residential demand.At present, most of the residential areas are unable to provide better living conditions.

"Zoning" is identified as the predominant tool to control the use of land in the urban areas. Zoning means dividing a city into different areas or regions, according to actual (current) and potential (future) use of tenements and urban propertiesand to monitor and direct development practices for the optimum utilization of those lands and tenements (Saeednya, 2004). Generally, urban zones are divided into four major categories: residential, mixed residential, commercial and industrial. "Residential zones"are areas in which the predominant use of land is for housing settlements.

In the Sri Lankan context the practice of land use zoning is subject to many planning laws, some of which are direct and some are incidental. The various Urban Development Authority Acts are the primary legal instruments in use today in Sri Lanka that provide support for the implementation of zoning. In Sri Lanka many cities are currently formulating and implementing zoning regulations. The City of Galle has been enforcing zoning regulations with the implementation of the Galle Development Plan in 2008 by the Urban Development Authority. According to the proposed zoning plan (2008-2025), there are demarcations of eight Primary residential zones within the Galle Municipal Council area. This paper evaluates the prevailing challenges faced by these primary residential zones and then identifies the suitability level of each zone by using GIS based analysis.

This approach can help planners and policy makers to monitor the urban land development process for formulating urban growth policies and strategies for a typical city. This will also be useful for those people who are looking for suitable and profitable places to purchase their residential properties and to identify the development level of the area. Research outcomes can be applied to other cities in Sri Lankaas well as to other countries that have similar needs but with different parameters.

2.0. Literature review

Residential Zoning

Zoning came in to practice in 1916 when NewYork City adopted a comprehensive citywide zoning ordinance as a tool for mitigating negative health effects from undesirable uses.

Historically the goal of zoning was to separate land uses to limit the negative impacts of industrial and manufacturing businesses on residences.

Zoning is a universal form of development control. It may be defined as the practice of dividing a land area into districts within which only specified activities may take place (Ervin *et al.,* 1977). Zoning may also be considered as the main legal instrument for controlling and ordering the utilization and appropriation of the built environment (Luciana Corrêa do Lago, 2006).Zoning regulates the use of land for residential, commercial, industrial, agricultural and other land-use purposes (Dowall& Giles, 1977).

In Asian cities, land is frequently used in combination for both residential and commercial purposes and for other mixed uses. Through zoning, governments canensure the most appropriate use of land and avoid mixing incompatible activities within the same neighborhood. Zoning has been used as a regulatory tool to deal with changing environmental and development conditions as well, including flooding, rising sea levels and the loss of infrastructure (Grannis, 2011).

In Sri Lanka the authority for land use zoning is vested with the Urban Development Authority under the UDA Law.The Patrick Geddes Plan (1921) was the first development plan implemented in Sri Lanka. The laws for the City of Colombo were based on this. In Sri Lanka many cities are currently practicing zoning regulations.

The City of Galle is currently practicing zoning regulations by implementing the Galle Development Plan for 2008-2025. The Residential Zone under this development plan was demarcated after considering the residential demand based on the number of building applicationsreceivedtogether with the comments made by the stakeholders at a meeting held by the UDA. The plan had also taken into account the existing land uses, road network pattern, availability of spaces and existing facilities for the purpose of demarcating the residential zones in the year 2008. According to the zoning plan, the area has been divided into 8 primary residential zones.The following uses are permitted in the Primary Residential Zone (Galle development plan book, 2008).

(a) Houses for human habitation

(b)

1. Dormitories and residential flats
2. Educational institutions, libraries and allied uses
3. Health institutions and religious places
4. Professional and administrative offices (not exceeding 100 m^2)
5. Hotels, guest houses and rooms (not exceeding 10 m^2)
6. Public buildings (not exceeding 250 m^2)
7. Boutiques (not exceeding 50 m^2)
8. Private educational institutions (not exceeding 50 m^2)

(c) Uses indicated in 1 (b) will be allowed only ifthe developer fulfills the following requirements:

i. Such uses shall be compatible with the intended uses of the vicinity and should not have any negative impact on the activities of the Primary Residential Zone and should not be a hindrance to privacy or the environment in the surrounding area.

ii. Such uses shallnot hamper the movement of vehicles in the area and not create any traffic congestion.

iii. Sufficient space shall be provided for such uses withadequate vehicle parking, water supply, waste disposalfacilities, along with protection from fire and other disasters.

(d) In addition, subject to initial planning clearance, approval for the following uses shall be considered in a site not less than 20 perches in extent.

i. Bakeries not exceeding 50 m^2
ii. Domestic industries not exceeding 50 m^2 in extent and with equipment not exceeding 3 HP and which do not cause any environmental pollution.
iii. Nursing homes not exceeding 500 m^2
iv. Private institutions not exceeding 100 m^2

Factors affected to acceptability of residential zone

A residential zone is a land area in which housing predominates. Under the land use sector, residentialSector is the largest one of the urban space; it may include 30-50% of developed land in urban areas. (Kaiser E.J., Godschalk D.R. and Chapin F.S.,1995). The increase of population in the world, suitable land requirements for residential development has become a major factor in urban planning.

The residential zoning is required to serve the residents effectively by considering such issues as the livability, accessibility, infrastructural facilities, environmental quality, financial affordability, etc. of that area. Belching (2000) investigated the factors that determine the acceptability of a residential location for that purpose. He mentioned various factors that are highly significant in assessing locational suitability for residential development, such as accessibility, neighborhood quality, negative environmental influences (pollution, traffic, etc.), sensitive environmental factors (wetland, wildlife, scenic rivers, etc.), desired infrastructure, reasonable size and design, activities in surrounding areas and additional factors (such as historical development, topographical features and land extent, dynamic changes and government policy).
Many factors have to be considered to ensure effective settlement planning as shown in Table 2.1.

Table 2.1: Key factors to be considered in settlement planning

Suitability of location, stability and constraints	**Infrastructure – availability, adequacy, quality and consistency**	**Socio-economic factor**
-Land availability -Suitability of soil for constructions (roadways, foundations & sewerage) -Environmental conditions (natural hazards such as flooding, landslides, erosion, etc.) -Topography	-Distance from city center and employment prospects -Accessibility and transport facilities -Water supply, power, and communication -Administrative services, schools, hospitals, shops & marketplaces, recreational	-Ability to pay for housing and services -Land values, land ownership, development costs -Residential density, ethnic groups, religious and socioeconomic classes -Political and commercial factors

	facilities	-Housing development policy -Existing and proposed development projects

(Ranathunga, 2001)

According to Berke et al. (2006), suitability factors for livable residential areas should include:

1. Accessibility and transportation systems
2. Safe environment free of danger of traffic and hazards
3. Privacy (secondary and tertiary streets)
4. Proximity to service, community facilities, shopping and activity centers, employment
5. Infrastructure capacity for basic services: water, sewer, gas, electricity and cable
6. Proximity and access to social facilities: educational system and health facilities
7. Proximity and everyday access to place-making in public space (streets, sidewalks and parks), open-space network, nature, places for recreation, relaxation and socializing
8. Mixed uses and diversity of activities
9. Preservation of historical structures: sense of place, belonging, pride and satisfaction
10. Housing compatible with different budgets and life-cycle stages (income and age).

Residential Land Suitability Assessment

"Suitability" refers to ability to be fitted for a given purpose. Land suitability analysis is the process of determining the fitness of a given tract of land for a defined use (Steiner, McSherry et al. 2000). In other words, it is the process to determine whether the land resource is suitable for some specific uses and to determine the suitability level.

Suitability techniques are essential for informed strategic decision-making (Steiner et al., 2000; 1991). Generally, there are two types of land suitability assessment approaches. First, the qualitative approach is used to assess land potential at a broader scale or is employed as a preliminary method for more detailed investigation (Baja, 2002; Dent and Young, 1981). The results of qualitative classification are given in qualitative terms such as highly suitable, moderately suitable and not suitable.

Second, the quantitative approach is using parametric techniques involving more detailed land attributes which allow various statistical analyses to be performed (Baja, 2002; 2001). Recently, most studies combined the qualitative and quantitative approaches in the process of land suitability assessment. The composite technology including expertise, mathematic model and GIS has been used in the land suitability assessment (Malczewski, 2004; Yang and Jia, 2002; Chen, 2002; Bydekerke et al., 1998).

Application of GIS in in land suitability studies

GIS plays a vital role in planning for many decades of land-use suitability mapping and modelling (Malczewski, 2004 and Malczewski, 2006). GIS technology has been used to assess the criteria requested to define the suitability of land (Joerin, 2001). Senes and Toccolini (1998) combine Ultimate Environmental Threshold method with map overlays to evaluate land suitability for development. Hall et al. (1992) and Wang (1994) also use map overlays to define homogeneous

zones. Eastman et al. (1993) produced a land suitability map for an industry near Kathmandu using a raster GIS and AHP (Analytical Hierarchy Process) (Saaty, 1990). Pereira and Duckstein (1993) have used MCDA and raster GIS to evaluate a habitat for endangered species.
The land suitability assessments process is made up of three steps. The first step is selecting the influencing factors and grading the weights and relative values for the factors. The second step is incorporating the maps and database in GIS. The last step involves calculating the suitability score of each land parcel for the given use and making the land suitability map.

According to the literature, GIS have been applied in many studies to land suitability solution for managing spatial data and presentingvisual results than other techniques. With the development of science and technology, the integration of GIS and Analytic Hierarchy Process (AHP) has been utilized for selecting the best and most suitable location for residential location.

D.S. Munasinghe et al. (2017)develop a GIS based model to identify suitable sites for residential development in Rathnapura municipal council of Sri Lanka and to identify suitable areas asresidential areas while determining the suitability level. Slopes, land use, distance to roads, distance to natural hazardous areas and distance to environmental sensitive areas were the selected factors and then weightedthedefined factors by using AHP technique. AHP is a decision making technique developed by Thomas L. Satty in 1980 and based on a “pair-wise comparison” matrices which compare all the factors to one another. It is a measurement model theory that ranks the hierarchy and consistency of judgmental data provided by a group of multiple experts and decision makers (Saaty T.L., 1980).Then the overlay process in GIS was used to combine the factors and constraints in the form of a Weighting Overlay process.This study has Integrated GIS and AHP as a decision support system for residential site selection.

H.K.G.M.Madurika et al. (2017)carried out a GIS based analysis for suitability residential area selection in Greater MataraRegion, Sri Lanka.Elevation,population density, land use,land use zoning and Available Facility (Accessibility roads, Hospital, School) has been selected as the criteria and then prioritize them based on the AHP method.Arc GIS 10.3 Model builder tool was used for the preparation of final result of land suitability for residential development.In the application of Weighted overlay method,each raster layer is assigned a weight in the suitability analysis and then Values in the raster maps are reclassified to a common suitability scale and Finally, Raster layers are overlaid to derive a suitability value.

Review of the literature on selecting best residential location shows that GIS have been applied in many studies to land suitability solution for managing spatial data andpresenting visual results than other techniques. With the development of science and technology, the integration of GIS and Analytic Hierarchy Process (AHP) has been utilized for selecting the best and most suitable location for residential location.

3.0. Problem statement

Presently, more than one half of the world population lives in urban areas and nearlyone half of the population in developing countries also lives in urban areas. The significant feature of urbanization is the concentration of urban population in and around metropolitan areas and mega cities. Due to the high demand for residential premises, the population is unevenly scattered in the urban edges of the metropolitan areas.

According to the UDA statistics, average density of population of Galle Municipality in 1981 was 41.1 persons per hectare and this had increased to 52.2 persons per hectare in 2001. Location of

the Teaching Hospital and Medical Faculty of Ruhuna University at Karapitiyahad partly contributed to theincrease of density in the recent past.The following are the other reasons.

1. Development of industry and the development ofnational projects such as Pinnaduwa Interchange of the Southern Expressway and the bypass road that connects to Galle harbor. Further, employment opportunities will be provided, especially in the tourism sector in the town as proposed bythe Department of National Physical Planning.

2. Migratory trends due toenvironmental and physical improvement of the town as a result of the MoragodaEla canal development project.

3. Migratory trends due to thelocation of national schoolsin the townand higher education institutions adjacent to the town.

The population density is increasing steadily in Galle Municipality. Therefore, the Residential land development plays a major roleand this requires planners to focus on the financial capacityof the residents to live and work in the city, while also paying attention to accessibility, infrastructural facilities, environmental quality, etc. If these issues are not addressed the residents may face many difficulties in their day-to-day life. Therefore, demarcating of suitable zones for residential development is essential. Hence, this study will evaluate the prevailing challenges faced by the residential zones and then rate the suitability level of each zone by using GIS based analysis.

4.0 Objectives of the Study

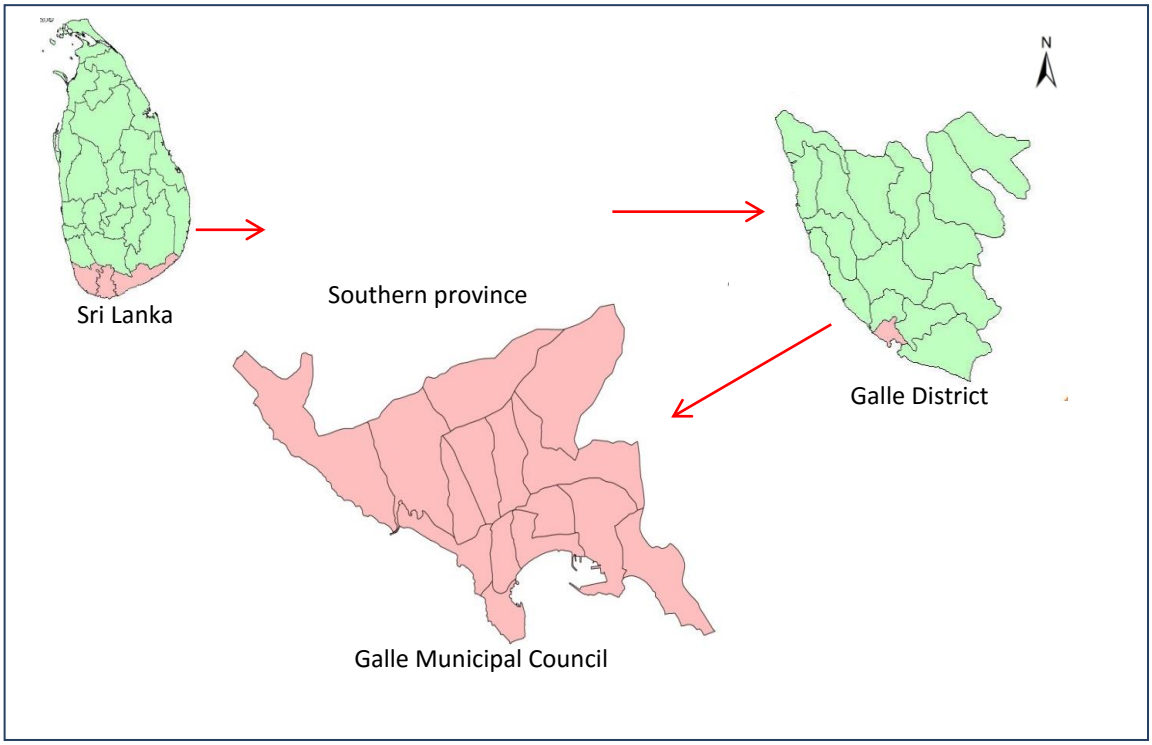
General objective of this study is to measure the suitability of residential zones in Galle Municipal Council area by using spatial analysis. To achieve this general objective, the following specific objectives were developed.

i. Identify the criteria that will be used tomeasure the suitability of primary residential zones in the Galle Municipal Council.
ii. Develop an integrated GIS based modelto measure the level of suitability.
iii. Identify the level of suitability of each primary residential zone in the study area.

5.0 Study area

The City of Galle, Capital of the Southern Province is a famous and highly populated city that is developing rapidly. Galle Town is a1st order town as per the urban hierarchy in the Southern Region. The gross population density in the town was 44 persons per hectare in 1981, and this increased to 52 persons per hectare in 2001 (Department ofCensus & Statistics). Galle Municipal Council area covers an extent of 1742.4 hectares and consists of 15 wards, which are subdivided into 43 GramaNiladhari Divisions. See Map No. 4.1.

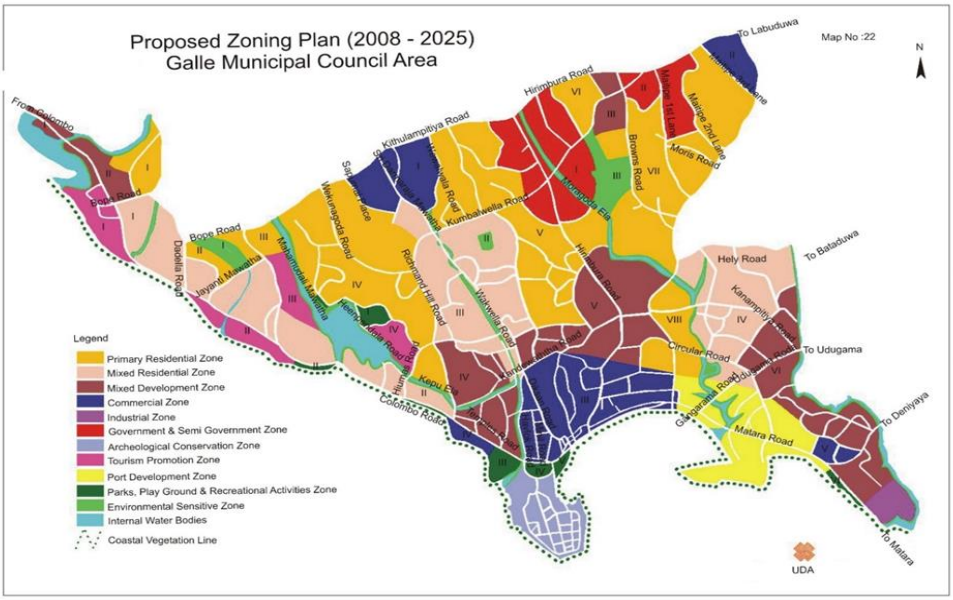
Map 4.1: Location map of Galle MC



This urban area was first establishedas a municipality on 01.01.1867according to the gazette notification no. 3571 issued by the Governor on 24.11.1866 under the Urban Council Ordinanceof 1865. More recently, it had been recognized that there was a necessity to have planned development due to the population growth and other urban issues. Therefore, this town had been declared as an urban development area under Section 3 of the UDA Act No 41of 1978 by Gazette Extraordinary notification No. 38/16 of 01.06.1979 for the purpose of formalizing the urban diversity arising with the population growth in the town.

Proposed Zoning Plan was prepared basedon the development requirements of the town up to the planned period of 2025. Accordingly, the town was divided into 11 zones (Map No. 4.2). A Mixed Residential Zone and a Mixed Development Zone have been established especially to discourage linear development that existed in the town. Accordingly, opportunities are given to low density development activities in the Mixed Residential Zone and to high density development activities in the Mixed Development Zone.

Map no. 4.2: Proposed Zoning plan (2008-2025)



According to the proposed zoning plan (2008-2025) of UDA for the Galle MC, there are demarcations of eight “Primary residential zones,” which are selected as the study areas (Map no. 4.3).

Map no.4.3: Residential units of the Primary residential Zones in Galle MC

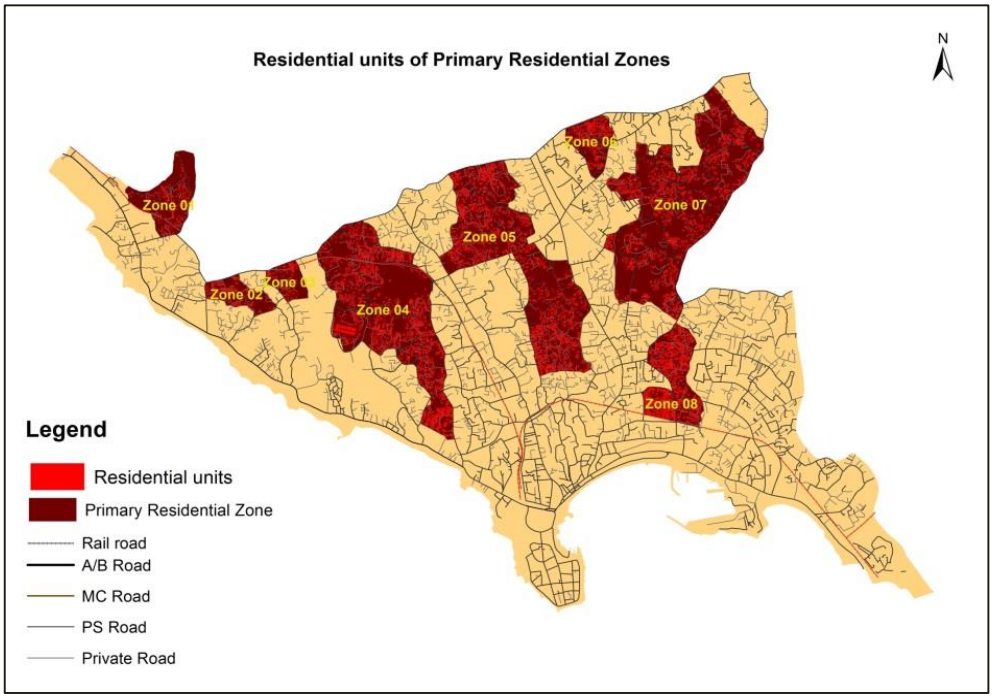


Table 4.1: Detail of each Primary residential zone

Zone	Extent (Acres)	No. of housing units
Zone 01	59	176
Zone 02	34	214
Zone 03	25	122
Zone 04	306	1620
Zone 05	291	1542
Zone 06	41	280
Zone 07	371	1252
Zone 08	87	1126
Total	1214	23,832

The total land extent of the Galle MC is 4249 acres and of this 1214 acres of land cover (27%) are demarcated into primary residential zones. There are 23,832 residential units in these residential zones (Table no. 4.1).

According to the UDA analysis 86% of the total land area is devoted to urban useswhile non-urbanlands represent 14% of the area of which 2.18% is taken up by agricultural lands and 3.4% by internal water bodies. The land covered by marshy areas is 1.73%. Bare lands account for 6.36% and thus the land available for future development is limited. The land allocated for residential use was 49.2%. The land use data of 2006 revealed that 41.62% represented residential use while the land allocated for homesteads was 16.73%. This shows an increase in residential use due to thefollowing factors.

1. Migratory trend due to thelocation of national schools, Medical Faculty of the Ruhuna University and other educational institutions.
2. Southern Provincial Council becoming more autonomous due to the decentralization of administrative activities.
3. Land sub-division that occurred in thenorth of the town after the establishment of Teaching Hospital at Karapitiya.

5.0. Methodology

The steps of the methodology applied for the study can be seen in Figure 5.1.

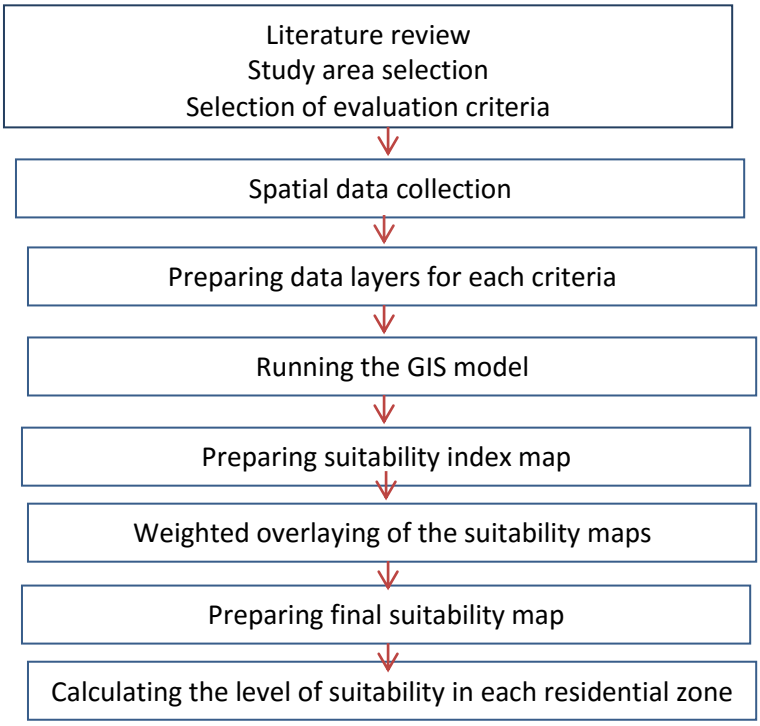


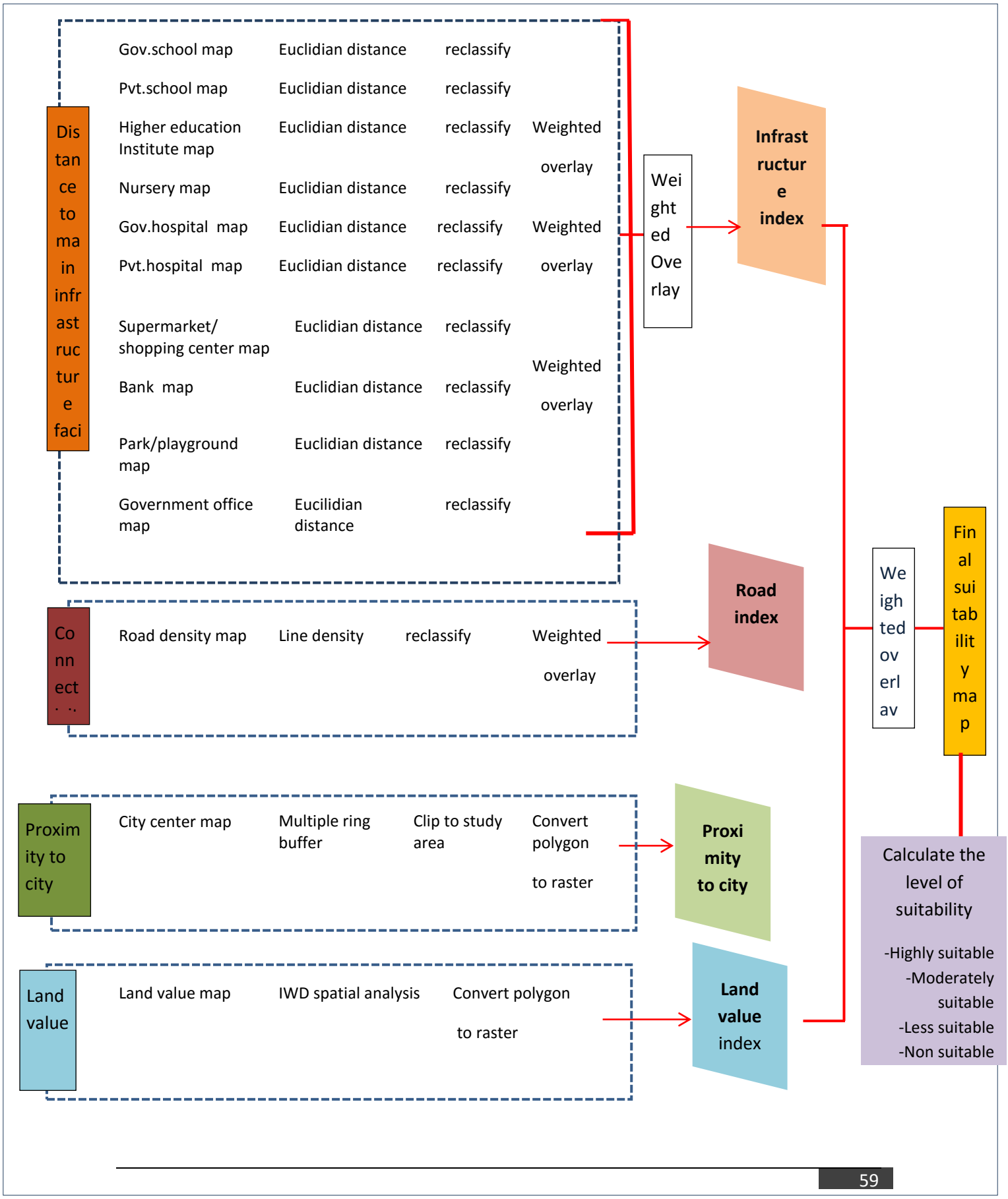
Fig. 5.1: Methodology

The following factors were selected to measure the suitability of residential zones based on the experts' opinions, literature review and the availability of spatial data.

a) Availability of social infrastructure facilities
   Distance to educational facilities
   Distance to health facilities
   Distance to recreational facilities
   Distance to other facilities such as shopping centers/banks
   Distance to public institutions
b) Accessibility
c) Proximity to city center
d) Land value

Raster analysis was performed using the data in each map and then it was reclassified on a scale of 1 to 5, with 1 being the least suitable and 5 being the most suitable. Once the four indexes were created, a raster analysis was performed with an arbitrary weighting system to show which land parcels would be most suitable for residential uses within the study area. The applied GIS model is attached to Figure 5.2

Fig. 5.2: Flow of GIS model



6.0. Analysis

6.1. Infrastructure index for Primary Residential zones

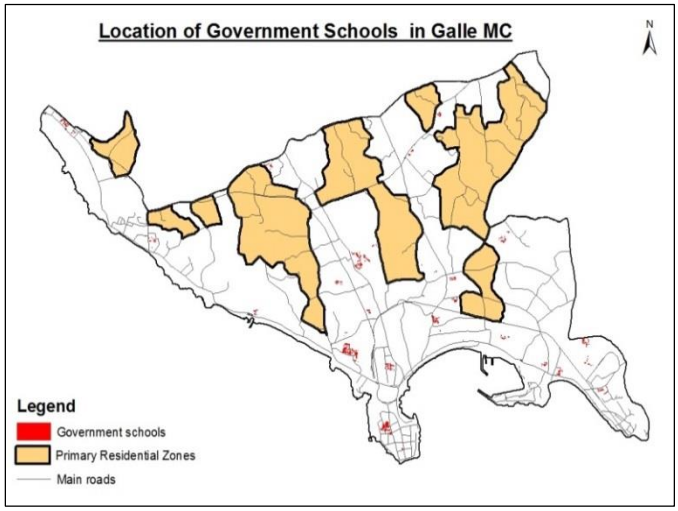
Proximity to major infrastructure facilities is a desirable factor to look for when selecting the best residential land.The minimum distance to urban amenities such as educational facilities, health facilities, recreational facilities and other services such as shopping centers were considered in the preparation of the infrastructure index for the residential zones.

a) Educational facilities

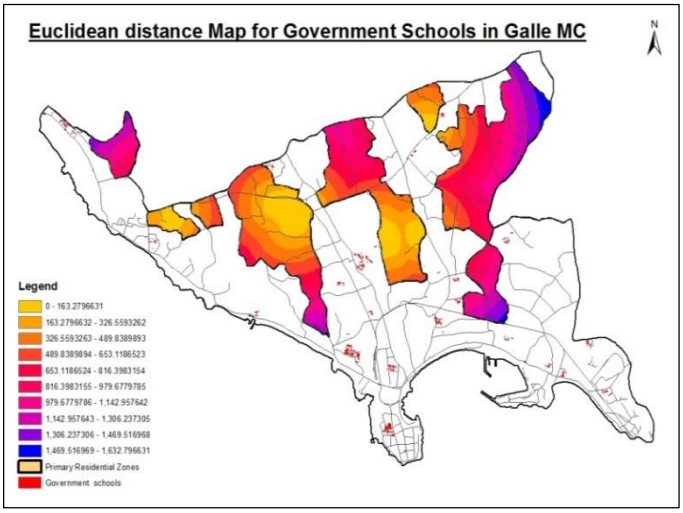
Access to educational facilities is defined by weighted overlaying of the reclassified Euclidean distance map of government schools, private schools, higher educational centers and nurseries.

The steps carried out to find a suitably located government school is explained below. Map 6.1 shows the existing location of a government school in the study area and map 6.2 shows the result of Euclidean distance calculation.

Map 6.1: Location of government schools



Map 6.2: Euclidean distance map for government schools



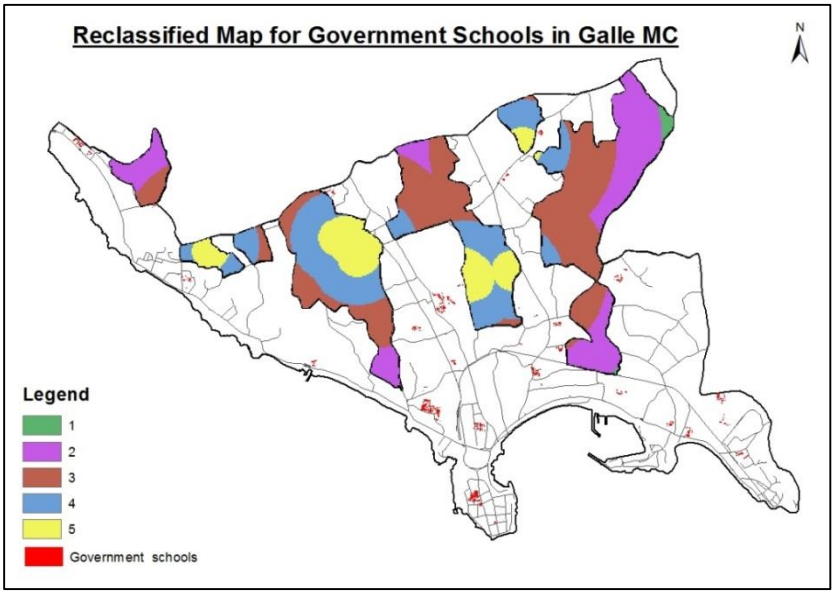
Then each value class in raster map 6.2 is assigned a new reclassified value on an evaluation scale of 1 to 5, where1 represents the lowest suitability and 5 the highest suitability as shown in Table 6.1.

Table 6.1: Evaluation scale for Government schools

Distance to government school	Assigned value	Evaluation criteria
100m	5	Highly suitable
500m	4	Moderately suitable
1000m	3	Marginally suitable
1500m	2	Less suitable
<2000m	1	Not suitable

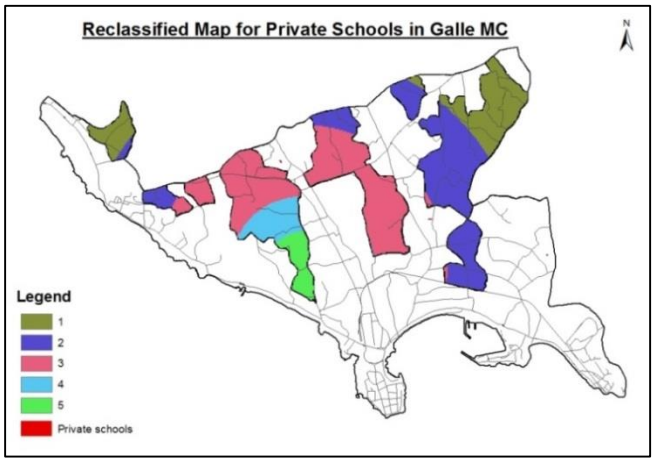
Based on above criteria, the prepared reclassified values for government schools are shown in Map 6.3

Map 6.3: Reclassified map for Government schools

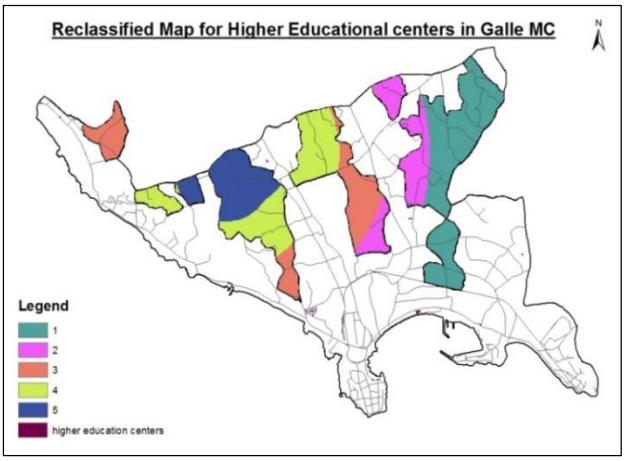


The most suitable areas are shown asyellow patches and the blue areas come next. Purple and green areas are the least suitable.
In accordance with the above method reclassified maps are created for other educational uses as private schools, higher educational uses and nurseries as displayed in Map 6.4, Map 6.5 and Map 6.6.

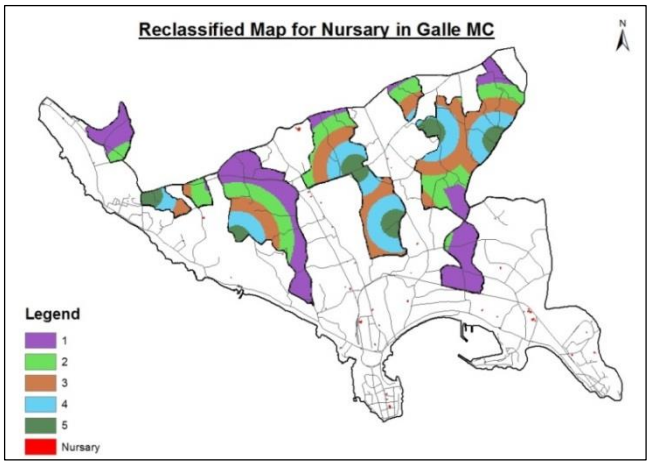
Map 6.4: Reclassified map for Private schools



Map 6.5: Reclassified map for Higher educational centers



Map 6.6: Reclassified map for nursery



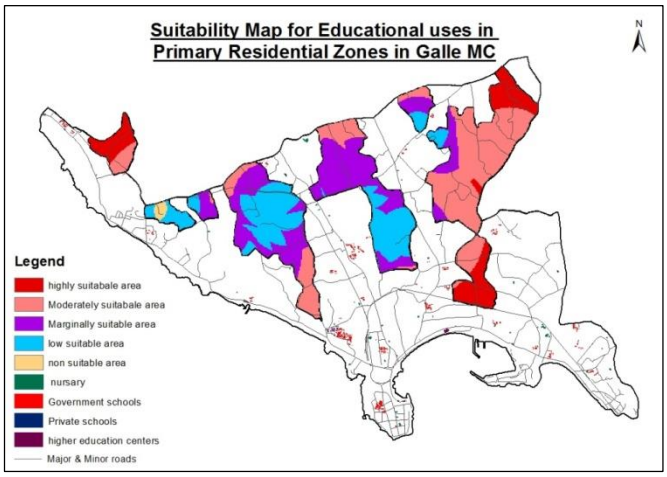
Distance to each educational facility may not be equally important. Distance to government schools is moreimportant in evaluating a residential zone than the distance to other educational institutions. Therefore, based on the influence of each criterion, a value is assigned as in Table 6.2.

Table 6.2: Evaluation scale

Criteria	Assigned weight based on the influence
a) Distance to Government school	45%
b) Distance to nursery	25%
c) Distance to private schools	20%
d) Distance to higher educational centers	10%

The final suitability map for educational uses (Map 6.7) was created by weighted overlaying of all the reclassified maps.

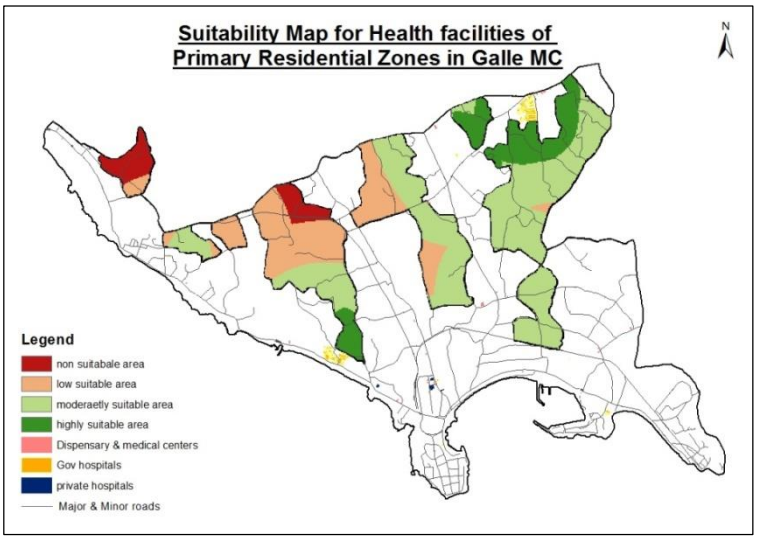
Map 6.7: Final suitability map for educational uses



b) Distance to health facilities

Distance to Government hospitals, private hospitals, dispensary and medical center were considered when creating the suitability map to reflect the Accessibility to health facilities can be seen in Map 6.8.

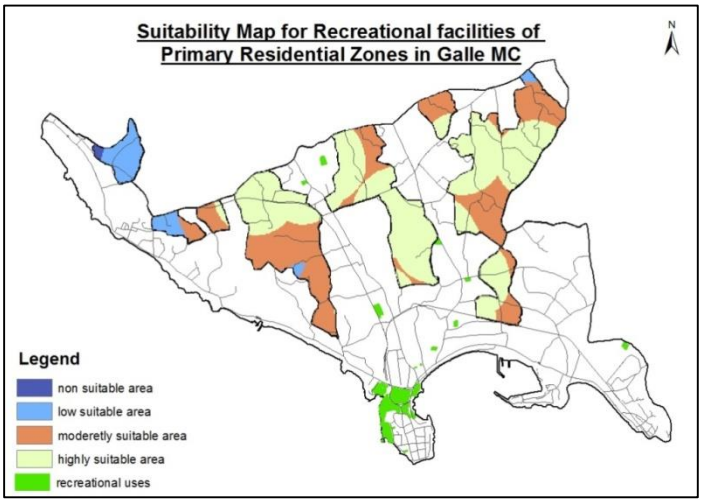
Map 6.8: Suitability map for health facilities



c) Access to recreational facilities

Access to recreational facilities has a significant impact on determining the suitability level of residential zones. The areas marked out based on this criterion are shown in Map 6.9.

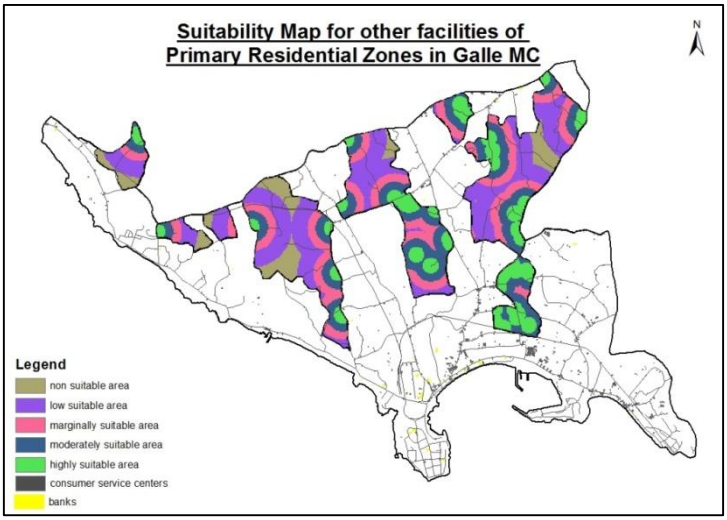
Map 6.9: Suitability map for recreational facilities



d) Access to other facilities

Easy access to other services such as shopping centers, supermarkets and banksare significant for measuring the suitability of residential lands. This is shown in Map 6.10.

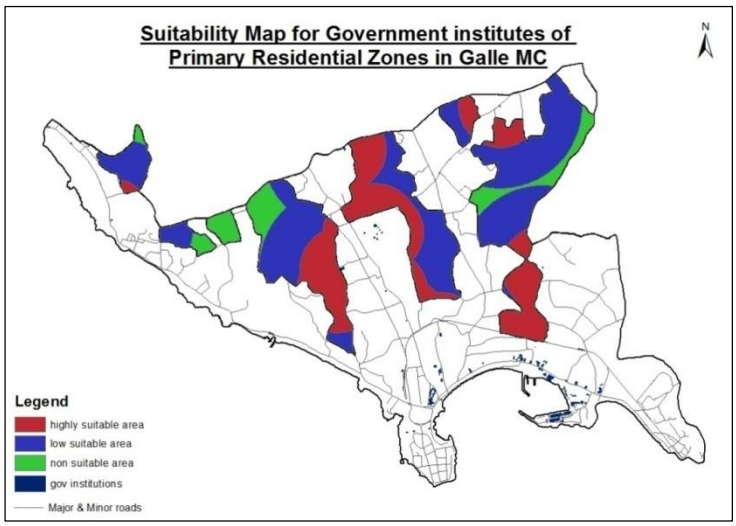
Map 6.10: Suitability map for other facilities



e) Access to public offices

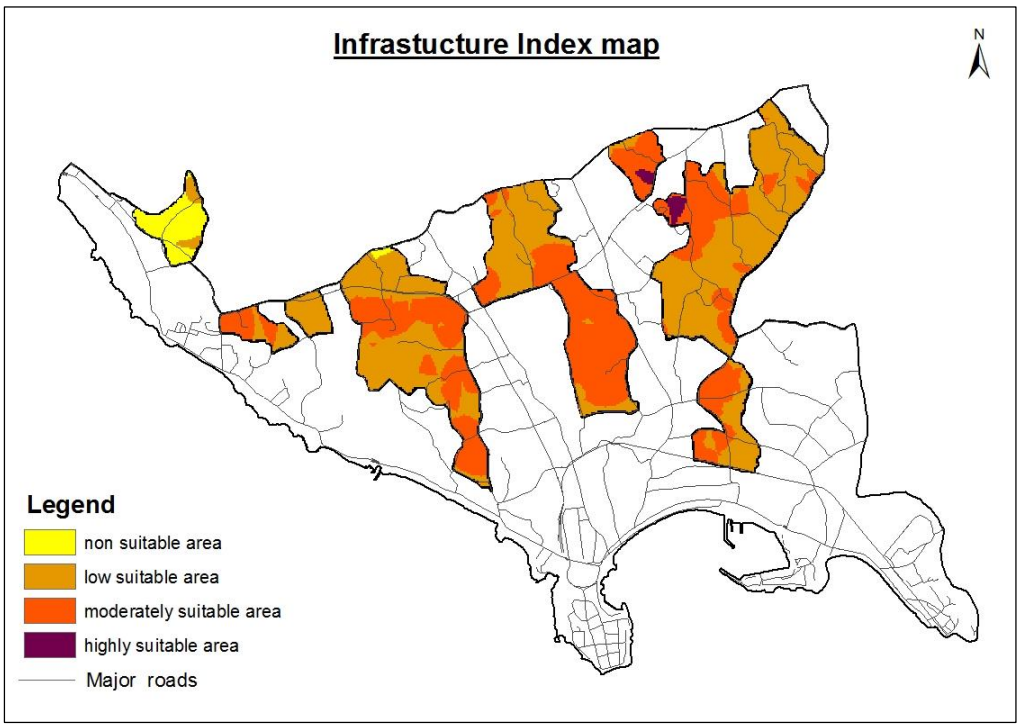
Reasonably convenient access to government institutions is also considered during the creation of an infrastructure index. It is important to public servants to ensure easy access to their workplaces and also for the convenience of the residents in getting the public services. The ratings for the areas are marked in Map 6.11.

Map 6.11: Suitability map for government institutions



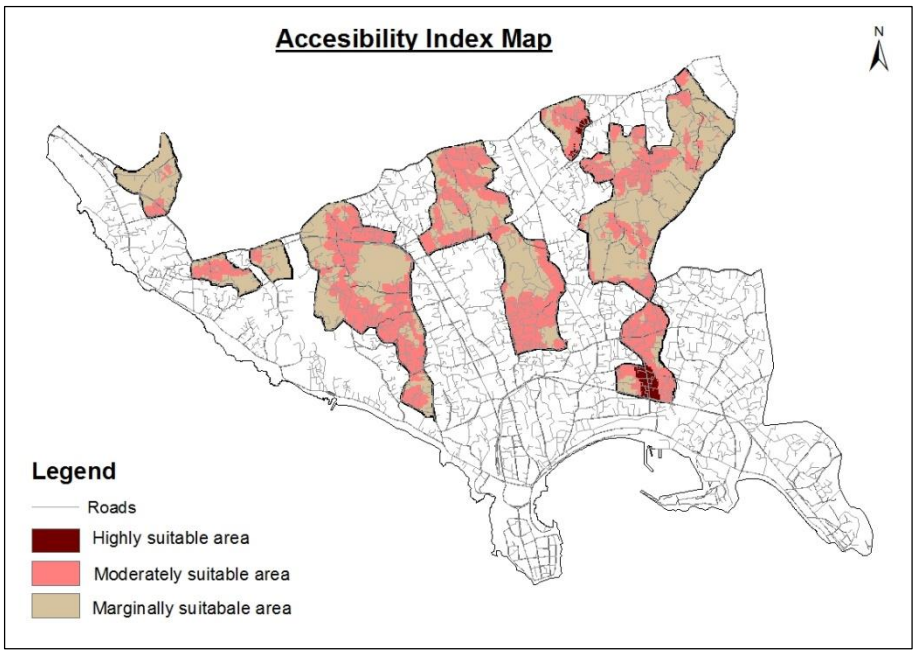
Based on the influence of each criterion a weight is assigned to it; then the criteria are overlaid on the educational, health, recreational and other services layers to create the infrastructure index for residential zones (Map 6.12).

Map 6.12: Infrastructure index

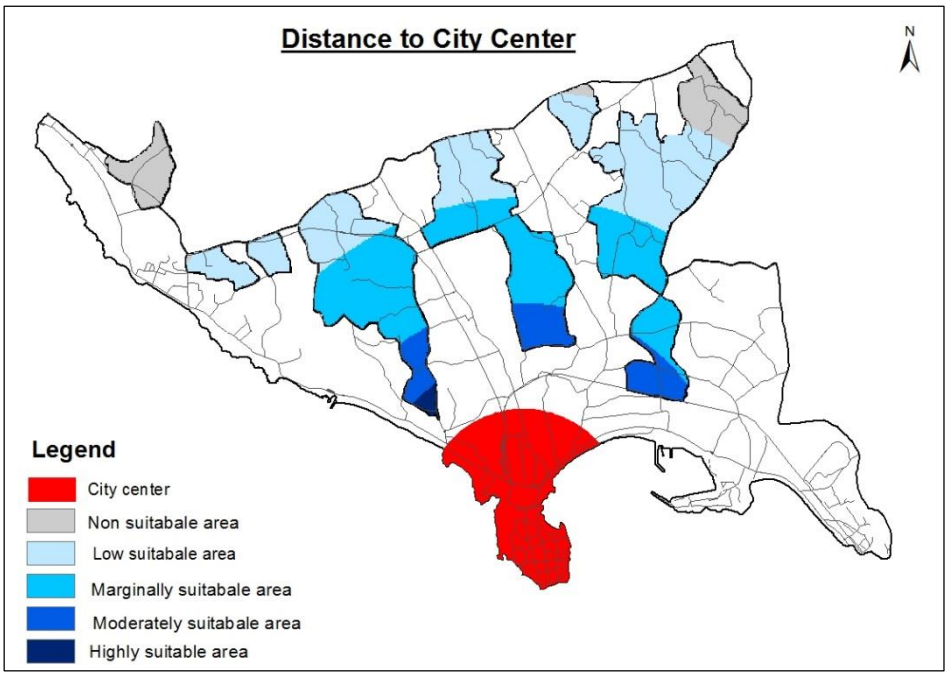


In accordance with the above method the other indexes are also prepared and attached to the following maps, viz. 6.13: Accessibility index, 6.14: Distance to city center, and 6.15: Land value index.

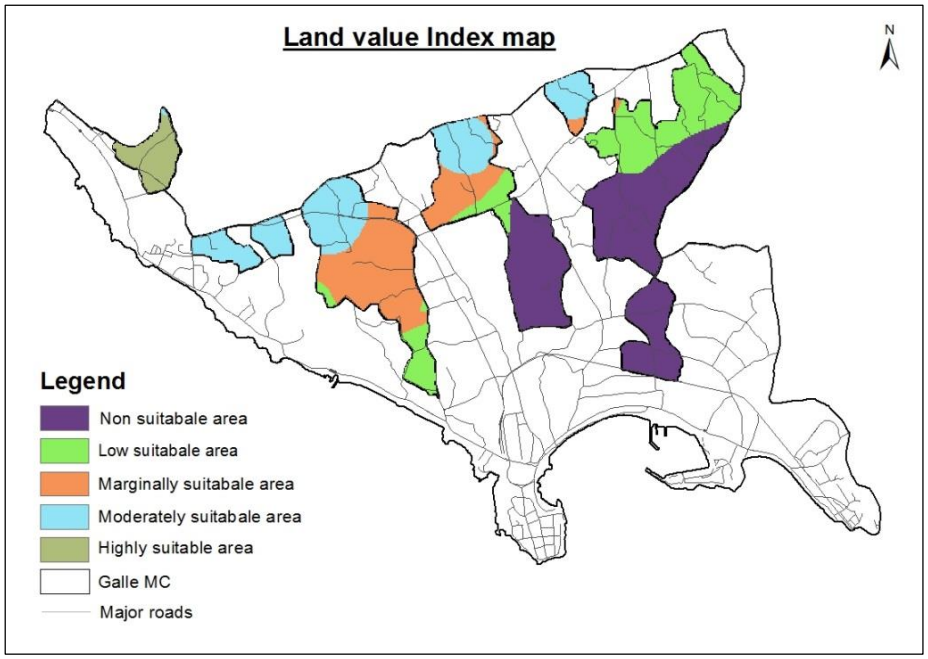
Map 6.13: Accessibility index



Map 6.14: Distance to city centre



Map 6.15: Land value index



The weighted overlay of the above four indexeswere used to create the final suitability map (Map 7.1).

7.0. Results

The purpose of this study was to measure the suitability of urban residential zones for living purposes. The results of the analysis are shown as one composite map (Map 7.1).

Map 7.1: Residential suitability map

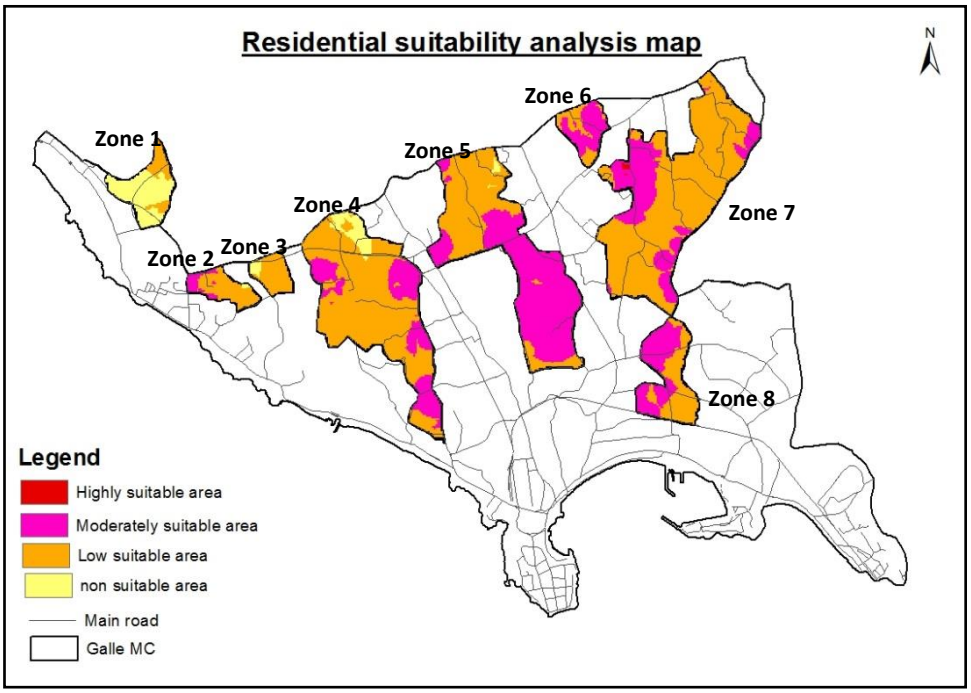
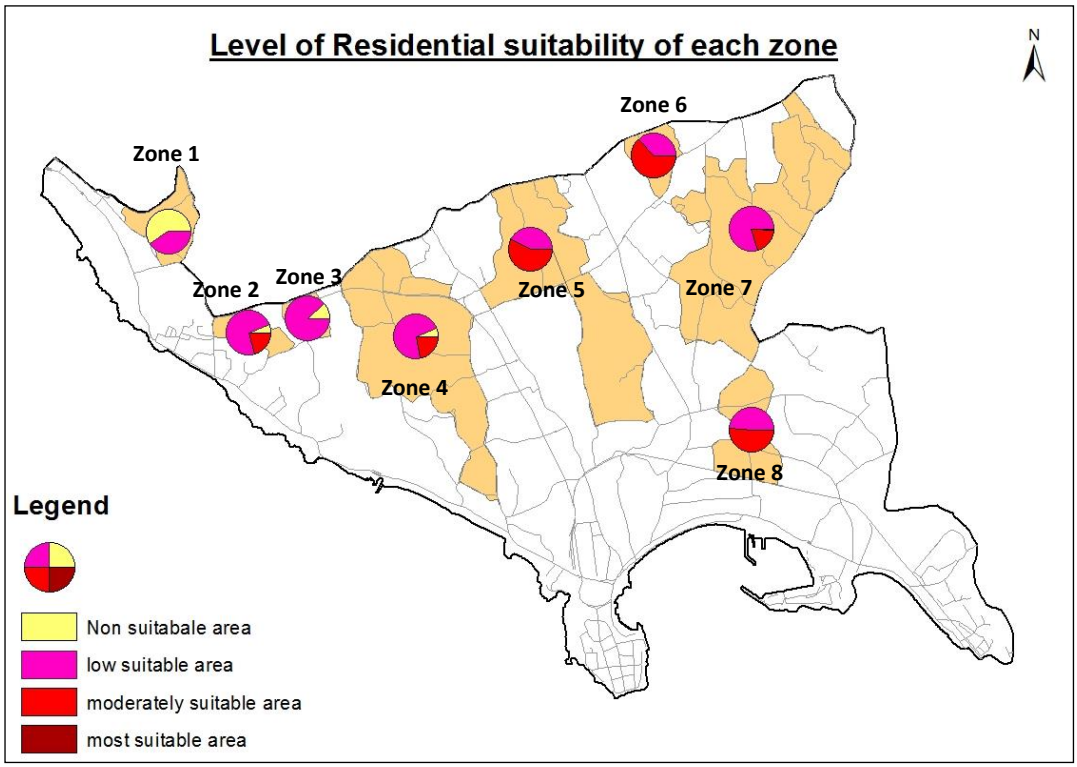


Table 7.2: Details of the Analysis

Zone	Total land extent (Acres)	Most suitable area (Acres)	%	Moderately suitable area (Acres)	%	Less suitable area (Acres)	%	Non suitable area (Acres)	%
Zone 1	59	-	-	-	-	24	41%	35	59%
Zone 2	34	-	-	07	21%	25	74%	2	6%
Zone 3	25	-	-	-	-	22	88%	3	12%
Zone 4	306	-	-	66	22%	221	72%	19	6%
Zone 5	291	-	-	166	57%	122	42%	3	1%
Zone 6	41	-	-	26	63%	15	37%	-	-
Zone 7	371	05	1%	72	19%	294	79%	-	-
Zone 8	87	-	-	44	51%	43	49%	-	-
Total	1214	05	0.41%	381	31.38%	766	63.10%	62	5.11%

Map 7.2: Level of suitability of each residential zone



8.0 Conclusion

The urban development authority has demarcated eight primary residential zones in Galle, which cover 1214 acres. According to the analysis 5 acres of land (0.41%) in primary residential zone 7 is designated as the most suitable residential area. This area is located in close proximity to educational, health, recreational and other facilities and has good road accessibility; the land value is also low in this area. 381 acres of land (31%) are moderately suitable for living while 766 acres (63%) are deemed as less suitable areas. 5.11% of the land area is demarcated as non-suitable for residential purposes as can be seen in Table 7.2.

According to Map 7.2, Zone no. 8 and zone no. 6 are the most suitable zones for residential development. Zone 1 is undesirable for residential purposes due to the very poor access it has to basic infrastructure and road connectivity. Therefore, it is necessary to increase the access to basic infrastructure facilities in Zone no. 1 as this will considerably enhance the comfort of the residents currently living there.

This analysis dealt with four major criteria, which are level of infrastructure, land value, connectivity and proximity to city center for measuring the suitability of residential zones. Additional criteria such as Land availability, Environmental conditions and Natural hazards such as flooding, landslides and Topography can be considered in future studies.The findings will contribute to better decision making by urban planners, land use policy makers and associated agencies.Using such land suitability models will contribute to rational decision making for futureurban development planning. This study was limited to primary residential zones but the methodology can be used for other zones as well.

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