

**AN EVALUATION OF THE PLANNING IMPLICATIONS
DRIVEN BY URBAN SPRAWL WITH SPECIAL
REFERENCE TO THE SUBURBS OF KANDY CITY**

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08/9601



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Department of Town and Country Planning

University of Moratuwa

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DRIVEN BY URBAN SPRAWL WITH SPECIAL
REFERENCE TO THE SUBURBS OF KANDY CITY**

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08/9601

This Dissertation is submitted in partial fulfillment of the requirement for the Master of
Science degree in Town and Country Planning of University of Moratuwa
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University of Moratuwa

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Declaration

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Abstract

The world urbanisation level is reaching to 60% in the year 2030 which is now at the level of 50% out of world's total population as forecasted by the population and statistical division of the United Nations. As a result of this transformation process, the urban sprawl takes place in the edges and outside the areas of cities while creating many socio, economic and physical issues specially in the aspect of environment. Urban sprawl is defined as unplanned expansion of urban boundaries in to the rural areas outside the city boundary. Urban sprawl is also characterised by suburban residential areas or as Metropolitan areas that comprises with the number of secondary townships around the main city. These main city and secondary townships highly connected with the interacted transportation networks lead to establishing growth corridors along the connection lines.

There are two significant differences in urban sprawl in developing and developed countries like car based communities, income level, Infrastructure availability etc. But some features like traffic congestion, environment degradation, and linkage with transportation networks and are common to both types of countries.

The transportation is dominant root cause in urban sprawl that leads to expansion of the city functions towards the rural areas or edges of city boundaries along with the transport networks and where the higher transport linkages are available. In the same time many environment degradations in natural and manmade environments are available due to this urban sprawl like water pollution, air pollution and agriculture land fragmentation etc.

This study focus to find the interrelation in between urban sprawl areas of main city and the secondary and other townships and to degrade the environment quality of the area that is adversely affected to sensitivity of the environment. This evaluation is done by the case study for Kandy city and its suburbs that one of the developing and main cities in sensitive area in central hill region of the country.

The urban sprawl areas are measured by the Space Syntax analysis and the level is measured by weighted ranks of the townships. environment impact of these areas are evaluated by developing an environment degradation index by searching the Google images.

Key words: Urban Sprawl, Environmental degradation, Evaluation,

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1 INTRODUCTION

The Urbanisation is inevitable phenomena in the world population, is now reached to the level of 50% in the world as per the United Nations population reports while various governments in the world facing various kind of problems in this transformation process. Among these problems the governments are facing the problems like landlessness, underserved settlements, environment degradation, conversion of the agriculture lands, pollution and inability to serve newly built settlements in developing countries and etc. associate with urbanisation.

The urban sprawl is an outcome of the unplanned urbanization process. Simply the urban sprawl can be defined as unplanned expansion of urban boundaries in to the edges and the outside the areas of urban boundaries. Landlessness, Lower affordability of the migrants to city, higher land values within the city, Transportation development towards the secondary cities, availability of agriculture lands in the outside the area of city boundaries are some of the reasons to urban sprawl. There are many adverse effects of urban sprawl in both developed and developing countries. Most of them are environment pollution, specially deforestation, reduction of green spaces, traffic congestion, single use zoning are some of other problems associated with urban sprawl.

Many researchers have carried out researches to find different negative implications of the urban sprawl like pollution specially air, water and land, insanitary health condition and accidents but very low attention has given to find the interrelation in-between level of urban sprawl into is affecting to its implications. So this study is focused to view in find is there any positive or negative interrelations are taken place with urban sprawl.

The integration of townships in case study area is measured by the Space Syntax analysis (Depth map) and there level is measured by weighted ranking of townships in sub regional area of Kandy. The levels of environmental implications of these townships are measured by forming a degradation impact index by using the Google maps. Finally these two results will be compare and interrelate.

1.1 Background of The Study

The urban sprawl can be simply defined as an expansion of urban activities to the edges and immediate periphery of the urban area which is now not properly developed. Urban sprawl is a byproduct of unplanned urbanization process. After industrialization huge transformation to urban activities are taken place everywhere in the world. The industrialization process pull people to places of urbanized where the non agricultural activities are taken place. In the same time rural agriculture sector also modernize tend to lower the labour absorbing capacity rural agricultural sector push the rural people to urban industrialized locations.

This transformation process created some adverse effect to location of newly came labour to occupy and most of marginal lands get converted to residential activities most commonly known as slums and shanties. Lack of affordability for proper housing towns gets insanitary condition by overcrowding and resides in the unsuitable lands by new comers known as “Black flight”. In the same time the wealthier people off the town to reside in suburban areas with environmental quality and with consuming more individual space known as “White flight”.

Though the first instant of urban sprawl was happened in that way, due to the development of transportation sector crested more disperse the urban activities in uncontrolled manner. The development of private vehicles in western countries and development of mass transport modes in other developing and European countries sprawled the cities as suburbanization and metropolitans that is comprises with bunch of townships act together with main city.

This big phenomenon has created many harmful effects in the both cities and the peripheral areas in physical, socio, economic and environmental sectors. Urban sprawl causes much direct and indirect societal and environmental harm. Urban sprawl also threatens biodiversity and contributes to transportation-caused air pollution and the deterioration of river water quality as development destroys green areas, displaces agriculture uses, creates impervious surfaces and adds to river discharges are some of them. Though there is close linkage in between environment

degradation and urban sprawl, very few studies has been done to find out how far urban sprawl affected to degrade the immediate surrounding environment.

Many scholars have engaged to consider various aspects of urbanization and urban sprawl to use and understand the situations for possible and sustainable future in urban planning specially in developing countries. Measuring of urban sprawl, health aspect of the urban sprawl, managing of urban sprawl, Environment side of the sprawl and possible strategies for urban sprawl are some of the aspect are some of them.

Specially the location of cities in developing countries in the environmental sensitive areas, the urban sprawl creates many harmful effects by exposing them into the natural disasters. The main focus of this study has been given to evaluate the pattern of urban sprawl by evaluating the integration the space and ranking the townships and how far these townships are created different levels of environmental degradations.

1.2 Problem Definition

The most of city expansions (urban sprawl) have created many adverse effects to the environment and created diseconomies to the city and peripheral area as well. Degrading natural eco systems/ agriculture land fragmentations, loss of green spaces, air, water and land pollution, traffic congestion and accidents are some of the direct adverse implications and indirect implications like encroachments of sensitive lands, acquiring vulnerable lands, fragmentation of agriculture lands and eco sensitive lands are also created by the urban sprawl. Its note that no study has carried out the issues of the urban sprawl with its level and this level how far affected to the degradation level. The problem of this study is to find how far these urban sprawl pattern and level affected to degrade the environment quality of the immediate features of the sprawl areas environment.

1.3 Aim and Objectives of the Study

1.3.1 Aim

The aim of the study is to evaluate how urban sprawl affecting the environment degradation by studying the level of urban sprawl and level of environmental degradation of the study area.

1.3.2 Objectives

The objectives of the study are as follows.

- 1 To identify the pattern of urban sprawl by using social spatial integration and level of urban sprawl by ranking the township by weighted functional analysis
- 2 To identify different level of environment impact of the townships in the study area by developing the degradation index
- 3 To compare the pattern and level sprawl townships and find the causes of sprawl.
- 4 To identify the relationship between level of sprawls and level of environmental impacts.

1.4 Scope and Limitations of the study

1.4.1 Scope

The scope of the study is how urban sprawl level and pattern will affect to level of environment degrade by studying by considering the townships in the sensitive area.

1.4.2 Limitations

- 1 The study is focused to find the pattern and level of urban sprawl areas existence in the study area and their level of environmental degradation.
- 2 The areas will be finding through the Space syntax analysis and level of the township will be finding through the weighted rank index.
- 3 The area limits to Kandy city and is suburban townships.
- 4 The aerial photograph survey will be done to the areas where the sprawl is taken place.

1.5 Conclusions

The urbanization is inevitable phenomena and urban sprawl is a byproduct of unplanned urbanization which has created many adverse and favorable effects. This study is going to test impacts of the urban sprawl and how far the different levels of urban areas created different impacts in different level. The space syntax, weighted ranks of townships and environmental degradation index also use as techniques.



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2. LITERATURE REVIEW

This chapter discuss the matters of evolution, features, causes, impact of the urban sprawl and environmental degradation through the previous researches and articles. Specially different book reviews and studies conduct by the researches in various fields of urban sprawl has summarized here.

2.1 Background of Urban Sprawl

“Initial flight from urban centers to suburbs started decades ago with the development of highways and mass transit systems. The exponential increase in the use of cars made previously inaccessible areas available for residential and business use. The shift of many families in the 1950s and 1960s to suburban housing involved a shift in the location of work places. Most employment in metropolitan areas remained in central cities. Today in contrast, the increasing magnitude of sprawling development patterns and associated harms include not only a shift in residential housing, but also a shift in workplace locations” – (Buzbee - 1999). The author argues that initially the richer people in the city have shifted to the suburban areas and then town centers occupied by the low-income groups. As well as in the developing countries like American and European countries much squatter and slum settlements can be seen due to immigration of these people. Further he argues that the shifting of job locations also tend to increase urban sprawl.

“For the newly sprawling cities, cars are the main, if not, the only, option for transportation. In recent decades, there has been a dramatic increase in the percentage of dual career families, causing many households to contribute pollution from at least two cars while still using transportation infrastructure built when single career, one car families were the norm. The shift away from reliance on railroad or river transportation and increasing use of trucks for transportation of goods, many businesses have abandoned the central city in favor of new factories, warehouses, and service sector offices on the urban edge” – (Buzbee 1999)

2.2 Definition of Urban Sprawl

There is no composite definition for urban sprawl but the western planners defined the urban sprawl as their characters and with differencing from the developing counties.

- 1 Urban sprawl will be defined as spatial growth of cities that is excessive relative to what is socially desirable. The key word in this definition is excessive (Brueckner 2001).
- 2 In many developing countries, urban sprawl comprises two main, contrasting types of development in the same city: one is characterized by large peri-urban areas with informal and illegal patterns of land use with a lack of infrastructure, public facilities and basic services, and often is accompanied by little or no public transport and by inadequate access roads. The other one is a form of “suburban sprawl” in which residential zones for high and middle- income groups and high-valued commercial and retail complexes are well-connected by individual rather than public transport (UN-HABITAT 2010/11)
- 3 The growth of metropolitan cities will continue to take the form of continuous expansions around the edges, with a belt of land always in process of conversion from rural to urban use (Harvey RO and Clerk WAC 1965)
- 4 ‘Urban sprawl is the growth of a metropolitan area through the process of scattered development of miscellaneous types of land use in isolated locations on the fringe, followed by the gradual filling-in of the intervening spaces with similar uses’. Low density development beyond the edge of service and employment, which separates where people live from where they shop, work, recreate and educate thus requiring cars to move between zones (1000 friends of Florida 2005 say Mashour and McDonnell)
- 5 Sprawl is sometimes equated to the natural expansion of metropolitan areas as population grows or to unplanned growth, whatever form it may take. More often, though, sprawl is defined in terms of specific development patterns deemed dysfunctional by critics, whether scattered development, leapfrog development (a type of scattered development that assumes a single-centered city), commercial strip development, uniform low density development, single-use development (with different land uses segregated from one another, as in bedroom

communities), or development that is ugly, monotonous, or unending. (Ewing et al – 2003)

2.3 Definition of Environmental Degradation

Defining environmental degradation poses a much more difficult task. Cites deforestation, land degradation, water shortage and contamination, air pollution and the loss of biodiversity are some of the many environmental problems. Environmental degradation comprises a large degree of subjectivity on the part of the agents involved or who own the resources. Different ecosystems as well as different values placed on environmental resources by different societies make the definition of environmental degradation difficult and complex. For example, the tolerance level to air-pollution by New York City citizens may be much lower than the tolerance level of Shanghai's citizens. How do we define a degradation of the air-space in the two cities? A common solution is to use physical characteristics of the system as a threshold level beyond which degradation is assumed to take place. However, this is easier said than done, as detailed knowledge of the ecosystems must be known before these physical thresholds can be determined. (Duraiappah – 1996).



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2.4 Major Studies / Articles in the Urban Sprawl

The followings are the major articles, researches and studies in the field of urban sprawl and environment degradation.

1. Buzbee WW - 1999 – Urban Sprawl, Federalism, and the Problem of Institutional Complexity - Fordham Law Review.

In this Article the author tries to find different decisions in both government and private sector in the physical development and control measures which has been affected to urban sprawl and influenced by the politics. Within the article part 1 comprises with reviewing the market and government actions contributing sprawling development pattern and discusses the benefits of an alternative anti-sprawl or “new urbanism” vision for urban form. Part 2 offers the theoretical political-economic framework and part 3 examines use of conditional spending incentives to encourage state and local considerations of measures to address sprawl's ills. Part 4 compares the

dynamics, successes, and failures of environmental law. The author stated within the article regarding some effects of urban sprawl.

1 While obvious discomforts associated with sprawl are often mentioned. Air pollution, costly delivery of government services, increased commuting time and traffic congestion, destruction of previously exurban green and agricultural areas, and abandonment of urban centers that would benefit from “Infill” efforts.

2 Urban sprawl also threatens biodiversity and contributes to transportation-caused air pollution and the deterioration of river water quality as development destroys green areas, displaces agricultural uses, creates impervious surfaces and adds to river discharges.

3 Decisions to develop in a sprawling pattern also necessarily involve choices of locations for new real estate development investment. These development decisions can contribute to an ongoing avoidance of underutilized or decaying urban centers and “Brownfield” sites. Abandonment of the urban core, which is both a cause and effect of sprawl, increases disparities in wealth, housing, environmental, and business conditions.

4 For this newer cities cars are the main Disserat ideas, there has been a dramatic increase a percentage of dual career families, causing many households to contribute pollution from at least two cars.

5 The most significant subsidy of sprawling development patterns is from federal and state expenditures on highway development

6 To face the effects of the sprawl some cities have begun to experience downtown and inner suburb business and residential revitalization, or at least substantial increases in real estate prices, advocate more concentrated forms of urban design that include more mixed types of uses in close proximity, and rely less on automobiles and more on mass transit. More concentrated forms of urban development also provide opportunities for preservation of exurban green spaces and the economic and aesthetic benefits of agricultural uses.

7 The political influence of the transportation and real estate industries is unlikely to be countered effectively by voters, who as commuters, homeowners, or renters may be opposed to sprawl and might embrace anti-sprawl policies. Many

citizens, of course, seek their own piece of suburban living, and as such, might oppose anti-sprawl reforms.

The author argues that the urban sprawls causes are part social, part market driven, and part the result of current legal structures and division of political authority. Finally he stated that rigid legal prescriptions or prohibitions would be a mistake; different incentives and policies will be appropriate in different contexts.

2. Frenkel A and Ashkenazi M –2005 –Measuring urban sprawl: how can we deal with it? –Environment and Planning B: Planning and Design 2008, volume 35.

In this research the authors found the problem of that measuring of urban sprawl is controversial and still different measures do not sure to measure the urban sprawl correctly. Still some planners argues the sprawl has positive effects such as an outcome of free market decisions, associated with higher income rates, greater influencing capabilities to government such as passing zoning regulations and lower crime rates. In the same time some planners argues that the urban sprawl have many alleged negative effects such as lack of scale of economies, reduces the level of public services in the suburbs, weakens the economic base of central cities, increased energy consumption through increasing the using the private vehicular causing air pollution and damages the eco system caused by fragmentation of open lands.

i. Definition of urban sprawl

There is no acceptable composite definition, but commonly characterized followings.

- A scattered and discontinuous pattern of development
- Development of residential areas with low densities
- Commercial strip development
- Segregation of land uses
- Low accessibility and high dependency on private vehicles

Basic traditional measures of sprawl

The followings are the major five groups of urban sprawl measures.

- Growth rates
- Density
- Spatial geometry
- Accessibility
- Aesthetic measures

ii. The methodology

Based on the urban land use surveys have performed in the 78 urban settlements in town and metropolitan scales in 15 years. On behalf of traditional measures they formed a measure called “integrated sprawl index” comprising the characters of ‘configuration’ and ‘composition’. The dimensions they measure from this density and scatter in configuration and mixture of land uses in composition. To calculate these dimensions different variables and indices uses.


iii. Results

Highly compacted settlements are usually large, denser cities, while highly sprawling settlements are usually small and semirural. There is high and negative correlation between the level of sprawl and the size of a settlement. Sprawling settlements are less efficient in using land than are compact urban settlement. Growth rates of the population and built up area is high in the sprawling settlement means these settlements are attractive and consumers preferable than the compacted settlements. If the configuration score decreased and the composition score slightly increased. Still what is sprawl, how it affects the urban environment and how it should be measured is unanswered. With the landlessness and sensitivity fully justifies regulating and restrains sprawl.

3 Duraiappa A – 1996 - Poverty and Environmental Degradation: a Literature Review and Analysis –International Institute for Environment and Development.

Aim of this paper is to find complex of factors in the existing literature on the links between poverty and the degradation of four natural resource sectors. Though there is not interrelation to urban sprawl to environmental degradation, the agents to acquire those resources are the urban sprawl activities that the residential, commercial and

industrial. The analysis highlights the institutional and market failures which encourage unsustainable activities, which in turn forces some income groups have more resources rise in the poverty level. To minimize conflicts in the analysis, we shall use a combination of ecological thresholds as well as revealed preferences where appropriate as indicators of environmental degradation. In this research the following features identified as environmental degradation.

- 1 Loss of green
 - a. Watershed protection
 - b. Soil erosion
 - c. Destruction of safety buffer
 - d. Productivity drop
 - e. Fuel wood shortage
- 2 Land degradation
 - a. Soil exhaustion
 - b. Salinisation
- 3  Desertification
Water pollution
 - a. water shortage
 - b. water pollution or contamination
- 4 Air pollution
 - a. Outdoor pollution
 - b. Indoor pollution

Method

Study separate natural elements and their rate of degradation and their causative factors

Findings

- The conflicts between different user groups of natural resources which in turn marginalizes some of the groups which eventually fall into the poverty group.
- The conflicts to a large extent are either initiated or encouraged by institutional or market failure Certain groups benefit while others suffer

- Unsustainable use of natural resources inevitably causes poverty policy must be focused on environmental policies and not poverty alleviation poverty
- The first objective is to first identify if it is indigenous or exogenous poverty. If it is indigenous poverty, then policies must be focused on environmental policies. However, if it is exogenous poverty, then poverty alleviation policies need to be formulated and implemented.

4 **Cohen B - 2006 – Urbanization of developing countries: Current trends, Future projections, and Key challenges for sustainability –Technology in Society 28**

The purpose of this paper is to provide broad overview of recent patterns and trends urban growth in developing countries. Nearly half of world’s population lives in the urban areas. The cities dominating in both production and consumption, rapid urban growth throughout the developing world is seriously outstripping the capacity of most of cities to provide adequate services for their citizens.

Table 1 Urban population in the world by major geographic area 1950 – 2000

Region	1950	1975	2000	2030
Population living in urban areas				
World	29.1	37.3	47.1	60.8
More developed regions	52.5	67.2	73.9	81.7
Less developed regions	17.9	26.9	40.5	57.1
Distribution of urban population				
World	100	100	100	100
More developed regions	58.3	46.4	30.9	20.5
Less developed regions	41.7	53.6	69.1	79.5

Source : Cohen /2006

Findings

Most of the growth will not occur in the largest cities but in smaller secondary cities and towns where the poverty higher, basic public services low. Managing the urban growth and support the capacity of local governments is another one of the important challenges of the 21st century.

5 Maya MM – 2008 – Transporting Planning and the Prevention of Urban Sprawl –New York University law review – Vol 83 – 879

The aim of this paper is finding to how the transport planning could be used to control the urban sprawl. The cost of sprawl is not alongside with the environmental degradation, pollution, climate changes, threatening to eco systems, urban poverty but the travel distances in between place of reside and work with automobile tending to congestion.

Transport infrastructure has curtailed sprawl in two main lines.

- 1 Transportation planning laws must discourage uncoordinated and unnecessary road building. Most of the new arteries may little impact on the traffic congestion but much to increase urban sprawl.
- 2 The concurrency rules must prohibit growth where transportation infrastructure is insufficient to support it. Local government should not issue permits, make planning changes unless necessary transportation



Findings

- 1 Prevent the construction of roads where there are no people.
- 2 Stop the development of housing where there no roads.

6 Bruekner JK – 2000 – Urban Sprawl : Diagnosis and Remedies – International Regional Science Review

The author of this article explains the underlying forces of urban sprawl. There are three powerful forces behind the urban expansions namely growing population, rising income, and falling of commuting costs. There are three fundamental forces upsetting the allocation of the land between agricultural and urban uses.

The author defines urban sprawl as “The term urban sprawl will refer to excessive spatial growth of cities”. Always the competition between the real estate developers and non urban users (mainly farmers and other agricultural users) helps to determine the spatial sizes of the city.

The three fundamental forces are

- 1 Failure to account for the benefits of open space
- 2 Failure to account for the social cost of congestion
- 3 Failure to make new development pay for the infrastructure costs it generates

Findings

Development taxes, congestion tolls, and impact fees can use as price mechanisms. Use of urban growth boundary easy to use but has greater potential for misuse that increases density and housing prices. The high incomers in sprawling areas form separate jurisdictions for the provision of public goods such as education, public safety, and parks. The development tax can be used to real estate development by shrinking the city size may attract the real estate investments in to the decayed city center redevelopments.

7 R Ewing et al – 2003 – Relationship between urban sprawl and physical activity, obesity, and morbidity –American journal of health promotion

Purpose of this study to determine the relationship between urban sprawl, health, and health related behaviors.

Method

Cross sectional analysis using hierarchical modeling to relate characteristics of individuals and places to levels of physical activity, obesity, body mass index (BMI), hypertension, diabetes, and coronary heart disease.

Results

After controlling for demographic and behavioral covariates, the country sprawl index had small but significant associations with minutes walked, obesity, BMI, and hypertension. Residents of sprawling counties were likely to walk less during leisure time, weigh more, and have greater prevalence of hypertension than residents of compact counties.

8 S. Islam – 2007 - Physical Density and Urban Sprawl : A Case of Dhaka City - Department of Urban Planning and Environment (KTH)

The objective of the study is to analyze the physical densities and spatial qualities of formal and informal settlements as well as investigate their relationship to the urban sprawl.

Method

The physical densities have been explored by using Google earth software where the spatial qualities have been analyzed by using photographs.

Findings

The floor area ratio and plot coverage of informal settlements is very low. And the floor area ratio and plot coverage by buildings in formal settlements are very high except some high income class areas.

It is recommend the block type low rise high density housing with natural light and ventilation for low incomes to combat the urban sprawl.

9 Ewing R et al – 2003 – Urban Sprawl and Transportation – TRB Annual Meeting

The objective of this paper is to measure urban sprawl and test for relationships between sprawl and transportation outcomes.

Method

Consolidation of variables of sprawl (density, land use mix, centering, and accessibility) related to vehicle ownership, commute mode of choice, commute travel time, vehicles miles traveled per capita, traffic delay per capita, and traffic fatalities per capita.

Findings

Sprawling regions perform less more than compact ones in transport outcomes. More traffic fatalities in transit use. Sprawl regions have disperse congestion create more vehicle miles travel.

10 Frumking H - 2002 – Urban Sprawl and Public Health –Public health Reports Vol 117

This article offers a public health framework for understanding the consequences of urban sprawl.

Direct effects of reliance on automobiles

Per capita daily travelling miles per day is increasing. Comparatively more compacted cities have very lower miles per day. However, it is also associated with health hazards, including air pollution, motor vehicle crashes and pedestrian injuries and fatalities.

Effects on land use decisions

The distances are in great there more chance to use cars for travel. Physical activity is very low in the sprawl area liable to lowering the walking and bicycling tend to overweight and heart deceases, blood sugar, high cholesterol, and diabetes. The sprawl may be threatened to the supply water quality and quantity. Clearing of forest cover, impervious surfaces built in larger area, not properly recharging the ground water, and loss of rain fall runoff as storm water. Polluting of water ways may increase this situation. The heat island affects another outcome. More combustion of fuel and more produce carbon dioxide may affect not only to heat island and also global warming.

2.5

Causes of Urban Sprawl



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Urban sprawl's causes are part social, part market driven, and part the result current legal structures and division of political authority. Urban sprawl arises from a confluence of private and government decisions. The most significant subsidy of sprawling development pattern is state expenditures on highway development pursuant to federal and state transportation laws. – (Buzbee 1999)

Urban sprawl involving the poor occurs because authorities pay little attention to slums, land, services and transport. Authorities lack the ability to predict urban growth and, as a result, fail to provide land for the urbanizing poor. In addition, the urban poor are denied land rights which are one of the main factors driving people to the periphery of the towns, associated with urban sprawl in developing countries. (UN-HABITAT 2010/11). Though the urbanization and urban sprawl is taken place in the case of some push pull effects, the urbanization is verse in the developing

countries that the governments of these developing countries couldn't provide sufficient land or housing creates shanty and slum settlements in the urban areas.

In both developing and developed countries have experiences of driven urban sprawl by transportation development in the private and common both. That makes urbanize people to travel large distances from the city.

Tendency of high and middle income consumers to form separate jurisdictions for the provisions of public goods such as education, public safety tend to expand city boundaries by promoting high quality services. To protect these benefits they often impose the minimum lot size, and other fiscal regulations to poor households from entering the community. Sometime family farming, home owner tax subsidies also encourage urban sprawl. (Brueckner - 2001).

The dominant root cause of the urban sprawl is the development of transportation network and non agricultural economic development leads to urbanization. Some other causes like upgrading living standards of the people, landlessness within the area of city and weak policies of the government also tend to increase this situation. In the developing countries the excess labour in the rural agricultural areas also push to the urban areas and availability of some job opportunities also pull these people to the urban areas. Concentrations of carbon monoxide, lead, and suspended particulate matter in many large cities greatly exceed World Health Organization guidelines. Among the greatest environmental health concerns are exposure to fine particulate matter and to lead which contributes to learning disability in young children. (Cohen – 2006)

2.6 Negative Effects of Urban sprawl

Urban sprawl causes much direct and indirect societal and environmental harm. Urban sprawl also threatens biodiversity and contributes to transportation-caused air pollution and the deterioration of river water quality as development destroys green areas, displaces agriculture uses, creates impervious surfaces and adds to river discharges. While obvious discomforts associated with sprawl are often mentioned – such as costly delivery of government services, increased commuting times and traffic

congestion, destruction of previously exurban green and agriculture areas, and abandonment of urban centers that would benefit from “infill” efforts – sprawl in most respect cannot be analogized to societal dynamics leading to environment destruction. – (Buzbee 1999)

The development decisions can be contributed to an ongoing avoidance of underutilized of decaying urban centers and “Brownfield” sites.

1 Abandonment of the inner urban core –

- a. Rents in the central city, however, may drop as the demand for urban real estate decreases. Old industrial sites with actual or perceived contamination problems are often described as “Brownfield” sites.
- b. Brownfield sites are also often avoided because developers fear substantial contamination cleanup liability under federal or state statutory law.

2 Traffic and air pollution

- a. As cities develop in a sprawling pattern, with a new highway links and more distant workplaces and disperse residents, citizen’s travel increased miles in their cars.
- b. Residents of sprawling cities drive increasing distances each day due to increased commuting distances and the tendency of residents to drive even to acquire basic home necessities. This increase vehicle miles travel per resident has substantially undercut the benefits of improved automobile pollution control.
- c. This increase of the time for commuting lesser the time to work, enjoy or spend time with family.

Low level of investment on mass transit both cause and effect of sprawl. The economic viability and attractiveness of mass transit system, particularly rail systems, decrease as development spreads over wide areas instead of concentrating near the commuter rail service. (Buzbee 1999)

3 Green space, Bio diversity loss, and water quality effects

As agriculture lands and green spaces are cleared for residential or business use, the aesthetic and environmental benefits of green spaces are forever lost, as are the biodiversity benefits of linked green spaces. (Degraded water quality and quantity by siltation) (Buzbee 1999) Destruction of wildlife habitat, Introduction of non-native invasive plants and animals into natural areas, increased potential for flooding and soil erosion due to impervious surfaces such as concreted pavement, decrease ground water.

- 4 Lack of scale of economies, which reduce the level of public services in the suburbs and weakens the economic base of central cities, increased energy consumption through encouragement of the use of private vehicles (Brueckner 2000 say Frenkel and Ashkenazi)
- 5 Urban environment- Urban areas do not have only local environmental impacts but also large so-called 'ecological footprints' (WWF 2000). In their immediate vicinity, cities have a variety of impacts: conversion of agricultural or forest land for urban uses and infrastructure, reclaiming of wetlands, quarrying and excavation of sand, gravel and building materials in large quantities and, in some regions, deforestation to meet fuel demand. The use of biomass fuel also causes indoor and outdoor air pollution. Other effects can be felt further afield such as pollution of waterways, lakes and coastal waters by untreated effluent. Air pollution from cities has an impact on residents' health as well as on vegetation and soils at a considerable distance. Urban transport contributes to air pollution and the large concentration of cars and industries in cities causes the lion's share of urban global greenhouse gas emissions.
- 6 The city conditions of the developing countries are in such bad conditions. As an example of India's experience. Pressures of rapid growth and years of neglect have severely stressed the condition of India's cities and towns. This is evident in the innumerable challenges facing them—large areas not serviced by roads, water supply, sewerage and storm water networks, inadequate health and education amenities, traffic congestion, ineffective and inadequate public transportation systems, unregulated and chaotic growth, slums, poor building stock, destruction of heritage resources, etc. All of these make India's cities



and towns polluted, unlivable, inefficient, and vulnerable to disasters. (Ballarney – 2008)

2.7 Controlling the Urban Sprawl

Upgrading and redevelopment in central neighborhoods, higher densities in the core, new urbanism and relaxation zoning requirement are some of the measures can be taken to control the urban sprawl. (Brueckner - 2001)

2.8 Spatial Distribution of the Urban Population in Sri Lanka

The spatial distribution of the urban population in Sri Lanka shows an uneven pattern between the country's two climatic zones and also between its administrative districts. Thus, the wet-zone which is roughly correspond to the south –western quadrant of the country that comprising 23% of its total land area, has contained about $\frac{3}{4}$ of the total population. (Mendis – 1982)

An Examination of the distribution of urban population within the South-Western quadrant indicates a large concentration in and around the capital city of Colombo. In terms of climatic zones, the average annual growth rate of urban population in the dry zone is higher than the corresponding rate in the wet zones. (Mendis – 1982)

The distribution of urban population by administrative districts indicates that Colombo is the only district which has more than half of its total population as urban, while those Jaffna, Tricomalee and Batticaloa, have between $\frac{1}{4}$ and $\frac{1}{3}$ of its total population as urban. Rest of the districts has smaller shares of urban population. (Mendis – 1982)

2.9 Features of urban sprawl in developed and developing countries

According to the above features of urban sprawl it can be assumed that there many comparable features in the urban sprawl developed American and European countries and developing countries like Sri Lanka and India. Take all those feature in literature considerations the following summery can be made.

Table2 Comparison of the features of urban sprawl in developing and developed countries

No	Feature of the urban sprawl	Developing Countries	Developed countries
1	Locate outside the city	Locate within and outside the city	Locate outside the city
2	Land use Segregation	Highly segregated in outside Some mix character in underserved settlements	Highly segregated
3	Low density development	Outside low density development high density in underserved settlements	Low density development
4	Low accessibility	Low accessibility in both Outside and underserved settlements	Low accessibility
5	High traffic congestion	Low traffic congestion in underserved settlements High traffic congestion Outside	High traffic congestion
6	Degrading green spaces	Degrading green spaces	Degrading green spaces
7	Reducing ecological values	Degrading green spaces	Degrading green spaces
8	High car ownership	High car ownership in outside Low car ownership in inside underserved settlements	High car ownership
9	Strip malls	Strip malls in outside Mix development in underserved settlements	Highly available Strip malls
10	Low occupancy	Low occupancy in outside sprawl Higher occupancy in underserved settlements	Low occupancy
11	Conversion of agriculture lands in to urban lands	High land conversion in outside sprawl Squatter settlements in underserved settlements	High land conversion
12	High and medium incomers	High and medium incomers in outside Low income in underserved settlements	High and medium incomers
13	Unavailability of infrastructure	Common facilities in underserved settlements	Good facility network

Source: 2011 literature survey

In developing countries, poorer neighborhoods can have dramatically lower levels of basic services. Consequently, a large number of urban residents in developing countries suffer to a greater or lesser extent from severe environmental health

challenges associated with insufficient access to clean drinking water, inadequate sewerage facilities, and insufficient solid waste disposal. (Cohen – 2006)

2.10 Space Syntax

Space syntax is a term that is used to describe a family of theories and techniques concerning the relationship between space and society. Space syntax as a theory of space has been developed more than twenty years; it could be act as a semantic explanation to nature of space and its correlation between social behaviors. “Space syntax is a set of techniques for the analysis of spatial configurations of all kinds, especially where spatial configuration seems to be a significant aspect of human affairs, as it is in buildings and cities.” (Space Syntax Laboratory - 2008)

1 Pattern cognition - Spatial pattern

It is widely accepted that space is the key aspect of how social and cultural life are proceed, not the framework. As B. Hillier (1996) described that different human behaviour not just happen in space, it has its own spatial forms. No matter that space use for what purpose, gathering, interacting, teaching, eating or dwelling. The arrangement of spaces always constitutes a spatial pattern which B. Hillier call it spatial configuration. Hillier showed general types of spatial configurations. Although they have similar appearance in physical existing, their underneath topology are totally different.

2 Spatial elements, convex spaces and axial lines

The most important elements of space syntax are convex spaces and axial lines, B. Hillier et al (1984) had an imagery depiction of them as “beads” and “strings”. lines act as “strings” which connecting a sequence of convex spaces, the “beads”, to form a longest line of sight and access. The idea of depth from the justified graph, each axial line in the axial map is assigned a number that according to how many changes of direction separate it from the starting line. The least the number show more shallow in the graph, we called more integrated, whereas larger the number indicate deeper in the configuration and tends more segregated. If we apply the same idea to each line to every line in the map to obtain a static global measure, we called the Global

Integration, of the map. This average measure could make sense for comparing different spaces integration. Normalized Integration value can be used as measure to compare the status of streets in different cities. Local Integration measure has been proposed for maintain an accuracy measure in district level.

Space syntax is a theory and a tool which has the capacity to make the spatial characteristics of settlements measurable and comparable, which proved to be a reliable platform for this research, therefore, was chosen as the one of a technique to analyse the sprawl of the settlement and their integration.

2.11 Conclusion

The urban sprawl simply can be defined as expansion of urban boundaries in to the rural areas of outer boundaries of the city. Many scholars found that the negative effects of urban sprawl such as environmental degradation, inner city decay, pollution, loss of open spaces, traffic congestion and costly delivery government services. In both developed and developing countries had happened sprawl in different ways. The measuring of sprawl has to be considering many aspects of sprawl.

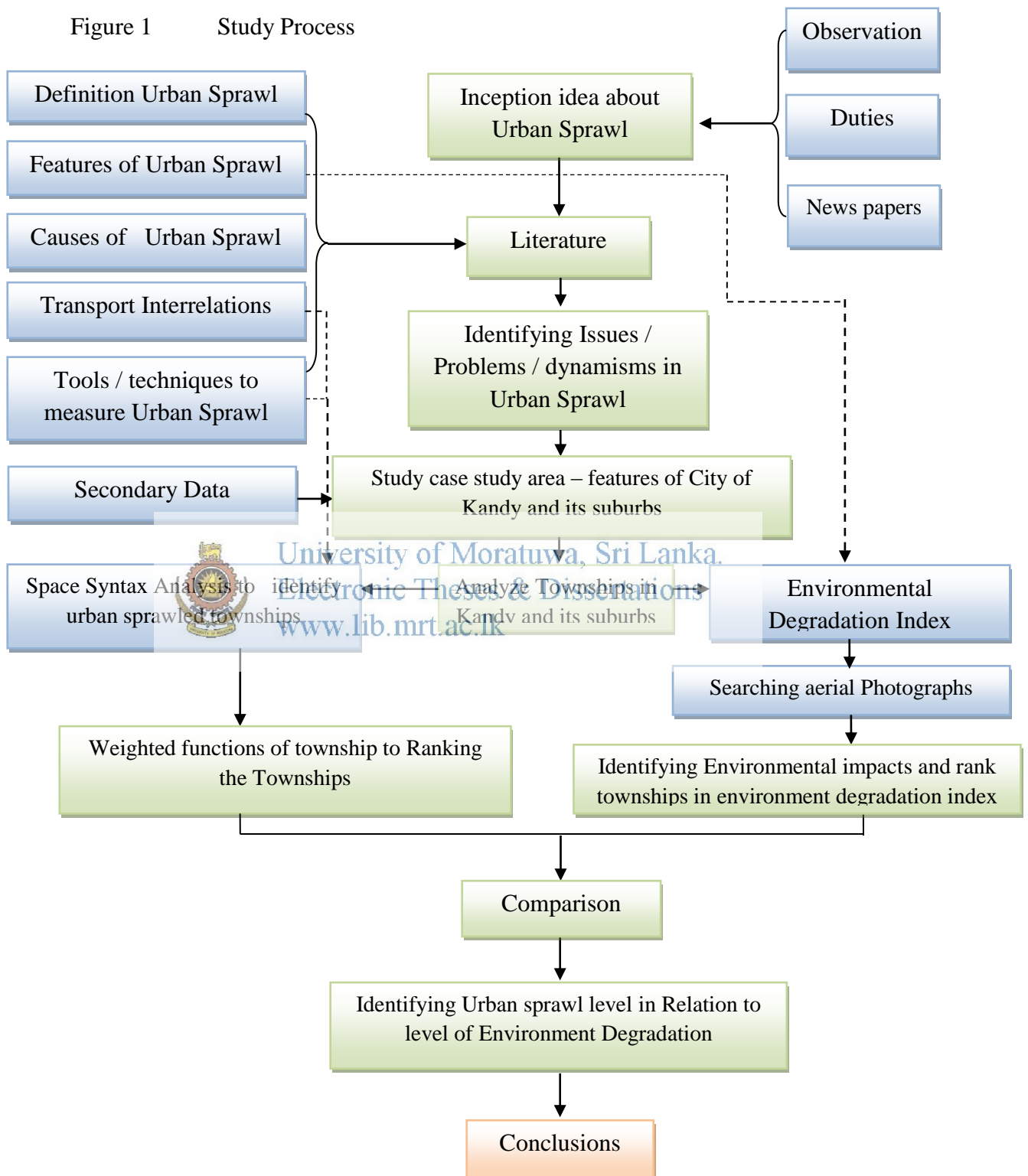


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3 RESEARCH DESIGN

The study methodology can be expressed as follows.

Figure 1 Study Process



The inception of the idea of ‘environmental degradation’ in the case of ‘urban sprawl’ is observed during the duties in Kandy. And also media gave big publish regarding the basically environmental degradation through air and water pollution in and around Kandy city become more interested topic to study. So I interested to find causative factors to find these issues through the literature. From the literature survey the problem has been defined and also different definitions, features, and different features also has been identified. Through the secondary data urban sprawl and features of Kandy and its suburbs are identified. In the secondary sources it could be found out the features of the case study area specially how the shape and level and environment sensitivity of the area. To evaluate spatial integration of the townships of the Kandy, Space Syntax analysis will be used to find the possible urban sprawl area where the in favorably development is taken place. And weighted ranking index is used to find the level of sprawl and rank the city size. The level of environmental degradation will be evaluated by searching aerial photographs including 4 main indicators. Affected to natural water stream, Affected to existing green, The building density, and Paddy lands filling are them. In the same time the environmental degradation index also calculated with indicating available features of environmental degradation of the above townships. Then it can be compare the township of the case study area, is there any environment degradation in the different level of urban sprawl. These comparisons will any interrelation in between the environment pollution and urban sprawl. In the same time these results will show what will be the effective features of urban sprawl and environmental degradation. And also could be identified the immediate reasons to sprawl and affective environmental features and their interrelations to degradation.

3.1 Conclusion

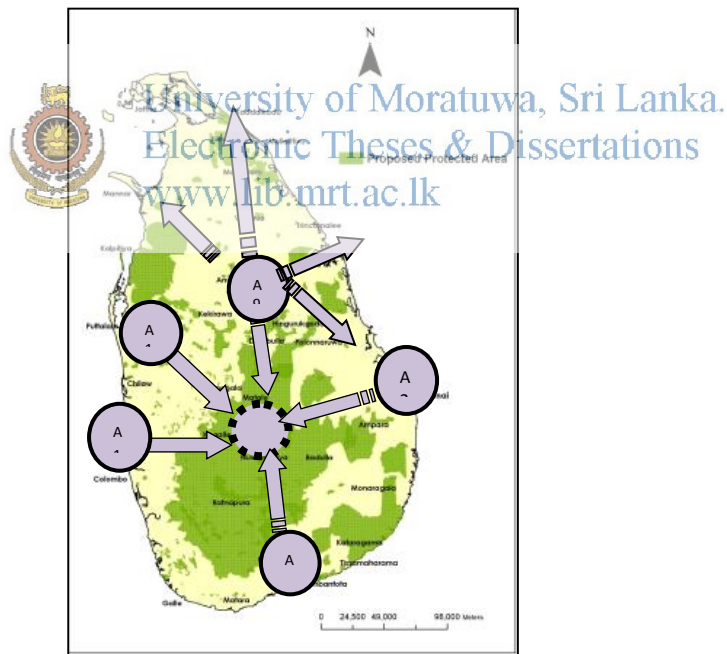
The different level of urbanization of cities created different level of environmental degradations. And the level of urbanization can be measured by the functions and the spatial integration which has done through this as space syntax and weighted rank of the cities. And environmental degradation can be measured by the individual town survey through Google images for specifically identified features that can be applied to every township. By comparing these two results linkages can be find out.

4 THE FEATURES OF URBAN SPRAWL IN KANDY CITY AND ITS SUBURBS

4.1 Location and Linkages – Kandy town

The city of Kandy and its suburb are located in a very sensitive area of the island which is centrally located in the hill region and hydro catchment head waters. Other than the location advantages, the other features like slope, Temperature, Drainage and surface runoff velocity, vegetation and scenic beauty is also important to look at comparatively with the location of the town. The adverse impacts of the location of the town in the environment fragile area severely affect to degrade entire environment condition in the local, regional and national level due to unplanned expansions of urban boundaries towards the peripheral areas of the Kandy city.

Figure 2 Location of Kandy city



Source: National Physical Planning Department

Not only location of the town in the central fragile area is an important factor but small changes of town make big implication to the regional and national environment as well.

4.2 Features of Kandy town

- **Population**

The population of the Kandy Municipal council area is as follows.

Table 03 Total Population in Kandy Municipal council area

Year	Population	Growth Rate %
1871	16,881	
1881	22,026	3.04
1891	20,375	2.27
1901	26,386	
1911	29,927	1.18
1921	32,562	0.81
1931	37,147	1.23
1946	51,266	1.84
1953	57,200	1.48
1963	68,202	1.61
1971	93,303	3.36
1981	97,872	0.47
2001	110,049	0.62



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Source: Census and Statistics
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Though that the city is locate in a place like valley still the city is crowding. The location of the city is as a main economical hub of the region, people attract continuously. Not only economical but also with the other facilities, administration and traffic conditions tend to people reside in the city. With the size of population and township the tremendous urban sprawl has been taken place where along the arterial roads and sensitive areas where natural disasters are taken place. So the physical developers and planners have been develop the basic sectoral facilities like roads, Electricity and water further attract the people

- **Population density**

The population density of the city has gradually increased within the year 1981 and 2001. The size of the city has been enlarged though there has limited number of developable lands. By this expansion more residential uses has been spread towards the higher hill slopes like Bahirawakanda, hantana and Dodanwala.

Table 04 Population Density in Ward wise in Kandy Municipal council area

Ward Name		Extent Hectare	Population		Density per Hectare	
			1981	2001	1981	2001
1	Peradeniya	245	3817	4299	16	28
2	Mulgampola	270	3795	4182	14	33
3	Katukele	41	2683	2962	65	105
4	Bahirawakanda	49	3591	4362	73	60
5	N'Dodanwala	150	5199	5251	35	40
6	Asgiriya	105	5955	8310	57	75
7	Mapanawatura	135	4641	5271	99	46
8	Katugastota	47	2648	2883	56	37
9	Mawilmada	129	5625	5657	43	45
10	Kahalla	76	4164	4289	55	81
11	Watapuluwa	157	5621	6843	36	14
12	Lewella	195	5187	6875	27	24
13	Boowelikada	121	3720	4282	31	43
14	Ampitiya	128	3960	4308	31	61
15	Talwatta	393	3938	6251	10	11
16	Deiyannewela	41	6860	13,309	167	170
17	Yatinuwara	56	6450	6486	115	63
18	Kotugodella	48	2923	3365	61	15
19	Wewelpitiya	58	4161	4495	72	75
20	Mahaiyawa	20	2710	3234	135	90
21	Suduhumpola	26	3609	5382	139	107
22	Siyambalapitiya	71	2582	3302	36	65
23	Bowala	64	3972	4042	56	39
		2645	97,872	110,049	38	42

Source: Census and Statistics

Kandy is popularizing to the deferent type of commercial activities. Car sales, hotels and guest houses, Food items and shopping are some of them. Another important factor is that the some wards has been reduced the population densities due to the commercialization like Kotugodella, mahaiyawa, Katugastota and Suduhumpola. Some wards are more popularizing due to location of the schools and close proximity to the town. Ampitiya, Boowelikada and Lewella areas are popular due to Dharmaraja and Mahamaya schools. Katukele and Mulgampola are famous for the Girls High School and Kingswood colleges.

- **Land use**

The historical land use starts with the agriculture, residential, religious and nature conservation. British's further establish the plantation sector in hilltops where the areas used for the conservation and roads and other infrastructure were developed. Further the development of infrastructure like roads and services like schools, hospitals and establishment of administration with bigger institution like university and agriculture department resulted to influx of population made bigger attraction to the city changed the entire land use pattern in the city. Last few decades the change of uses from the residential uses to commercial uses with the city and outside the city the residential purposes mostly established in the hill slopes.

The changes of the land uses within the city limits are as follows.

Table 5 Changes of Land use pattern in Kandy Municipal council area

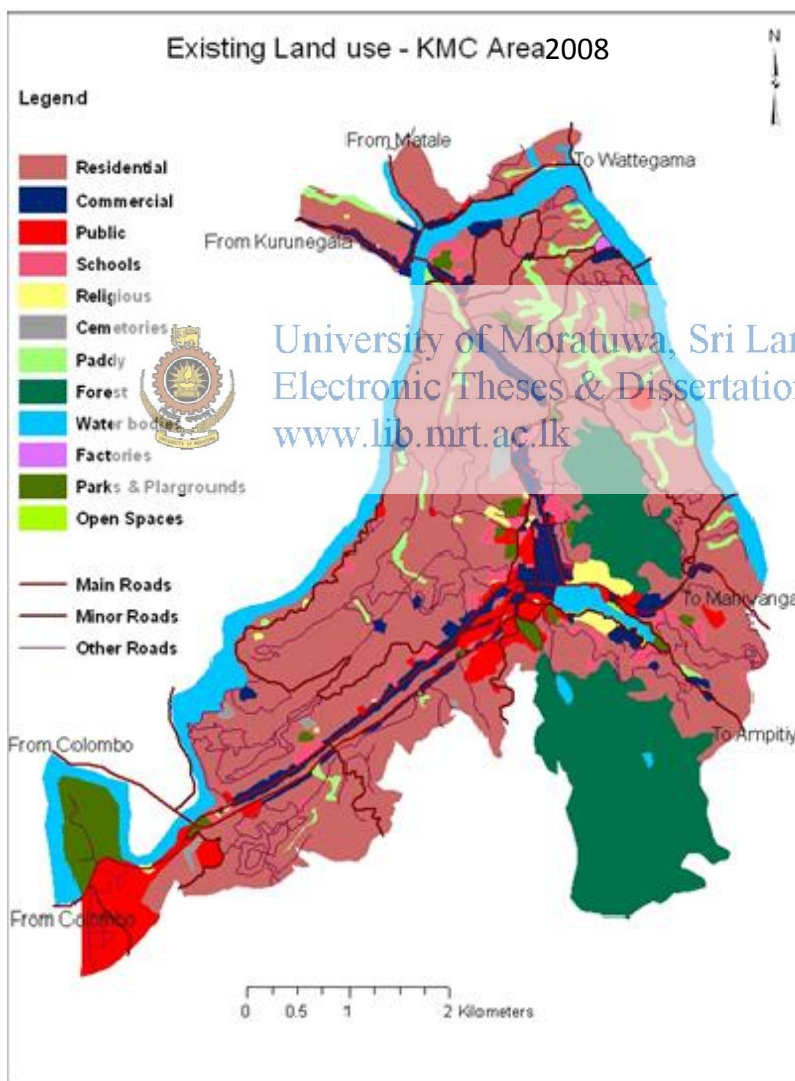
Land Use	1988 %	1999 %
Residential	44.7	48.5
Commercial	1.7	3.1
Industrial	0.6	0.4
Public	3.2	3.8
Schools	2.4	2.3
Religious	1.4	1.6
Roads and Transport	7.3	7.3
Parks and Playgrounds		3.6
Cemeteries	12.7	0.5
Vacant Lands		5.6
Paddy lands	3.9	2.6
Forest reservations	14.5	14.0
Water Bodies	7.6	6.7
Total	100.0	100.0

Source: Urban Development Authority

Very limited no of parks and play grounds never met the demand of residential and commuting people. There are large numbers of forests and green patches which can be used to increase the recreational areas. Increasing of residential, commercial, public sector activities are occurred due to demand of the area is so high. In the same

time the sensitive areas like paddy, water bodies and forest reservations are declining day by day. Even the higher pitched slopes very vulnerable to landslides also got reside. The either side of the major arterial roads got commercial uses. And also conversion of residential buildings in to other uses also very popular specially for the hotels and guest houses. In the following map it can be clearly seen that the all over the city the residential use. The north, west, and eastwards the residential development is taken place. Specially Haragama, Kundasale and Pathadumbara areas converted to residential areas.

Figure 3 Land use Kandy Municipal council area - 2008



Source: GIS unit, Dept of T&CP, University of Moratuwa

- **Importance of the area**

The city of Kandy has the places and monuments that have a historical, archaeological, religious and cultural and environmental value.

Historical importance

Some buildings contains with some kings associated buildings namely Royal Palace, the queens bath called “Ulpenge”, the lake and protective wall around it, and the houses or “walauwas” of the kings’ ministers. In addition to these the buildings are more than 100 years old to be conserved as per the legal requirement. Mainly Temple of the tooth relic, the four “devalas”, Malwatta and Asgiriya temples and other deferent religious worship places are the culturally valued buildings.

Environmental value

Basically the environmental valuable places are Udawattakele forest reserve, catchment of Kandy lake and the reservoir, natural vegetation of the steep slopes and hills height above over 1800 ft. though there need to conserve this natural environment good part of the same has been lost due to unplanned constructions and infrastructure developments. Soil erosion, landslides, blocking of drains, depletion of ground water resource, destruction of valuable flora and fauna and micro climatic changes are some of the significant problems in Kandy environment.

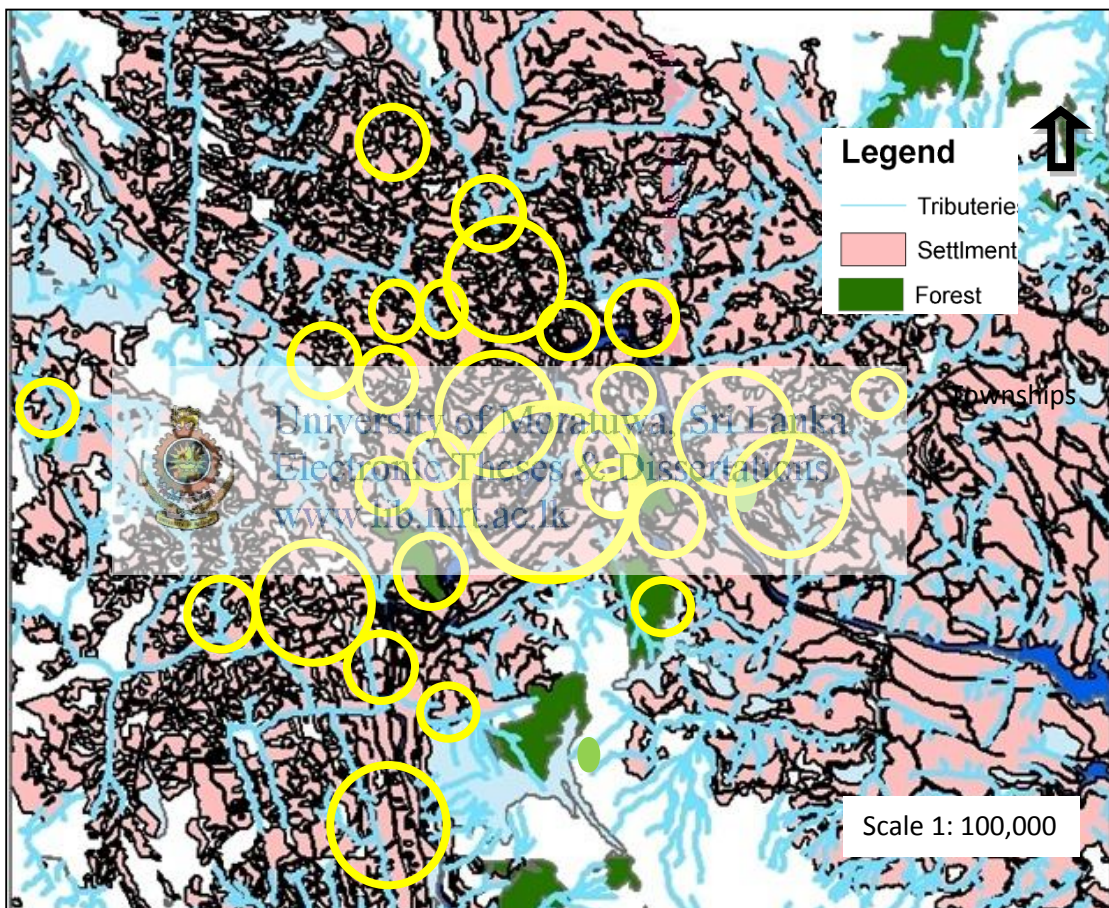
National, Regional and Local importance

In national context Kandy is second important city in Sri Lanka mainly because religious and cultural centre in the national context. Location of Temple of tooth relic and number of cultural events are the leading factors to attract tourists to the city. Not only that national interest but also with the regional commercial and administrative centers of the central province. Location the town in central place its easy to access other town of the region to Kandy hence it become regional service center. The trunk roads leading to Kurunegala, Matale, Mahiyangana and Nuwara Eliya is the major traffic routs. This is one of the best transit points to the various parts of the islands. Nearly in between 125,000 – 150,000 commuters daily come to the city.

4.4 Suburban Expansion against the Natural Vegetation and Drainage of the Area

The drainage and natural forests are one of very important features in the sensitive lands in Kandy district. The settlements normally follow the water sources and economic activities such as agriculture. Minor exports, vegetables and Paddy are some of the dominant agriculture in the district.

Figure 5 Natural vegetation and drainage pattern of Kandy city and Suburbs



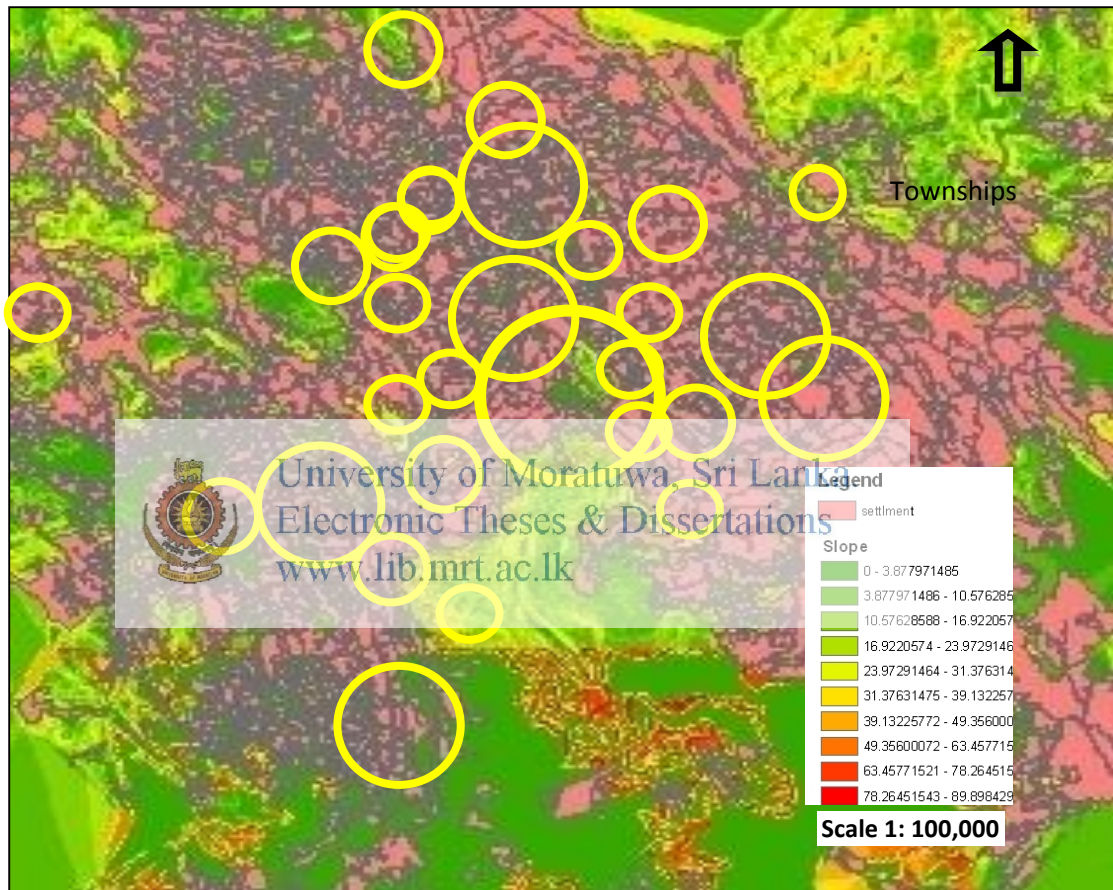
Source: National Physical Planning Department

The radial pattern drainage network is available in the district. Only very few forests are available in the area like Udawattakele, walkers forest and Hantana where the area is not accessed by major arterial roads. But those elements are affected by the settlement developments and encroachments and planted forests.

4.5 Suburban Expansion Against the Slopes and Possibility to Soil Erosion

Soil erosion is one of a severe problem in Kandy district lead to number of environmental problems in the area. Marginalizing of existing top soil layer, sedimentation of reservoirs, reduces water level and reduces the sensitivity and vulnerable to landslides are some of the major issues in soil erosion.

Figure 6 Suburban Expansion against the slope of Kandy city and Suburbs



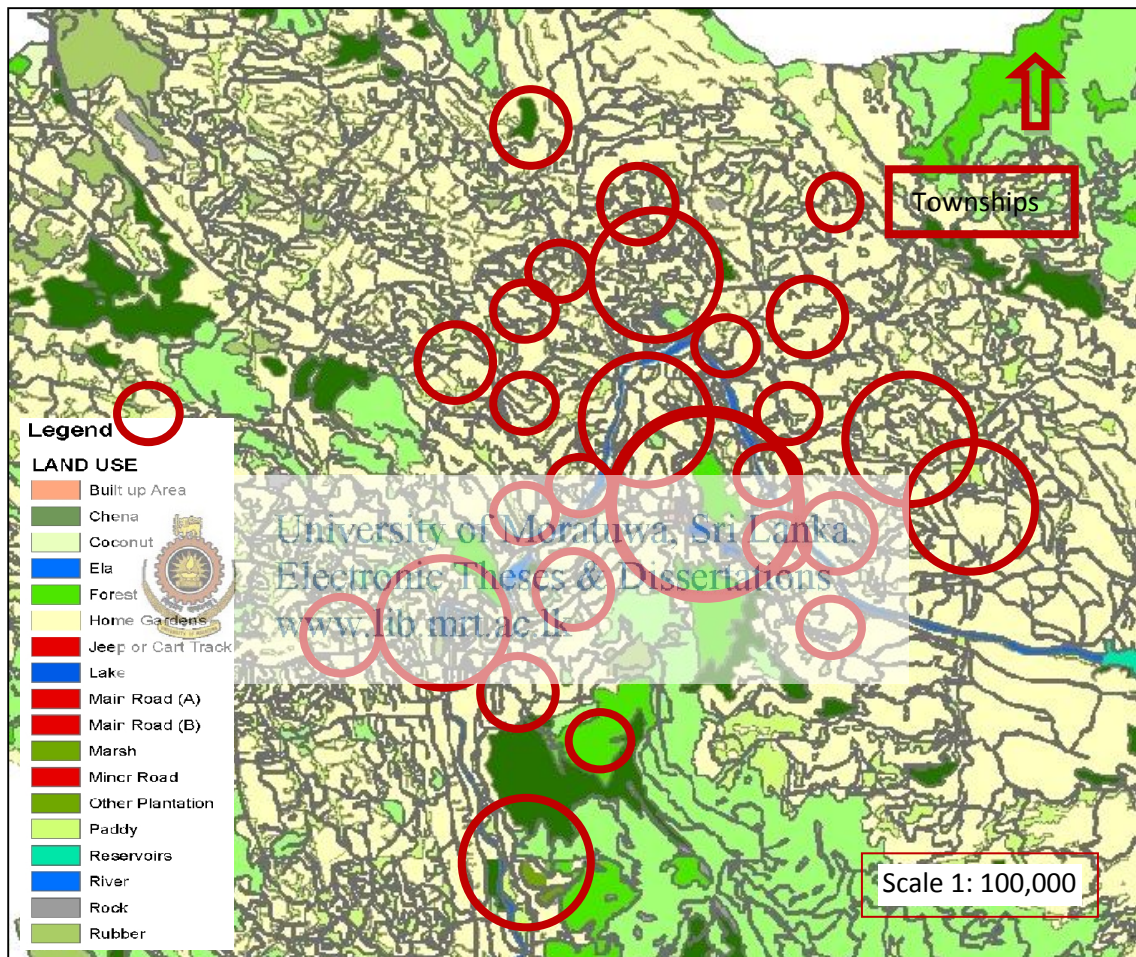
Source: National Physical Planning Department

The settlements developed in the high altitude and slope along the major arterial road network create some adverse effects to the environment.

4.6 Suburban Expansion Against the Other Land Uses

The development of settlements are important to effect the other land uses specially reduces of agricultural lands and open spaces as well as develop the settlement in sensitive areas.

Figure 7 Land use of Kandy city and Suburbs



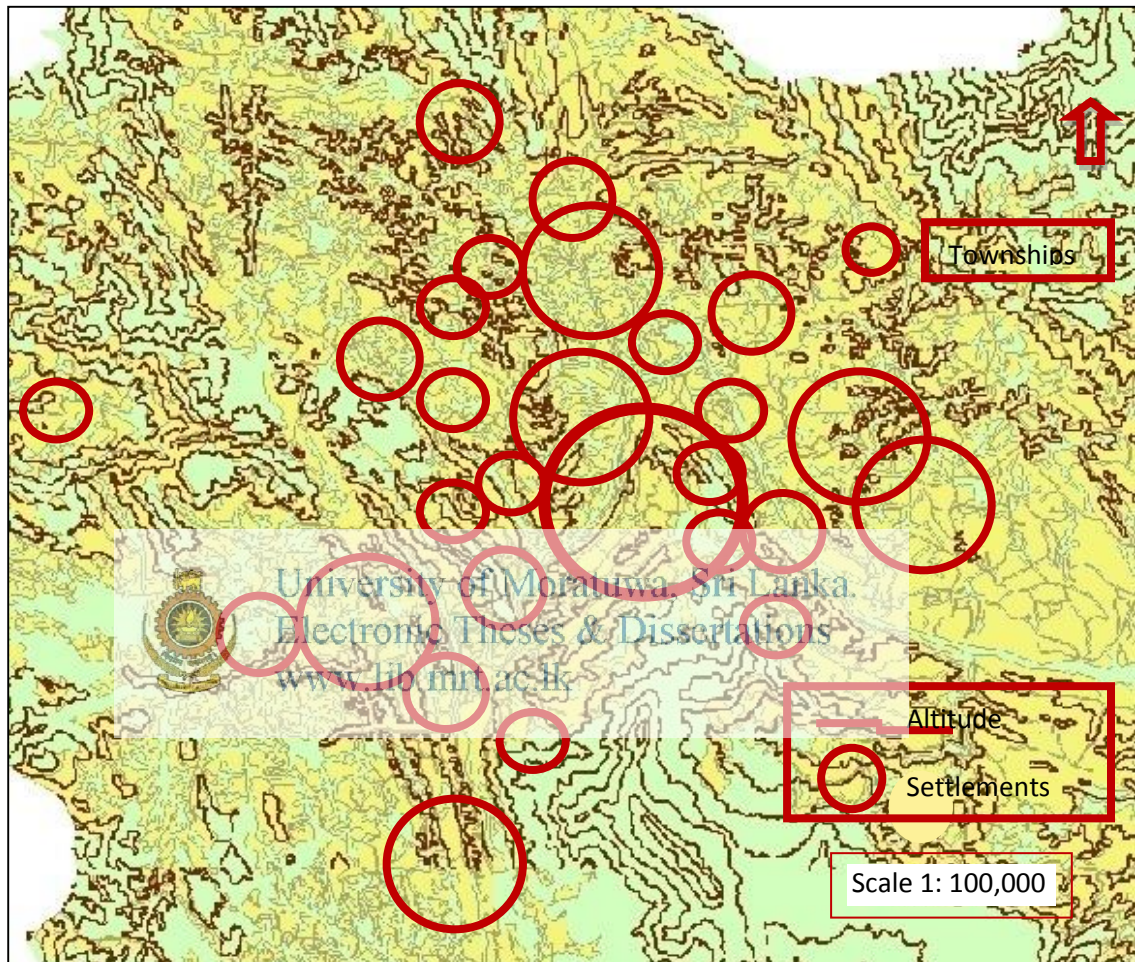
Source: National Physical Planning Department

The considerable part of the area has been occupied by the home gardens. Very few significant other land uses like Tea, forests and other plantations is also available. But gradual increasing of residential activities and decreasing of mix crops, paddy and other plantation is significant in recent land use changes.

4.7 Suburban Expansion against the Altitude

The altitude also very important environment character in the Kandy district leads to deteriorate the environment through erosion and degrading the natural vegetation.

Figure 8 Settlements against the Altitude in Kandy city and Suburbs



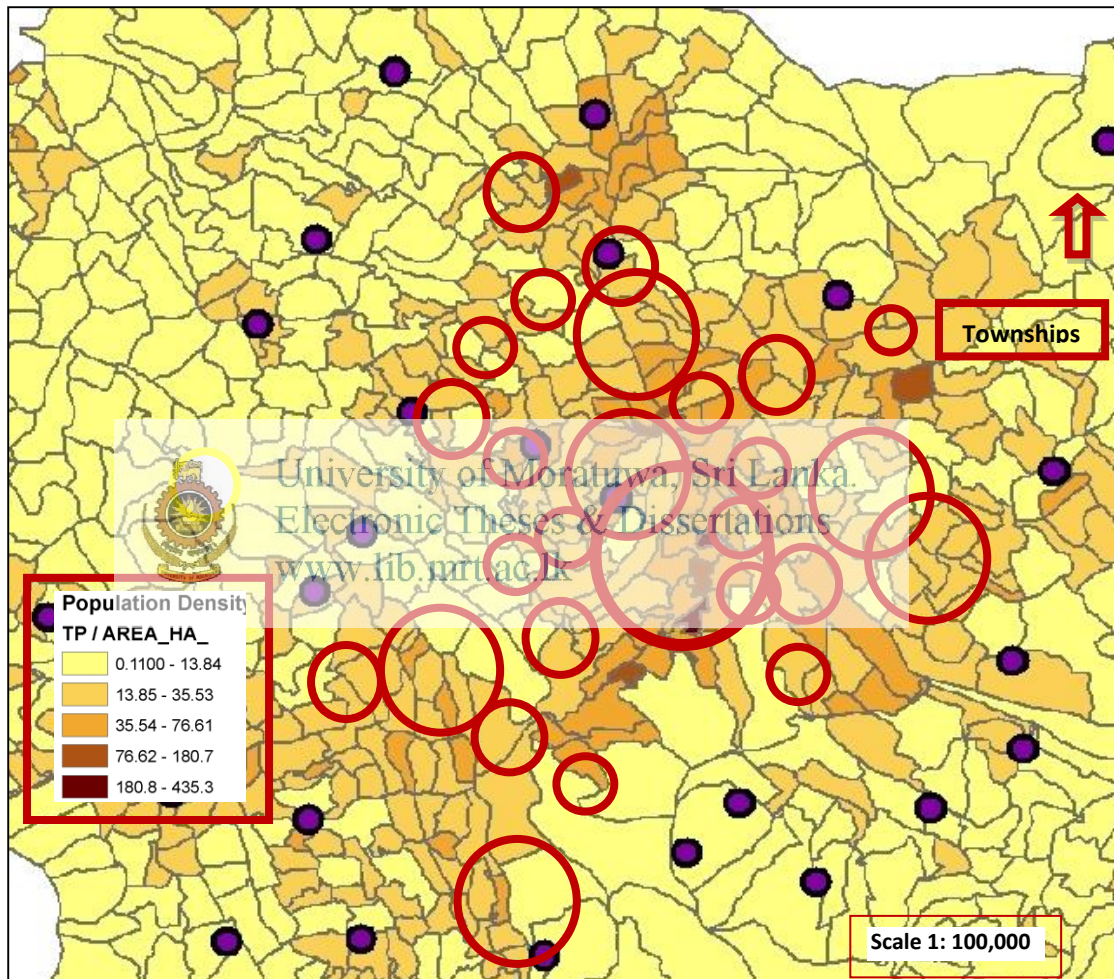
Source: National Physical Planning Department

The settlement expansions are taking place basically around the Kandy city except the south and southeast part due to physical barriers, but gradually those expansions are taking place along the main roads towards the sensitive areas in terms of natural vegetation and water catchment. E.g. Towards Nawalapitiya, Nuwaraeliya, Hunnasgiriya, and Hantana. This phenomenon also leads to degrade natural scenic beauty, vulnerability to landslides, soil erosion and heavy cost on developing infrastructure.

4.8 Townships and Population Density

Major features of the distribution of population densities are located adjoining GN divisions of national roads transport linkages. Northwards along the A9, westwards along the A1 and Eastwards along the Mahiyangana road and Southwards along the A5 Nuwaraeliya road are some of them.

Figure 9 Population density in GN division wise in Kandy city and Suburbs



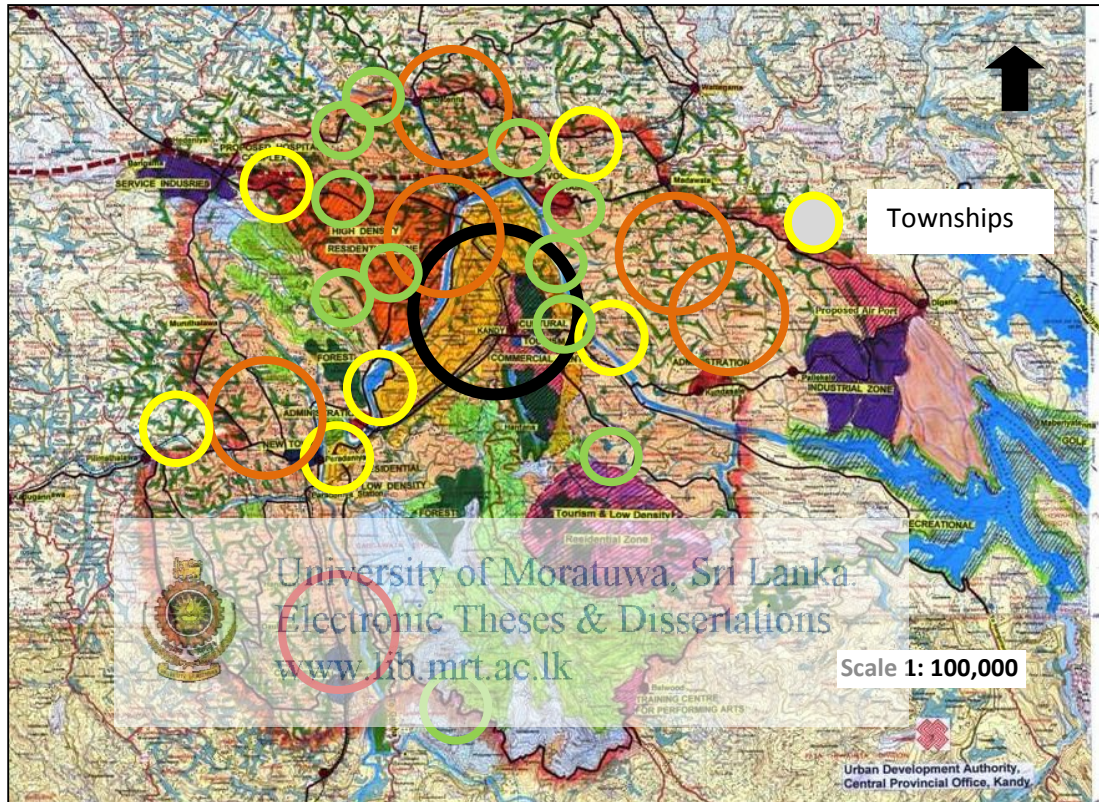
Source: National Physical Planning Department

The density is one of a dominant feature in the urban sprawl. Above figure shows us how density factor distributed along the major roads. The road connectivity is one of dominant causes to create urban sprawl.

4.9 Townships against the Future Plans

Future scenarios in planning are also very important. Specially location of industries, Institutional and high density residential should be consider.

Figure 10 Future development trends



Source: Urban Department Authority

The future plans also realize how to support the urban sprawl specially in the environment aspect. Specially location of industrial zone near the national reservoir can be increased the urban sprawl and environmental degradation as well.

4.10 Conclusion

The city of Kandy has a higher centrality to the island created very good attraction to commute different parts of the population. In the same time it is demanded by various reasons to reside and invest. In the same time the locality of the Kandy has a very important environmental value in the case of hydrology, slopes, natural vegetation and scenic beauty.

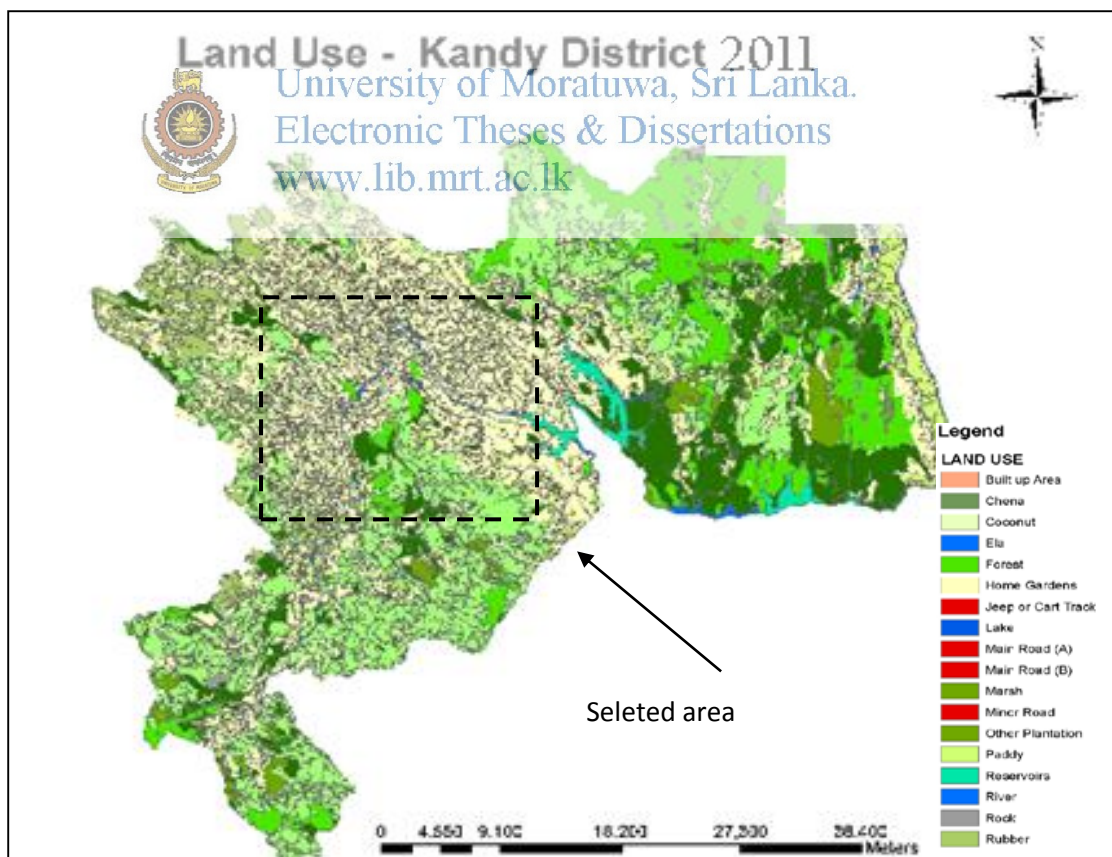
5 ANALYSIS

The analysis of this study has been done by using of the three techniques. Firstly, Urban sprawl areas (integrated) are measured by the space Syntax and level of sprawl has been measured by calculating the weighted town ranks. Environmental degradation is measured by applying the environmental degradation index by using the Google images.

5.1 Space syntax – Kandy sub-regional sprawled area

This technique is used to find the spatial integration of the existing urban centers through the transportation network. To analyse the spatial integration it has been extracted the road layer from the Geographic Information System for selected area in the Kandy district.

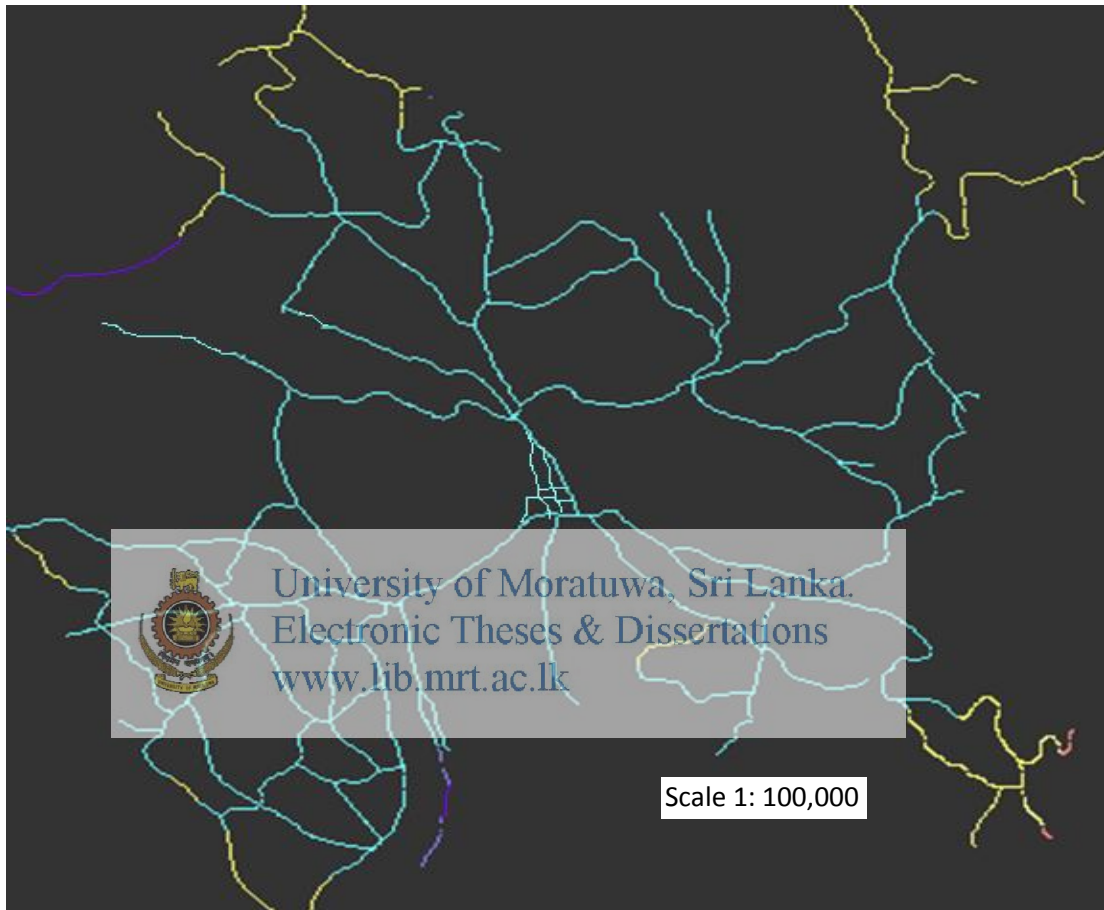
Figure 11 Land use in Kandy District 2011



Source: National Physical Planning Department

All that Major roads, Minor rods, and Jeep or Cart tracks layers are as follows. The blue and yellow lines show the road lines and spiral shape can be seen. Some lagging area also can be seen due to geographical conditions and natural features like forest or mountainous uses.

Figure 12 Road layer in suburbs and Kandy city



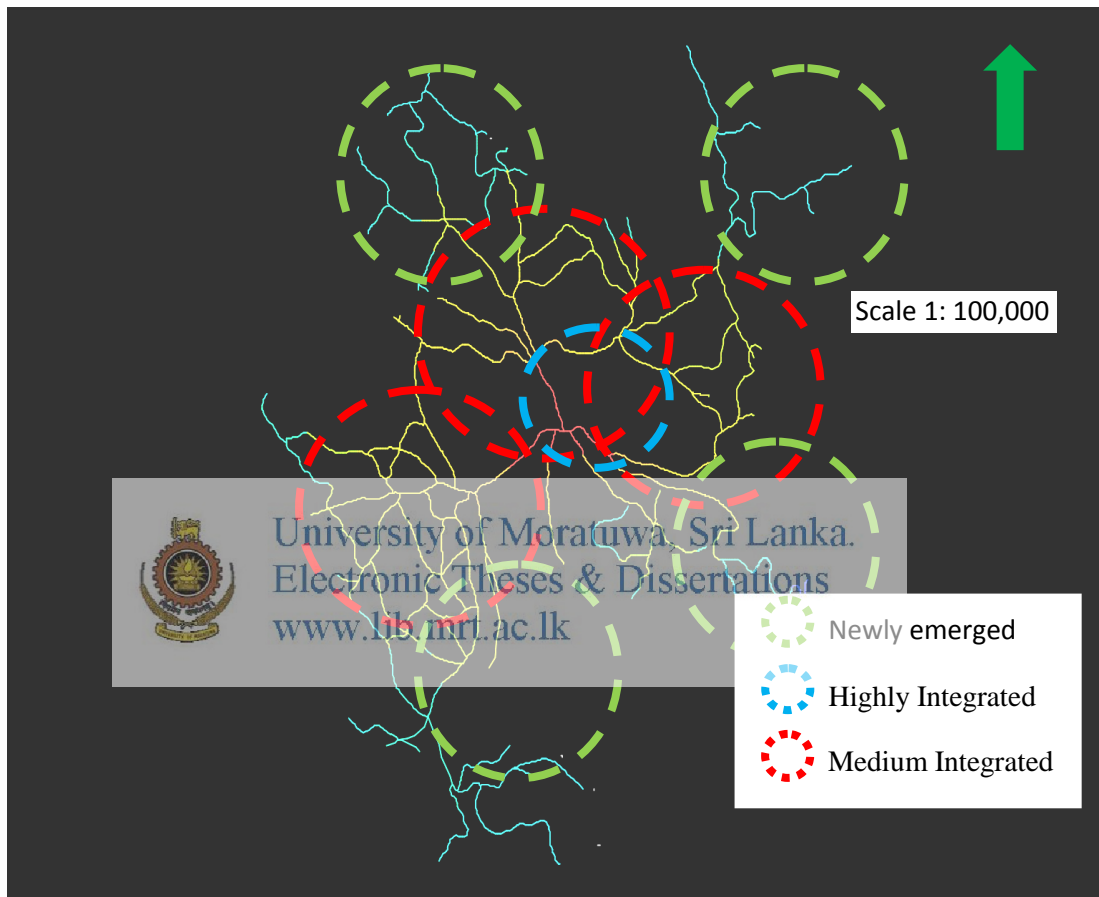
Source: Department of Town and Country Planning- University of Moratuwa

The roads are in the radial in shape that leading to the Kandy City. It's very clear that the road density is higher in the areas of major access roads are available. The location of secondary townships with urban agglomeration is directly driven by the transportation linkages.

I Integration in suburbs and Kandy city

By using the above road layer the Depth Map computer application is used to find different levels of integration and the results can be shown as follows.

Figure 13 Accessibility and Regional integration



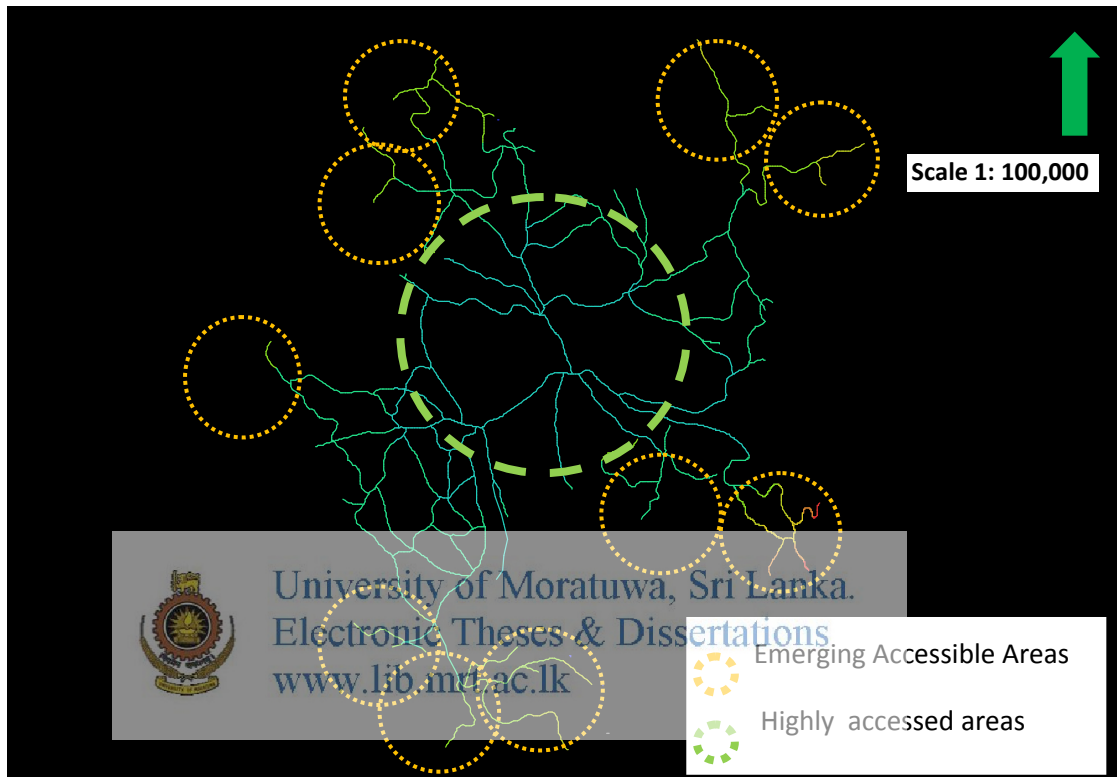
Source: Department of Town and Country Planning- University of Moratuwa

The centrally red lines (within the blue dotted circle) show the higher central areas where the higher accessible places and yellow lines (within red circles) show medium accessible places. And blue lines (within the green circles) shows that low accessible places. If the spatial integration is higher, that tends to increase the commercial value and establishment of commercial sector that is highly sprawled.

II Emerging accessible areas in suburbs and Kandy city

The next result of the depth map application is emerging accessible areas. This picture shows us how newly accessible areas locate.

Figure 14 Emerging Accessible areas



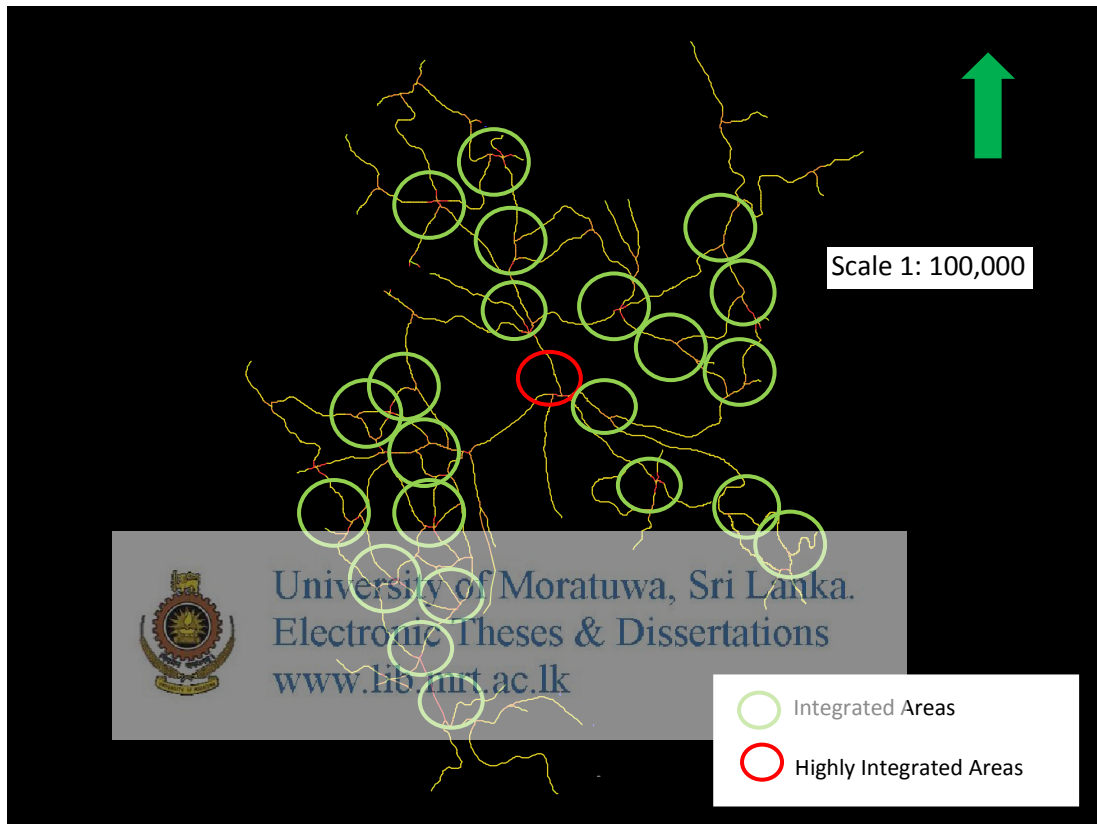
Source: Department of Town and Country Planning- University of Moratuwa

The newly accessible areas are located in the edges of the road network. It can be assumed that more complex situations are not taken place in these areas due to more developments are emerging and still major environmental consequences can't be seen. Specially these newly developed areas are located near the main and secondary road networks.

III Local integration in suburbs and Kandy city

Next finding is local integration that by considering local area, integration is measured.

Figure 15 Local integration



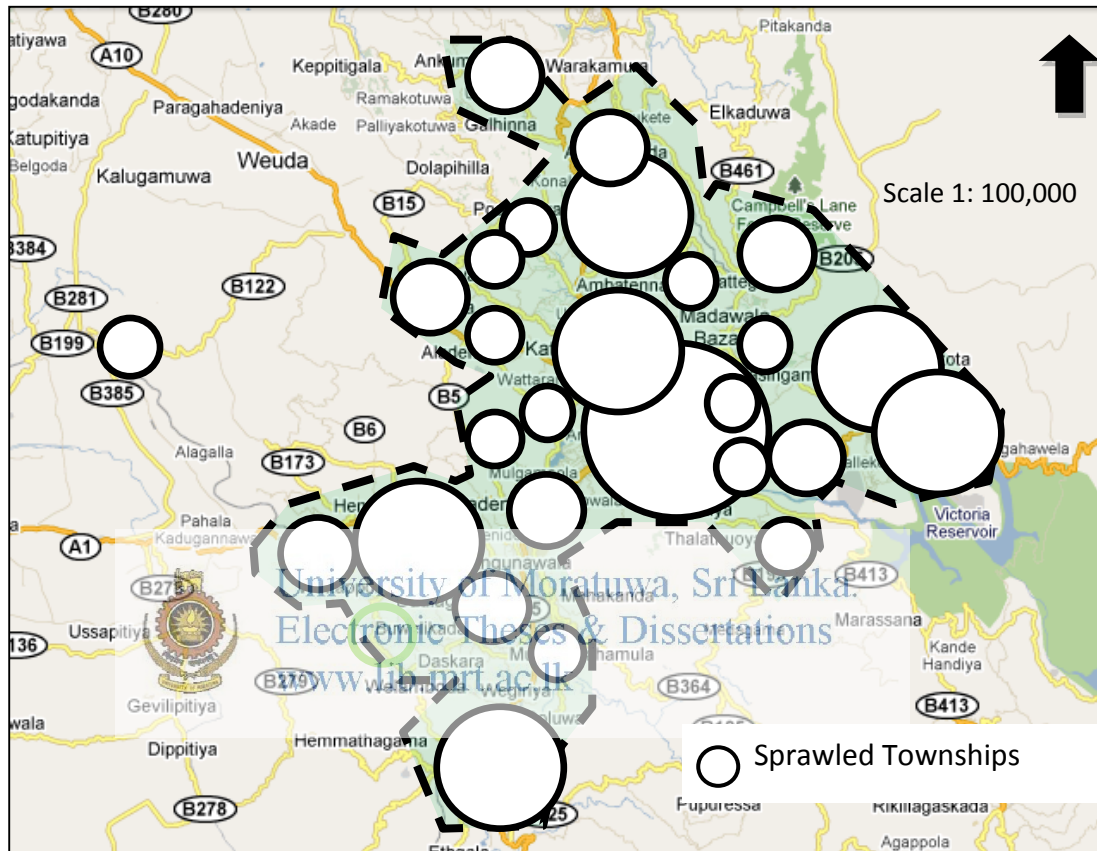
Source: Department of Town and Country Planning- University of Moratuwa

This result valuably can be used for the local accessible findings. Specially to find the traffic jam areas congested areas this map can be used. Specially some converging points can be easily identifies. The road without alternative is also can be easily identified.

V Urban sprawl area in suburbs and Kandy city

By considering the above 3 main findings the urban sprawl area can be identified through the connectivity networks. The identified urban sprawl area is as follows.

Figure 16 Urban Sprawl Areas in Kandy city and its suburbs



Source: Msc TCP Study 2012

All the townships of above figure can be described as urban sprawl or expansion of metropolitan area. The significant character of this metropolitan area is strong linking with major road network. Specially national roads of A1, A5, A9, A10 and A26. In the direction of Sothern part of the city has limits due to geographical barriers of Hantana Mountain and Western wards, Northern ward, and Southern way it's the causeway limiting factors to urban sprawl.

5.2 Total weighted functions and ranks of the Townships in suburbs and Kandy city

After demarcating the urban sprawl area, the following townships are identified according to the different functions of these townships different scores are given and finally total scores shows the rank of the city itself. (See annex 3)

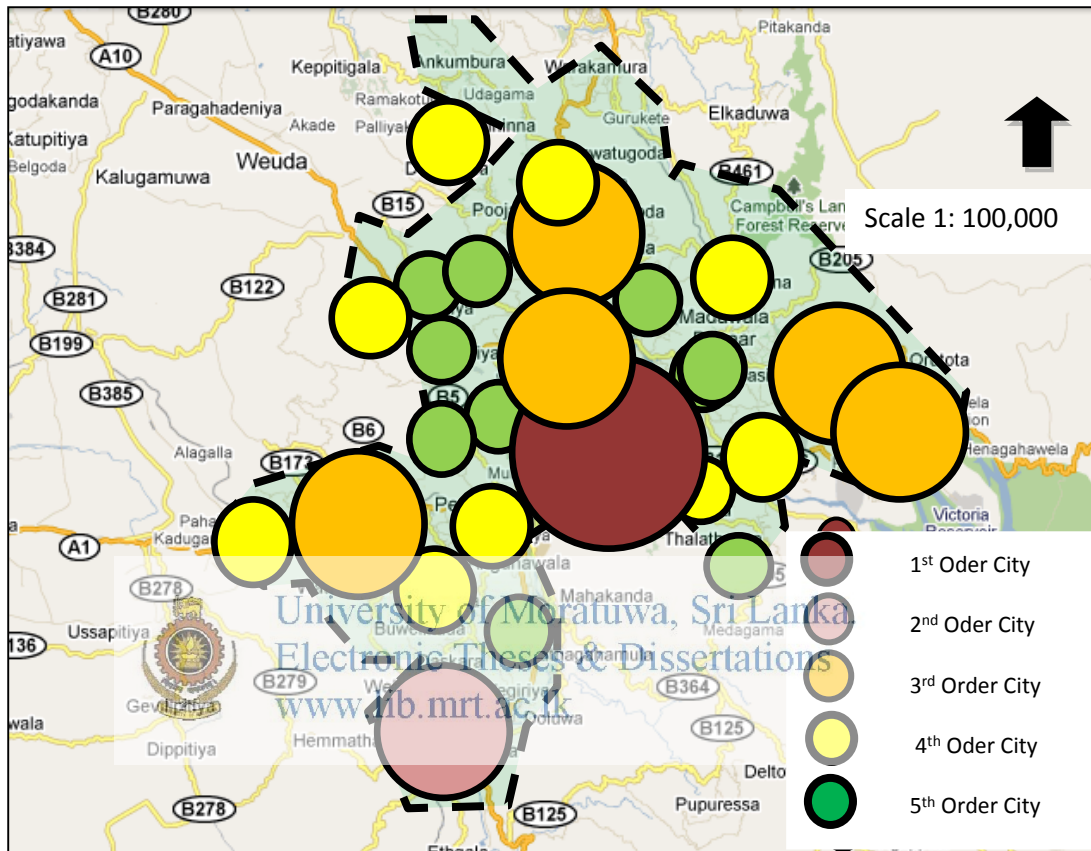
Table 6 - Weighted rank of the township in suburbs and Kandy city

Town	Total Score	Rank
Kandy	4160	1
Gampola	1003	2
Katugastota	786	3
Akurana	654	3
Digana	594	3
Menikhinna	581	3
Pilimathalawa	574	3
Wattegama	471	4
Peradeniya	445	4
Kundasale	330	4
Kadugannawa	297	4
Ankumbura	277	4
Hedeniya	267	4
Alawatugoda	264	4
Daulagala	259	4
Thathuoya	251	4
Geliya	238	5
Madawala	230	5
Pottapitiya	181	5
Medawala	181	5
Pujapitiya	166	5
Ampitiya	154	5
Thalawinna	142	5
Muruthalawa	126	5
Yakgahapitiya	121	5
Tennekumbura	116	5
Aladeniya	104	5
Halloluwa	100	5

Source : Msc Town and Country Planning Study 2012

Considerable gap between 1st order, 2nd order and other order cities are taken place. But after 2nd order 3rd 4th and 5th order cities are gradually rise down.

Figure 17 Ranking of the towns according to the weighted ranks in suburbs and Kandy city



Source : Msc Town and Country Planning Study 2012

Kandy city is the 1st order city, gathering most of the functions to the city. Good regional and national roads linkages associate with Kandy. In the same time considerable distance from Kandy, Gampola will be the second city serves to considerable portions of the periphery. The towns like Digana, Menikhinna, Katugasthota, Akurana, and Pilimathalawa are converging points to the newly establish residential areas.

5.3 Environmental impact in suburbs and Kandy city

The environment degradation index through Google images to selected locations is used to find environmental impacts in the suburbs and Kandy city.

I Analysis environmental features of individual townships in suburbs and Kandy city

The evaluation of this environmental degradation of individual townships is evaluated under the 4 indicators in the aerial photographs. (See Annexure 1) And then classified and weight those indicators in according to the level of degradation and availability of affected features. Then categorize those degradation levels to environmental degradation levels. Though there are number of indicators can be used to measure the environment degradation, due to limitation of time to visit individual localities, or non availability of reliable data tends limit to select following indicators.

- 1 Impact on natural water stream - indicate water pollution
- 2 Impact on green patches – Indicate degrade natural environment and condition of air
- 3 Density of buildings – indicate ground pollution
- 4 Paddy lands reclamation – indicate loss of open spaces and low lying

(See appendix 1)

Each locality weighted the above indicators and finally shows the overall results in the appendix 2.

II Comparing environmental impacts of Townships in suburbs and Kandy city

After searching the Google images of each township the above four indicators and their influence to the individual township have identified. See appendix 2 to detail understanding regarding the indicators and overall weighted results of the environmental degradation index. By using environmental degradation index different levels of the environment impacts can be identified.

III Categorise the levels in suburbs and Kandy city

The overall results of towns have categorize in to 3 categories according to individual town indexing value they collected. These categories are identified as the (final value) over 20 < as High level impacted areas, (value) 15 – 19 moderate level impacted areas, and 10 – 15 low level impacted areas. The results are as follows. (See appendix 2)

Table 7 Environmental Degradation levels in suburbs and Kandy city

High Level	Moderate Level	Low Level
Kandy	Ambatenna	Alawathugoda
Gampola	Madawala	Wattegama
Akurana	Digana	Menikhinna
Katugastota	Tennekumbura	Gurudeniya
Peradeniya	Pilimathalawa	Ampitiya
Gelioya	Kadugannawa	Thalathuoya
	Daulagala	Murathalawa
	Buwelikada	Barigama
	Weligalla	
	Wattappola	
	Kundasale	
	Pallekele	
	Hedeniya	
	Medawala	
	Poojapitiya	
	Ankumbura	
	Galhinna	
	Galagedara	

Source : Msc Town and Country Planning Study 2012

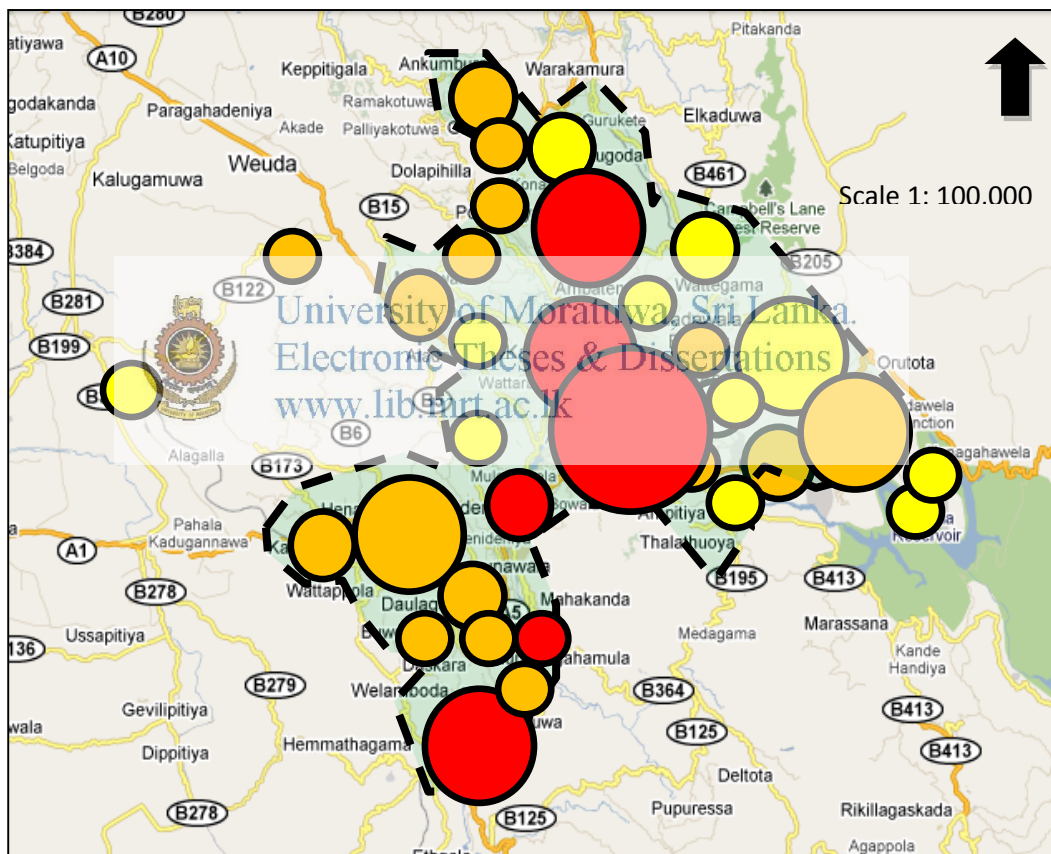
IV Impact levels in suburbs in Kandy city

The main impacted features in the environment degradation are the natural water stream pollution, loss of green coverage, and density of buildings. The location of the all cities in the sensitive area in Kandy district creates some considerable impact to degrade the environmental features like natural water stream pollution and loss of green coverage. Specially analyzed environmental indicators have covered the Air,

Water and Land as important part of the environment. So every city creates some impact on the every indicator finally accumulated in bigger degradation.

The location of nationally important features like Rivers, Wetlands, Mountains and green coverage made the area so sensitive. One of an important finding is that further possibility to projecting the sprawl in the sensitive areas will create irreparable damage. Most of the big cities have more sprawl areas and bigger commercial establishments. E.g. Kandy, katugastota and Akurana. Another finding is that towns economy is also tend to create urban sprawl in distances.

Figure 18 Level of Environment Degradation in suburbs and Kandy city



Source : Msc Town and Country Planning Study 2012

Some locations without having common transportation, sprawl had taken place Eg. Hanthana and Udawela. The people occupied those types of areas due to preference of the natural environment value.

The highly environment degraded urban areas are impacted not only to the main natural features like Mahaweli river but its concentration pattern reduces the environmental quality. Most of these cities have severely affected to reduce the green coverage. Another very important social aspect is that those high impacted cities are large gatherings of Muslim communities.

Though some low order cities also have high concentration pattern and closer to the natural environment creates them in impacted level. Eg. Gelioya and Galhinna. Some urban localities are far from valuable elements of natural elements create them in low impact in environment degradation. Eg. Menikhinna and Wattegama.

5.3 The Linkage Between Level of Urban Sprawl and Level of Environment impacts in suburbs in Kandy city

The city of Kandy is historically, administratively and culturally functioned city. The historical value, locations of historical valued buildings, sensitive geographical features created the push factors of Kandy sprawl and land availability, transport development and infra availability is the pull factors of sprawl to suburbs of Kandy city.



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The main finding of this analysis is that there is a strong positive relation in between the urban sprawl and the environment degradation. The higher environmental degradation is taken place where the higher order towns. The reasons for this situation is that the main cities influence their development through vast area where more vulnerability of more environment degradation events like water stream pollution, loss of green spaces and low lying reclamation.

The main city Kandy and second city Gampola have a considerable gap in relation to other towns in terms their functions. In the same time impact of these cities on urban sprawl is higher than the other towns.

The main cities comprises with spiral shape national roads centralising. There is a relationship between transportation and urban sprawl along the arterial road network finally affected to environment degradation. In the same time cities locate close

proximity to the national important water courses tend to face more environment degradation.

Though the urban sprawl is derived by car users in western countries in literature, the developing world derives urban sprawl from higher percentage from common transportation, tend to sprawl in high density with close proximity to major arterial roads where the passenger common service is high.

Some special sprawling pattern like western countries derives by private vehicles is also can be seen in the environmentally aesthetic areas where away from the common transportation comprises with higher and middle income groups eg. Hanthana.

The unavailability of main facilities of the towns like sewer, drainage, and garbage disposal are the effective reasons for the degradation. In the same time the loss of green and filling of paddy are some of the additional reasons to degradation. Most of the sprawling indicators like subdivisions are doing on the basis of facilities to be provided basis created unhealthy situation in the settlements (Water). Most of the cities do not have fare enough amount of public open spaces.

5.4 Conclusion

There is a close relationship in between the major transport connections and urban sprawl. The areas, where the higher spatial/social integration tend to have a higher level of urbanization taken place. Accordingly functions are taken place. In the same time there is a close relationship between level of urban sprawl and the level of environmental degradation.

6 CONCLUSION AND REMARKS

The main objective of this study is to find the interrelation between urban sprawl and environment degradation. While the urbanization process taken place, the environment features like green coverage and water get affected heavily due to insanitary disposal of wastes and tree cuttings.

The urban sprawl created many impact to the environment like degradation of natural settings through different man made activities. And this study asses the how urban sprawl was taken place in different levels and by using connectivity analysis and how urban sprawl affected to environment degradation by forming a environment degradation index. Analyze the connectivity the depth map computer application has been used in three main levels of local and regional integration and emerging accessible areas. In this study the application has been done to the Kandy town and its suburbs and following findings were made. The highly connected areas have more horizontal density says those areas are highly sprawled. Specially in the converging points of major arterial roads the bigger sprawl areas are found. They are Akurana, Kandy, Gampola, and Digana. Those areas are in the higher ranking urban center as per the weighted functions. As well, those areas created very populated.

The environment degradation is measured by the environment degradation index including different aspects of filling of paddy lands, loss of green coverage, building density, and affected to natural drainage that all covers water, air and ground pollution through searching aerial photographs. After applying these indicators to different townships there are positive interrelation bigger cities created more environment degradation. Another very important factor is nationally important environment features like rivers and natural streams and affiliated green coverage dominate the environmental degradation.

The followings are the findings. If the important natural elements are closer by the township tend to higher degradation. Eg. Mahaweli river. Other finding is that gradual decreasing of green coverage is everywhere the common phenomena to the country like Srilanka specially in the Kandy district where locate very valuable sensitive area. By combination of those to findings get correlated the bigger urban entities where

located in the higher accessible areas are got highly degraded. So finally further allowing of urban sprawl in this type of sensitive areas very harmful specially near the Valuable natural elements. And also it has a strong linkage in between the transport network and environment degradation in this type of sensitive areas critically. Reconsidering the road network, diversion strategy by limiting the subdivisions of sprawling the mountainous area has to be further studied.



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Appendix 1 Calculating environmental impact in individual townships

1 Kandy

Figure 1 Thilanka hotel road



Source : Google images

Figure 2 Mahaiyawa



Source : Google images

Figure 3 Dharmashoka Mawatha



Source : Google images

Figure 4 Dharmashoka Mawatha



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓		✓	✓			✓					
2		✓		✓			✓					
3	✓			✓				✓			✓	
4		✓		✓				✓			✓	
Total/Av	5	3	1	5			5				1	

2 Gampola

Figure 5 Kahatapitiya



Source : Google images

Figure 6 Kandy road - start



Source : Google images

Figure 7 Sinhapitiya



Source : Google images

Figure 8 Nuwara Eliya road - start



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓		✓	✓			✓			✓		
2	✓			✓			✓			✓		
3		✓		✓				✓		✓		
4		✓		✓				✓		✓		
Total/Av	5	3	1	5			5			5		

3 Akurana

Figure 9 Bulugohotenna



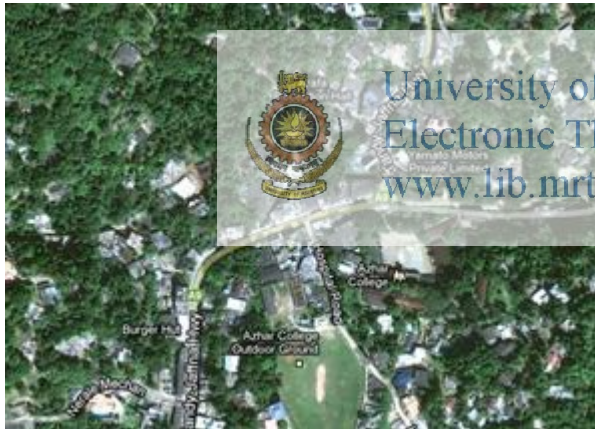
Source : Google images

Figure 10 Matale road



Source : Google images

Figure 11 Bulugohotenna



Source : Google images

Figure 12 Matale road



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓		✓	✓			✓			✓		
2	✓			✓			✓			✓		
3		✓		✓				✓		✓		
4		✓		✓				✓				
Total/Av	5		1	5			5			5		

4 Katugastota

Figure 13 Punchi Palama



Source : Google images

Figure 14 Medawala road



Source : Google images

Figure 15 Ambatenna



Source : Google images

Figure 16 Katugastota Town



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓	✓	✓	✓			✓			✓		
2		✓		✓			✓			✓		
3	✓	✓		✓				✓		✓		
4	✓	✓		✓				✓		✓		
Total/Av	5	3	1	5			5			5		

5 Alawatugoda

Figure 17 Alawatugoda Town



Source: Google images

Figure 18 Balakaduwa



Source: Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1			✓	✓				✓			✓	
2			✓	✓				✓			✓	
Total/Av			1	5				3			3	

6 Ambatenna

Figure 19 Ambatenna Town



Source : Google images

Figure 20 Matale road



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1			✓	✓				✓			✓	
2		✓		✓				✓			✓	
Total/Av		3	1	5				3			3	

7 Halloluwa



Figure 21 Dumping site



Source : Google images

Figure 22 Haloluwa town



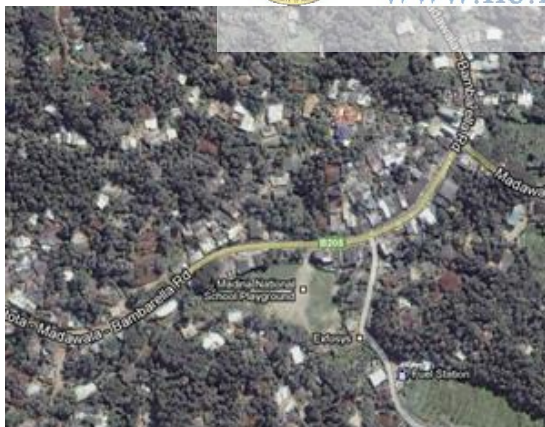
Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓			✓				✓			✓	
2			✓	✓				✓			✓	
Total/Av	5	3	1	5				3			3	

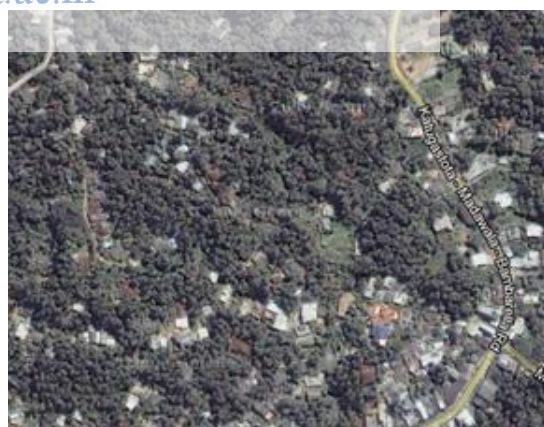
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Figure 23 Madawala Bazaar



Source : Google images

Figure 24 Madawala Bazaar



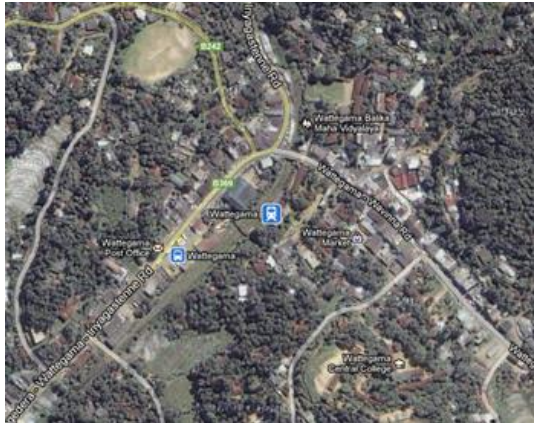
Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1		✓		✓			✓				✓	
2		✓		✓			✓				✓	
Total/Av		3		5			5				3	

9 Wategama

Figure 25 Wattegama town



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1		✓		✓				✓			✓	
Total/Av		3		5				1			1	

10 Digana

Figure 26 Digana town



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓			✓				✓			✓	
2		✓		✓				✓			✓	
Total/Av	5	3		5			3			3		

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Figure 27 Digana Village



Source : Google images

Figure 28 Menikhinna town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1		✓	✓		✓		✓	
Total/Av		3	5		3		3	

12 Kundasale

Figure 29 Chocolate Factory area Warapitiya



Source : Google images

Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓		✓		✓		✓	
2		✓	✓		✓		✓	
Total/Av	5	1	5		3		3	

13 Tennekumbura

Figure 31 Tennekumbura



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓		✓	✓			✓				✓	
Total/Av	5		1	5			5				3	

14 Gurudeniya

Figure 32 Haragama village  University of Moratuwa, Sri Lanka. Electronic Theses & Dissertations www.lib.mrt.ac.lk Figure 33 Gurudeniya town



Source : Google images



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1			✓	✓				✓				✓
2	✓			✓				✓				✓
Total/Av	5		1	5				1				1

15 Ampitiya

Figure 34 Ampitiya town



Source : Google images

Figure 35 Ampitiya Subdivisions



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓			✓					✓			✓
2			✓	✓					✓			✓
Total/Av	5		1	5					1			1

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Figure 36 Thalathuoya town



Source : Google images

Figure 37 settlements



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1		✓		✓				✓			✓	
2			✓	✓				✓			✓	
Total/Av	3		1	5				3			3	

17 **Peradeniya**

Figure 38 Peradeniya town



Source : Google images

Figure 39 Gannoruwa road



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓		✓	✓				✓			✓	
2	✓	✓		✓				✓			✓	
Total/Av	5	3	1	5				3			3	

18 Pilimathalawa

Figure 40 Pilimathalawa town



Source : Google images

Figure 41 Daulagala junction



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1			✓	✓				✓		✓		
2		✓		✓				✓		✓		
Total/Av		3	1	5				3		5		

19 Kadugannawa

Figure 42 Kadugannawa town



Source : Google images

Figure 43 Colombo road



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1		✓	✓		✓		✓	
2	✓		✓		✓		✓	
Total/Av	3	1	5		3		5	

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Figure 44 Welanboda town



Source : Google images

Figure 45 Welanboda town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1		✓	✓		✓		✓	
2	✓		✓		✓		✓	
Total/Av	3	1	5		3		5	

21 **Daulagala**

Figure 46 Daulagala town



Source : Google images

Figure 47 Watadeniya Junction



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1		✓	✓			✓		✓
2	✓		✓			✓		✓
Total/Av		3	1	5		3		3

22 Buwelikada

Figure 48 Daulagala town



Source : Google images

Figure 49 Watadeniya Junction



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1		✓	✓			✓		✓
2	✓		✓			✓		✓
Total/Av		3	1	5		3		5

23 Gelioya

Figure 50 Gelioya town



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1	✓	✓	✓	✓				✓		✓		
Total/Av	5	3	1	5				3		5		

24 Weligalla



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Figure 51 Weligalla town



Source : Google images

Environment Degradation indicator

	Natural Drainage			Green			Density			Paddy		
1		✓	✓	✓				✓		✓		
Total/Av		3	1	5				3		5		

25 Hedeniya

Figure 52 Hedeniya town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓		✓	
Total/Av	3	1	5		3		3	

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Figure 53 Poojapitiya town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓		✓	
Total/Av	3	1	5		3		3	

27 Ankumbura

Figure 54 Ankumbura town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓		✓	
Total/Av	3	1	5		3		3	

28 Galhinna



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Figure 55 Galhinna town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓		✓	
Total/Av	3	1	5		5		3	

29 Madige

Figure 56 Madige town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓		✓	
Total/Av	3	1	5		3		3	

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Figure 57 Galagedara town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓		✓	
Total/Av	3	1	5		5		3	

31 Barigama

Figure 58 Barigama town



Source : Google images

Environment Degradation indicator

	Natural Drainage		Green		Density		Paddy	
1		✓	✓			✓		✓
Total/Av		1	5			1		1

32 Muruthalawa

Figure 59 Barigama town



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Source : Google images

Environment Degradation indicator

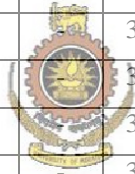
	Natural Drainage		Green		Density		Paddy	
1	✓	✓	✓		✓			✓
Total/Av	3	1	5		3			1

Appendix 2

Calculating the Environmental Degradation index

Town	Indicat or	Affect to Natural Drainage			Affect to Existing Green			Ground pollution			Paddy land reclamation			W.E.D index	Impacted Level
	Level	Major	Sub	Minor	High	Medium	Low	High	Medium	Low	High	Medium	Low		
	Weight	5	3	1	5	3	1	5	3	1	5	3	1		
Kandy		5	3	1	5	-	-	5	-	-	-	-	1	20	
Gampola		5	3	1	5	-	-	5	-	-	5	-	-	24	
Akurana		5	-	1	5	-	-	5	-	-	5	-	-	21	
Katugastota		5	3	1	5	-	-	5	-	-	5	-	-	24	
Alawathugoda		-	-	1	5	-	-	-	3	-	-	3	-	12	
Ambatenna		-	3	1	5	-	-	-	3	-	-	3	-	15	
Madawala			3		5			5			3			16	
Wattegama			3		5			-	-	1	-	-	1	10	
Digana			3		5			5	3			3		19	
Menikhinna			3		5			3	-	-	3	-		14	
Tennekumbura		5	-	1	5	-	-	5	-	-	-	3	-	19	
Gurudeniya		5	-	1	5	-	-	-	-	1	-	-	1	13	
Ampitiya		5	-	1	5	-	-	-	-	1	-	-	1	13	
Thalathuoya		-	3	1	5	-	-	-	3	-	-	3	-	14	
Peradeniya		5	3	1	5	-	-	-	3	-	-	3	-	20	
Pilimathalawa		-	3	1	5	-	-	-	3	-	5	-	-	17	
Kadugannawa		-	3	1	5	-	-	-	3	-	5	-	-	17	
Murathalawa		-	3	1	5	-	-	-	3	-	-	-	1	13	
Welanboda		-	3	1	5	-	-	-	3	-	5	-	-	17	

Town	Indicat or	Affect to Natural Drainage			Affect to Existing Green			Ground Pollution			Paddy land Filling			W.E.D index	Impacted Level
	Level	Major	Sub	Minor	High	Medium	Low	High	Medium	Low	High	Medium	Low		
	Weight	5	3	1	5	3	1	5	3	1	5	3	1		
Daulagala		-	3	1	5	-	-	-	3	-	-	3	-	15	
Buwelikada		-	3	1	5	-	-	-	3	-	5	-	-	17	
Geliyoa		5	3	1	5	-	-	-	3	-	5	-	-	22	
Weligalla		-	3	1	5	-	-	-	3	-	5	-	-	17	
Wattappola		-	3	1	5	-	-	-	3	-	-	3	-	15	
Kundasale		5	-	1	5	-	-	-	3	-	-	3	-	17	
Pallekele		5	-	1	5	-	-	-	3	-	-	3	-	17	
Hedeniya		3			5									15	
Medawala		3			5				3			3		15	
Poojapitiya		3		1	5				3			3		15	
Ankumbura		-	3	1	5				3			3		15	
Galhinna		-	3	1	5			5				3		17	
Galagedara		-	3	1	5			5				3		17	
Barigama		-	-	1	5					1			1	8	



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Appendix 3 Calculating the level of townships by Weighted function

	Functions	National important places	Central Govt Office	National Hospitals	National schools	porvicial offices	Pvt Edu cent	Channeling / pvt hos	International schools	Schools	Bus / Rail terminals	Commuting center 10000's	A grade banks	Banks	Shopping malls	Hospitals	Other com office	Comm services acv 50's	Hotels	Restaurants	Cenemas	Shops	Total score	Rank
Town \\ Weight		20	19	18	17	16	15	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
Kandy		20	76	18	119	32	450	300	210	39	36	495	120	27	320		480	500	400	360	8	150	4160	1
Gampola					51	16	30	30	14	52	24	110	20	45	32	7	180	100	40	150	2	100	1003	2
Wattegama					34	16	15	45	39	24	44		45	8	7	60	40	14	60		50	471	8	
Kadugannawa					17	16	15	15	13	24	33		27	8	7	30	20	12	30		30	297	11	
Katugastota					51	16	15	14			165	20	36	32	7	120	100	16	90	4	100	786	3	
Peradeniya		20	19	18								110	20	18	16		30	60	20	30	2	50	445	9
Tennekumbura						16				13		44						10	8	15		10	116	25
Akurana					34		15	30	28	13	12	110	10	27	24	7	60	100	24	60		100	654	4
Alawatugoda					17		15			13	12	66		18			30	20	8	15		50	264	14
Pilimathalawa					17		15	15		13	12	110	20	18	16		120	40	16	60	2	100	574	7
Hedeniya											12	55		18			60	30	12	30		50	267	13
Aladeniya												44				7		10	8	15		20	104	26
Halloluwa										13	12	33						5	12	15		10	100	27
Muruthalawa										13	12	33		9			12	10	12	15		10	126	23

Pottapitiya										13	12	44		18		7	30	10	12	15		20	181	19	
Danture										13		33		9				5	8	15		10	93	29	
Geliya										13		66		18		7	30	20	24	30		30	238	17	
Weligalla												33						5	4	12		10	64	33	
Daulagala							15	15		13		44		18			42	40	12	30		30	259	15	
Ampitiya						17		15		13	12	44						20	8	15		10	154	21	
Thathuoya						17					12	66		27		7	30	30	12	30		20	251	16	
Marassana												44						10	8	9		5	76	32	
Kundasale		20	38				16				14		110			16	7	30	30	24	15		10	330	10
Digana						15	15			13	12	165		27	8	7	60	100	12	60		100	594	5	
Menikhinna						17				13	12	165		27	8	7	60	100	12	60		100	581	6	
Yakgahapitiya										13	12	66				7		5	4	9		5	121	24	
Madawala										13		77		18			30	20	12	30		30	230	18	
Thalawinna										13	12	55		9				10	8	15		20	142	22	
Pujapitiya										13	12	55		18		7	12	10	4	15		20	166	20	
Medawala										13	12	77		18			12	10	4	15		20	181	19	
Ankumbura										26	12	77		27		7	30	30	8	30		30	277	12	
Wattappola										13		44						5		9		10	81	31	
Doluwa										13	12	44				7		5		9		5	95	28	
Gurudeniya										13	12	33						5		9		10	82	30	



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