WAYSIDE TREES IN CITY OF COLOMBO

The Dissertation is submitted to the Department of Architecture, University of Moratuwa in fulfillment of the requirement for the Degree of Master of Science in Landscape Design.

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DECLARATION

I here by declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no materials previously published or written by another person or materials which, to a substantial extend has been accepted for the award of any other degree or diploma of a University or other institute of higher learning, except where the knowledge is made in the text.

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W.K.D.Gunasinghe

2009 | 11 | 18

Date

For facing and taking many pains with understanding, to beloved wife Kumari and loving daughter Devumi.

CONTENTS

TABLE OF CONTENTS

ABSTRACT

In the present study, a review was carried out on the wayside tree Colombo city. In addition, a structural interview was carried out with the relaxants authorities including government and non governmental institutions.

First chapter of the dissertation introduce the brief history of the wayside trees in Sri Lanka emphasizing different historical periods ruled by native and foreign rulers. The review indicated that there was a trend of integration of wayside trees in to a number of developments scheme.

The second chapter and evaluation of way side trees of Colombo City was also made and there was drastic change in the planting of wayside trees with the introduction of modern construction in the city. Most of the wayside trees in the Colombo city have been evidence that the colonial rulers have paid an attention to preserve the wayside trees. In addition, there were roadside tree plantation plan during the time of foreign ruling and after the independence.

The chapter tree briefly dealt with the wayside tree landscaping special reference to management of wayside trees. The review indicates that there is no appreciable level of the management of wayside trees attempted by local government, authorities in Colombo city. This may be due to the lack of finance, labours force, expertise and inefficient communication between the relevant authorities.

Chapter four in the dissertation focuses the issues related to the wayside trees in the Colombo city. There are number of contributive factors in these issues, namely population increase, illegal encroachment, urbanization, and industrialization let to minimize the biodiversity in the city area. The earth slip, water logging, root damaging and water stress can be let to death of road tress and increase the risk of natural disasters. The beneficial effect of the wayside tree plantation let to minimize the industrial and vehicular CO_2 emissions and create the microclimatic effect in Colombo city.

The chapter five discuses the main importance of the wayside trees in Colombo city. In this chapter, a comparison of different forms of roadside tree plantation in the Colombo city with the similar forms found in else ware.

The sixth chapter of the dissertation briefly discusses the major uses of the wayside trees in general and points out the importance of strengthening landscape policy. A progress of wayside tree plantation of Colombo city also discusses and it was reveal that there was an increasing trend in tree plantation within the city. The study suggests that wayside tree plantation should be carried out with proper national plan under the supervision of government organizations with the support of the NGOs. In addition it should be worthy to seek advisors from landscape expertise and botanists in planning the plantation of wayside trees in Colombo city and elsewhere in the country.

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CHAPTER 01

CHAPTER 1

HISTORICAL BACKGROUND IN WAYSIDE TREES AND GREEN CITY

1.1. INTRODUCTION

The man has passed a number of stages during his development. In the hunter/gatherer phase, he was a wanderer and with no one place named as a home needing planted trees. Trees provided him with fuel, tools and also shelter. As food production increased to a level that could support several families, villages were formed (Fig.1.1). Over time these villages grouped together and formed cities. People lived in suburbs linked by tracks. *Track* is a word that implies the most basic course along which movement may take place. The wide streets, laid out like spokes of a wheel allowed for rapid deployment of troops to any part of the city. Many economic activities developed within cities and there was a need to build a network of roads and streets linking cities and the path of cities.

Fig. 1.1 a) The avenue tree creates the formal approach to the village. It is enhancing the natural landscape setting of the village area (Reproduced by courtesy of the Trustees, The National Gallery, London). Source: McCluskey, 1992

Fig. 1.1 b). A Sri Lankan example from an avenue of royal palm in Peradeniya Botanical Garden.
Credit: Gunasinghe W.K.D.

The concept of "Green City" can be used to develop cities with vegetation merging with the natural environment. Though there is no clear definition of the term Green City and a number of attempts have been made to define the term. Green cities can provide sufficient green areas for functional and productive green space (Hough 1990; Beer 1994). Green areas can be designed not only for recreation, but also for productive purposes. By using organic gardening practices, people learn more about the nutrient cycle. Organic gardening, "the development of planting design techniques, inspired by natural plant succession and speeded up through management, has helped to prepare the soil through sequential plant associations" (Hough 1984, p. 250). The amount of green space should be based upon site specific and community requirements, instead of a blanket policy requiring a certain percentages (Charette 1995).

The word *street* is derived from the latin *sternere*, to pave, and so relates to all latin-derived words with the *str* root that are connected with building, with construction. *Alley,* for example, always implies a narrow passage; *avenue*, a wide street with one or more lines of trees; *boulevard* again suggests a tree-lined street as applied to eighteenth- and nineteenth- century towns. All of these words suggest different ways of considering the street. The term *high street* or *main street*, commonly a name of the principal street of many English and American towns, still carries the suggestion that an important long distance route passes through a settlement, and its built-up area (Anderson, 1978). Planting trees, landscaping parkway strips, and growing gardens offers that rare hands-on opportunity for neighbors to work together side by side, says Berry, director of San Jose's Our City Forest but always within a coordinating plan related to the particular kind of streets involved.

The introductions of trees to urban areas including roads increase the green coverage in an area and add to the aesthetic value. Brenda Colvin (1973) has elaborated this idea stating that a town without gardens and vegetation in which two open space element of the pattern consist only of roads, courtyards and paving soon becomes monotonous, the larger the town the greater the need for green open spaces and tree forms as a foil to the buildings, and as additional elements in the design aesthetic indications again corresponding with the biological needs of sound health and social structures (Colvin,

Fig. 1.2 Foot paths and cart roads have been traditionally used for traveling and for the transport of goods and as these roads extended into the surrounding country. The offered the travelers the opportunity to experience surrounding nature. Source: (McCluskey, 1992)

Brenda - Land and Landscape. It is not surprising that roadsides (waysides) in Sri Lankan urban and suburban areas have been planted with trees mainly for thepractical purpose of providing shade and thus this was particularly beneficial in providing shelter for trtavellers on foot and by cart from earlier times. Many of these pathways and cart roads were eventually incorporated into Sri Lankas modem road network (Fig.1.2). Most of the ancient foot paths and cart roads were constructed through forest vegetation without exerting much pressure on the surrounding vegetation (De Silva, 1973) (Fig.1.3). For instance, during the Anuradhapura, Polonnaruwa kingdoms, roadsides were planted with trees and these roads were considered as a landscape element (Knox, 1681).

Fig.1.3. The most of the ancient foot paths and cart roads were constructed through forest vegetation.
Source: www.anothertravelguide.com

Both endemic and exotic tree have long been planted along these roadsides. Further, during the colonial period wayside trees were planted as a shady element in urban environments. Therefore, it is important to investigate the reintroduction of planting wayside trees along Sri Lankas roads and to explore the community perception on the potential use of wayside trees in a landscape context. Introducing trees along the roadside will contribute to the mitigation of atmospheric CO_2 through the sequestration process carried out by green plants and offers landscape strategies that encourage sustainability and increase green space in the city. This helps to offset destruction of trees in cities, for road construction is very much higher than their introduction and establishment. Rapid urban growth with subsequence land clearances, construction or expansion of roads and increase in traffic threatens trees in our cities.

1.2. HISTORY OF WAYSIDE TREES LANDSCAPING AND GREEN CITY

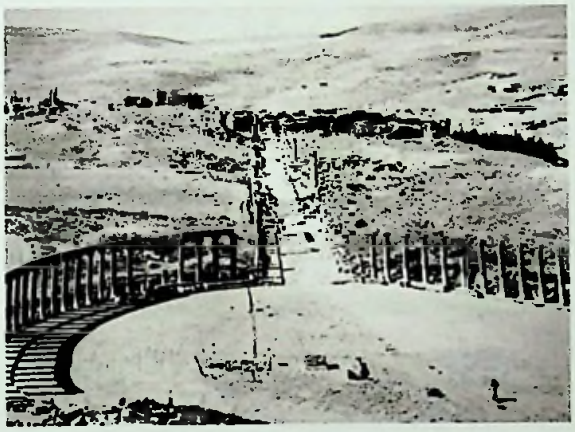

Fig. 1.4 The straight line of road direct to a round theater in ancient Egypt. The colums had been erected as a trees. Source: (McCluskey, 1992)

The history of planting trees along roadsides extends back to the ancient civilizations (Geoffrey Jellocoe, 1987). It has been well-known that beautiful trees and water bodies are linked to religious faiths. For instance, in Mesopotamia, the Sumarians built the cities along the rivers which later these cities were organized into city-like structures referred to as "temple towns". Subsequently, this Green City concept led to introduction of wayside trees. The ancient Egyptian Civilization provides a best example of urban planting of trees (Fig.1.4) (Jellicoe, 1975, 1987).

During the early history, (Fig.1.5) in China there were vast functional water project way the inspiration for a tranquil lake landscape active with artificial islands and bunds and an urban scene of water streets that must have been clean and healthy (Jellicoe,1975,1987).

Fig. 1.5. Ancient China garden function with tranquil lake, buildings and trees.
Source:
www.aroundchina.chinaassistor.com

In France tree-lined boulevards were introduced to Paris in the mid-1800s (Fig. 1.6). The main reason for boulevards, however, was to control movement of troops, and the trees provided those with some measure of shade and such plantings also provided beauty and unified architectural elements (Gene and Frederick, 1986).Trees have been esthetically important to people since earliest civilization. The Egyptians, Phoenicians, Persians, Greeks, Chinese and Romans held trees in high esteem and in certain situations worshipped them. They used trees for their esthetic benefits, developing formal gardens and sacred groves to enhance temple settings and to provide shade.

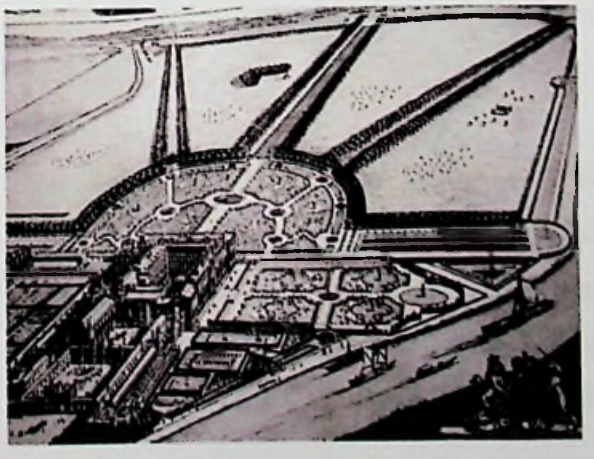

Fig. 1.6 The tree lined boulevard is the main character of the early France cities.
Source:(McCluskey, 1992)

In Western Classicism of wayside trees has been describing according to Jellicoe, 1975, 1987. By mid-century the Authoritative straight line across the landscape, the ideal of which had been the enclosed tree-lined avenue, began to take note of the environment through which it passed, whether urban or rural. Conceptually, the road or path may well pre-exist the permanence of human settlements (Anderson, 1978).

Even in these early culture trees were also used to complement status and provide a landscape for buildings. Along with these uses developed a rudimentary knowledge of tree care. Trans-planting of trees was common as early as 1500 B.C. in Egypt (Winters, 1974). Jorgensen stated that urban forestry as developed in Canada does not deal entirely with city trees or with single tree management, but rather with tree management in the entire area influenced by and utilized by the urban population. Part of the report focused on the theme that city trees constituted a resource that was not being adequately cared for. An urban and community forestry program is created in the United States Forest Service. The program should encourage research into the problems of city trees, provide financial and technical assistance for the establishment and management of city trees and develop Federal training programs for the care of city trees (Gene and Frederick, 1986).

The urban forest includes all woody vegetation within the environs of all populated places, from the tiniest village to the largest cities. In this sense it includes not only trees within city limits but trees on associated lands that contribute to the environment of populated places-for example, green-belts, municipal watersheds, recreation sites, and roadsides.

Thus, in New York State, the urban forest enlarge from rows of street trees and clusters of park trees in New York City to ever-broadening greenbelts in contiguous suburbs, to coalensce in the forests of the Catskills, Adironacks, and Allegheny Highlands (Andresen, 1975). Along some highways, particularly those maintained by countries or states, tree situations are similar to those along streets. However, federal highways (often

called interstates, freeways, or traffic ways) generally involve large land areas where trees, shrubs, and other landscape plants have been planted (Gene and Frederick, 1986).

1.3. ANCIENT SRI LANKA WAYSIDE TREES LANDSCAPING AND ATTITUDES

Fig. 1.7. The historic village "Kada Mandiya" adjacent to road and natural vegetation.
Source: www.lankapura.com

The village was identified with the tank and the tank was mostly named in association with a tree. The tank associated with Palu trees (*Mimusop hexandra*) was named as Palu-gas wewa, with the divul trees (*Limonia feronia*) as Divul-gas wewa, with the Kon trees (*Scleichera olesa*) as Kon-gas wewa etc. Some times also the village associated with a large tree was identified by the name of a tree, i.e. Katugahamulla, Muratagaahmula, Dompe, Ampe, Nape etc (Fig. 1.7). When the village was identified with a grove of trees, the following terms were used with the name of the tree, Aramba, Damana, Patana, Landa, Vinna, Hinna, Deniya, Pola etc. When a village is identified with a forest, the following terms were used with the name of the tree type, Ana, Kaduwa, Kela, Wala, Gomuwa, Gola etc. (De Silva, 1996).

The historical evolution of street planting in Sri Lanka the present day situation and what measures can be recommended to preserve and enhance the urban environment by tree

planting in the future need to given special attention. An urban tree can't be compared to a person in a prison cell- with its restricted root spread and restrained spread of its branches (Chandradasa, 1995). In Sri Lankan tradition, it is believed that there are divine spirits living in association with large trees and villagers still have the habit of respecting large trees and also lighting oils lamp in respect of the 'Wruksha Devata' or the Deity living in association with the tree. All these religio-cultural practices have influenced Sri Lankan society in respecting trees and nature. In ancient city planning in Sri Lanka, it is possible to identify the planning principles adapted in creating a built environment, while integrating and enhancing the aesthetic of nature in creating an architectural landscaping embracing the natural elements and vegetation. The proper understanding of these Sri Lankan traditions, plant species, their growth patterns, socio cultural uses and aesthetics are necessary in creating a health landscape environment (De Silva, 1996).

1.4. HISTORY OF GREEN SPACE WITH WAYSIDE TREES IN SRI LANKA

1.4.1 ANURADHAPURA AND POLONNARUWA KINGDOM

In natural sloping lands and in hills, different levels were reached either by walking along the slopes or creating steps to climb at pre-identified places. Creating terraces or slopes in landscaping and the construction of buildings by using retaining walls and earth embankments were a common feature found in Sri Lankan Architecture and landscape. Paths were commonly flanked by rows of irregularly planted trees. The monasteries such as Sigiriya, Arankele, Ritigala are among the examples found in Sri Lanka (Fig.1.8 and 1.9).

In the royal park at Sigiriya, shallow reflecting ponds, elongated ponds and water fountains were found on either side of the main axial path and side path which were almost certainly carefully tree-shaded enhancing the leisure and beauty. In planning urban settlements of the early historic periods, the city planning practices in India would have echoed specially in the establishment of Anuradapura, the city that continuously served as the seat of governments for a period of more than thirteen hundred years. Anuradhapura was established on the Western bank of Kahamba Nadi, and with the construction of large irrigation reservoirs on to the West and South- West of the city

provided the required water for cultivation throughout the year and a green cool environment. (De Silva, 1996).

Fig. 1.8 The main path ways of Ritigala long dress curb stones, some neatly paved paving and closely shaded by the tress of the dry zone rain forest. Credit: Gunasinghe W.K.D.

Fig. 1.9 These stone paved paths are laid down for kilometers in straight and curved forms at Ritigala. Credit: Gunasinghe W.K.D.

With the help of existing ruins of buildings, caves, terraces, flight of steps, retaining walls, etc., it is possible to visualize Mihintale as a large forest monastery with an excellent utilization of natural hill slopes, boulders, streams, ponds, terraces, and intergrated with trees in the forest. Coolness of the shady trees and the ponds around, the irregular and formal flights of steps and paths laid winding round the boulders and the trees, passed through gaps and arches found by the leaning rocks, went climbing on the rocks, creating levels, terraces and vistas and exploiting the breeze on the edges of the silent forest would have created a fascinating surrounding for the meditating monks (De Silva, 1996).

The Arankele is located in hilly area with stones and boulders, washed by streams and covered with thick green forest creating an ideal environment for meditation. The main axial pathway paved neatly with well dressed stones started from a building complex with common facilities. Meditation halls etc. were connected with curved foot paths defined with curb stones. The path ways leading to these buildings surrounded by water originated from main axial path and as at Sigiriya and Mihintale together with the subsidiary path derived much of their characters and amenity from the shade of the adjoining forest and with three temples mark with their Bo trees creating points of special emphasis. Path junctions were often enlarged to form a stone circle or a stone square demarcated with curb stones and some times had stone seats for the monks rest as also at Ritigala. The overall design of the monastery complex was beautifully guided by the topography of the forest, the terraces, streams, rocks and naturally grown trees in the forest (De Silva, 1996). The description of King Parakramabahu I(1153-1186 AD) on establishing the city of Polonnaruwa as given in Culawamsa, carries a detailed description of the laying out of the Nandana and Dipuyyana gardens, landscaping of the city and landscaping of the palace garden (De Silva, 1996).

Fig.1.10. Abayagiriya Dagaba and its surrounding vegetative environment, tree-shaded foot paths linking the city's monasteries and dagobas. Source: www.lankaenews.com

There were settlements which possessed many attributes of urban life in Ancient Ceylon thousands of years ago. Ancient cities like Anuradapura, Polonnaruwa, Yapahuwa, and Kandy were large settlements, widely distributed over the country with communal defenses containing street buildings and city walls. Sri Lanka has an urban landscape history of about 2000 years (Fig.1.10). Cities like Anuradapura, Polonnaruwa and Sigiriya exhibit a series of parks and gardens in the urban plans, (Pilipitiya, 2007). There were four gate ways to the city of Anuradhapura and planted Banyan trees (*Ficus benghalensis*) along them. It is believed that there were structures built on the Banyan trees to worship the trees. A special occasion where tree planting and honoring trees was when, a branch of the sacred Bodhi was brought to Sri Lanka and established in Anuradhapura and is been looked after and worshipped to the present day. The 'Chulawamsa' notes that in Poonnaruwa, the gardens of King Parakramabahu, Nandana Uyana and the Dipuyyana previously mentioned had many types of fruiting and flowering trees and these were watered through channel. Among the trees there were many tree-surrounded ponds of different forms and sizes filled with water for bathing and other pleasure activities. These gardens had small pavilions to relax, with beautifully designed pathways and water filled ponds, shaded with systematically planted trees.

1.4.2 SIGIRIYA KINGDOM

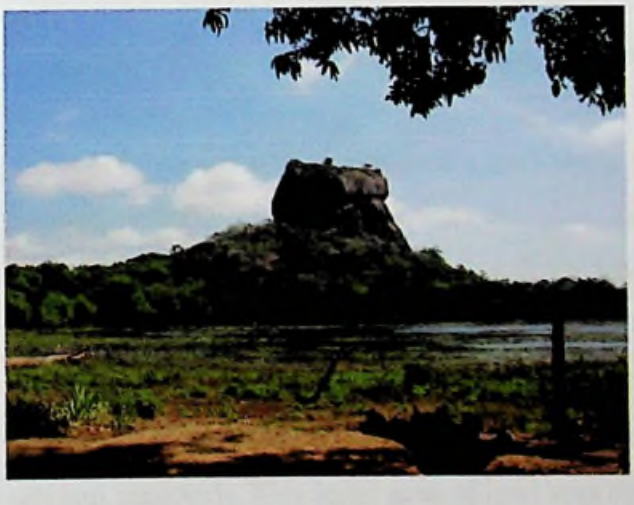

Fig. 1.11 Sigiriya Rock surrounded by the green terrain of the dry rain forest and which provided shade to all parts of its complex. Credit: Gunasinghe W.K.D.

At the 5th Century water gardens in Sigiriya pathways were laid according to the Concepts of "Giridurga", "Jaladurga" and "Wanadurga" century old traditions of town

planning (Fig. 1.11). The king's pedestrian's circulation paths were located within the palace premises include water garden, pleasure garden and so on. The historians consider Sigiriya, as one of the oldest and best preserved landscaped places city complex in Asia. It has been created with an axial symmetry along an East-West axis but bringing symmetrical and asymmetrical balance utilizing the natural elements, the topography, creating terraces, pathways, water ways, city walls, moats, open space and planted trees (De Silva, 1996) (Fig. 1.12).

Fig. 1.12 Sigiriya- Symmetrical pathways. The main central axial pathway, originally planted with shade trees along its sides. Credit: Gunasinghe W.K.D.

The whole garden was planned on a grid along the main axis in the East-West direction forming mirror image plans on the two sides. Further here would have been systematically planted ornamental and shady trees bearing beautiful tropical flowers and fruits enhancing the charm of the gardens. A The serpentine stream shallow, and were made out of lime stone slabs and curbs to carried a thin sheet of water that brought movement and reflection on either side of the king's private garden enclosure along the western approach. This large area of land was covered with buildings, terraces and ponds creating a specially designed environment to collect the seasonal rain water, and the structures to withstand the stormy wind. The trees selected to plant on the summit

gardens would have provided a the shady and pleasing environment. The stone or timber bridges that crossed moats and streams also have defined the width of the path way. The 5th century fortified city of Sigiriya is considered the best preserved landscape city not only in Sri Lanka but in the whole world.In some places the width of the terrace was reduced to the width of the pathway creating side space for buildings and trees(Fig.1.13), (De Silva, 1996).

Fig.1.13 The way side trees in Sigiriya, adjacent to inner moat surrounding the lower and western palace complex.

In laying out paths and walk ways, the traditional landscape has mostly followed the topography of the land, keeping in harmony with the levels, rock and boulders, watercourses etc. But in some landscape, define axial paths have been created in the layout imposing a discipline but with great expect to the natural elements and their organic forms. The width of the path was mostly defined by placing curb stones on either side, having walls on either side, by paving the path way or by the width of dressed stone steps laid when changing levels from one terrace to another.

1.5. URBAN WAYSIDE TREE LANDSCAPING THE LATTER KINGDOMS OF SRI LANKA.

1.5.1 SRI JAYAWARDANAPURA KOTTE

Fig. 1.14 Jayawardanapura Historical City.
Source: Sri Lanka New Capital-SriJayawardanapura- UDA

Today Kotte, or SriJayawardanapura as it is officially referred to, is the political capital of the Sri Lanka. It was also, from 1411A.D. to 1588 A.D. - a brief interlude within the long time span of Sri Lanka's history- the capital of the last great kingdom of the Sri Lankans. King Rajasinghe of Sethawaka (1581-1592 A.D.) waged war against the Portuguese and destroyed the whole city of Sri Jayawardanapura. Within a short period of time the city was covered with jungle.The "Diyawanna Oya" and surrounding wetlands according to folklore of Diyawanna Oya dates back beyond the era of King Rawana. They are important historical landmarks. The city of Kotte had full natural security because of the surrounding water ways and marshy land. The old historic 'Konthagastota' the doorway to the Diyawanna Oya had been close to the present bridge on the Sri Jayawardanapura Mawatha. Kotte was renamed as Sri Jayawardenepura when it was declared as the official capital of Sri Lanka in 1982. Today Sri Jayawardanapura, especially the area around the Parliament is perhaps one of the most beautiful places in Sri Lanka, with alternating patterns of space and water, foliage and sky (Fig. 1.14).

1.5.2. KANDY

The city of Kandy, features the most sacred of all Buddhist shrines- the temple of the Tooth or the 'Dalada Maligawa'. The main natural attraction of the city of Kandy is the lake which is surrounded by greenery. The Lake in the heart of the city give the city an intermediate sense of place, and creates a picturesque atmosphere to visitors (Fig.1.15 andl.16). The near by natural forest reserve of *Udawattakale is* rich in rare species of plants and animals. The Colombo road at Kandy directly view the Udawatthakele as it's surrounded in the Colonial period (Fig. 1.17). The surrounding tree-covered slope of kandy give it is valley side much of its essential character, and include much wayside tree planting. As the city expands it is important that this character is not lost.

Fig.1.15 Town and lake at Kandy, 1870s Source:www.lankapura.com

Fig.1.16 Fig.1.13 Kandy Lake and surrounding landscape, 1800c. Source:www.lankapura.com

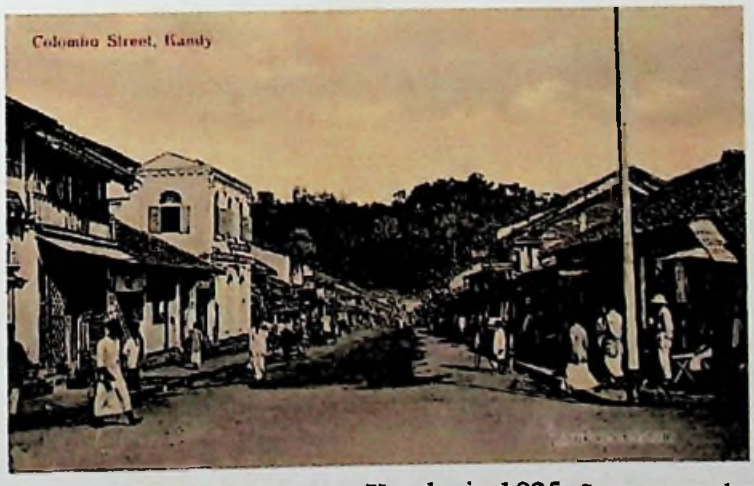

Fig. 1.17 Colombo Street at Kandy, in 1925. Source:www.lankapura.com

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CHAPTER 02

CHAPTER 02

THE EVALUATION AND HISTORY OF WAYSIDE TREES IN THE CITY OF COLOMBO

2.1. THE CITY OF COLOMBO

Colombo benefits from its position of being Sri Lanka's ancient port city due to its strategic location on the East-West sea trade routes. It became the capital city of Sri Lanka only in the year 1815, when it gave itself up to the authority of the British Empire. However, the position of acting as the capital was retained after Sri Lanka gained independence in 1948. Colombo came to be regarded as the country's commercial hub in 1978 when the administrative office was shifted south to Sri Jayewardenepura Kotte (Fig. 2.1).

There is much folklore about the derivation of the name of the city Colombo. It has been believed that the name is derived from a classical origin "KolonThota" which means port on the river Kelani. However, many authors are of the opinion that a Sinhalese origin is also behind the framing of the name Colombo. The Sinhalese name "Kola Amba Thota" meaning 'harbor with leafy mango trees' also provides the capital city with its present name.

Colombo has been well known to traders for more than 2000 years. The Romans, Chinese and Arab traders preferred this port city as it enhanced their trade to a great extent. With such an exclusive position, Colombo witnessed the occupation of three rulers- Portuguese, Dutch and British.

This era of foreign rule of the country was ended peacefully in 1948 when Ceylon gained Independence from Britain. Due to the tremendous impact of Independence, on the city's inhabitants and on the country as a whole, the changes that resulted at the end of the colonial period were drastic. Changes in laws and customs, clothing styles, religions and proper names were a significant during the colonial era. These cultural changes were followed by the strengthening of the island's economy.

Fig.2.1 Road Map of Sri Lanka reference to city of Colombo

Even today, the influence of the Portuguese, the Dutch and the British is clearly visible in Colombo's architecture, names, clothing, food, language and attitudes. Buildings from all three eras stand in their glory as reminders of the turbulent past of Colombo. The city and its people show an interesting mix of European clothing and lifestyles together with local customs and the Colombo is one of the most modern cities in South Asia city's tree planting also reflects this diversity. Before the skyscrapers were built it was the Old Parliament Building (Fig.2.2) that stood majestically in the Fort district with the Old Colombo Lighthouse situated close to it. Another important landmark of the city is the Independence Hall at Independence Square in Cinnamon gardens. During this period there was greater concern on the wayside trees since most of the foreign nations are from the cool temperate countries who found that tropical climate was extremely trying. Wayside trees planted by the colonial rulers were foreign exotics and not indigenous to Sri Lanka. The figures 2.3 and 2.4 show source of the planting.

Fig.2.2 Old Parliament Building as a land mark and commonly seen wayside trees offering shade to the side of the building. Credit: Gunasinghe W.K.D.

With increasing transport facilities in the Colombo city, there was an extreme demand for land for roads and parking lots for the vehicles comes in to the city. This demand led to the cutting down of many trees along the road sides. The figures 2.5, 2.6, 2.8, 2.9 and 2.10 show the road side trees in certain popular places in the city of Colombo during the colonial period. At the same time Figures 2.11 (a),(b), 2.12 and 2.13 indicate the present situation of those places showing evidence that there has been a considerable reduction in the number of roadside trees.

Fig. 2.3 Colombo Clock Tower with colonial wayside tree planting.1880s (Compare with Fig.2.12)
Source:www.lankapura.com

Fig. 2.4 Banyan tree Kolpittya, 1880s
Source:www.lankapura.com

Fig. 2.5 Colombo Busy Street Scene, Ceylon early 1900s.
Source:www.lankapura.com

Fig. 2.6 Colombo Town Hall Ceylon 1915 with Banyan trees shading the street. Source:www.lankapura.com

Fig. 2.7 Early 1900's Galle Face,Colombo, a papules evening promenade for enjoying the offshore breeze at that time of day at sunset, and when trees ones little useful shade. Source:www.lankapura.com

Fig. 2.8 Early 1900's union place Colombo, Ceylon-wayside planting combining forest emergent and smalles trees. Source:www.lankapura.com

Fig. 2.9 Main Street at Colombo , 1940s. (Compare with Fig.2.12).
Source: www.lankaenews.com

Fig. 2.10 Chatham Street at Colombo, 1940. *Samanea saman* trees offering shaded.(Compare with Fig.2.13).
Source: www.lankaenews.com

Fig. 2.11 (a) and (b) Colombo old Town Hall at "Gaspha" Junction at Colombo 12, in 2009 and need for large shade trees in the roundabout. Credit: Gunasinghe W.K.D.

Fig. 2.12 Main Street at Colombo 12, in 2009 not a tree in sight.
Credit: Gunasinghe W.K.D.

Fig. 2.13 Colombo Clock Tower at Colombo 11, in 2009 compare with Figures 2.3 and 2.10.
Credit: Gunasinghe W.K.D.

Colombo is located on the West coast of Sri Lanka. It gets an average annual rain fall of approximately 2387mm. The temperature average for the year is around 26.67^0 C. The monthly mean maximum is around 30^0 C and the mean minimum is 23.88^0 C. The daily fluctuation of temperature is generally low, being around 12.22^0 C. The mean humidity throughout the year is around 75% in the day time and about 90% at night. The highest daily function of humidity is 60% in July- August period, compared with 25% in February. These climatic parameters have a direct influence on the selection of tree species and also the survival of the trees used in wayside planting.

2.2. HISTORICAL BACKGROUND OF THE CITY OF COLOMBO

During the colonial period, many routes were developed spontaneously, to facilitate communication between the kingdom in the Central hills and the colonial towns on the surrounding low lands. Those routes enabled not only communication, but also the transfer of cultural elements and the spread of commercial and trade activities. Since most of them were linked with fortified cities, and which were the nodes of international sea routes, they automatically became the links of spreading international cultural elements into the island's hinterland region. Many of these townships developed distinctive colonial characters, and which have survived to the present. Most of them were established during the Dutch period, which spanned between 1656 and 1796 (Manawadu, 2005).

2.2.1 THE PORTUGUESE PERIOD

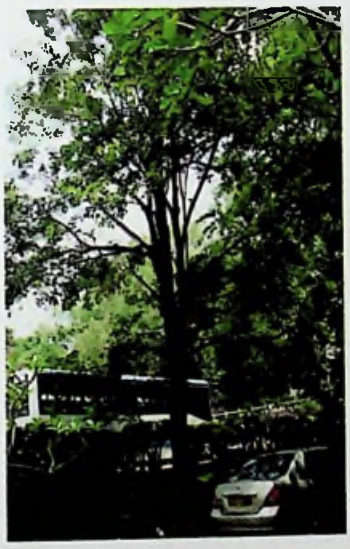
The first invaders of the port city were the Portuguese. They set their feet on the soil of Sri Lanka in 1505 and chose this country mainly for the benefit of their spice trade. On arriving, they signed a treaty with the King of Kandy to carry on the trade of cinnamon and were given full authority to trade along the fertile coastline. It was also their look out to keep the coastlines free from foreign competition. The Muslim inhabitants of the Colombo harbour were uprooted and the Portuguese built their fort there. When the Portuguese arrived in Colombo it was spread round the shallow bay. The land between

the fortress and the interior was at first unoccupied and covered with trees. The Portuguese were compelled to reinforce the garrison to resist attacks by Mayadunne and Vidiya Bandara and they cut down the trees. The new population needed houses depots and space for stores supplies.

2.2.2. THE DUTCH PERIOD

The Dutch were the next arrivals in 1656 according to the history of Sri Lanka and under their siege only a handful of Portuguese were allowed to walk safely out of the Fort. During the period of the Dutch rule, Colombo served as the capital of the Maritime Provinces put under the strict control of the Dutch East India Company. They stayed till 1796.

2.2.3. THE BRITISH PERIOD



Under the British government of Sri Lanka many plants were not only introduced to the Island, but a great deal of planting was carried out; with every new road laid out, trees were planted. The roads of Colombo and Kandy are shaded by *Pterocarpus indicus*, *Delonix regia*, (exotic) and the local *Peltophorum inerme*. Gardens of colonial times had similar trees along with smaller trees like flowering *Jacaranda mimosaefolia* from South Africa and others. More recent additions have been the pink, seasonally flowering, *Tabebuia rosea* from South Africa (Fig.2.14).

Fig.2.14 *Tabebuia rosea* Tree as awayside trees. Credit: Gunasinghe W.K.D.

The current trend is to use indigenous tree species for roadside planting since the introduce species indicate invasiveness and become weeds (Hulugalla, 1965). Meanwhile certain introduced species are naturalized to the country and are not potentially invasive.

Fig. 2.15. Busy York Street with tram cars, Colombo, in 1920's
Source:www.lankapura.com

Fig. 2.16 Busy York Street, Colombo, Ceylon in 1900's
Source:www.lankapura.com

The British were the last to invade the port city in 1796. However, the port city gained the status of being the capital only in 1815. After 1833 the Government Agent of the Western Province administered the city until the Municipal Council was established in January 1866. During the time they were in control of the Colombo, the British were responsible for much of the planning of the present city. In some parts of the city tram car tracks and granite flooring laid during the era are still visible today (Fig.2.15). The above and following figures show some of the streets planted with roadside trees (Figures 2.16, 2.17, 2.18) they all show trees (Figures 2.15 , 2.17 and 2.18).

Fig.2.17 Colombo harbor, Queen Street, in 1880.
Source:www.lankapura.com

Fig.2.18 Harbor from Queens Street, Government house & Post Office Colombo 1885. Source:www.lankapura.com

Fig. 2.19 Pettah Street scene Colombo c1950s. Source:www.lankapura.com

Fig. 2.20 Baillie Street, Colombo, 1910s, Ceylon.
Source:www.lankapura.com

Fig. 2.21 Prince Street Fort, Colombo, Ceylon, 1930s
Source:www.lankapura.com

Fig. 2.22 Dam Street, Colombo - Ceylon ca. 1930.
Source:www.lankapura.com

Fig. 2.23 Dam Street, Colombo - 2009
Credit: Gunasinghe W.K.D.

2.3 URBAN LANDS USE PATTERN AND THE ROLE OF STREET TREES

Trees are often in competition with people. They are highly controlled by man in both urban and rural areas. A better balance and more sustainable development in both town and country in needed. In this effort tree planting and the creation of more open greens have been identified as important. In urban areas development encroaches too often upon green areas and road development often involves cutting down trees. In certain places we may sometimes be able to improve existing green areas. In Sri Lanka, the percentage of roads in urban land uses varies from 10% to 20%. Part of this may be assumed to be space which should be available for road side planting. In our urban areas, there are already some trees and plants, but not enough and often those that exist are poorly located or the wrong spaces. (Chandradasa,1995).

Land use means the utilization of land for various activities such as residential, commercial, industrial, recreational etc. In Sri Lankan town development all towns of the colonial period contained lot of greenery. In the period before motor vehicles came in to use all the roads were shaded for the benefit of pedestrians, carts and chariots. Even today, most of our urban centers include a modification of the old commercial system called "Pola" (Village fair). The system operated under tree shade on the road site or in an adjoining land (fig. 2.24). Wider roads are shaded by trees. In all town s the percentage of roads tend to be high. That means urban planners often have the space for tree planting and which could extent the 'Pola' tradition serve modern living conditions in Sri Lankan town and cities.

Fig. 2.24 The old commercial system "Pola" in village area.
Source: www.lankapura.com

According to the UDA the percentage of land used as roads exceeds 10% of the total urban land area with the development of adjoining areas, and with urban renewal, the amount of roads gradually increases. In the case of wider road reservations it means that the space for street planting is increasing. (Itagaki, 1982). The importance of tree planting in urban areas evolved historically mainly to protect the health of towns. Clouston and Stancefield in their book "Trees in Towns" explain it as follows. "The planned inclusion of trees in town was seen in the 19th Century as beneficial to the health and morality of the working classes, as recorded in the report of 1843 select committee on the health of towns. A year later, the New York Board of Health defined trees as improvers of city air and encouraged the planting of them in built areas. They were appreciated not only for their visual qualities, but also as of benefit to builders and rate payers in enhancing property values" (Clouston Brain,1981).

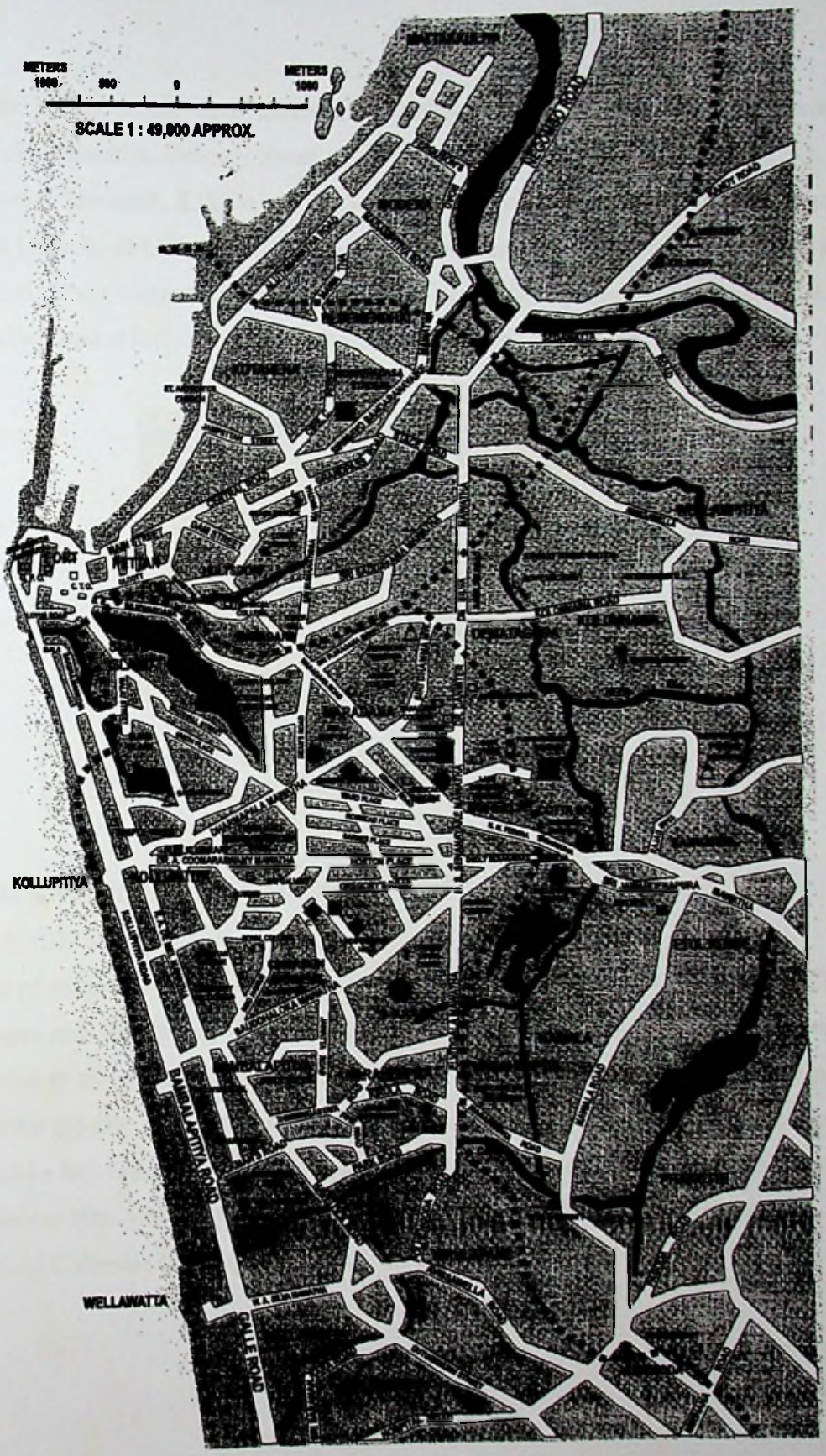
The street system from the structure of the town plan and serves to provide convenient internal circulation. In tropical climates such as Sri Lanka the side walks of all kind of streets should be shaded over for protection against the sun. (Chandradasa,1995)
Tree planting on the street or pathways gives the shade for the pedestrian. In Sri Lanka we tend to plant trees for streets, around path not only for shade but also for environment protection and all paths have a starting point from which we are taken through a sequence of spaces to a destination. The contour of a path depends on our mode of transportation. While we as pedestrians can turn, pause, stop and rest changing un topography, direction and points of interest in response to changes (Hettiaracchi,1997).
Today most urban road surfaces are tarred and sidewalks are paved with tar or concrete materials. In rural urban centers, like Mahiyanganaya there is gravel or roads. In most hill country towns steps leading up to or down from houses are very often of unsustainable materials, causing erosion and there fore causing difficulty for the pedestrian. These roads are flanked by trees of the adjacent forest and scrub land. However, the majority of our urban streets in residential and commercial areas are often entirely devoid of road side trees due to unplanned constructions and developments.

2.3.1 EXISTING WAYSIDE TREE AREAS AND EXTEND GREEN AREAS IN CITY OF COLOMBO

Roads are often named after trees, flowers, and even the life here after, e.g. in Colombo. Flower road, Shady Grove Avenue, Aloe Avenue, Massager street (from Masangas Vidiya- the 'masang' tree street), Madampitiya (the plain of 'Madan trees), Dematagoda ('Demata' trees), Gorakagaha Avenue, Thimbirigasyaya, Kotahena (Cottanchena) and Paradise place (Map 2.1). In addition, individual, occupations under trees of religious significance, for example Bo trees (*Ficus religiousa*) for a considerable period of time,may ultimately result in a place of warship being established there and the treepossibly finally dying . Examples of such instances are the Bo trees at Pettah, Punchiborrella junction, Rajagiriya junction (Chandradasa, 1995).

In the Pettah and Maradana and all to the north of these areas the general change of aspect as regards buildings is not striking. But the southern half of the city, the western or sea side of Steuart place, Kollupitiya, was in earlier times nearly all one large bare open space with a few coconuts on it, and the only areas built up to any extent were what was then regarded as the Cinnamon Garden proper (roughly the area covered by Flower road, Tuwet road, Ward place, Kynsly road, Gregory's road, Maitland crescent), (Hulugalla, 1965).

The rest consisted of coconut gardens and grass fields with old houses dotted here and there (Fig2.25.). There was, for instance, no Government town of Buller's road and Alfred house was one vast garden; there was nothing in Havelock road between Laurie's and Vajira road, the west site being a rubber plantation and Wellawattha, south of the station, was almost uninhabited. Union place had only been made up to a width of about 16 feet between rows of tulip trees and had no footways. Shorts road did not exist; Darley road was little more than 20 feet wide; Panchikawattha and Skinners road were 1 3/4 miles of about 16 feet carriage way lined with Madras thorn trees. The large garden of the late C.H. de Soysa's residence; Alfred House, where he entertained Alfred, Duke of Edinburgh, in 1870, is now a built-up area intersected by several "avenues", "places" and "roads", (Hulugalla, 1965).



Map. 2.1 Road Map of city of Colombo
Source:www.lankapura.com

At present certain roads have abundant roadside trees e.g., Dharmapala Mawatha, Bauddhaloka Mawatha, Gregory Road, Guildfred Crescent, Independence Squre, Dr.A. Comarasvamy Mawatha, R.A.De.Mel.Mawatha, Reid Avenue, Union Place, Gangarama Road, and Galle Road Galleface Green, etc. Some originally well-planted, have had roads are deserted. Their trees removed to make way for buildings and road widening e.g. Pettah, Galle Road at Kolpitiya, Bambalapitiya, Mainstret Colombo11, etc.

Fig. 2.25 Big Bagatelle, Colombo, Sri Lanka 1865, Coconut garden. Source:www.lankapura.com

2.4. EVALUATION OF COLOMBO WAYSIDE TREE PLANTATION /LANDSCAPING

A number of plans have been introduced to deal with the green spaces in Colombo City. These began with the Patrick Geddes work in 1921. Since then there have been several plans related to the green spaces in Colombo city. The main concept of the Geddes plan was to make the city of Colombo "The Garden City of the East" The tree lined streets (Bauddhaloka Mawatha) and the grid system of roads in Cinnamon Gardens are legacies of the Geddes Plan which today provide the most sought after residential areas in the city" (City of Colombo Development Plan-Volume 1-1999).

2.4.1 ABERCROMBIE PLAN (1949)

In 1948 Patrick Abercrombie developed a plan which was approved by the Central Planning Commission in March 1949. The Plan focussed on the city of Colombo and surrounding region covering nearly 220 sq miles which extended up to Ja-ela in the North, Moratuwa to the south and 14 miles inland to the east. The main problems highlighted in the Abercrombie Plan were the high concentration of economic, trade and port related activities in the city and their effects. Decentralization of activities was one of the main objectives of the plan. The introduction of 'Satellite Towns' in Rathmalana, Homagama and Ragama werer based on proposals made in the Plan (City of Colombo Development Plan-Volume 1-1999).

Describes a well planned industrial suburb, serving a garden city or country town, at a moderate distance from large city, but physically separated from that city by a country belt. In Sri Lanka cities like Rathmalana and Homagama have some of the characteristics of satellite towns but lack the planned rural country belt and the green areas in side the towns.

2.4.2 COLOMBO MASTER PLAN PROJECTS

The development that has taken place during the last twenty years has significantly changed the urban environment in and around Colombo. This development has brought positive changes such as economic diversification, new employer opportunities and better infrastructure facilities as well as negative outcomes such as environmental pollution and congestion (City of Colombo Development Plan-Volume 1-1999).

2.4.3. PUBLIC OUTDOOR RECREATION SPACES (PORS) PLAN FOR COLOMBO (1999)

The PORS Plan for Colombo recommends having active and passive outdoor recreation spaces and where possible indoor recreation facilities as view points and special landscape features and sites, a hierarchy of park facilitating the space requirement criteria

combined with a 'Nesting' concept of special planning, links between nodal parks in the form of linear parks and road and foot path access to the parks. It is stated in the 'Nesting' Concept of the PORS, that 'The service area of a higher order park should include the service areas of a number of lower order parks'. When the PORS standard of 1 ha per 1000 population is taken in to consideration, it has 635 ha of such spaces in the city of Colombo (PORS plan UDA, 1999). linking roads and foot paths accessing these parks were to be planted with trees.

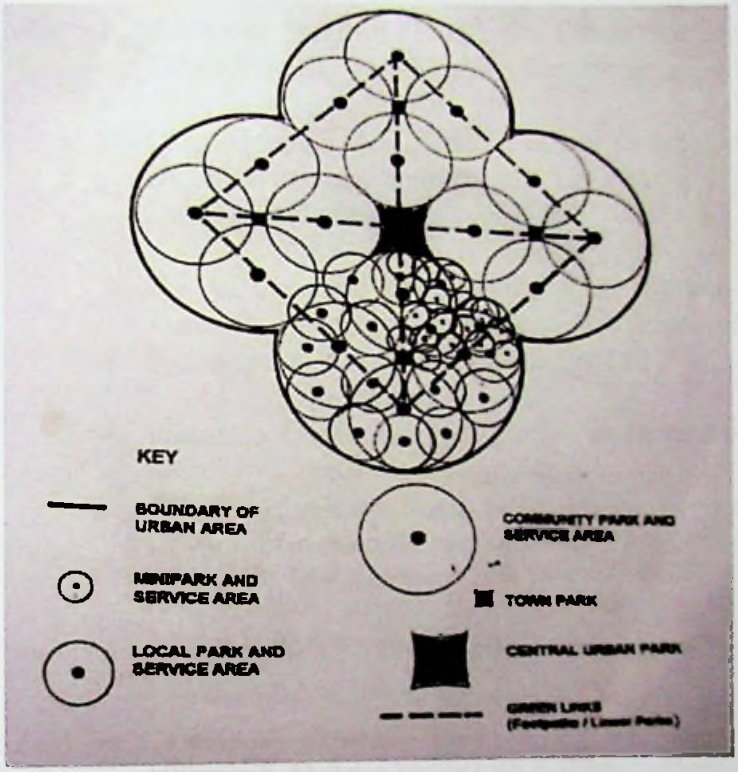


Fig.2.26. Nesting Concept Introduced In the PORS Plan by the UDA (1999).
Source: Urban PORS Plan- UDA Environment and Landscape division

2.4.4. COLOMBO METROPOLITAN REGIONAL STRUCTURE PLAN (CMRSP)

In 1996 when the UDA started revising the Colombo Master Plan (CMP) (1979) the physical environment and socioeconomic factors had changed so much that the idea of revising the CMP was abandoned and a new plan was prepared for the entire Western

Province. It was decided that a frame work based on ecological and environmental factors should be the basic framework for the future physical structure for the Colombo Metropolitan Region CMR. The CMRSP addressed the green space issues in its 'Green Finger Concept' (Pilipitiya, 2007).

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CHAPTER 03

CHAPTER 3
WAYSIDE TREE LANDSCAPING

3.1 MANAGEMENT OF WAYSIDE TREES

Although trees are by far the most important plants in relation to roads, shrubs also have many vital roles to play. Some of these have already been mentioned: the formation of ecological communities of plants at the woodland edge of roads in the country side;(Fig.3.1) the planting of hedgerows instead of building fences when the use of hedges is the local way of containing land; as a screen between pedestrians and traffic (McCluskey, 1992).

Fig.3.1 The formation of ecological communities of plants at the woodland edge of roads in the country side. Source: Photo by David Lamont

The management of roadside tress demand considerable effort and cost. As far as road side vegetation is concemed vegetation type represent a saving in management effort and cost. Five types of vegetation are common in western temperate climate road waysides.

(a) Mowed grass (b) meadow/low shrubs, (c) tall shrubs, (d) small trees with herb layer, and (e) Natural forest/woodland (Forman and McDonald, 2007).

a. ***Mowed grass*** In low density development with wide verges, a mowed grass maybe introduced. If these lack kerbs to the street and if footpaths are not set well back from the road then they may be hazardous and accident prone. They low little application in

Colombo due to their high cost of maintenance, and difficulties of preventing their abuse. Mowed grass requires the highest management effort and cost.

b. Meadow/low shrubs are especially desirable in certain cases and many of these highway situations represent a balance between open conditions for driver visibility and somewhat natural vegetation conditions. Bur again, those have little application in Colombo as a planted verge of this kind is likely to be encroached upon illegally.

c. Tall shrubs especially desirable vegetation for centre of the high ways with many tracts but only if these can be introduced without hazard.

d. Small trees with herb layers are desirable roadside vegetation type. These highway situations generally combine relatively good driver visibility with certain forest conditions, such as shade and partial wildlife cover, but again are likely to be illegally occupied in Asian cities.

e. Natural forest/woodland is desirable for country side roads. In this type tall trees may be suitable close to roads carefully placed in relation to road speed. Management effort and cost are low (Forman and McDonald, 2007).

It is necessary to develop a schedule for assessment and trimming the roadside vegetation. The program should include information showing in which year, and time of year, all roads will be assessed. This program should be incorporated into a Geographic Information System (GIS) or similar computer program and a summary of the program included in all subsequent reviews of the Management Plan (Whyalla City Council Roadside, 2008)

According Whyalla City Council Roadside, 2008 in Australia, the type of clearance proposed here is not meant to imply or establish safety standards. The main clearance envelope allows for the passage of legal height vehicles (4.6 m) across the full width of the traffic lanes. To allow for re-growth between pruning and sagging of branches caused by wet or windy conditions, a minimum clearance height of 5.0 m will be maintained under a high level maintenance require and while is not applicable in Colombo.

Rural or non-built up areas is desirable to maintain a vertical clearance of 5.0m between the guideposts along a road. The district council may seek to maintain a minimum clearance envelope that is 5.0 m high, extending the width of the road (usually taken as the edge of the traffic lane) or 7.0 m, whichever is the greater, as shown in the **Fig.3.2.** Urban or built up areas is desirable to maintain a vertical clearance of 5.0m from kerb face to kerb face. The district council may seek to maintain a minimum clearance envelope that is 5.0 m high, extending over the width of the travel lanes that are available for the passage of all legal road vehicles as shown in the above **Fig.3.3**. The factors will be taken into consideration when determining clearance at roadsides are; Department for Transport, Energy and Infrastructure guidelines, concerning widths, lengths, setbacks and overhang (usually 5 m), visual amenity values, safety, signage, drainage.

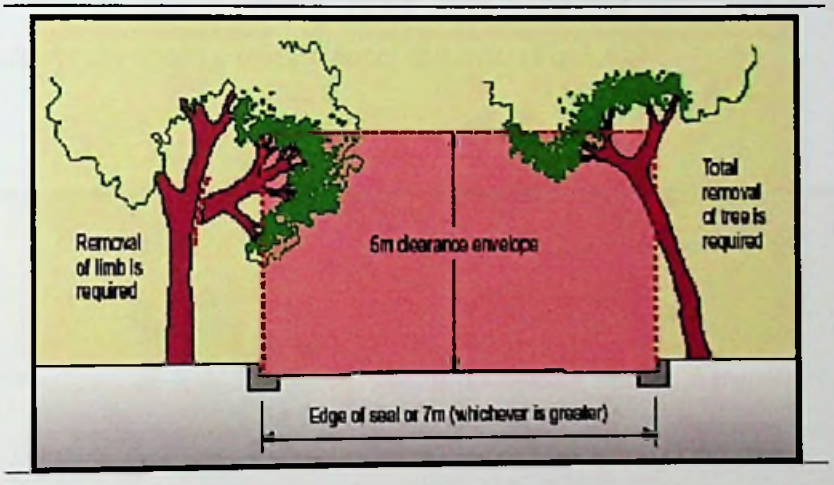

Fig.3.2. Rural Clearance Envelope (Minimum) Source: Whyalla City Council Roadside. 2008

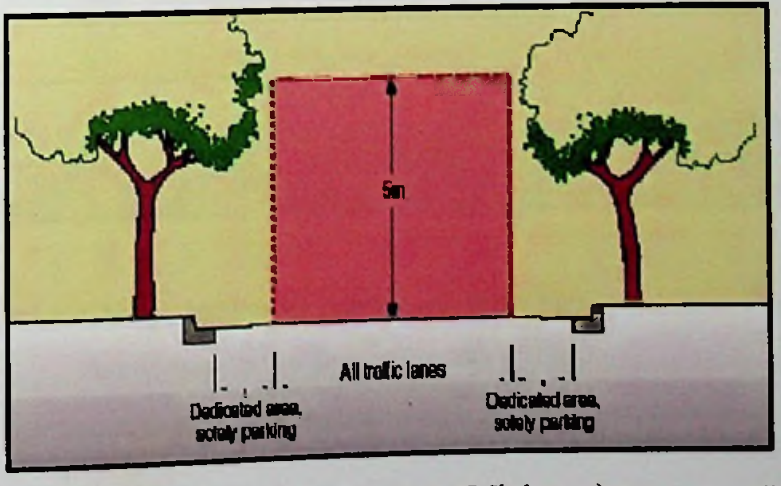

Fig.3.3. Urban Clearance Envelope (Minimum) Source: Whyalla City Council Roadside. 2008

The Management of the road reserve is vested with the responsibility of maintaining these resources in an efficient, cost effective and appropriate manner. It must be recognized that Road Reserves are often dynamic in nature, particularly those close to human habitation however, those reserves in 'out of the way' locations may not be subject to dynamic change or impact, but still require careful management. This clearance envelope may vary depending on the highway characteristics and location. The clearance envelope is further modified on highway medians. A clear height of 2.1 m will be maintained at the kerb and extend 1.0m from the carriageway or to the nearest edge of the trunk, whichever is lesser (**Fig.3. 4**). A secondary clearance envelope extending up to 500 mm around roadside furniture may also be sought (**Fig.3.5**). An additional vegetation control may be undertaken on the approach side of sign boards and delineation devices to ensure that the sign is clearly visible from a distance equivalent to the stopping sight distance for the speed environment of the road (**Fig.3.6**).

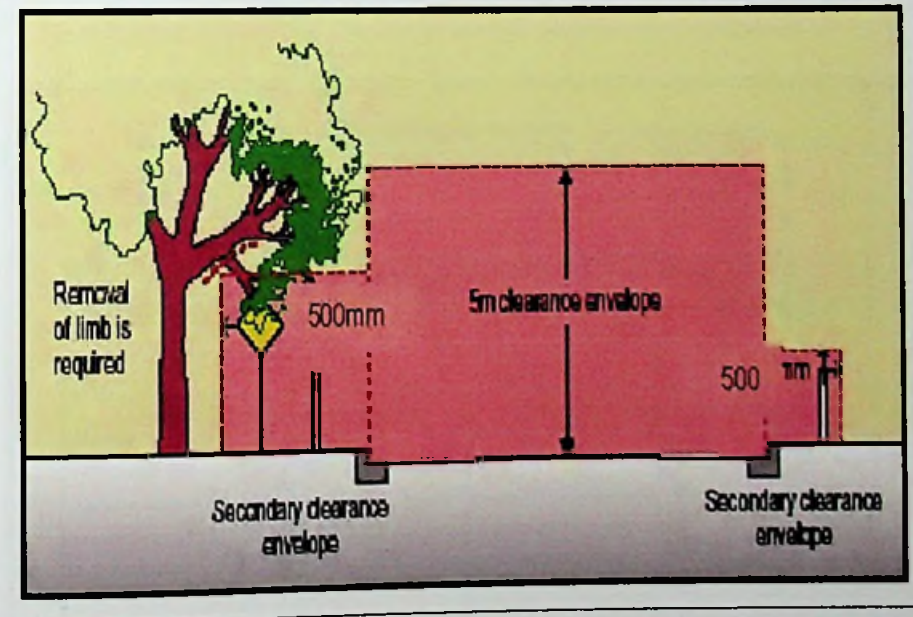

Fig.3.4. Change to clearance envelope at medians

Source: Whvalla Citv Council Roadside. 2008

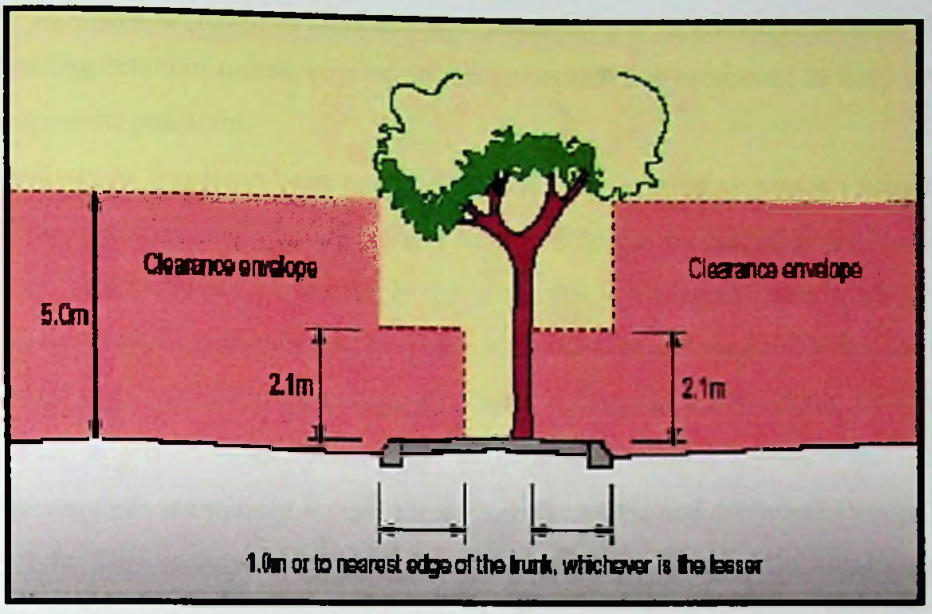

Fig. 3.5. Secondary Clearance Envelope

Source: Whyalla City Council Roadside, 2008

85th percentile speed (km/h)	Stopping Sight Distance (m)
51-60	65
61-70	85
71-80	115
81-90	140
91-100	170
101-110	210
111-120	250

Source: extract from AS/NZS 2890, table 2.6

Fig. 3.6. Sight distance for the speed environment of the road

Source: Whyalla City Council Roadside, 2008

The high quality roadside management practices are required to ensure road reserves containing remnant native vegetation are protected and preserved to help prevent future management problems.

In landscapes that have been extensively cleared, roadside vegetation provides essential wildlife corridors and habitat for local flora and fauna, including a number of threatened species. Hence it is highly desirable that this asset is managed in such a way as to ensure its conservation and sustainability. The control and management of roadside vegetation is the responsibility of the road manager. Local government authorities, as road managers, are often approached for 'permission' to take various flora products from the roadside. These requests are mainly for wildflowers, native seed and firewood (Verge Notes 2006) (Fig.3.7). This management type is not at present practiced in Sri Lanka, however, it is worthy of consideration in managing roadside trees in Sri Lanka.

Fig.3.7 The Roadside vegetation in open, non-urban Australian Countryside.
Source: Verge Notes 2006

The nature loving societies marks the first organizational effort by both lay and professional people to respond to public concern for the planting and care of lawn and street trees. Management of the urban forest is the responsibility of public and private owners. It involves any combination of property owners, City Park or forestry departments, city tree boards or commissions, private tree care firms, nursery people, and others. Optimum management, however, requires a system that considers both the needs of individual trees and the forest as a whole. Ideally, it must be a system that provides for

the social value of the forest while protecting the rights of all property owners as much as possible (Gene and Frederick, 1986). There are similar attempts to manage the roadside trees in Sri Lanka by a number nature loving societies such as Ruk Rekaganno, university students in March for Conservation etc.

Road construction and maintenance involves environmental considerations that range from the socially oriented aspects such as preserving heritage sites and maintaining amenity for residents living alongside roads, to biodiversity aspects such as protecting conservation areas and preserving valuable roadside vegetation (Fraser 2002).

Road reserves were initially established to provide legal access, and a route from one place to another. Since that time, road reserves have evolved to cover a wide range of activities. For example, service corridors for gas, electricity, drainage, sewage and communications are usually located on roadsides. Maintaining remnant vegetation within road reserves is important for many reasons (Whyalla City Council Roadside, 2008). The removal of plant material from roadsides includes: 1. Collection of dead timber; 2.Cutting of live timber; 3. Brush-cutting; 4. Seed collection; 5. Flower harvesting.

Fig.3.8 Roadside trees in Sri Lanka are subjected to removal or damaged due to maintenance services of different authorities and institutions. Here tree roots are dangerously curtailed by the roadside monsoon drain. Credit: Gunasinghe W.K.D.

The road formation and its associated drainage works are accommodated within the road reserve. The remaining space is called the roadside or road verge. Therefore, the roadside is the strip of land between the road formation (beyond the drainage area), and the boundary of the adjacent property (Jackson, 2002). In this context, the roadside trees in Sri Lanka are and have been subjected to removal or damaged due to maintenance services of different authorities and institutions. Further, there is no proper coordination and also no master plan between the authorities in the case of maintenance and upgrading of services etc.(Fig.3.8).

Fig.3.9 CMC (Colombo Municipal Council) laborers trimming roadside tree branches every Sunday in Colombo city. Credit: Gunasinghe W.K.D.

Trees and other vegetation on roadsides can affect road safety by restricting vision of road users, and encroach on the road asset in such a way as to contribute to its degradation. Vegetation type and growth vary across the State, so control techniques and timing of their application vary accordingly. Control needs to be undertaken in a way that avoids unnecessary damage to vegetation. Maintain vegetation clearances and sightlines in a way that preserves or enhances aesthetic and conservation values of roadsides. Thus, Removal, pruning, slashing, and mowing of vegetation in the road sides are important (Fraser, 2002). In general the following practices have been long recommended for road side vegetation. This management should ensure workers understand the aim of the particular type of vegetation control and operate only within the nominated areas. The commonly used practices are pruning and/or removing vegetation sufficient to meet

safety requirements, avoiding damage to other vegetation; avoidance special environmental areas; Identification of any re-vegetation areas or individual plants that need to be avoided; Pruning of a natural finish, e.g. prune entire branch, cut tree stumps close to the ground; chipping and mulching cleared material or replace whole where appropriate; spreading mulched material on bare areas for weed/erosion control, not on existing good quality native vegetation; disposing of waste vegetative material to an appropriate site, and do not bum. The Colombo Municipal Council also practices the above-mentioned management methods by the Land and Environmental Unit of the council under the supervision of a Director and Supervisor. However, there are no proper trained people and capital to carry out these practices. In addition there is no landscape architect and botanist in the municipal council (Fig.3.10).

Fig.3.10 Colombo Municipal Council laborers cleaning Colmbo roadside.
Credit: Gunasinghe W.K.D.

In Australia, the re-vegetation for roadsides must also include the following: Replanting near power lines must comply with the relevant guidelines of the power supply companies; Replanting on roadsides where exposure to the elements such as coastlines is an issue should be carefully planned. In general, lower shrub species should be planted on the windward side, grading to taller vegetation on the leeward side; On roadsides containing some remnant native vegetation, it may be possible to encourage natural regeneration through control of exotic weeds and grasses; Direct seeding of native species, using seed collected locally, can be a very effective and economical approach; Particular care is needed in dealing with native grassland areas as it may be inappropriate

to plant trees or shrubs in those areas; re-vegetation should allow for such items as access to fences and properties, future service requirements and maintenance of re-vegetation (Whyalla City Council Roadside, 2008). However, there are no such regulations related to the planting and management of roadside trees in Sri Lanka.

3.2 INVOLVEMENT OF GOVERNMENT AUTHORITIES AND INSTITUTES ON WAYSIDE TREE LANDSCAPING AND GREEN AREA

Road side tree planting and management in general requires an involvement of a number of institutions including governmental and non-governmental organizations. As far as Sri Lanka is concerned, a number of authorities such as the Central Urban Planning Agency (CUPA), Urban Development Authority (UDA), Road Development Authority (RDA), and Ceylon Electricity Board (CEB) are responsible for the improvement of the urban environment in the development plans for urban local authorities. Landscape planning becomes a must, and it should be kept in mind when proposing strategies to facilitate urban street planting, in conjunction with the work of all these authorities.

When dealing with road side tree planting and maintenance within the local government areas, it is necessary to establish the identity the owners of roads in town. Up to 1978 all of the roads belonged to the local authority i.e. the Municipal Council, the Urban Council and the Town Council. The Colombo Municipal Council has a horticulture and landscape division headed by a chief horticulturist. Colombo city has being divided in to six divisions and each division is headed by a horticulturist. Each division has twenty five labourers.

However, this process is at present coordinated by the UDA and its Landscape Division. This division guides local authorities in planning and designing landscape and tree planting programmes and carry's out work with programmes with advice from consultants. The other important owner of roads is the Road Development Authority. Earlier the Highways Department and then Public Works Department planted a lot of trees in regional roads which included Tamarind trees (*Tamarindus indicus*) and Paremara (*Samenea saman*). Other Departments actively participated in this programme

were the Coast Conservation Department, Sri Lanka Land Reclamation and Development Corporation and the Central Cultural Fund (in historical cities). However, there is no directly responsible national agency for street planting.

Fig. 3.11 Ceylon Electricity Board, Sri Lanka Telecommunication and Water and Drainage board labourers working at the roadside. This work frequently damages tree roots, weakening trees and making them vulnerable to wind throw during high wind and storms. Credit: Gunasinghe W.K.D.

Many cities have "official" street lists of trees from which adjacent property owners may choose. Other cities prohibit by ordinance the planting of certain "undesirable" species. Street side planting may also be controlled or influenced by subdivision regulations that require developers or property owners to plant trees. The most positive control, however, is in American cities where all street side trees planting is done by municipal forestry departments (Gene and Frederick, 1986). Municipal tree districts is USA may extend the concept of landscape assessment districts by receiving funding from air quality districts, storm water management agencies, and electric utilities in proportion to the value of future air quality, hydrologic, and energy saving benefits provided by municipal tree programs (Schwan, 2002). As far as Sri Lanka is concerned, there is no official list trees recommended for planting along the roads.

The road Development Authority in Sri Lanka under the provisions of Act No. 73 0f 1981 the Road Development Authority was established under the section 26 of the Act. Road improvement is interpreted as follows. "Improvement of roads includes widening of any roads" and includes widening of any roads, the leveling of roads, the provisions of pavements for the use of pedestrians, the treatment of a road for mitigating the nuisance of dust, the planting of trees and laying out of grass margins in roads and the doing of any other work in respect of roads beyond ordinary repairs essential to placing any existing roads in a proper state or repair" (Chandradasa, 1995). A adjoining owners of wayside trees include the Ceylon Electricity Company Pvt. Ltd., and Electricity Board. The Telecommunication Department and other institutions may chop back tree branches. Road maintenance may damage tree bases. Diggers may cut their roots in forming services trenches for electricity, water and sewage.

In Australia roadside vegetation is protected by both the Local Government Act 1934 and the Local Government Act 1999. It is also protected by the Native Vegetation Act 1991. There are several Acts of parliament that affect the way in which Roadside Vegetation is managed within South Australia. These Acts include; Local Government Act 1999, Native Vegetation Act 1991, Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth legislation) and the National Parks and Wildlife Act 1972. Local Councils must ensure all works or activities conducted within road reserve areas have prior Council permission and are being conducted subject to the requirements under the relevant Act of parliament. (Whyalla City Council Roadside, 2008). Sri Lanka needs similar legislations.

In addition community participation in the way side tree planting and management also plays a crucial role in California all-volunteer committee meets monthly. They review proposed tree removals, conduct tree tours, and organize two annual tree plantings. The group also initiated the city's first street tree inventory; volunteers walked the streets and recorded the health, size, and species of trees in the public right-of-way. They found an aging urban forest (Schwan, 2002).

In developed countries such as Australia, the Civilian Conservation Corps (CCC) have also made a significant contribution by its involvement not only in forestation,

reforestation, and windbreak plantings, but also in the planting of street trees in many cities (Gene and Frederick, 1986). Similar civil organization should be established for the purpose of planting, and conserving the roadside trees of Sri Lanka. However, the following aspect should be considered in development activities:

- New or replacement services should be established on cleared land wherever possible;
- Where services occur on roadsides the clearance of native vegetation must be kept to a minimum;
- Existing clearance standards can be maintained without consultation with the relevant authorities
- Disturbance of under storey vegetation and spoils (e.g. by vehicles and machinery) must be kept to a minimum

In Sri Lanka, the UDA Building and Planning regulation No.16 specifies the minimum width of roads in housing units. It varies from 3 m (10 feet) to 9 m (30 feet), (4 blocks to more than 20 blocks) for nonresidential buildings the minimum width is 6 m (20 feet). Regulation 19 of the same gives the minimum building lines for the roads in urban areas: 1. Local roads 6 m (20 feet), 2. Secondary roads 9 m (30 feet) 3. Principal roads 15 m (50 feet)

With inspiration from Los Angeles' Tree People, assistance from San Diego's People for Trees, and in collaboration with other likeminded residents, California's interest in trees led to the establishment of the Coronado Street Tree Committee. Before European settlement, the island of Coronado-with its abundant sun, sandy beaches, and meager rainfall-was covered with shrubs and grasses, not trees. In 1888 Coronado was established as a resort community for wealthy East Coast American families. These new residents brought a love of trees, and ensured that many were planted. Later, the island also became a major military base, which boomed when sailors stationed on Coronado in World War II returned to settle there. Today, the community of 30,000 is one of the wealthiest in California, but its urban forest is aging and in decline (Schwan, 2002). Sri

Lankan organizations such as Ru Rekaganno are also involved in the similar activities in Sri Lanka.

Urban development areas in Sri Lanka are the areas declared as such by the Minister in charge. According to the UDA law No. 41 of 1978. All categories of roads in the declared areas definitely become urban streets. However, according to No. 70 of the UDA planning and buildings regulations of 1986; "Public street" means any street over which the public have a right of way and has become vested in any authority under any law and includes the drain of any footway attached thereto(City of Colombo Development Plan-Volume 1-1999).

3.3 PROBLEMS OF WAYSIDE TREES

There are a number of problems related to the planting and maintenance of way side trees in Sri Lanka. According to Fraser (2002), there plant pathogens including both bacteria and fungi which cause a variety of diseases. For instance, dieback is a disease that results in the slow death of vegetation and is caused by the introduced *Phytophthora fungus*. This fungus is spread by the movement of spores in water, and by human activity that moves infected soil. *Phytophthora* is restricted to the part of Thiland where approximately a third of native flora is susceptible to attack. *Phytophthora* cannot be eradicated once an area is infested, therefore it is imperative that road management activities avoid introducing and spreading it.

The disturbances due to human impacts have led to increase the vulnerability of Sri Lanka wayside trees to many diseases and also to direct destruction of trees. In Sri Lanka, it common that during the political meeting, funerals of famous personalities, religious processions, national and international sport activities damage is caused to street trees. Trees are also damaged by careless and reckless drivers ramming vehicles in to way side trees. Highly competitive commercial activities have also resulted in the removal of trees the roadsides in order to make an have an open road frontage opposite their establishment to attract customers. In addition, bill board and advertising banners also damage trees and disfigure aesthetic views (Fig.3.12 (a) and (b))

Fig.3.12 (a) and (b) Bill board and advertising banners on Sri Lankan wayside trees, injuring and disfiguring them. Credit: Gunasinghe W.K.D.

Many environmental problems with trees in urban areas can often be traceded to stress resulting from soil conditions, limited growing space, pollution, and wounding. Many of these problems could be avoided by designing road side tree plantations by careful design.

The methods of urban garbage disposal also critically influence the dying of roadside trees. Due to piles of garbage around the base of roadside trees. When the garbage is dry, it's often burnt. Road menders also often use a tree trunk as a part of an open furnace to boil tar in barrels. Carters, pilgrims etc (Fig.3.13). often light fires under a tree, adjacent to its main trunk. Road side trees are also used to hold advertisements, banners and posters. One can often see coir ropes and string still dangling from the branches even after the banners and posters have been removed.

Fig.3.13 The methods of urban garbage disposal also critically influence the dying or damage of roadside trees.
Credit: Gunasinghe W.K.D.

It is unfortunate that roadside vegetation faces clearing of the vegetation in order to erect and maintain boundary fences. This will exert higher pressure, especially in road reserves where only a few meters width of vegetation remain. This can be avoided by issuing a"Verge Note" aiming to highlight ways in which landholders can work with road managers on fence line issues to ensure the continuity, longevity and health of roadside vegetation for personal, community and environmental benefit (Roadside Conservation Committee, 2008). People in Sri Lanka should be made aware about the issues related to roadside trees by the media including magazines, papers, handouts and electronic media etc.

Title to trees growing on street rights-of-way sufficient to claim injury damage is commonly given to adjacent private property owners. The responsibility for pruning and care of street side trees is also often transferred to property owners. The transfer of rights and responsibilities is generally prescribed by ordinance or code. In many cities and towns in Sri Lanka however, street side tree responsibility is based on policy or tradition rather than ordinance.

When the new saplings are planted in Sri Lanka it is very difficult to protect them from stray cattle, goats. The most recent danger caused to street trees is from the dropping of polythene on trees for various functions and political party meetings. There is legislation

to prevent this practice; but it is often ineffective. Strips of polythene entwined in the branches hinder the free growth of the trees. Trees of medicinal value like Kohamba (*Azardirachta indica*) are a good choice for street planting, but people remove parts of the tree for medicinal purposes.

b. In summary, it may be seen that there is a relentless destruction of existing roadside trees instead of planting new trees. Therefore, conservation and protection of roadside trees is very important. Human abuse of wayside trees in Sri Lanka is the bigger reason for this continuing loss. A relatively small loss is due to natural causes.

3.3.1. HUMAN INVOLVEMENT

There are a vast array of human interferences with the planting and maintenance of wayside trees. Some of these activities are beneficial, most are not. In addition, activities of certain governmental institutions such as the Ceylon Electricity Board and Department of Telecommunication have the right to prune trees to maintain adequate clearance for overhead cables, or to cut roots to safeguard ground services.

1. Dust

Many of the human interferences to trees have already been maintained but the following is a summary list. Road construction and maintenance activities often generate amounts of dust, especially in very dry conditions. Dust is a nuisance in the environment and can decrease amenity values. It can also be a health hazard causing respiratory problems and can pose a risk to traffic safety by reducing visibility. Control dust emissions for the benefit of nearby residents and to limit the effect on native vegetation. The following practices have been suggested for minimizing the dust formation.

- Clear vegetation only when necessary.
- Control dust by spraying soil with water as required.
- Treat areas due for soil stabilization as soon as practical to minimize soil blow.
- Use dust suppressants as appropriate, that are suitable to the environment and in accordance with the manufacturer's recommendations.

- Inform the adjoining community about planned activities that might cause significant dust.
- Tree planting generally helps to reduce dust nuisance.

2. Noise and Vibration

Noise and vibration cannot be noticeably reduced by tree planting. Any apparent reductions are largely psychological.

3. Waste Management

Construction and maintenance activities generally produce various types of waste, including waste from work camps. Waste materials require proper disposal to avoid pollution, hazards, and visual blight. Minimize environmental degradation by properly disposing of waste. The following measures have been forwarded to mitigate the effect of waste on roadside trees.

• Identify waste products from road activities and plan correct disposal.
• Identify suitable areas for disposal of spoil from road works.
• Dispose of waste that could cause environmental degradation in areas determined as suitable.
• Ensure workers are aware of proper disposal.

4. Fire hazards

The effects of burning beneath wayside trees in damaging tree canopies and roots.

3.3.2. NATURAL CAUSES

Natural causes of tree loss include the followings:

1. Aging - each living being and plant has its age limits, when it comes to that limit the tree will die. The long term planed replacement of trees reducing the end of this useful life made careful consideration.

2. Adverse Environmental Changes such as **Thunder showers**- lightning striking on trees may cause injury or death to trees. Heavy rain showers falling on branches increase the

load that they can bear and branches break off. Wind and cyclones severely affect street trees. For instance, recently many of the wayside trees on the Bauddhaloka mawatha Colombo 7 have fallen due to thunder showers and storms. The devastative cyclone of 2004 led to the loss to of 106 road side trees in Colombo City.

Fig. 3.14 In case of parasitic attacks roadside trees are decay and die. At Bauddhaloka mawatha and Wijerama road junction. In old age trees are increasing liable to suffer dieback and decay. Credit: Gunasinghe W. K.D.

3. Allopathic reasons and parasites-Without careful maintenance most urban wayside trees in the country such as *Tabubeia* and *Samanea* (Paremara) may be colonized by the strangler trees (*Ficus* sp) (Fig.3.14 and 3.15) Due to the parasitic growth such as *Loranthus sp.*, ultimately the original tree will be completely covered by the new comers which subsequently suppresses the original tree. Many roadside trees have been colonized by *Ficus* species in Colombo city.

4. Weeds - Weeds are unwanted plants colonizing particular habitat. Weeds may interfere with agricultural production, compete with and displace native vegetation, and become a visual blight on the landscape and also increase fire hazard. Weeds are classed as either "declared" or "pest plants" by regulations and require specific actions to be taken, that may involve voluntary actions by individuals and organizations. Transport corridors such as roads are a means of spreading weeds, either by road construction and maintenance activity or by actions of road users. Controlling the spread of weeds is essential.

Fig. 3.15 Matured trees of *Tabubeia* and *Samanea* (Paremara) colonized by the strangler trees and being converted to *Ficus religiosa* or *Ficus benjamina.* At Reid Avenue and most of the other roads. Credit: Gunasinghe W. K.D.

5. Water Quality, Erosion and Sediment Control - Runoff from road construction and maintenance sites can contain pollutants and affect the quality of receiving waters such as wetlands, watercourses, ground water, and drinking water supply. Pollutants can include hydrocarbons such as oils, heavy metals especially in urban areas, and sediment. Large volumes of runoff from cleared areas can cause significant erosion and general land degradation and sever damage to the topsoil on which wayside trees deuced.

Maintaining of water quality in wetlands, waterways, and drinking water catchments areas and also wayside that adjoin roads are of important in preventing the damaging effect of above-mentioned factors. Control erosion from cleared areas to avoid erosion and siltation of watercourses (Fraser 2002).

3.3.3 PROBLEMS EVOLVE IN RELATED AREA (PAVED AND ROAD AREA)

Trees are still being planted in individual raised, containers in some of our urban areas. Tree roots require an area ten times the diameter of raised planters to grow large enough to meet the scale requirements of the street. Raised planters on side walks disrupt the ground level and detract from the street space (Henry, 1993). But today with the expansion or development of urban areas the authorities dig the existing roadways frequently. They damage the roots of the existing trees. This happens because of the lack

of planning in road development and design. Road development always pared the side walks without considering the damage which could be caused to trees. Concreting and tarring around base of tree trunks without leaving room for the roots to breath and the tree to flourish in its natural growth is another source of tree injury. This will first kill the roots and then with the monsoonal wind tree falls on the road. Recently, with the fear psychosis caused by terrorism, most people tend to protect their premises with a high boundary wall around it. The excavations for the foundations of these walls may also damage or hider the growth of roadside trees (Fig. 3.16).

Fig.3.16 The *Samanea saman* trees and *Turmanalia cattapa* tree root system come over the surface damage the pavement and cause difficulties for pedestrians.

Credit: Gunasinghe W.K.D.

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CHAPTER 04

CHAPTER 4
ISSUES RELATED TO WAYSIDE TREES IN CITY OF COLOMBO

4.1. ISSUES

There are a number of issues related to the wayside trees in the city of Colombo. These can broadly be considered under the following headings: Population increase, encroachment, urbanization, sustainability, surface hazards, branch drop, bird and bats nuisance, and microclimatic effect.

4.1.1 POPULATION INCREASE

Population growth is the change in population over time, and can be quantified as the change in the number of individuals in a population using "per unit time" for measurement. The term population growth can technically refer to any species, but almost always refers to humans, and is often used to refer specifically to the growth of the population of the world.

Population Density by Planning Units of City of Colombo

Name of Planning Units	Population per Hectare		
	Year 1981	Year 1997	Year 2010
Fort	85	70	82
Kochchikade	486	506	536
Maradana	221	222	236
Kollupitiya	147	136	153
Manakkuliya	159	191	216
Kotahena	188	180	180
Grandpass	218	244	272
Dematagoda	225	343	469
Borella	182	222	256
Cinnamon Garden	51	57	64
Bambalapitiya	99	92	104
Wellawatta	141	152	166
Narahenpita	78	86	97
Kirillapone	129	188	230
Total	158	180	208

Source : UDA and CMC

Fig.4.1 Population Density by planning units of City of Colombo
Source: UDA and CMC

The increase in the population density is one factor that influences the wayside trees of a country and this is more critical in the urban or suburban areas in a country. To support densely packed urban populations, societies take resources from their surroundings and concentrate them in cities. Moving natural resources in this way sustains modern society and results in significant environmental degradation. People extract resources from remote areas, causing deforestation and soil erosion, and they move resources to urban areas, causing problems with waste disposal and water and air pollution (Wackernagel and Rees , 1994).

The extent of the city of Colombo is over 3733 hectares with a population of 660,000 according to the last census of 2001(Fig. 4.1). The growth rate is 1.25% per annum and population density is 176.80 persons per ha (Fig.4.2). The road percentage is 16.3% of the total land use. There is increasing population demand or land for settlement and other activities such as recreation. However, the limited availability of land aggravates the problems related to urban forestry and the difficulty of establishing new wayside tree planting in Colombo (Fig.4.3).

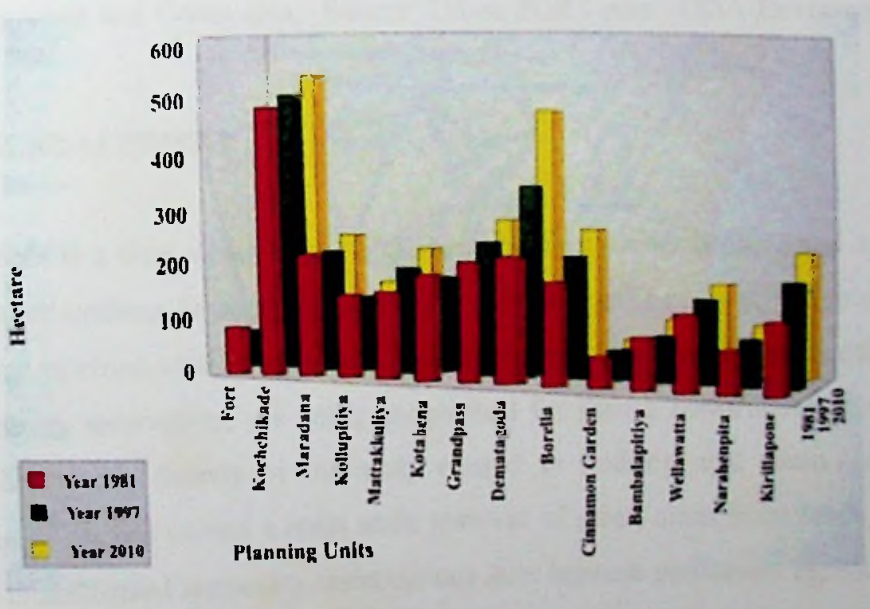

Fig. 4.2 Population Density by planning units of City of Colombo
Source: City of Colombo Development Plan (1999)

Planning Unit	Estimated Population 2001	Existing Parks (Ha)		Proposed (localised) Parks (Ha)	Proposed linear parks and water bodies
		Public	Other		
1. Fort	17,000	0.6	2.20	2.4	*0.72
2. Kochchikade	76,000	3.25	-	4.3	-
3. Maradana	47,000	-	4.3	4	0.9
4. Kollupitiya	46,000	*11.61	2.20	0.3	*1.98
5. Mattakkuliya	55,000	5.54	-	12.9	7.65
6. Kotahena	33,000	0.3	-	2.3	-
7. Grand pass	51,000	*10.61	-	10.9	2.4
8. Dematagoda	60,000	*10.0	0.7	5.3	2
9. Borella	32,000	5.1	3.1	2.9	0.464
10.Cinnamon garden	34,000	*36.72	14.4	2.1	-
11. Bambalapitiya	41,000	3.0	0.2	7.4	3.0
12. Wellawatta	64,000	5.51	5.4	4.9	11.81
13. Narahenpita	104,000	1.0	1.70	10.6	2.0
14. Kirulapone		2.0	41.4	2.2	5.0

Fig. 4.3Colombo Municipal Council - Existing /Proposed PORS in relation to population of planning units and Green area. Source: Urban PORS plan -UDA Environment and Landscape unit.

4.1.2. ENCROACHMENT

Encroachment is a term which implies "advance beyond proper limits", and may have different interpretations depending on the context. In Sri Lanka many of the open spaces, green spaces in cities, road reservations, river reservations and state owned other lands such as railway reservations are being encroached for illegal construction every year. These problems are directly or indirectly related to political and socio-economical interference. This has caused a mass scale removal of green areas from lands in many cities. The unauthorized temporary constructions later become permanent especially with the consent of some political influences in which negative social or environmental issues are ignored. For instance, there are many boutiques in the Colombo City area which were set up under wayside trees preferring the shade of the trees (Fig. 4.4). The activities of these boutiques directly or indirectly affect the survival of the trees.

Fig. 4.4. Photographs showing boutiques under trees at Slave Island, near the Gangarama Temple, Colombo city, Sri Lanka. Credit: Gunasinghe W.K.D.

4.1.3 URBANIZATION

Urbanization is a term used to describe the concentration of people and activities on into areas classified as urban. In brief, the conversion of a rural environment into an urban area could be considered as a process of urbanization. In an urban area people tend to concentrate, seeking the better facilities available. These problems are compounded in the developing world since economic constraints are much larger in countries like Thailand, than in North America or Europe. It is difficult to find money for adequate environmental management when basic needs and poverty are an immediate concern. In Bangkok alone, one third of all homes do not have water and most sewage ends up untreated in the canals that crisscross the city (Sivaramkrishnan and Green, 1986).

There are a number of governmental organizations and non-governmental organizations are concentrating in the Colombo city limit and most of these organizations are not well-organized. This situation has led to the degradation of available areas for the urban trees (Fig.4.5 and Fig. 4.6).

Fig. 4.5 Rapidly urbanizing Fort area of Colombo city.
Source: www.slgssr2007.org

Fig. 4.6 Private development adjacent to Beira Lake is high urbanized area.
Credit: Gunasinghe W.K.D

4.1.4 INDUSTRIALIZATION

The term industrialization refer to an over riding economic precedence given to industrial development within on area of urbanization and maintaining in very large scale concentration of a industrial processes often of a highly polluting nature (Fig4.7).

Fig. 4.7. A European city after the industrial revolution.
Source: www.indrevo- sustainability.Murdoch.edu

Industrialization has brought a number of environmental problems which are obviously affecting the wayside trees since many roads in Colombo are association with industrial areas. In addition, transportation networks linking these industrial areas have been

increased to transport the products efficiently and other to the determinant of wayside trees. Pollutants such as gases, liquids, solids of industries may be handled carelessly and released to the environment. In addition, adjacent roads and vehicles also spread and spill various chemicals, from mineral nutrients and road salt to heavy metals and hydrocarbons, on the roadside. These can have very harmful effects on trees in industrial areas. These environmental changes alter the range of plant species that barely survive or that become competitively dominant on roadsides. The root systems, formation of leaves of roadside trees can be damaged and die due to air pollution from industrial byproducts. In Colombo city having more factories, especially in Dematagoda, Mattakkulioya, Kotahena, Grandpass, Modara, Paliyagoda etc. tends to reduce areas of vegetation coverage and to create very high air pollution. A well developed planting plan must be introduced for these areas and the source of pollutions dealt with (Fig.4.8).

Fig.4.8 In industrialized areas of Colombo city. There are planted only small bushes. Where a large trees in needed to create a satisfactory contrast to the surrounding urbanization.
Credit: Gunasinghe W.K.D

4.1.5. BARRIERS AND OBSTRUCTIONS

Wayside tree planting areas may be restricted where street lighting and telecommunication equipment has to be accommodated. Trees themselves may sometimes be regarded as obstruction, for example, when closely planted against the light so that they are perceived by drivers as an irritating flicker.

Fig. 4.9 Telecommunication and Electric power lines increase the visual and physical obstruction to roadside tree planting in city of Colombo and are very visually intrusion. Credit: Gunasinghe W.K.D

4.2. SUSTAINABILITY OF BIODIVERSITY

The planting of wayside trees should be carried out whenever possible so that the biodiversity of the city area is not reduced. In this regard native vegetation of conservation value should be kept and introduced special discarded. Roadsides are now highly valued for their remnant vegetation and the role this vegetation plays in the conservation of natural resources. This includes the conservation of water, soil, indigenous flora and fauna and the contribution this vegetation makes to landscape values across an area. In the colonial period introduced wayside trees were planted in Colombo

and a relatively low percentage of these were indigenous. Present policy is to plant indigenous species whenever possible (Fig.4.10).

Roadside vegetation may also provide essential habitats to threatened or endangered faunal species. For instance, in some areas in Australia there are rare fauna such as the Carnaby's cockatoo, when breed in the hollows of roadside trees. In addition, more than 50% of Declared Rare Flora has at least one population on a roadside, and some species are dependent on roadside vegetation for their continued existence. Roadside vegetation also has benefits for local communities. It provides farmers with shade and shelter for their animals and crops, and prevents soil erosion. The visibility of roadside vegetation can provide locals with a defined sense of place based on easily identifiable characteristics they recognize as "home". Wildflowers on roadsides also attract wildflower tourists to the Wheat belt, as roadsides are often the most accessible patches of bush to view the Australias's flora (Verge Notes 2006). Above planting method must be applied to roadside vegetation of Sri Lanka, therefore it is very important to protect our native species and enhance the own aesthetic environment.

Fig. 4.10 The wayside trees in city of Colombo mostly species are introduced by the Colonial peoples. Credit: Gunasinghe W.K.D.

Roadside vegetation is valuable in forming linear strips of vegetation (and habitat) between other remnants. They assist the movement of native animals and plants between remnants. They also provide habitat in themselves for many native plants, mammals, reptiles, invertebrates and bird-life. The density, width and connectivity of roadside vegetation affect its potential as a wildlife corridor. In general, wider, more continuous stretches of vegetation act more effectively as corridors and provide more shelter and food than narrower ones. The concept of the 'edge effect' applies to roadsides that are quite narrow, and have a large edge: area ratio. Edge effects include greater invasion of weeds, higher proportion of common birds, such as crows, and higher exposure to wind, rain and heat and roadside pollution (Jackson, 2002).

Roadsides are often the only remaining example of the original vegetation communities within extensively cleared areas. This is particularly true in agricultural landscapes, where almost 98% of the vegetation in some areas has been cleared. As such, roadsides also support many populations of threatened species of flora but this is unlikely to be the care in cities, and there are no good examples of this in Colombo (Jackson, 2002).

Roadside managers are encouraged to retain timber on roadsides as an important component of the natural habitat, which fulfils ecological, aesthetic and land management functions. Fallen logs and branches within the roadside create important habitat for many species of insects, reptiles, mammals and birds, thus enhancing the roadside biodiversity. Insects and reptiles that live in fallen timber are also important elements of the food chain, and are very important to the functioning of natural systems, and the survival of many other native animals (Verge Notes 2006).The country side of Sri Lanka can be seen above roadside communities but in urban areas such as Colombo the roadside community is drastically different from the countryside and again there are no good examples of this in Colombo.

4.3. INCREASE VULNERABILITY TO URBAN NATURAL DISASTER

The natural disasters badly affect the way side tree in different ways. These disasters can be listed as bellow:

a. Earth slip- In the rainy season earth slips are frequently in the hill country waysides. But can't be seen in the Colombo city area.

b. Water logging- Due to unfavorable drainage system our roads are often water logged. Some times this can lead to continuous damage and leakage of plumbing lines and drains. They severely affect root breathing system and kill the tree gradually. Most of our main urban centers are on flood plain (Kelani -Colombo). The urban street constructed on meshes and water logged areas frequently result in the dying of wayside trees. E.g. New Parliament road at Sri Jayawardana Pura.

c. Root damages- Natural decay due to various fungi and bacterial infections.

d. Water stress- Specially dry and arid zone street plants die in their early stages due to shortage of water not in Colombo, in dry zone.

4.3.1. SURFACE HAZARD FROM LEAF AND BRANCH LITTER AND OTHER NUISANCE

Fig.4.11 The formation of slippery carpet made the traffic in the roads specially in rainy days.
Credit: Gunasinghe W.K.D.

Plant litters winds spread across road surfaces from verges can cause hazards not fruit from fallen branches but also leaf litter fallen regularly cleaned up. Tree species used in

wayside planting should ideally have a higher level to minimize this nuisance. The fallen leaves and plant debris including twigs can be accumulated on the roads and make the roads slippery. Therefore fallen leaves should not be allowed to accumulate because of the danger of the skidding. Further, the crowns must be kept above the tops of the largest vehicles and regular removal of old, diseased and damaged branches must be undertaken. Some from of barrier should be used between the trees and the traffic; initially to protect the trees and later to protect the traffic (fig4.11). Fallen branches from road side trees and cause damages to the vehicles, buildings and, power and telecommunications lines. This may badly affects the country's economy. Further, the removal process of fallen trees demands high labor and cost which is an additional burden to the budget of the Colombo Municipal Council. Colombo often suffers such loses for example during heavy rains and storms. In 2004, 106 large old trees were lost.

Fig. 4.12 The crows and bats dirty on the road. Credit: Gunasinghe W.K.D.

Some times trees may be resting places for avifauna and if the bird population is excessive, the waste will pollute the area and may eventually kill the trees. All such problems occur above ground and they are obvious reasons why some people may reject the concept of tree planting close to buildings. But underground conflict can be more serious. Sometimes roots can block drains and damage paths, walls and building by their direct growth (Fig. 4.12).

4.3.2. INDUSTRIAL AND VEHICULAR EMISSIONS (CO_2)

Increased concentrations of greenhouse gases are now generally accepted as a cause of climate change. Trees can reduce atmospheric carbon dioxide (CO_2), the dominant greenhouse gas, by directly storing carbon (C) as they grow. Large healthy trees sequester about 93 kg C/yr as compared to 1 kg C/yr for small trees. In addition, urban trees can also reduce CO_2 emissions from power plants by reducing energy use as they lower temperatures and shade buildings during the summer, and block winds in winter. Perhaps a more immediate concern in cities is the heat island effect, a condition of excessive accumulation of heat associated with impervious surfaces. The reflection rate of paving is important as higher reflectance means cooler temperatures. Black pavements, the hottest, have solar reflectance of only 5 to 10%. Lighter pavements are at 25% or higher. In the peak of summer in warm climate areas, temperatures of asphalt and automobile surfaces can reach as high as 170°F. In addition, paving materials act as thermal batteries, accumulating heat during the day and releasing it at night generating wide daily fluctuations in temperature. Vegetation canopies can very markedly help to cool paving by direct shading of the ground surface. They also cool paved areas indirectly through transpiration of water through leaves and exposed soils. A study of day temperatures at a mall in Alabama found parking lot temperatures at 49°C. However, beneath planters containing trees the temperature was only 32°C, and nearby small groves of trees recorded 17°C less than nearby parking lots (Dixon and Wolf 2007)(Fig.4.12).

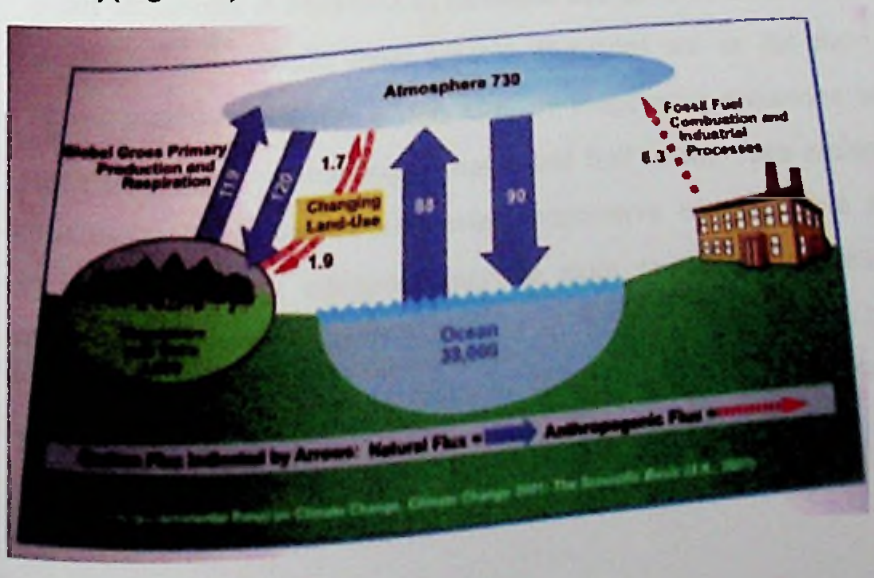

Fig.4.13. Gaseous exchange between the environmental layers. Source:www.wikipeadia.com

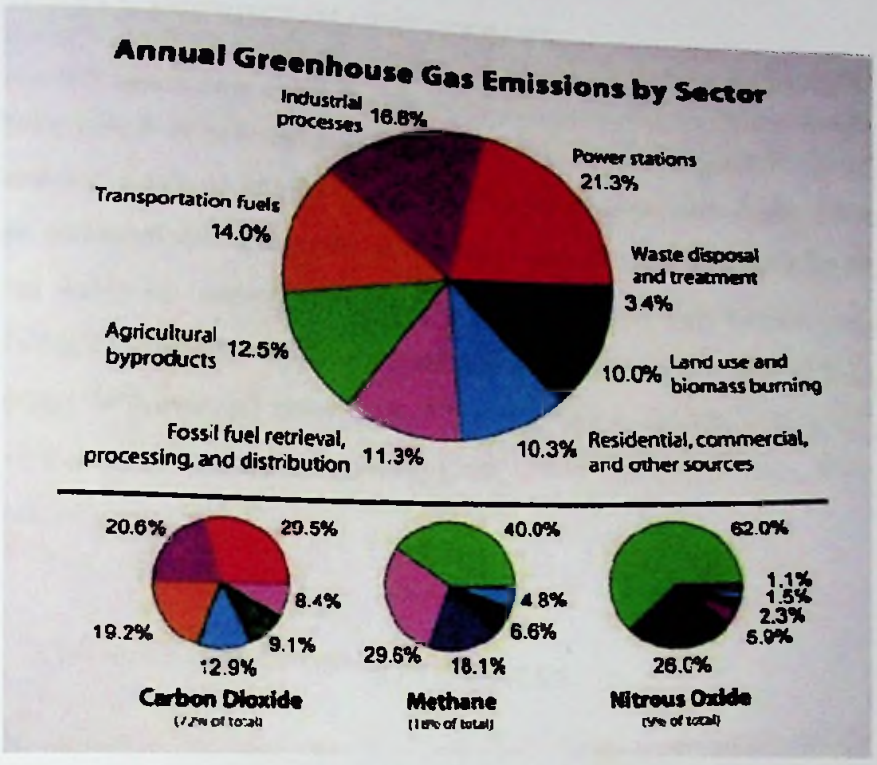

Fig. 4.14. Annual Green House Gas emissions by sector. Source: www.wikipedia.org

Urban vegetation directly and indirectly affects local and regional air quality by removing air pollution and altering the urban atmospheric environment. Urban forests have a positive impact on air quality through adsorption of pollutants by the vegetation canopy, sequestration of atmospheric carbon dioxide in woody biomass, reduction of summertime air temperatures and associated ozone formation, and energy savings that reduce power plant emissions. A net effect of increased tree cover in urban areas is a reduction in ozone concentrations. While most vehicle emissions are in the form of tailpipe exhaust, approximately 16% are in the form of evaporative emissions when vehicles are not operating (that is, from engine hoses and fuel tanks). Such emissions contribute to the formation of ground level ozone. Evaporative emissions are sensitive to local air temperature. Such emissions may be more severe in locations where vehicles are concentrated, and where temperatures are high. Trees that shade pavements can reduce asphalt temperatures by as much as 36°F, and fuel tank temperatures by nearly 7° F (Dixon and Wolf 2007)(Fig.4.14).

4.3.3. URBAN MICROCLIMATIC EFFECTS

The urban forest exists in a microclimate of itself and human structures. The microclimatic factors having the greatest influence on tree growth are air temperature, humidity, and wind. Microclimatic can be either beneficial or harmful depending on how much the extremes and duration of heat, cold, wind, and evapotranspiration are influenced (Gene and Frederick, 1986). The reduction in green spaces leads to higher temperatures in towns and cities generally than in the surrounding countryside. This is known as the 'heat island effect' (Lowry, 1967).

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CHAPTER 05

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MAIN IMPORTANCE WAYSIDE TREE LANDSCAPING AREAS IN COLOMBO CITY

In this chapter a comparison is made with landscape areas in Colombo city with cited cities in McClumskey (1992).

The vertical enclosure created by vegetation or other objects provides visual control. Everything that occurs within the enclosure is a part of the visual function of that space and must be taken into account. A desirable object can be emphasized and, conversely, an unattractive object negated by manipulating the vertical enclosure (Fig **5.1**).

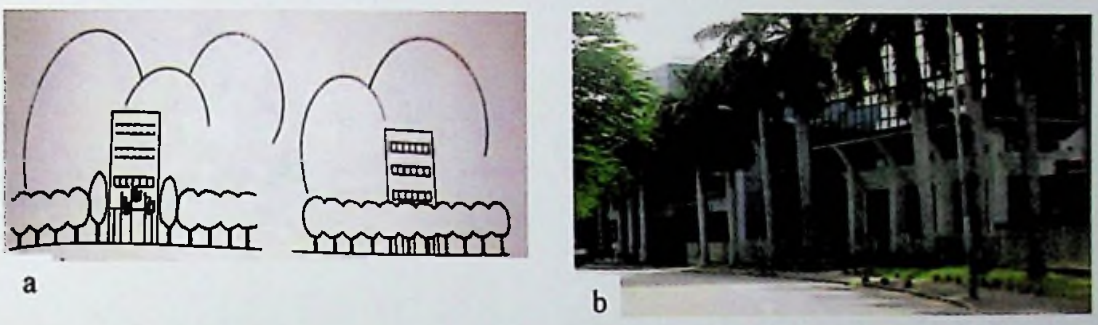


Fig. 5.1 (**a**). The sketch diagram showing manipulation of the vertical enclosure can emphasize or negate an object. (**b**). This photograph can be compare with a. at Perahara Mawatha, Slave Island, city of Colombo, Sri Lanka (Palm Tree Line).
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

Strong contrasts in form, size, texture, and color, or combinations of the design elements will create interest and lead the viewer's eye to a desired object (Fig. **5.2**). By the same token, repetition of any one of the design elements may tend to negate an associated object (Fig. **5.3**).

Generally strong contrasts within the vertical enclosure should be avoided. Repetition and subtle changes in form, size, texture, and color are desirable. Exceptions to this principle occur at major street intersections or at any other area where alertness and viewer attention are desired (Fig. **5.4**).

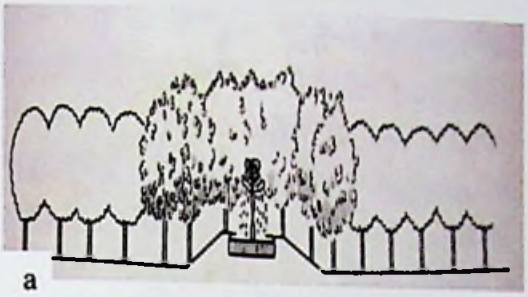


Fig.5.2 (**a**). The sketch diagram showing strong contrasts in texture and color will attract viewer attention to a desirable object. (**b**). Similar characters shown in this photograph at Gangarama Seemamalakaya, Slave Island, Colombo city, Sri Lanka (*Plumeria obtusa* and *Pithecelobium dulce* line).
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

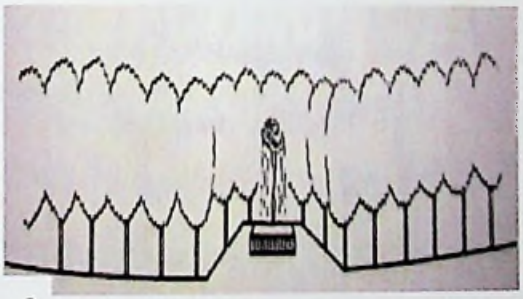


Fig.5.3a.) The sketch diagram showing repetition of the design elements, (form, size, texture and color) will negate an associated object. (**b**). Similar tree planting can be seen at Independence Square, Colombo 7.
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

In certain cases the designer utilizes all four of the design elements at one time in concept development, but all four must be considered. The common denominators should usually be size and form (Fig. 5.5) (Gene and Frederick, 1986). A row of trees need not always line the whole length of the road. In a short street this is preferable but on long stretch of road the change of scale and sense of containment which is experienced by moving from a part of the road without trees into a tree-lined length gives variety and interest (McCluskey, 1992).

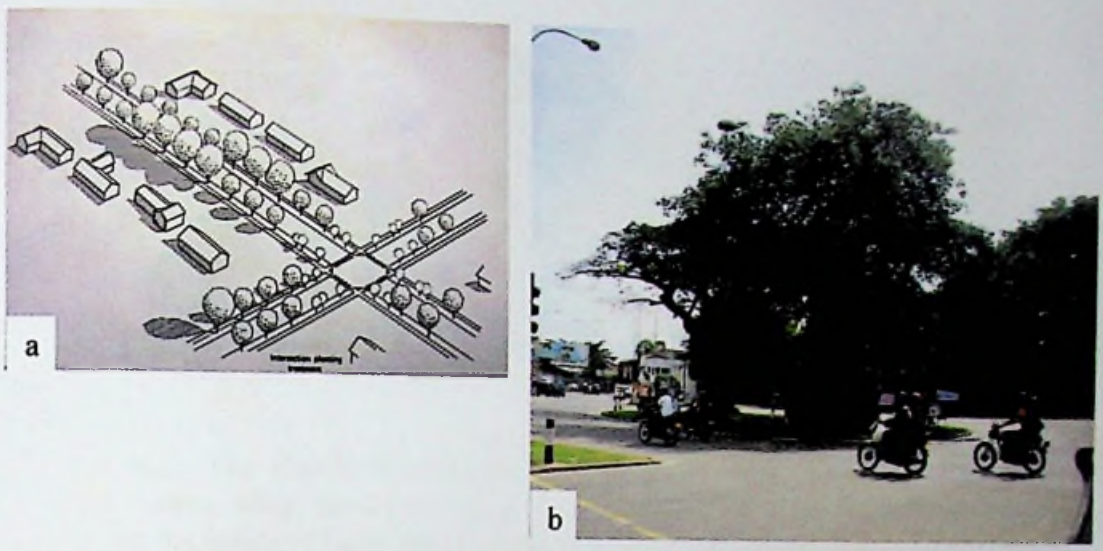


Fig. 5.4 **(a)**. The sketch diagram showing major street intersections can be emphasized by strong contrasts in the vertical enclosure. This intersection is emphasized by abrupt changes in tree size, color and texture. **(b)**. This Photograph somewhat similar to the above a. This place is Bouddhaloka Mawatha Roundabout, at Borella end, city of Colombo (*Peltophorum enerme, Pithecelobium dulce, Samanea saman, Ficus benghalensis, Ixora)*

Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

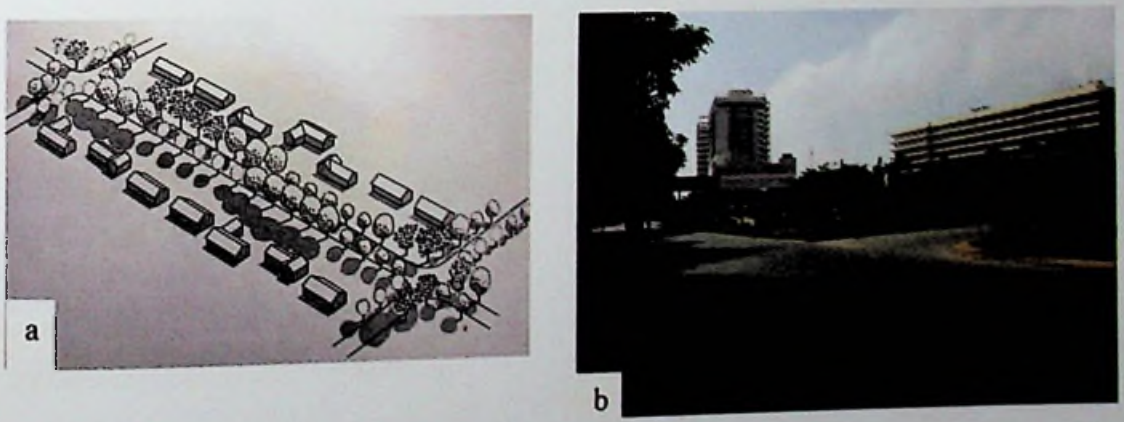


Fig.5.5 **(a)**. The sketch diagram showing a well designed interesting street corridor resulting from repetition without monotony and subtle change in size, form, and texture. **(b)**. Similar tree line and buildings arrangement shown in this Photograph at Colombo 2, Slave Island Police Station Roundabout, Sir Chittampalam A Gardinar Mawatha, Colombo2 (Near the Trans Asia Hotel).

Credit: Gunasinghe W.K.D.

Source: McCluskey, 1992

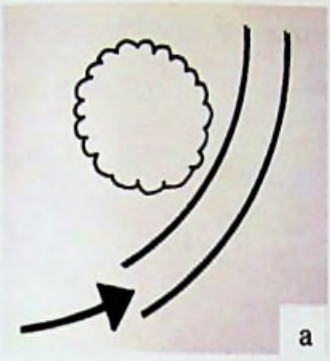


Fig. 5.6 (**a**). The sketch diagram showing a visual logic can be imparted to a horizontal curve, when the reason for it is not immediately apparent, by tree or shrub planting on the inside of bend. (**b**). This pattern can be seen in many curvings of roads. This place is Independence Square Road.
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

A visual logic can be imparted to a horizontal curve, when the reason for it is not immediately apparent, by tree or shrub planting on the inside of bend, Fig. **5.6.** In Fig. **5.7** the curve of the road follows the boundary of some playing fields and the logic of the line is emphasized by the need to avoid the clump of trees adjacent to the inside radius.

Fig.5.7 (**a**). Photograph showing the curve of the road following the boundary of some playing fields and the logic of the line is emphasized by the need to avoid the clump of trees adjacent to the inside radius. (**b**). Wijerama Mawatha, Colombo7, In front of the British Embassy (*Samanea saman* and *Pithecelobium dulce* trees can be seen here).
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

Planting on the outside of the curve will emphasize the line and the same time can seem to dictate the route chosen, Fig. **5.8.** This type of planting can be particularly useful for night driving.

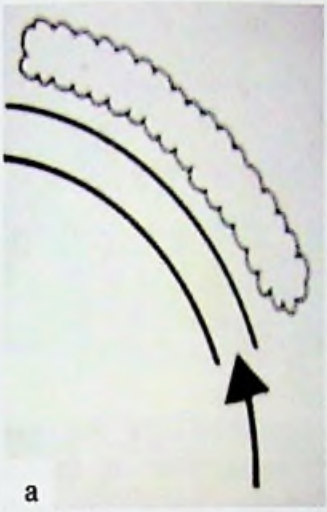
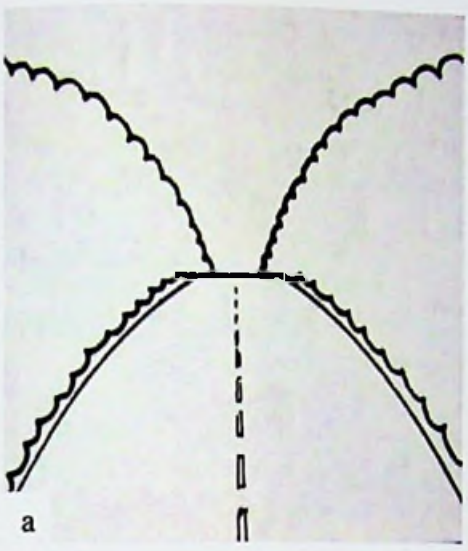


Fig.5.8 (**a**). Sketch diagram showing planting on the outside of the curve will emphasize the line and of the same time seem to dictate the route chosen. (**b**). Similar curve can be seen at Sir Chitthampalam A Gadinar Mawatha, Colombo2 with well- maintained bushes, palm trees, and a good lawn.
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

The continuation of a line on the other side of a vertical curve can be indicated by the presence of trees at the side of the road. When there is no change in horizontal direction across the summit curve this is clarified for the driver, Fig.**5.9**, and, more important, when there is a change of direction he is forewarned, Fig. **5.10**.

The existence of a fork in the road can be emphasized by planting, Fig.**5.11**. This is not a desirable form of junction except when vehicles are traveling at slow speeds. If trees are planted on either side of the less important of the two routes this will help to convey its secondary role since the motorist, if he takes this route, will have a sense of going out of one type of space and entering in to another, **Fig.5.12**. In a similar manner, vegetation can be used to emphasize the existence of slip road on the near side of the main route, Fig.**5.13**.



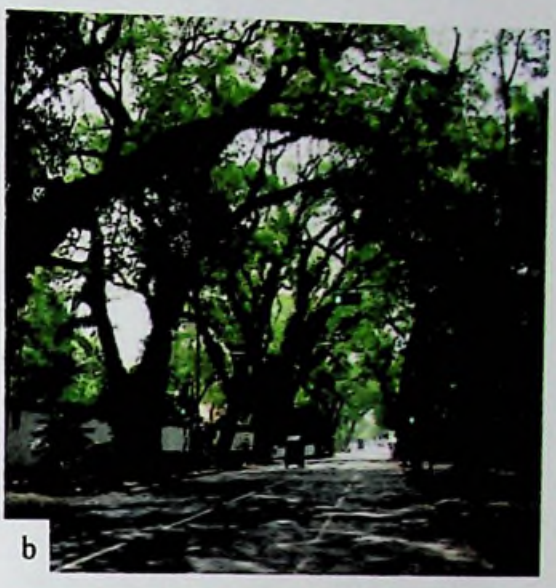


Fig. 5.9 (**a**). The sketch diagram showing when there is no change in horizontal direction across the summit curve this is clarified for the driver. (**b**). *Samanea saman* trees and *Pithecelobium dulce* tree line planted along the Stanley Wijesundara Mawatha, Colombo 7 as a Boulevard.

Source: McCluskev. 1992 Credit: Gunasinghe W.K.D.

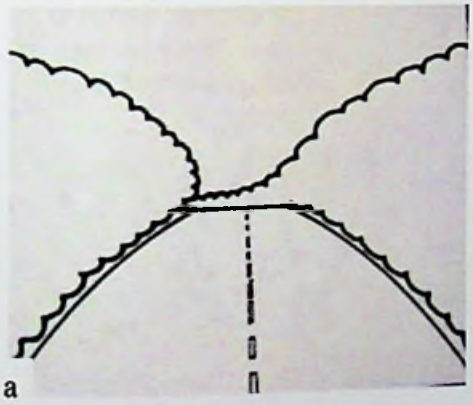


Fig.5.10 (**a**). The sketch diagram showing more important, when there is a change of direction he is forewarned. (**b**). the photograph showing the same curve (bend) enhances the direction he is forewarned. The planted trees were *Turmanalia arjuna, Terminallia cattapa, Filicium decipiens.*

Source: McCluskey. 1992 Credit: Gunasinghe W.K.D

In both these examples the tree planting helps to make the road read.

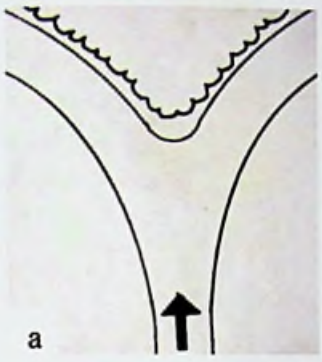


Fig.5.11 (**a**). The sketch diagram showing the existence of a junction in the road can be emphasized by planting. (**b1**). The photograph showing same junction at University of Colombo, Stanly Wijesundara Mawatha (*Pithecelobium dulce, Ficus religiosa, Terminallia cattapa)*. (**b2**). at the Alfred Crescent (*Samanea saman, Peltophorum pterocarpum)*.

Source: McCluskey, 1992

Credit: Gunasinghe W.K.D.

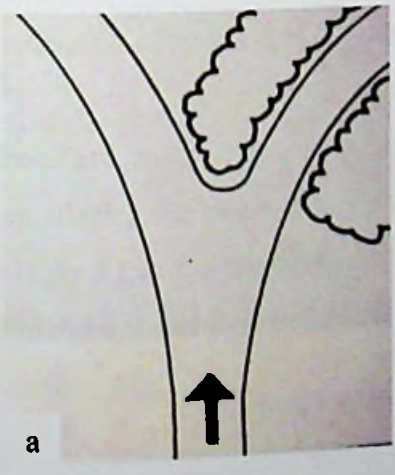
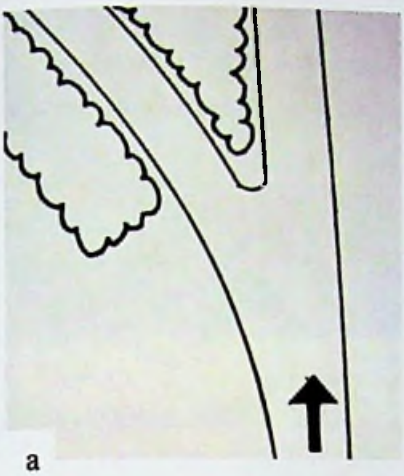


Fig. 5.12 (**a**). The sketch diagram showing trees planted on either side of the less important of the two routes. This will help to convey its secondary role since the motorist, if he takes this route, will have a sense of going out of one type of space and entering in to another. (**b**). this photograph is showing similar junction to the Dr. A.Coomaraswamy mawatha and Horton place. The tree species of *Tabubuwa rosea, Delonix regia, Turmanalia arjuna, Pterocarpus indicus, Tectona grandis, Terminallia cattapa, Ficus benghalensis* can be seen here.

Source: McCluskey, 1992

Credit: Gunasinghe W.K.D.



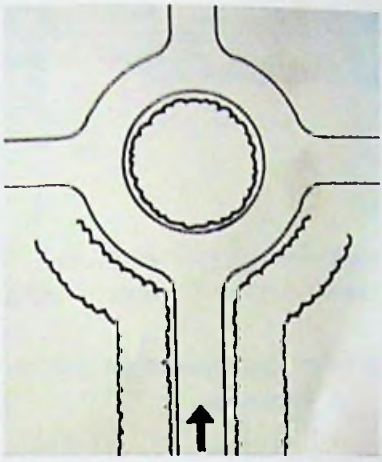
a

b

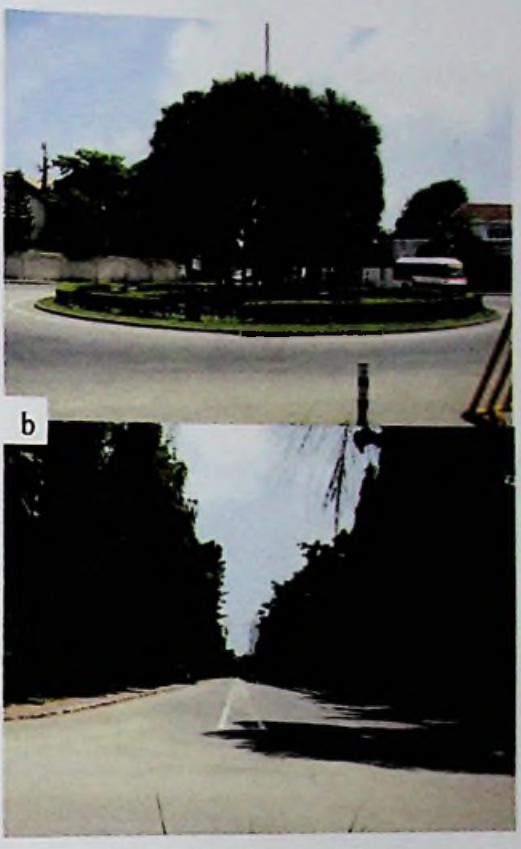
Fig. 5.13(**a**). The sketch diagram showing in similar manner vegetation can be used to emphasize the existence of a slip road on the near side of the main route. (**b**). this junction at in front of the western province chief minister's office Colombo7. The trees have been planted *Cassia fistula, Tectona grandis, ilicium decipiens, F. benghalensis*.
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

If trees as a kind of punctuation mark, or full stop, are grown on a roundabout this will present the approaching driver with a visible barrier which will act as a caution. Planting on either side of the approach road, by creating a sense of enclosure, will also encourage a reduction of speed, Fig. **5.14**.

There are many ways in which views can be framed by planting at the roadside. Considering the case where the road is flanked on either side by trees, the simplest way is to leave a gap the width of which can be scaled to the design speed, **Fig.5.15**. The profile of planting can be controlled by using smaller trees and shrubs so as to gradually reveal the view, **Fig.5.16**.



a



b

Fig. 5.14(**a**). The sketch diagram showing if trees are grown on a roundabout this will present the approaching driver with a visible barrier which will include caution. Planting on either side of the approach road, by creating a sense of enclosure, will also encourage a reduction of speed.(**b**). The photographs shown the as a same junction above sketch diagram at the Independence Road and Maitland Crescent Roundabout. The *Polyalthia longifolia* avenue and in Palm trees and *Ixora* shrubs inside the Roundabout.
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

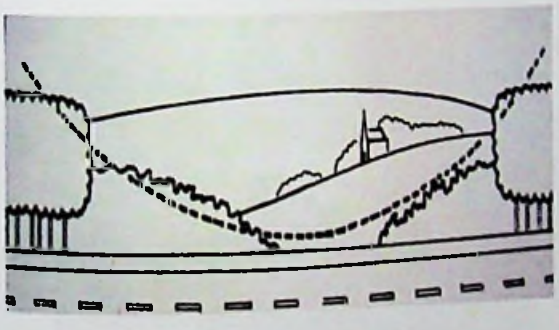
Alternatively the spacing of the trees may be increased so that, at the design speed, the view is not seriously interrupted. This could be done using regular spacing, **Fig.5.17**, which is increased with design speed. **Fig. 5.18.**

a

b

Fig.5.15 (a) The sketch diagram showing the road is flanked on either side by trees; the simplest way is to leave a gap which is scaled to the design speed. (b) These types of planting of trees can not be seen in the city of Colombo. But very famous views of these types of landscaping planting method can be seen in the Hill country (Central and Uva province of Sri Lanka).

Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.



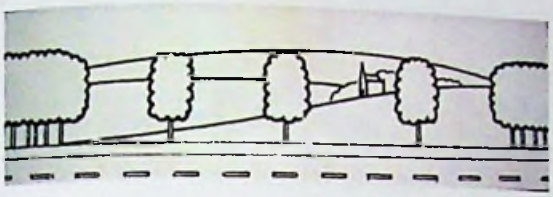
a

b

Fig.5.16 (a) The sketch diagram showing the profile of planting could be controlled by using smaller trees and shrubs so as to gradually reveal the view.(b) Similar roadside area cant be seen in Colombo city limits but can be seen along the Colombo Kandy road, at Kegalle.

Credit: Gunasinghe W.K.D.

Source: McCluskey, 1992

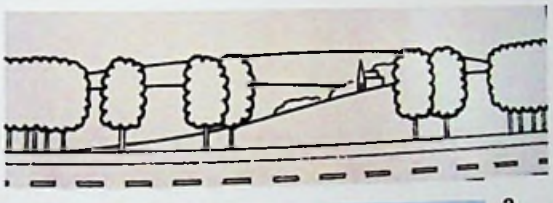


a

b

Fig. 5.17 (**a**)The sketch diagram showing alternatively the spacing of the trees could be increased so that, at the design speed, the view is not seriously interrupted. This could be done using regular spacing.(**b**) Similar scenic view seen in Wallawaya, Baticoll road. *Turmanalia arjuna* tree line with paddy field.

Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.



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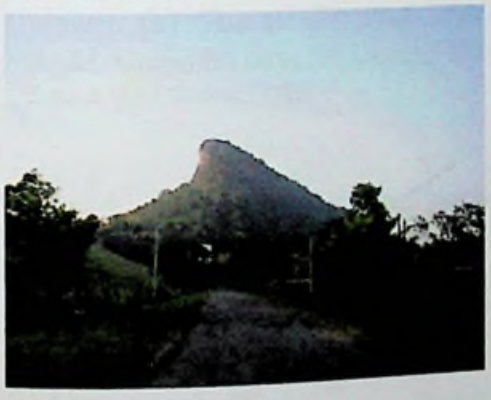


b2

b1

Fig. 5.18 (**a**). The sketch diagram showing alternatively the spacing of the trees could be increased so that, at the design speed, the view is not seriously interrupted. This could be done using irregular spacing. (**b1**) and (**b2**) Respectively seen similar roadside landscape at Wallawaya, Ampara road and Inginiyagala reservoir road.

Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

Single rows of trees on the road side exhibit a dual effect which is some times of special use to designers. When viewed along the road the trunks of the trees present a more or less solid wall, depending on their spacing and proximity to the viewer, **Fig. 5.19**. Yet when they are viewed at right angles to their line they can be arranged to present little visual obstruction, **Fig. 5.20**. This enables the designer to draw the attention of the traveler to the views at right angles to the line of motion (McCluskey, 1992), but again by relating tree spacing to the speed of travel.

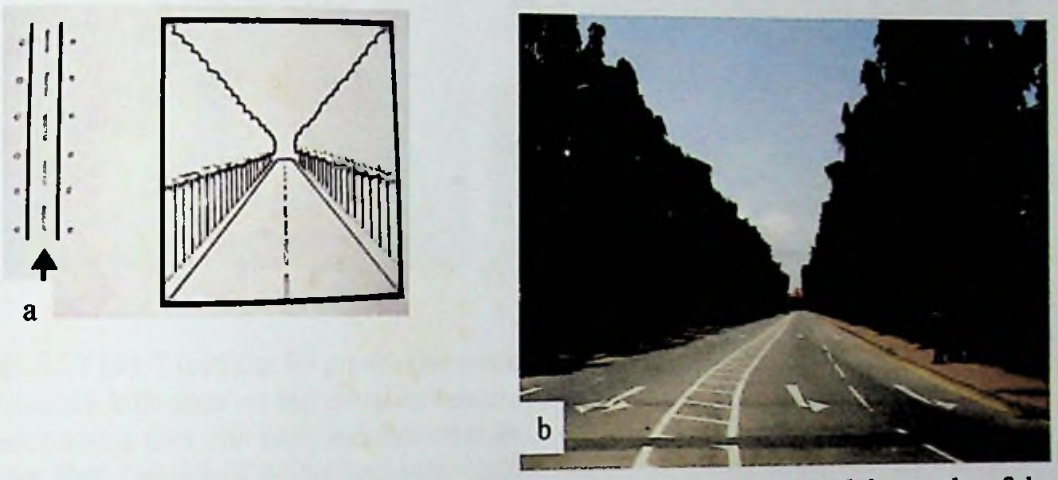


Fig. 5.19 (**a**). The sketch diagram showing when viewed along the road the trunks of the trees present a more or less solid wall, depending on their spacing and proximity to the viewer. (**b**). The similar view can be seen at the Independence Square, Independence Road, Colombo city, Sri Lanka (Willow Avenue).
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

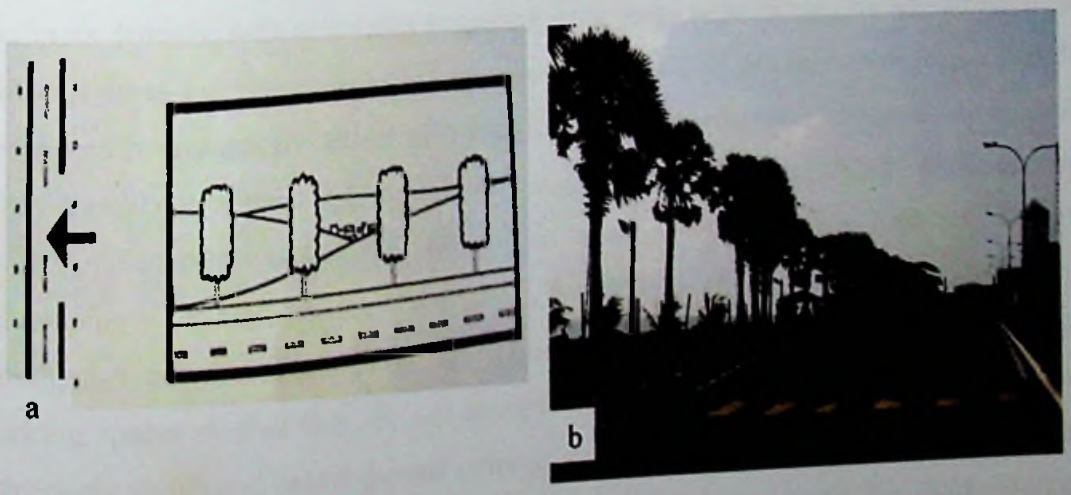


Fig. 5.20 (**a**). The sketch diagram showing when they are viewed at right angles to their line they can be arranged to present little visual obstruction. (**b**). At Galle face green, Galle Road, city of Colombo (*Palmyra* strip) to view the sea through the trees to the left.
Source: McCluskey, 1992 Credit: Gunasinghe W.K.D.

As with all aspects of road design, new planting must be considered at all stages of the design process as a three dimensional undertaking: the fact that some of the diagrams are presented in plan or elevation arises from the need to isolate particular points from their total context in order to emphasize them and from the convenience of this method of presentation.

a b

Fig. 5.21 (**a**). Trees can be grown successfully in business districts and can have a very favorable influence on the visual environment in USA and (**b**). A similar arrangement of road, parking area with trees, and pedestrian space can be seen in Dharmapala Mawatha, Town Hall, Colombo City, Sri Lanka (*Mangifera indica, Terminallia cattapa, Filicium decipiens,* Shrubs *and* Araliya trees).

Source: Gene and Frederick, 1986 Credit: Gunasinghe W.K.D.

Business districts, with sidewalks extending from curbs to buildings, are among the most difficult areas for tree planting. Spatial and site problems are most severe and people impact on it very greatly. Street side trees in business districts must be carefully located. They should not be used in front of major store entrances or display windows but may be used in front of areas between widows or buildings. Trees should also not obscure advertising signs but both should be carefully related to each other. Automobile parking arrangements must be considered. Trees should preferably be located directly in front of parking spaces so that they do not interfere with pedestrian movement between cars. Obviously above and below ground utilities, parking meters, and other physical features must also be considered and by open monsoon drain in hot climates (Fig. **5.21**).Modern subdivisions are products of our automobile-oriented society. They are characterized by

wide curving streets, few sidewalks, large lots, and houses set well back, from the streets (fig. **5.22**).

Fig. 5.22(**a**). Modern subdivisions are characterized by wide curving streets, few sidewalks, and houses set for back from the street in USA and (**b**). At Perahera Mawatha, Slave Island, Colombo2 (*Pithecelobium dulce, Terminallia cattapa*).

Source: Gene and Frederick, 1986 Credit: Gunasinghe W.K.D.

These areas often allow departure from the traditional single row of street side trees and provide opportunities for informal design. Original trees were often planted in the center of the tree lawn with strict regimentation by straight row and spacing (Fig. **5.23**). Spacing was often too close, perhaps reflecting a lack of appreciation for mature size. Close spacing was also a result of narrow lots with property owners often wanting two trees at the front of 40 to 50 m ft (12.19 to 15.24 m) lots (Gene and Frederick, 1986).

Fig.5.23 (**a**) Photograph showing a road, with tree line, turf and pedestrian in USA and (**b**). This is well exemplified in Gilfed Crescent road and trees of *Tabubuwa rosea, Filicium decipiens* at Colombo7, Sri Lanka.

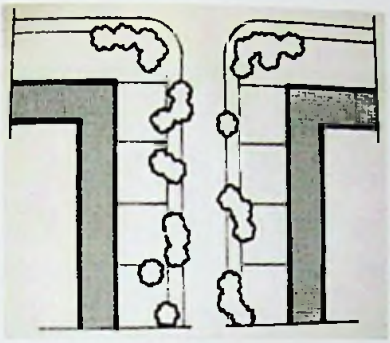
Credit: Gunasinghe W.K.D.

Source: Gene and Frederick 1986

Braxton Little, 2002). One alternative is to locate the trees in small groups with an occasional single tree along the length of the road, **Fig. 5.24**, resulting in a less formal appearance and rendering the space through which the road passes more visual and less static in character. In residential areas it may be possible to group the roadside trees together with trees growing in the front gardens (McCluskey,1992) but this is not common practice in Colombo.

Pedestrian movement is mainly local, directed toward parks, shops, school, adjacent streets, and rapid transit stops. There is a relatively high intensity of pedestrian flow from cross streets onto Commonwealth Avenue in example, which is part of a preferential route through Back Bay. Random movements are limited to the park, except for occasional groupings adjacent to churches and schools. Re routing some of the district vehicular traffic might foster a greater continuity between the sidewalks and the central green space as well as offering the potential for including many more structured activities of benefit directly to students, children, and the elderly - a basis on which increase further the residential and commercial uses along the avenue (Anderson, 1978) and including space for the planting of shade trees.

Roadside vegetation is a visible link to the natural heritage, representing a transect across the landscape of the original diversity of vegetation, certain types of which have generally been cleared from adjacent lands. In this regard, the roadsides also help to provide local communities with a 'sense of place' regarding their natural environment (Lamont and Atkins, 2000).



a

b1

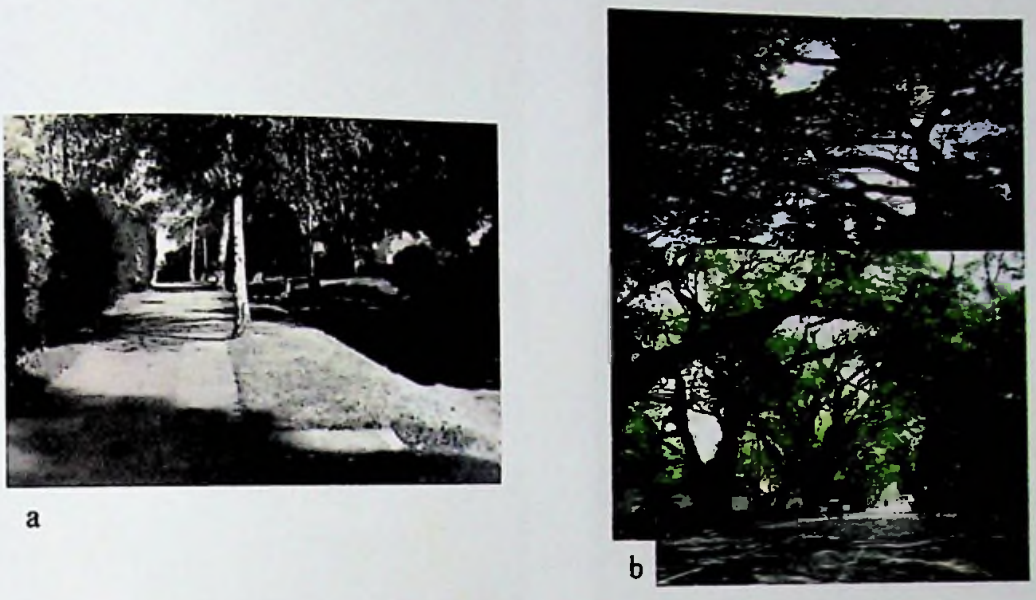
b2

Fig. 5.24. (**a**) Sketch diagram showing tree line in the residential areas. (**b1**) The similar type of tree planting at Stanley wijesundara Mawatha, Colombo City, Sri Lanka. (**b2**) Private Road of Alfred Crescent, Colombo7.
Source: McCluskey,1992 Credit: Gunasinghe W.K.D.

Steep side slopes have been used as can be seen on the far side of the road in the photograph and these, combined with the canopy of trees, provide a strong sense of enclosure to the area and the two tier segregation system contributes valuable visual interest. Fig **5.25** (McCluskey, 1992). The use of twin rows of trees is illustrated in Fig.**5.26**. In this example the pedestrian as well as the motorist is given the advantage of a separate, shaded, tree-lined route.

Even with a single row of trees the character of the walkway and the road are greatly dependent on the width of the foot path and the distance of the foot path from the kerb. In Fig. 5.27 people are resting or recreating on benches adjacent to the pedestrian way. In this example the sense of spaciousness resulting from the side verge and foot path area

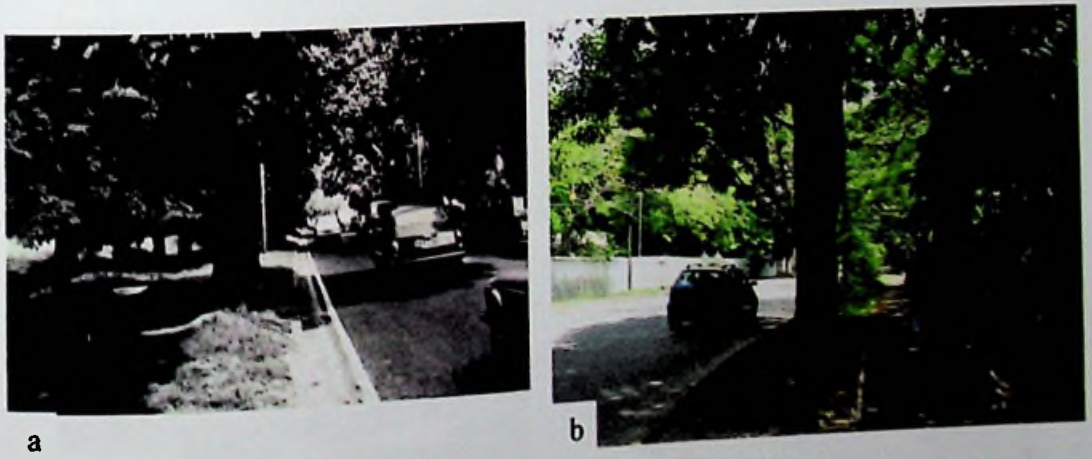
contrasts with the confinement of the pedestrian to a narrow strip between the trees and the front gardens in Fig. 5.28 (McCluskey, 1992).



a b

Fig. 5.25 (**a**). Photograph showing a road, with tree line, turf and pedestrian in USA and (**b**). The similar manner can be seen in Reid Avenue at Colombo7. More shaded tree boulevard made by *Samenia saman*, and *Peltoporum ptercarpum* trees.

Source: McCluskey,1992 Credit: Gunasinghe W.K.D.



a b

Fig. 5.26 (a) . In this example the pedestrian as well as the motorist is given the advantage of a separate, shaded, tree-lined route, and pedestrian path in USA (b). In Guilfed Crescent, Colombo City, Sri Lanka (*Filicium decipiens, Tabebuea rosea*).

Credit: Gunasinghe W.K.D.

Source: McCluskey,1992

Fig. 5.27 **(a)**. People resting or recreating on benches adjacent to the pedestrian way in USA **(b1)**. A similar situation shown in Slave Island road (in front of the Beire Lake), Colombo city, Sri Lanka (*Pithecelobium dulce, Tectona randis, F. benghalensis*). **(b2)**. Perahara Mawatha, Slave Island, Colombo2 (*Tectona grandis* Avenue).

Source: McCluskey,1992 Credit: Gunasinghe W.K.D.

Fig. 5.28(a). The side verge and foot path area contrasts with the confinement of the pedestrian to a narrow strip between the trees and the front gardens. (b). The Reid Avenue, Colombo7,has the same narrow pedestrian pathway. Credit: Gunasinghe W.K.D.

Source: McCluskey,1992

It is not always possible to have a dominant focal point at the end of a tree lined road and in this case if the containing elements are of adequate scale this is sufficient to achieve a satisfactory effect. In the example of **Fig. 5.29** building at the end of the road is not sufficiently substantial to act as a focus or to bring about adequate enclosure (McCluskey, 1992).

Fig. 5.29 (**a**). Showing dominant focal point at the end of a tree line in USA and (**b1**). similar Willow tree lines along the Independence Avenue, Colombo7, and (**b2**). Palmyra tree strip at Galle Road, Galleface Green, Colombo, Sri Lanka.

Credit: Gunasinghe W.K.D.

Source: McCluskey,1992

There are generally three ways of planting trees in relation to roadways. One way of planting in relation to roads, when sufficient area can be made available, is to provide them in such numbers that the impression is made of the road moving through woodland, **Fig. 5.30**.The trees then contain the space through which the road passes, **Fig. 5.31.** , and at the same time it creates a visual boundary to the spaces on the other side of the tree belt. The second way is a more open impression which can be achieved by placing the trees in informal groups with some single trees, **Fig. 5.32.**

When this type of arrangement is used, consideration must be given to the way in which the groups subdivide the overall space and to those views which are opened up and concealed. A third method is to plant the trees in rows parallel to the road, **Fig. 5.33**. Single or double rows may be used depending on the space available and the scale of effect required. The best results are often obtained when the trees are spaced close enough for their canopies to meet along the rows and in some cases also across the road (McCluskey, 1992).

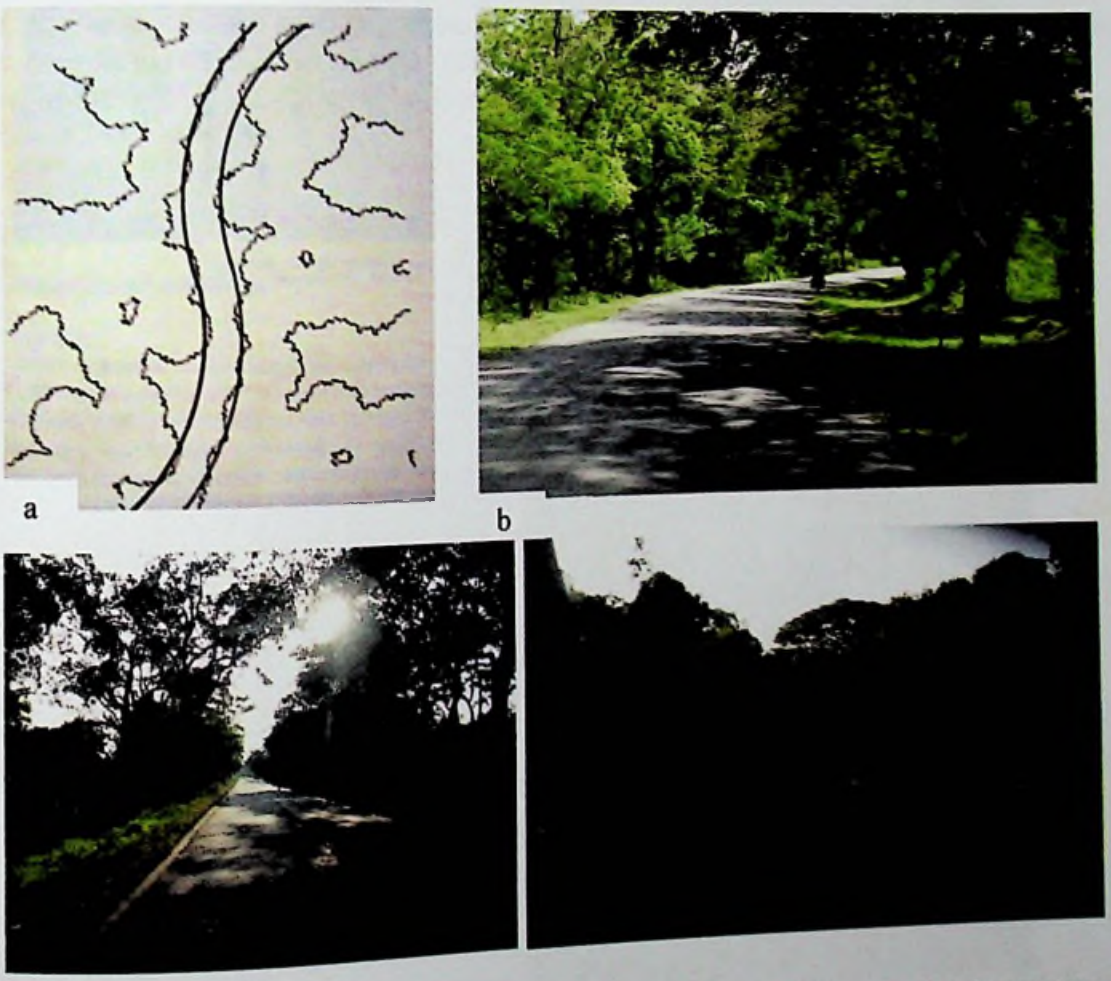
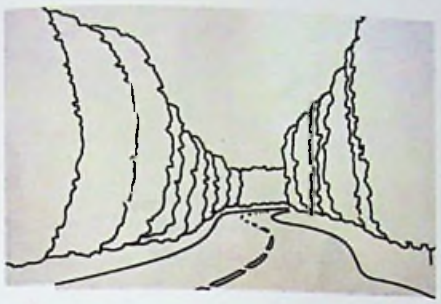


Fig.5.30(a) The road moving through woodland. (b)This type of road tree planting system not seen in city of Colombo except incidentially in the suburban outskirts of the city . It is well exemplified at Monaragala, Anuradhapura and Polonnaruwa in Sri Lanka.
Credit: Gunasinghe W.K.D.
Source: McCluskey.1992

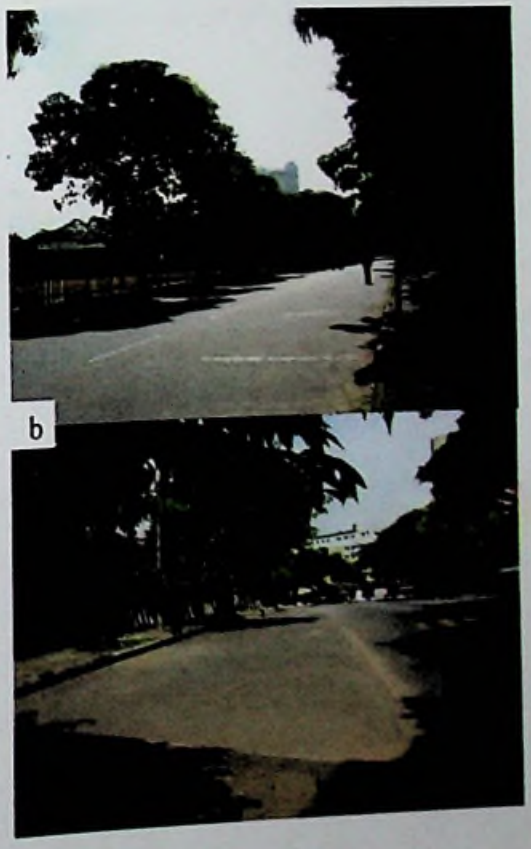


a

b

Fig. 5.31 (**a**) The effect of a road going through a woodland and the trees then contain the space through which the road passes, and at the same time it creates a visual boundary to the spaces on the other side of the tree belt. (**b**) Little bit create the above scenic view at Stanly wijesundara Mawatha planted by *Samanea saman and Pithecelobium dulce* trees.
Source: McCluskey,1992 Credit: Gunasinghe W.K.D.

a



b

Fig. 5.32 (**a**) A more open impression can be achieved by placing the trees in informal groups with some single trees. (**b**) At Perahara Mawatha, Slave Island, Colomb2. There are many tree species such as *Pterocarpus indicus, Tectona grandis, Terminallia cattapa, Tabubuwa rosea, Turmanalia arjuna, Ficus benghalensis, Delonix regia, Pithecelobium dulce* (These two photographs are same road).
Credit: Gunasinghe W.K.D
Source: McCluskey,1992

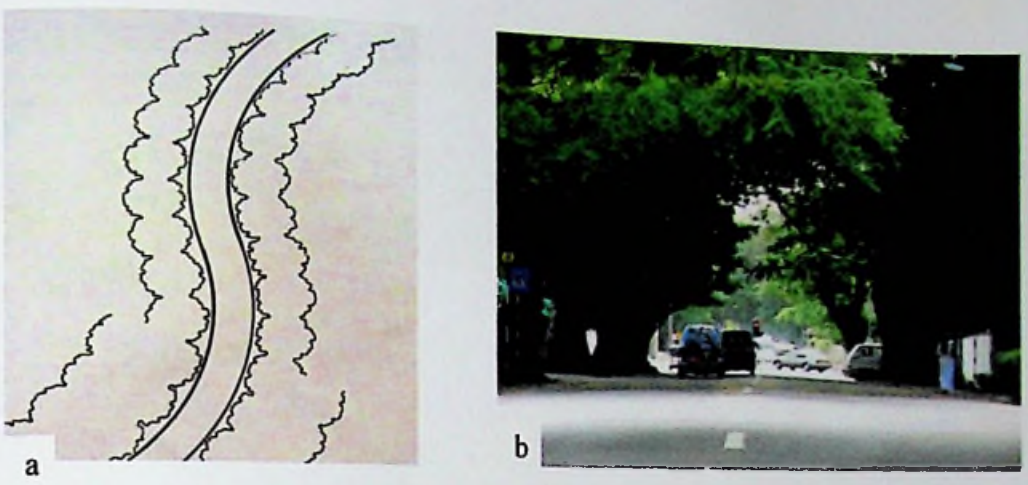
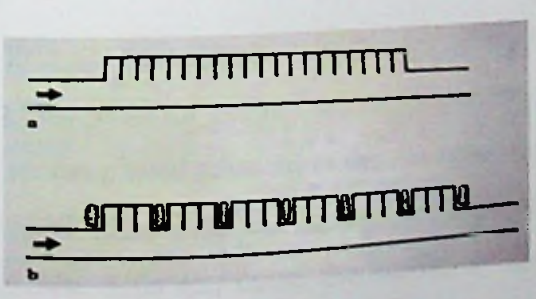


Fig.5.33 (a) Planting trees in rows parallel to the road. (b) The same tree rows can be seen at the Bouddhaloka Mawatha (Bullus Road), Colombo7, covered by *Pithecelobium dulce, Samanea saman* trees. This type of arrangement is to be found in Hill country and North and in East provinces in Sri Lanka.
Source: McCluskey,1992 Credit: Gunasinghe W.K.D

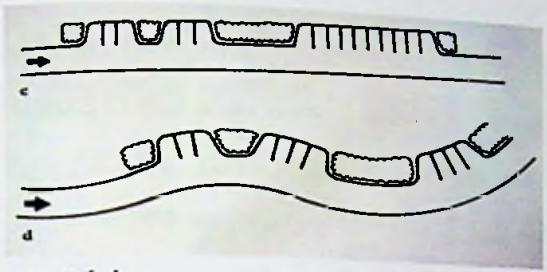
5.1. TREES AND PARKING

When cars are parked on, or adjacent to, a road the presence of trees will always soften their visual impact. This will be the case particularly if the case are in the shade of trees which cast a dense shadow. Most species of tree are unsuitable for use in the vicinity of parked cars since aphids feed on the leaf sap and exude 'honey dew' which will fall on the vehicles.



a and b

Fig. 5.34 (a) and(b). Sketch diagram showing parking lots with tree lines. (e). The similar tree lines in car park of roadside at Dharmapala Mawatha, Town Hall, Colombo city, Sri Lanka. Credit: Gunasinghe W.K.D.
Source: McCluskey,1992



c and d

f

f

f

Fig. 5.34. (**c**) and (**d**). Sketch diagram showing parking lots with tree lines. (**f**). The similar tree lines in car park of roadside at Slave Island, Colombo city, Sri Lanka.

Source: McCluskey,1992

Credit: Gunasinghe W.K.D.

In a so called temperate climate of Europe and North America *Tilia euchlora* may be considered for use in such areas since it appears to be shunned by these insects. Parking spaces placed adjacent to the road and at right angles to it will greatly increase the overall width of hard surface especially when there are large numbers of spaces side by side, **Fig. 5.34a**. This can cause the asphalt or concrete surface to appear out of scale with the surrounding. A great improvement in appearance can result if strips for shrub and tree planting are placed between small groups of the hard standings, **Fig. 5.34b**. Sometimes it is possible to incorporate quite long bands of planting between the groups and in residential areas specially, an irregular pattern can be advantageous since it dissipates the look of regimentation which may otherwise results, **Fig.5.34c**. The parked vehicles are likely to be even less conspicuous if a serpentine alignment is adopted for the road,

Fig.5.34d (McCluskey, 1992). All of this kind of planting needs to be very carefully designed to allow good sight for approaching traffic.

In the Arcadian environment the vegetation and not the building are dominant. The road is experienced as passing through a soft landscaped area with the structures glimpsed among the foliage. Obviously in such a setting the planting design is of major importance in determining the access of the road as an integral and enjoyable part of the environment. The Arcadian planting in relation to roads then can be informal and imitative of country arrangements of vegetation or it can be semi-formal with a greater emphasis on the architectural use of plants (Fig. 5.35). In city of Colombo Arcadian environments tend to be associated with wealthy residential areas.

Fig.5.35 Arcadian square shown in above photographs in city of Colombo.
(a) Indipendance Squire (b) Bauddhaloka Mawatha (c) In front of the BMICH
(d) Slave Island (Near the Air force camp)
Credit: Gunasinghe W.K.D.

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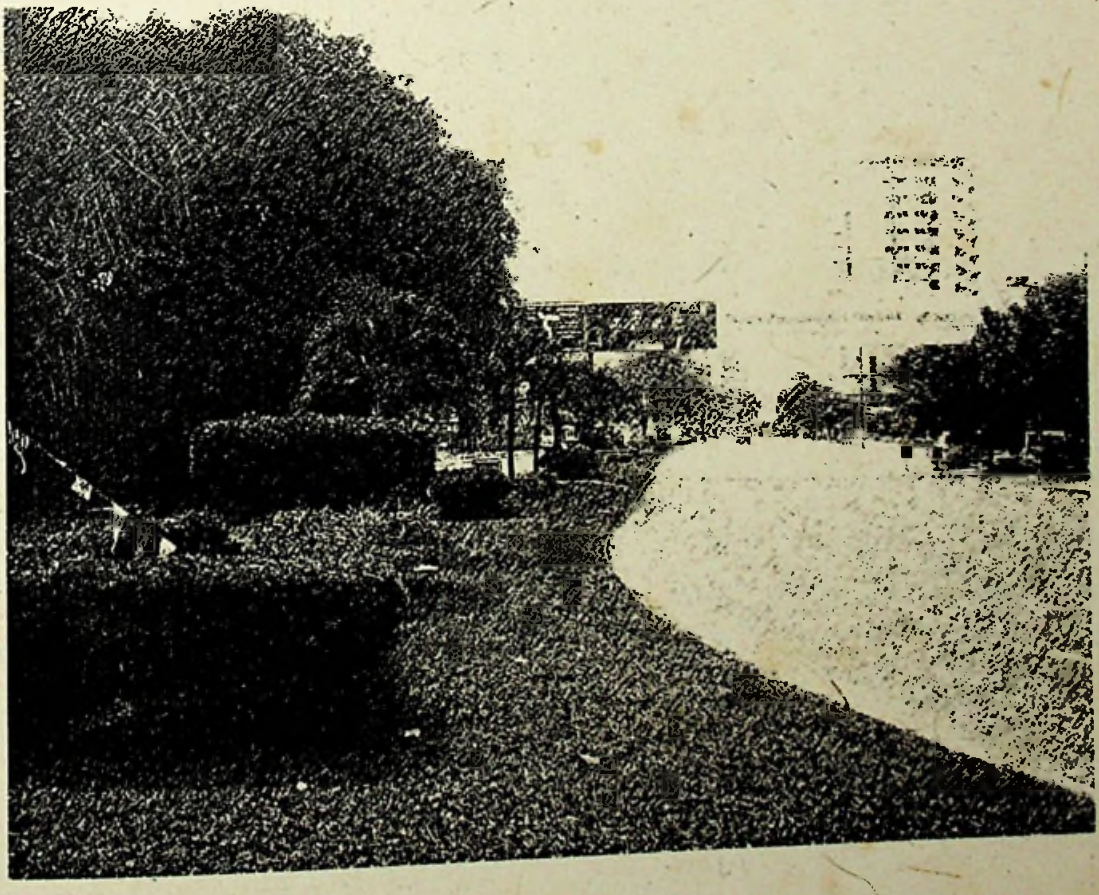
2. McCluskey Jim (1992), Road Form and Townscape,2nd ed. Butterworth Architecture, An imprint of Butterworth-Heinemann Ltd, Linacre House, Jordan Hill, Oxford OX2 8DP.

CHAPTER 06



CHAPTER 06

TOWARDS HIGH BIODIVERSITY, CLEAN ENVIRONMENT AND GREEN BELT THROUGH THE USE OF WAYSIDE TREE LANDSCAPE DESIGN

Vegetated roadsides often form linear corridors, linking other remnants throughout the landscape, allowing for the movement of plants and animals. (Kate Jackson)

6.1 BENEFITS OF URBAN WAYSIDE TREE LANDSCAPE

Although Sri Lanka is a small Island, the diversity of its tree flora is quite considerable. This could be attributed to the presence of several climatic regions and introduction of trees from other countries. Trees are always a very familiar feature along road sides. Often large trees are sited as landmarks when traveling.

The CEC has maintain a Significant Tree Register in which a list of trees plated in road sides in USA, states the following purpose of the Register as to identify and recognize the importance of significant trees in the landscape, to guide their management and to ensure their protection for future generations (Schwan, 2002). According to the CEC, the following values of road side tree could be identified:

- ***Historic and/ or natural value*** (i.e., indigenous/ cultivated origin)
  - Determination of origin as a component of natural ecological community or cultivated/ planted as part of historic development of the place;
  - Influence of historic figures, events and patterns of development.

- ***Botanic/ scientific value***
  - Associated with research and educational values, based on integrity, rarity and representative values.
- ***Social, cultural and commemorative value***
  - Focusing on qualities such as the spiritual, political, national and cultural sentiment reflected by the broader population or smaller community groups;
  - The commemorative events
- ***Visual and aesthetic value***
  - Must be based on existing physical fabric;
  - Relates to qualities of bulk, scale and contribution to defining local character and the "spirit" or sense of place.

Convince the home building industry and CEC to require planting and care for strategically located shade trees around every new home as a mandatory component of Title 24 of Residential Energy Efficiency Standards urge the Public Utility Commission and CEC to fund shade tree programs because:

- Over the long run it is less expensive to plant trees now than to purchase or build new power plants to produce electricity in the future.
- Shade tree programs contribute positively to the quality of life in communities, providing multiple benefits in addition to energy conservation.
- Shade tree programs have public relations value for utilities. Because of their appeal, such programs can also help utilities increase public awareness about other energy conservation programs.
- Shade tree programs provide a built-in economic incentive to promote long-term stewardship and proper tree care because trees planted for energy conservation must be healthy in order to do their job.
- Shade trees are one aspect of decentralized energy systems that cannot be threatened by terrorist attacks, (Schwan, 2002).

6.1.1. PRINCIPAL CONSERVATION VALUES OF WAYSIDE TREES

Road side Conservation Committee,(2008) in Australia following values of road side tree were identified and those values are given in the below:

- The roadside must contain a significant population of native vegetation. Introduced trees and grasses are not important for conservation.
- The native vegetation must be in as near to its natural condition as possible. In undisturbed vegetation, several layers of plants occur – trees, shrubs and herbs are present in woodlands, for example. If one or more of the expected layers are missing, the conservation value is reduced.
- The roadside may be the only remaining example of original vegetation within a cleared area. Therefore these types of conservative values are important to Sri Lanka and must be practiced by the Local Authorities, other relevant Authorities and Institutions.

A tree lined divider strip separates the two direction of traffic flow. The street space, contained by the continuous facades, tends to function as two separates, one- sided streets. The traffic lanes are not unusually wide, but the fenced- in center strip prevents pedestrian crossing except at breaks for cross streets. Wide side walks (16 to 20 feet in some cases) emphasize the presence of pedestrians and help reduce the impact of the automobile of the pedestrian activities (Anderson, 1978) (Fig. 6.1 a and b). Heavy planting may be required near the road when it passes close to built-up areas, especially when these areas contain housing, to protect from this sight and noise of traffic. (McCluskey, 1992). The above road system and planting methods should be applied to city area and emphasize the urban road network and its surrounding environment. It is more helpful to pedestrians, drivers and city dwellers.

Natural views, such as trees and lakes promote a drop in blood pressure and are shown to reduce feelings of stress. Many people express this effect by saying that a park or green space is a good place to 'get away from the stresses of life (Swanwick, and Woolley, 2002).

Fig.6.1 **(a)** The traffic lanes are not unusually wide, but the fenced in center strip prevents pedestrian crossing except at breaks for cross streets. e.g. at Galle road, Galleface green, Colombo 4.

(b) Tree lined divider strip separates the two direction of traffic flow. e.g. at Dr. A Coomaraswamy Mawatha, Colombo 7.

Credit: Gunasinghe W.K.D.

Pedestrian movement outside the mall space is between the entrance and parked cars; there is little possibility for random pedestrian encounters. In contrast, the mall space itself is subject to much random pedestrian movement. Individual activities take place in both the mall space and shops, which are open along their entire frontage to the mall(Fig.6.2). The insertion of fixed benches and planters along the center of the pedestrian way, although providing a level of amenity not readily found on city streets, significantly constricts the free flow of people (Anderson, 1978). As an example in city of Colombo at Pettah and Slave Island

Fig.6.2 An example at Pettah in Colombo 12.
Credit: Gunasinghe W.K.D.

Fig.6.3 An example at Slave Island in Colombo 2.
Credit: Gunasinghe W.K.D.

Roadside vegetation provides many functional benefits including the prevention of weed establishment, shelter for stock in adjacent land, help in defining road curves leading to a

safer driving environment, and a reduction in soil erosion and hence road maintenance requirements (Whyalla City Council Roadside, 2008).

Street rights-of-way constitute a substantial part of public urban forest lands (Fig. 6.4). These are strips adjacent to streets or medians between divided boulevards. They are often called tree lawns, parkways, or parking strips. Street side rights-of-way vary in width and often provide space for sidewalks. There is usually space for a single row of trees expect that median areas are often wide enough for trees, shrubs, and other landscape design features. Street side tree spacing varies according to lot width, driveways, utilities, and other spatial factors; but 50ft a (15 1/4m) apart or 200 tree per street mile (1.61km) is generally the recommended standard in residential areas. It must be stressed that the street side tree situation varies greatly within most cities 2(Gene and Frederick, 1986). However Sri Lanka roadside tree planting methods must be consider these rules and regulations, and some roads consider it (Fig.6.5).

Fig. 6.4 Showing a street with substantial part of urban forest land in USA.
Source:Gene and Frederick, 1986

Fig. 6.5 Showing a street with substantial part of urban forest land in Colombo.
Credit: Gunasinghe W.K.D.

The character of the avenue changes when it is used for ceremonial parades and demonstrations. This use, if frequent, might conflict with the residential (private) nature of the street; at present, however, it is well accommodated on the avenue. The double roadway allows simultaneous parades and car traffic, and park becomes a setting for watching, vending, and resting. (Anderson, 1978).

The needs of users need to be balanced against the benefits of retaining natural vegetation and wildlife including: Retaining rare, significant or endangered vegetation. Retaining biodiversity. Maintaining an attractive roadside. For shade and shelter particularly in summer. For erosion and dust control. For wildlife corridors, for the movement of fauna. To promote a better, more pleasant environment. Keeping remnant vegetation intact (Whyalla City Council Roadside, 2008).

The presence of remnant vegetation in road reserves also provides many conservation benefits. Road reserves can support rare or threatened plant species or vegetation associations, they can provide important habitat for fauna, act as corridors between blocks of remnant vegetation, and they provide an important source of seed for local re-vegetation projects. Furthermore, road reserves containing native vegetation add to the visual amenity of areas where there has been broad-scale clearance. Any significant disturbance to native vegetation within road reserves has the potential to cause long-term damage which will have long-term negative impacts (Whyalla City Council Roadside, 2008).Country side of Sri Lanka exhibit these type of roadside environments at North - East areas and its due to the interference of war for the security reasons, can be seen broad scale clearances (Fig 6.6).

Fig. 6.6 Roadside are broad scale clearance seen in Polonnaruwa, Baticllo road.
Credit: Gunasinghe W.K.D.

The road reserve is often used as a site to locate public service utilities. Water pipelines, electricity lines and telegraph lines are often built on the roadside. To construct and maintain them, native vegetation may be destroyed and so their presence is detrimental to the conservation value of the roadside (Fig.6.7). Vegetation may be destroyed in discrete areas for other uses, such as gravel or sand quarry, metal dumps or hard standing for machinery. Some landowners have ploughed the roadside outside their fence to act as a firebreak. This not only destroys native vegetation, but the disturbance enhances weed growth. Ignore disturbances if they are not obvious, (Jackson, 2002).

Fig. 6.7. Pipelines form a continuous disturbance along roadsides.
Source:Jackson, 2002 (Photo by Peter Thorn)

The urban forest is important to the city dweller in many ways. Its trees provide shade, beauty, and a long list of other benefits. In most instances these benefits are taken for granted. Indeed, the urban dweller may not even be aware of many or even relate to them. The various benefits can be grouped under the following four broad categories: 1.Climate amelioration 2.Engineering uses 3.Architectural uses 4.Esthetic uses

The value of roadsides vegetation in addition to their primary purpose as transport routes, road reserves play a vital role in the overall conservation of our landscape and environment. The roadside environment is so valuable because of the biological, cultural, aesthetic, and land care values contained within it (Jackson, 2002).

6.1.2 ECOLOGICAL AND ENVIRONMENTAL BENEFITS

Three major ecological and transportation goals of society are achieved by greatly increasing woody vegetation on roadsides (Forman et al. 2003; Forman 2005). These will lead to:

1. 1. Increase in wildlife habitat, biodiversity, and landscape connectivity
2. 2. Increase in highway safety and driver experience
3. Decrease in pollutant and peak-water-flow inputs to nearby water-bodies.
4. Roadside vegetation plays a role in protecting and maintaining both public and private infrastructure. For example, roadside vegetation can help prevent road wash-outs in high rainfall events.
5. The presence of roadside vegetation locally can reduce the need for road maintenance works because it militates against salinity impacts.
6. Roadside vegetation can prevent soil deposits on roads resulting from strong winds.
7. Reduction in the expense and time commitment required by the managing authority to maintain roads and control weeds, (Road side Conservation Committee, 2008).
8. There are conservation values of the roadside trees because they may be the only remaining example of original vegetation within a cleared area. These remnant patches in the roadsides:

a. assists in vegetation mapping and distribution studies;
b. provides a benchmark for study of soil change through agricultural development;
c. provides a source of valuable local seed for re-vegetation projects; and
d. acts as habitat for local plants and animals.

i. Rare or threatened plants may occur on the roadside. Because of past selective land clearing, roadside remnants may harbor the last few populations of certain plants.

ii. Roadsides may provide nest sites and refuges for native animals, particularly birds, insects and reptiles.
iii. Roadsides may act as a biological corridor. In agricultural areas, small bush remnants are islands in a sea of crops.
iv. Small animals, such as birds, reptiles and bats may be confined to them as they find it difficult to cross large open areas such as paddocks. Roadside can act as corridors, connecting these islands and helping animals to move along them to find food and breeding opportunities, (Road side Conservation Committee, 2008).

1. AIR POLLUTION ABATEMENT

The role of trees in reducing air pollution is not well understood, and there is considerable disagreement as to their effectiveness. Most important are those that are either gaseous or particulate. Particulate air pollutants can be reduced by the presence of trees and other plants in several ways. They aid in the removal of airborne particulates such as sand, dust, fly ash, pollen and smoke. Leaves, branches, stems, and their associated surface structures (i.e. pubescence on leaves) tend to trap particles that are later washed off by precipitation. Trees also often mask fumes and disagreeable odors by replacing them with more pleasing foliage or floral odors or by actual absorption.

Discussions about trees are largely framed in terms of aesthetic values, and may not be viewed as justification for trees when weighed against long-held assumptions about safety. Acknowledging that any roadside fixed object presents risk, it will offer design recommendations that may enhance urban roadside safety. Second it will offer recommendations for future research concerning urban streets, vegetation and safety (Dixon, and Wolf. 2007).

2. EROSION CONTROL AND WATERSHED PROTECTION

Soil erosion in urban areas is usually associated with construction activities where soil surfaces have been exposed. Splash erosion from the impact of falling raindrops causes soil particles to be dislodged and to move into runoff suspension where they act as scouring agents removing even more soil.

3. NOISE ABATEMENT

Plant attenuation of sound is shown in fig. 5.3; sound waves are absorbed by the leaves, branches, and twigs of trees and shrubs but not to any great or useful extent. These plants parts are light and flexible. Its been postulated that the most effective plants for absorbing sound are those having many thick, fleshy leaves with petioles but this is scarcely perceptible. This combination allows for the highest degree of flexibility and vibration (Owen 1970)). Sound is also deflected and refracted by the heavier branches and the trunk of the trees. it has been estimated that, on the average, forests can attenuate sound at the rate of 7 dB per 100ft (30m) of distance at frequencies of 1,000 CPS or less (Embleton, 1963) but such conclusion are contentious.

One particular problem of redevelopment in towns is noise. Trees are to some extent insulators against sounds, particularly high frequency sounds such as children's voices. Even a single row will have a noticeable effect a plantation 4.5 m -6m in height and depth dense from this ground to the top, and consisting of evergreen trees and shrubs. (Gene and Frederick, 1986) (Fig.6.8). Linear landscape in urban areas as well as in the very low density Arcadian setting it is sometimes possible to design the roads corridor as a linear landscape. This arrangement has the advantages of providing a pleasant environment for motorist, enabling pedestrian and bicycle routes to be located away from the traffic in park-like surroundings and at the same time distancing the vehicles from the dense urban areas with the accompanying benefits of relief from noise, pollution and the sight of the traffic (McCluskey,1992).

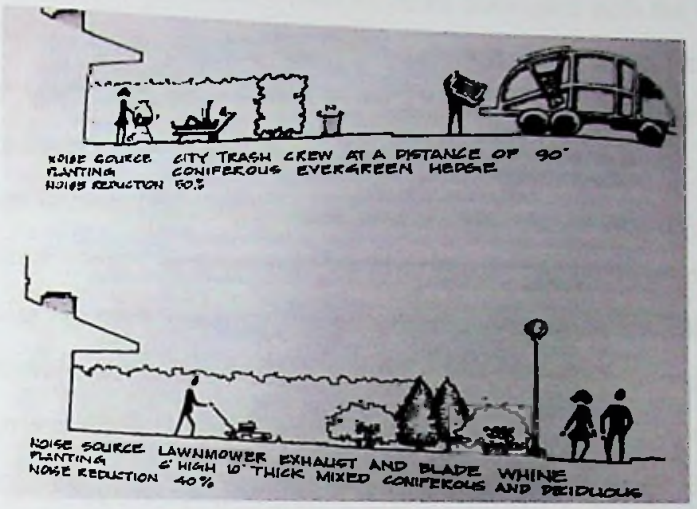


Fig. 6.8. The noise absorbent by the trees and shrubs. Source: Owen 1970

4. PRECIPITATION AND HUMIDITY

Roadsides are now highly regarded for their vegetation value as well as their contributions towards flora and fauna conservation. This value is especially crucial where native vegetation has been cleared from adjacent privately owned land, (Whyalla City Council Roadside, 2008).

Roadsides provide a benchmark for the study of soil change during agricultural development. In agricultural areas, most roadsides have the capacity to act as windbreaks and provide shelter for stock on adjoining farmland. Roadsides are easier to maintain and generally less fire prone than introduced vegetation (Jackson, 2002).

Trees intercept and filter solar radiation, inhibit wind flow, transpire water, and reduce evaporation of soil moisture. Thus, beneath a forest canopy, humidity is usually higher and evaporation rates are lower. Temperature beneath the canopy is also lower than the surrounding air during the day and warmer during the evening.

The major elements climates that affect us are solar radiation, air temperature, air movement, and humidity; and we have comfort zones associated with the interactions of these four elements. Trees, shrubs, and grass ameliorate air temperatures in urban environments by controlling solar radiation. Tree leaves intercept, reflect, absorb, and transmit solar radiation (Fig **6.9**). Their effectiveness depends on, for example, the density of species foliage, leaf shape, and branching patterns. Deciduous trees are very instrumental in heat control in urban settings in temperate regions. During the summer they intercept solar radiation and lower temperatures. In winter lost of their leaves result in the tall buildings, factories, low buildings, wide streets, parking lots, parks, courtyards, lakes, hills, and rivers among others. Each location within a city has its own microclimate and is unique in its effect on the inhabitants and their sense of comfort (**Fig6.10**) (Gene and Frederick, 1986).

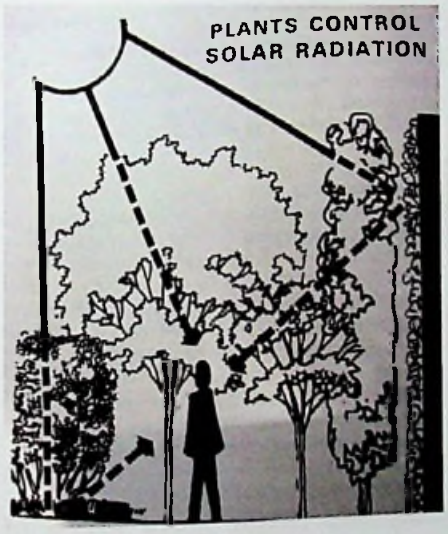


Fig.6.9. Plants benefit peoples by controlling solar radiation, as well as pedestrians and vehicles.
Source: Gene and Frederick, 1986

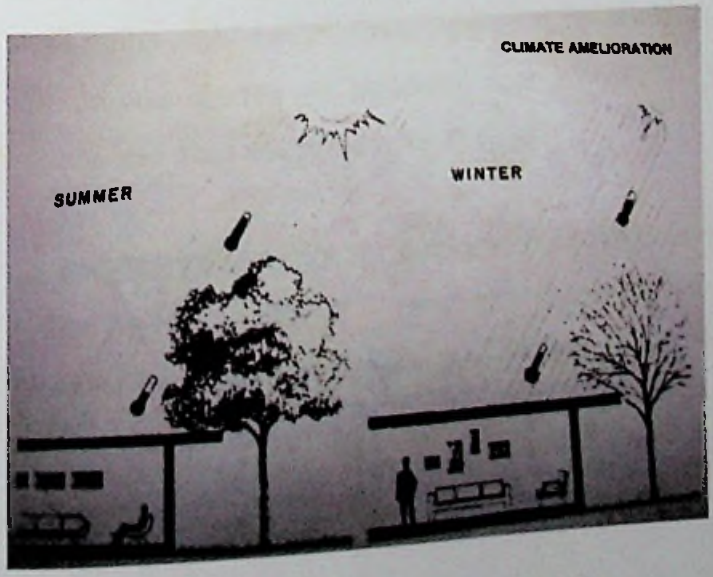


Fig. 6.10. Deciduous trees intercept the sun's rays during the summer months and allow them to pass through during the winter.
Source: Gene and Frederick. 1986

5. GLARE AND REFLECTION CONTROL

Solar radiation affects our visual comfort as well as our thermal comfort. We are surrounded by myriad of shinning surfaces-glass, steel, aluminum, concrete, and water - all capable of reflecting light. We experience discomfort when the sun's rays are reflected toward us by these surfaces. At night, we have to contend with glare from automobile headlights, streetlights, buildings, and advertising signs. Glare intercepted directly from the light source is termed 'primary' (fig. 6.11).

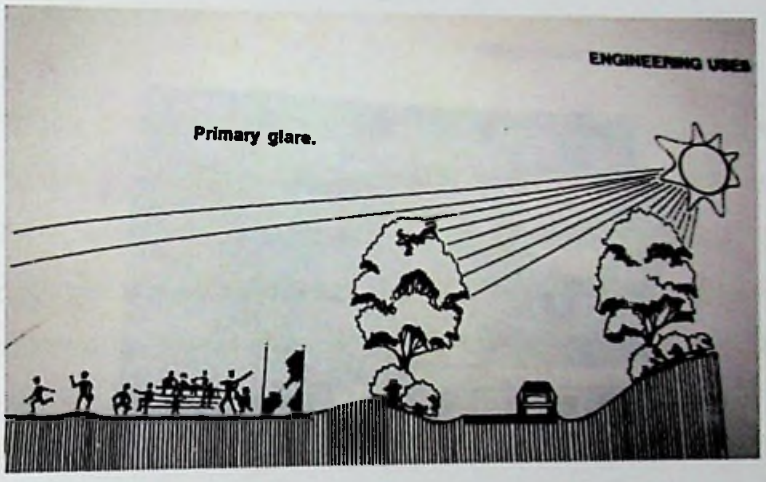


Fig. 6.11. In urban environments trees can be used to intercept primary glare.
Source: Gene and Frederick, 1986

6.1.3. ENGINEERING USES OF URBAN FOREST

In recent years, highly specialized uses for plants in helping to solve environmental engineering problems have been developed. Involved are not only landscape esthetics but soil erosion control, air pollution, nose abatement, wastewater management, traffic control, and glare and reflection reduction.

6.1.4. ESTHETIC USES OF ROAD SIDE TREE AS URBAN FOREST

Trees and shrubs provide their own inherent beauty in all settings. They are esthetic elements in our surroundings. They can be beautiful simply because of the lines, forms, colors, and textures they project. Trees and shrubs enflame views, soften architectural

lines, enhance and complement architectural elements, unify divergent elements, and introduce naturalness to otherwise stark settings. They also produce unique patterns through reflection from glass and water surfaces and can produce beautiful shadow patterns. Trees are also dynamic, giving different appearances in the changing seasons and throughout their span of life. They also provide movement and pleasant sounds-the rustling of leaves and the whistle of wind through a canopy as an example *Termanalia cattapa*, *Tabubuwa rosea* trees.

6.1.5. ARCHITECTURAL USES

Each species has its own characteristic form, color, texture, and size. Plants can very in their use potential as they grow or as the seasons change. Their proper use will vary with design and user. Trees, when used in a group, can form canopies or walls of varying texture, height, and density. Some functions can be performed by one tree and others may require many trees. Because they are alive and growing, trees and shrubs are dynamic with regard to their functionality in architectural design. Since trees and shrubs have architectural potential, they can be used individually or collectively as architectural elements performing the following functions: space articulation (defining space); screening; privacy control; and progressive realization or enticement.
Where columns of trees are used architecturally on each side of a straight length of road they will only look entirely satisfactory if they lead the eye to a focal point or focal area at the end of the road. It is also usually important that their presence defines the side of the contained space (McCluskey, 1992).

6.1.6. TRAFFIC CONTROL

While adding to environmental esthetics, trees and shrubs may be used to aid in traffic control. This includes not only vehicular traffic but also pedestrian and animal traffic. Plants enhance the beauty of an area when used to direct people through it in a definite pattern. Other elements often used to perform the same function (wires, fences, and chains) tend to destroy natural beauty. Some plants are more suitable for traffic control

than others because of such characteristics as branching habit, presence or absence of thorns, and stiff or flexible branches.

Transportation corridors are major infrastructure elements of today's cities, and actions by transportation designers and planners have great influence on social ecology and community. City streets are not simply thoroughfares for motor vehicles, but must also serve as public spaces where people walk, shop, meet, and generally participate in the social and recreational activities that make urban living enjoyable. Urban foresters, designers, and planners encourage streetscape tree planting to enhance the livability of urban streets (Dixon and Wolf. 2007).

With woody roadside vegetation in many areas and an associated slight decrease in traffic speed, the road kill rate might slightly increase or slightly decrease. The benefits to highway safety and driver experience primarily emerge from a modest decrease in vehicle speed in appropriate areas, as well as the use of visually diverse types of roadside woody vegetation. Fast-moving vehicles are not only at risk of hitting vehicles, structures, pedestrians, and wildlife, but also they consume more fossil fuel, emit more greenhouse gas, distribute more chemical pollutants along the road, and cause more traffic noise. Shortcomings of roadside woody vegetation for safety exist, but overall, reducing vehicle speed provides major societal benefits (Forman and McDonald, 2007).

Within such a garden-apartment complex, pedestrian movement is directed onto access pathways and sidewalks, devoid of the usual street-related activities. Provisions for bicycle paths, sitting areas for the elderly and mothers with children, and children's play grounds, often neglected or omitted entirely, are within the confines of the development area and limited to it (Anderson, 1978).

6.1.7. OTHER USES OF ROAD SIDE TREES

Although a lengthy list of benefits of the urban forest, there are others such as the values of places for children to play, for people to jog or to walk and contemplate nature and their own problems, for lovers to stroll, or for one to be alone. Trees are also used as

indicators of historic events, as memorials, and as substitutes for the natural's environment in inner cities, even on rooftops and balconies. Finally, trees also evoke memories of other times, places, and feelings because of the view they present, or a familiar sound, smell, or touch.

In general the people, regardless of place or nationality will be influenced in their walking by the physical condition of travel and by the time, direction length and purpose of any particular journey. Each of these may also be influenced by the other factors, such as a particular pedestrian size, mobility, health and well being and by many more subtle factors such as mood and comfort. (Hettiaracchi, 1997).

Roadside vegetation provides shelter, food and nesting sites for a range of native fauna. (Fig.6.12). Well-vegetated roadsides provide connectivity between patches of remnant vegetation. Roadsides provide the basis for our important wildflower tourism industry. In addition to this, they often contain sites of historical or cultural significance. Where surrounding bush has been extensively cleared, roadsides are a vital source of local seed for re-vegetation projects.

Several secondary goals are accomplished by a major increase in woody roadside vegetation. These include reduced management/maintenance costs, increased harvestable wood products, recreational benefits, and enhancement of adjoining and surrounding areas as well as storm water pollutant control in elongate shrub-lined depressions, nature and culture education, and other benefits. Together these benefits lead to a functionally and visually variegated roadside for society (Forman et al. 2003, Forman 2005).

Fig.6.12 The roadside vegetation provide shelter, foods and nesting sites for avifauna and other animals. At Bauddhaloka Mawatha.
Credit: Gunasinghe W.K.D.

6.2 FUTURE DIRECTIONS THROUGH CONTRIBUTION OF WAYSIDE TREES AS A LANDSCAPING

Concerned to achieve sustainable development based on a balanced and harmonious relationship between social needs, economic activity and the environment. Preamble to the European Landscape Convention (2000) (Scotland's living landscapes 2002).

Britain is already a world leader in protecting its landscape, and the Convention is a major step forward. It will ensure that any change and development is sympathetic and appropriate to the environment, and is designed to help create new landscapes where people want to live and work as well as protecting our most cherished scenery. UK Government statement marking the UK's ratification of the European Landscape Convention (Scotland's living landscapes 2002).

Green Factor would change urban landscape design, Proposed city program would require vegetation for new development in neighborhood commercial areas, By Marieke Lacasse And Shaney Clemmons Gglo . Wheaton, Illinois Wheaton Downtown Historic District, Camiros is assisting the City of Wheaton, Illinois, in assessing the need for an historic district designation or zoning change to protect the integrity of the residential neighborhood immediately north of the downtown. Also being developed are design guidelines for new construction and building renovation in the downtown itself. Camiros will advise the City on potential methods for using the guidelines to protect the traditional character and vitality of the downtown (McDaid 2007).

Linear landscape work could be designed in such a way that the route would eventually be part of a network of greenways covering a whole city area and connecting up the park, squires, greens and commons already in existence and those new metropolitan landscaped spaces plane for the future, such green corridors need not be more than say 30m wide on average, so that they would be easily crossed transversally by pedestrian moving from one urban area to anther on the other side of linear parkway. Plants along the road corridor should be designed to the scale of the vehicle speed. Belts of trees bordering high speed road will be elongated if they are to register on the consciousness of the driver. Thus gaps between the tree belts also must be scaled to the speed of travel (McCluskey,1992) .

Street side planting is done by city crews while post- planting care is the responsibility of adjacent property owners. Because of generally poor care exercised by residents, the city forestry division has discontinued planting unless it has prior agreement with the property owners for maintenance. Tree planting request and care agreement forms are published in the local newspapers prior to the planting season. Few forms are submitted by residents of low income section of the city.

6.2.1. STRENGTHENING LANDSCAPE POLICY

The Convention requires the establishment and implementation of landscape policies. The Forum's examination of the existing policy framework identified an extensive set of statements that address landscape directly or indirectly at the national level, supported by a suite of local policies. Sect oral policies are now giving greater consideration to landscape matters and increasingly these recognize landscape's contribution to a number of objectives, including biodiversity, health and physical activity, quality of life, economic and social regeneration, although scope exists for the linkages between landscape and these to be strengthened (Scotland's living landscapes 2002).

The visits demonstrated that these two communities were not only receptive to working with TEI to develop an urban green plan but also that local governmental officials were supportive from the outset. The next step brought the communities together for a workshop on urban greening. In May 2000, all community members and local officials were invited to an educational workshop (Fraser 2002).

6.3 PROGRESS OF COLOMBO

Way side trees of Colombo City were mainly planted by the British during the last century. Thus many of the tallest trees in the Colombo city that we see today are introduced ornamental trees. The light weight of leaves, quick decomposition of dry matter, slow growth and the ornamental value of flowers are some characteristics considered for selection of these species. These trees can be seen out of Colombo in places such as rest houses, monuments, railway stations etc. Planting of introduced ornamental tree species was continued until the concept of 'using indigenous plants' was

brought forward. Therefore many of the trees planted recently (1-2 decades ago) are mostly native/indigenous species (Attigala, L. R. 2006). Sometimes trees that are grown along fences and nearby gardens appear as 'street trees'. But these should not be taken into consideration as street trees, however could be considered as way-side trees.

Fig. 6.13. The street trees invaded by *Ficus* species within City of Colombo. At in front of the Faculty of Art, University of Colombo and Chief Minister's Office of Western Province. Credit: Gunasinghe W.K.D.

The street trees invaded by *Ficus* species within City of Colombo (Fig. 6.13). The collection of data related to roadside trees was recorded/measured from street and trees selected at randomly. The roads that were selected were Kumarathunga Munidasa Mawatha, Reid Avenue, Havelock road, Bauddhaloka Mawatha, Stanley Wijesundara Mawatha, Torrington avenue, Bullers lane, Rajakeeya Mawatha, Guildford Crescent, Cambridge place, Albert crescent, Maitland crescent, Gregory crescent, Maitland place and Independence Avenue. Observations of individual street trees were done in order to find out the presence and absence of *F. benghalensis*. The girth at breast height of the street trees were also measured using a diameter tape. The city of Colombo many road junction can be seen Bo (*Ficus religiosa*) trees as a religious place, such as Borella junction, Slave Island, Punchi Borella junction, Pettah Bo tree junction, etc(Fig. 6.14).

Fig. 6.14. Bo (*Ficus religiosa*) tree as religious place at Slave Island.
Credit: Gunasinghe W.K.D.

Table 6.1. The frequency distribution of the roadside trees in the city of Colombo.

Scientific name of the roadside trees	Common name of the tree (Sinhala)	Frequency	Percent
Mangifera indica	Amba	3	4.8
Pithecelobium dulce	Andara	11	17.7
Semecarpus species	Badulla	1	1.6
Ficus religiosa	Bo	2	3.2
Peltophorum pterocarpum	Kaha mara	7	11.3
Hambotia larucifosa	Magul Karanda	1	1.6
Delonix regia	Mei mara	1	1.6
Turmanalia arjuna	Kumbuk	2	3.2
Melia azederach	Lunumidella	5	8.1
Samanea saman	Paramara	13	21
Delonix regia	Rathu mara	2	3.2
Tabubuwa rosea	Tabubuwa	1	1.6
Terminallia cattapa	Kottamba	7	11.3
Tectona grandis	Teak	2	3.2
Pterocarpus indicus	Wal ehala	3	4.8
Pisonia grandis	Watha banga	1	1.6
	Total	62	100

The highest common roadside tree were *Samanea saman* (Pare mara) (21%), *Pithecelobium dulce* (Andara) (17.7%) and the rest of the trees were not so common in the Colombo city. This indicate that most of the indigenous trees has not been introduced as wayside trees in Colombo city.

Table. 6.2. The frequency distribution of height classes of the trees along the roads in the Colombo City.

Height class of trees	Frequency	Percent
< 3000 cm	7	11.3
>= 300 and <4500 cm	10	16.1
>= 4500 and < 6000 cm	27	43.5
>= 6000 cm	17	27.4
Total	61	98.4
System	1	1.6
Total	62	100

The most the roadside trees are belongs to the height class of 4500 – 6000 cm and within this high class *Smanea saman* , *Pithecelobium dulce*, and *Peltoporum ptercarpum* were dominated. The highest trees which are above 6000 cm are also common in the roadsides in the Colombo City. According to the result, it is evident that except the wayside trees included by British rulers, not much trees were planted by the local authorities.

Table 6.3. The distribution of number of branches in the roadside trees in the Colombo city.

No. of branches	Frequency	Percent
2	8	12.9
3	25	40.3
4	18	29
5	10	16.1
7	1	1.6
Total	62	100

The number of branches of the tree is an important in the context of a shade provided by the tree crown. The most of the trees in the Colombo City possessed three branches. On the other hand trees with higher number (>7) of branches are not common in the roadside trees within the Colombo City. The older trees in the Colombo city especially Paremara (*Samanea saman*) had been planted by the foreign rulers of Sri Lanka.

6.3.1. TREE SPECIES OF WAYSIDE TREES IN CITY OF COLOMBO

The selection of trees species for planting along waysides in Colombo city needs to consider several aspects. The city is located within the wet zone of the island and selected tree species should be belongs to the common plants in the wet zone. In addition, the trees grown in intermediate and dry zone could be try out and the best tree species then could be chosen. Further, an attention should be made to the ingenious trees of the country as far as possible. The naturalized trees can also be considered in this effort. The characteristics of the selected tree species are also important in selecting tree species. The tree species with narrow leaves, dense canopies and taller stems.

List of tree species categorized according to Attigala, L. R. (2006).

A. Introduced ornamental trees seen in the Colombo city

Scientific Name	Common Name (English and Sinhala)
Peltophorum enerme	Copper wood-E, Kaha mara-S (yellow flowers)
Pithecelobium dulce	Madras thom- E , Andara-S (twisted C shaped pod)
Jacaranda mimosifolia	Fern tree-E (pale purple flowers)
Tabebuea rosea	Robarosea-E, sakura-S (pink flowers)
Delonix regia	Flamboyant- E, mei mara/ mal mara-S – (Red Flowers)
Muntingia calabura	Jam tree
Samenia saman	Rain tree-E, para mara-S (pink flowers with lot of read Like stamens)
Polyalthia longifolia	Green leaves add the beauty
Acacia floribunda	Weeping acacea
Spathodea campanulata	Large orange-Red flowers

B. Indegenous / native wayside tree species in city of Colombo

Cassia fistula	Ehala-S, showers of gold-E (yellow flowers)
Cassia siamea	Yellow flowers in cluster
Erithrina varigata	Erabadu-S
Bauhinia varigata	Purple or pink flowers
Pongamia pinnata	Magul karanda-S
Cassia spectrabilis	Yellow flowers in cluster
Terminallia cattapa	Indian armond-E, Kottamba-S
Tectona grandis	Teak_E tekke-S
Chrysophyllum argenteum	Underside of leaves is golden yellow

Alstonia scholaris	Ruk attana-S
Filicium decipiens	Pihimbiya-S
Azadiracta indica	Neem/margosa-E, Kohomba-S
Pterocarpus marsupium	Gammalu-S
Bauhinia racemosa	Maila-S
Ceiba pentandra	kapok-E
Tamarindes indica	Siyambala-S
Manilkara hexandra	Palu-S
Drypetis sepiaria	Weera-S
Terminalia Arjona	kumbuk-S

6.4 CONCLUDING DISCUSSION

Roadside trees influence air movements in a city and create a micro-climate. The effect may be either positive or negative depending largely on the presence or absence of urban vegetation. Wind can increase evaporative cooling during the day. The cooling will vary with the surrounding terrain and the wind speed. Trees can provide effective wind protection for roads and highways. Highways at right angles perpendicular to prevailing winds are often subjected to strong crosswinds and gusts. Wind movement is also affected by highway cuts, breaks in terrain, and nearby buildings. Wind movement can often be controlled in such problem areas by the proper placement of trees and shrubs.

Most of Colombo's trees have been invaded by strangler trees and their girths were more or less equal to 2 m or above. It was observed that the roadside trees having a girth greater than or equal to 1 m and less than to 2 m were not invaded by *F. benghalensis* at all where as the trees with a girth greater than or equal to 8 m and less than to 9 or more were entirely invaded by *F. benghalensis*. In addition, the trees with girth greater than or equal to 5 m and less than to 9 m, there were a strong possibility of invasion of *F. benghalensis* compared with the trees with a girth greater than or equal to 1 m and less than 3 m. This may due to the reason that barks fissure and crevices providing anchoring sites for the strangler. Thus there may be said to be a rapid increase in the invasion of *F. benghalensis* with the increasing size of the roadside trees. Among the avenue trees of observed areas, 33% of trees were invaded by *F. benghalensis*.

In addition, there was a great pressure on the road side trees from the surrounding people. In most cases road trees were damaged by the unauthorized disposal of garbage by

burning under trees. Further, road trees are vulnerable to the activities of certain institutions such as telecommunication, and electricity board, and water board services. In addition, there was no proper management to maintain the roadside trees in Colombo city. On the other hand, there were no responsible authorities, even though there a number of governmental and non-governmental institutions. The Colombo Municipal Council has been willing to maintain the roadside trees and to introduce more roadside trees. However, there is slow progress in this process. There are number of contributive factors for the slow progress and among these the poor financial situation and the shortage of labor plays an important role.

The Municipal Council and other government institutions should work together in development projects in the Colombo City. The financial backing as well as the labor force of the Council should be increased. The public awareness on the roadside trees should be increased through school and community based programmes.

In conclusion the following points may be made:

a. Aged trees in the city limit should be removed with introduction of new tree saplings,
b. Most of the trees in Colombo city are not properly selected and planted in a suitable place and those trees also removed,
c. The communication between the relevant authorities such as road development authority, Colombo Municipal Council, Water Supply and Drainage Board, Sri Lanka Telecom, Ceylon Electrify Board should be increased to allow correct species of wayside trees to be planted and maintained.
d. A master plan for wayside tree planting need to be drawn and implemented with the details of each tree recorded and regularly monitored.
e. An awareness program for people in Colombo city conducted, so that they understand the importance of wayside trees.

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