

AN INVESTIGATION OF GREEN SPACE WITHIN HIGH-RISE CONDOMINIUM SITES IN SRI LANKA

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Abstract

Green spaces in cities have a positive impact on the health of the urban population as well as decrease urban heat Island effects. Therefore, green and open space should not be considered a luxury but an integral part of urban planning. For the purpose of this study a space is considered as a “green space” if the land cover has vegetation. The study investigates the impact of high-density housing developments in the Colombo city and its suburbs on green space. 90% of small Condominium developments (number of units ranging from 15 to 65) and 50% of large condominium developments (over 65 units) had less than 1% of green space on site.

The reason for lack of green space was found to be high plot coverage, high FAR, small site extent and no landscape, communal space and green buffer requirement in the current planning and building regulations for condominium developments.

Keywords: Condominium, green space, Sri Lanka, planning, sustainability

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1. Introduction

1.1 High density high-rise housing in Sri Lanka

High density high-rise housing in Colombo can be attributed to high population growth, decrease in family size, growth in household income, rapid urbanization, scarcity of land and high land price, security, convenience and location (Ariyawansa and Udayanthika, 2012).

In Sri Lanka ownership of high rise residential units, buildings and developments are regulated by the 1973 apartment ownership law and subsequent amendments by act No. 45 of 1982, 4 of 1999 and 39 of 2003. In 2003 the common amenities board was re-established as the Condominium Management Authority (CMA). The CMA regulates the ownership and Management Cooperations (MC's) of condominiums, however do not have any bearing on regulating the planning or building of condominiums. The UDA and the relevant municipal council regulate the planning and building of the residential development.

The term condominium refers to a form of tenure, a system of ownership; in which owners have full title to the individual unit and a shared interest in the common areas of the property. The term "Condominium" is used in Sri Lanka, USA and Canada while in Australia such form of ownership is known as Strata title. Elsewhere it is known by several other names including unit titles in New Zealand, coproprié'te' in France, and commonhold in Britain (Dredge and Coiacetto, 2011).

According to the data available at the CMA, 1115 condominiums have been issued a certificate by the Condominium Management Authority between the periods 2005-2017 September. The commercial capital of Sri Lanka, Colombo city is where the highest number of high rise condominium constructions is taking place.

1.2 Green space and psychological and physical health

For the purpose of this study green space refers to the amount of land cover with surface vegetation. Most research agree that green space have beneficial health effects even though a strong causal effect is difficult to obtain due to confounding explanatory variables (Lee and Maheswaren, 2011; James et al 2015, Ulmer et al, 2014). A study by Beyer et al, 2014, in the United States conclude higher levels of neighborhood green space were associated with significantly lower levels of symptomology for depression, anxiety and stress, after controlling for a wide range of confounding factors. The researchers conclude that "greening" could be a potential mental health improvement strategy in the United States. Therefore green and open space should not be considered a luxury which only the wealthy can afford, but an integral part of urban planning (Mass et al, 2009).

In general, most people would agree that the view of a green space has psychological health benefits. Seresinhe et al (2015) have found that that inhabitants of more scenic environments report better health, across urban, suburban and rural areas, even when taking core socioeconomic indicators of deprivation into account, such as income, employment and access to services. However, it is difficult to quantify the impact of intangible aspects such as views on human health. On the other hand, positive impact of natural views on residential market price is well established (Gillard, 1981; Benson et al, 1998; Bourassa et al., 2003).

Overall, higher densities have many benefits in terms of efficient use of infrastructure, housing affordability, energy efficiency and possibly vibrant street life. But higher densities alone, like other built environmental features, do not appear to be the silver bullet in the public health campaign to increase physical activity (Forsyth et al, 2007). Outdoor green space is therefore an important component to a healthy life.

1.3 UHI effect and green cover in Colombo city and suburbs

The higher degree of temperature in urban areas in comparison to the surrounds is termed the urban heat island effect. Many cities have displayed the effects of urban heat island. Higher densities can also have a negative effect on the microclimate. The megacities of developing countries in hot-humid climate zones, where air conditioning is spreading very rapidly, are experiencing increasing urban heat island effects (Cheshmehzangi and Butters, 2015). One of the main causes of the UHI effect is the loss of green cover in cities. Surface Urban heat Island (SUHI) is observed based on land surface temperature. There are many negative impacts of SUHI, such as the weakening of living environments, elevation of ground-level ozone, an increased mortality rate, increased energy consumption, elevated emissions of air pollutants and greenhouse gases, impaired water quality, compromised human health and comfort increased hospitalization of the elderly and children, heat stress and death of the bird population, and heat stress in plants (Ranalage et al, 2017).

In light of the health benefits of open and green space and the negative impact on the urban heat Island effect, the green cover of Colombo city needs to be increased. However, the green cover of Colombo city declined from 35.67% to 22.23% from 1956 to 2010 (Wickramasinghe et al, 2016). The study further revealed that the highest green cover (49.65%) was reported in Narahenpita and only three other wards (Kirillipone, Cinnamon Gardens, and Thimbirigasyaya) had green cover over 30% of the total land extent. In contrast, the green cover was less than 10% for ten wards, i.e., Kochchikade North, Kochchikade South, Grandpas North, Masangasweediya, Panchikawatte, Fort, Gintupitiya, New Bazaar, Maligawatte, and Aluthkade East. As a result of continuous reduction in green cover in Colombo SUHI could increase. Ranalage et al, 2017 found indications of intensifying SUHI effects, especially during the 2007–2017 period when urbanization was more rapid.

Recent beautification of Colombo has had some positive impact on greenery. Ranalage et al, 2017, has found indications of vegetation improvement in some parts of the CMA, especially from 2007 to 2017. However, in comparison to the loss of greenery the improvements are minimal in Colombo and its suburbs.

Increasing greenery is a key feature for the image of the city, better health of citizens and mitigating the urban heat Island effect. Unfortunately, Colombo city and its suburbs have decreasing green coverage.

2. Research Objectives

This study assesses green space within high-rise condominium development. The research focuses on the following three objectives.

- 1) Establish the parameters which impact green space in high-rise condominiums in the Sri Lankan context.

- 2) Investigate the impact of each parameter on green space within high-rise condominium developments.
- 3) Identify the parameters which decrease green space within Condominium developments.

3. Regulating open and green space in urban areas in Sri Lanka

The requirements of green space around a building in urban areas are governed by urban planning policies and regulations for the respective urban area. Urban planning and building regulations are not hard set rules. In building projects of national importance exception from the rule can be obtained by relevant authorities. However, such exceptions are generally granted taking in to account the benefits for the general public.

In Sri Lanka the Urban Development Authority (UDA) is the national body for forming planning and building regulation for development of urban areas. For the purpose of this study the following documents published by the Urban Development Authority (UDA) of Sri Lanka are referred.

1. Planning and building regulations (General) published in 2015.
2. Planning and building regulations 2008-2020

In concurrence to the planning and building regulations the development plans for the city of Colombo and its suburbs have also been approved by the government. For this study, the following development plans were considered.

1. The city of Colombo Development Plan 1999
2. City of Colombo Development Plan (Amendment) 2008
4. Dehiwala-Mount Lavinia Development Plan 2007-2020
5. Jayawardenapura Kotte Development Plan 2007-2020

In order to better understand the impact of the local regulations on sustainable development the study reviews the Master Plan for Western region-2030 and planning schemes of two international cities, Melbourne city and Singapore. Melbourne city was ranked number one for the seventh year in a row by the Economist Intelligence Unit as the most livable cities in the world. Singapore was ranked number one in Asia by ARCADIAS sustainable cities index for 2016 (ARCADIAS, 2016). Even though there are differences to the current Sri Lankan socio-economic context, valuable lessons could be learned. For example, the Singapore Land Titles (Strata) Act based on the Conveyancing (Strata Titles) Act 1961 of New South Wales, Australia (Christudason, A., 2004) at a time there were significant socio-economic differences existed between the two nations. Therefore, a study of the desirable aspects of international cities could have positive impact on Sri Lankan cities.

Master Plan for Western region-2030

The Ministry of Megapolis and Western Development has produced the Master Plan for Western region-2030. A draft was produced for Regulations and Guidelines for Planning, Zoning, Environmental and Building for the western region. The planning and building regulations pertaining to the Core Area in the Master Plan for Western Region-2030, is considered in this study as several improvements over current condominium development regulations were cited from this document.

Planning scheme for Melbourne city

The Planning scheme for the Melbourne city falls under the state of Victoria Department of Environment, Land, and Water & Planning. It consists of maps, an ordinance and incorporated documents. The ordinance lays out the standards, schedules to the zones and other requirements to be met and the map identifies the geographical areas of zoning and overlays (such as heritage sites, significant vegetation or flood risk).

Condominium tenure type in Australia is termed Strata title. The physical units are known as units or apartments. The planning scheme refers to condominium tenure type development as apartment development. An apartment development of five or more storeys, excluding a basement, must meet the requirements of Clause 58 of the ordinance. Clause 58 covers a wide range of objectives that are of concern of present day high rise residential building construction.

Development control parameters for residential development in Singapore

Singapore is a well-planned city state, where land development is planned and strictly controlled (Yuen et al, 2006). The ability of the Urban Redevelopment Authority (URA) to making urban planning a tool for economic development in Singapore is irrefutable.

Singapore has developed a unique housing system, with three-quarters of its housing stock is public housing built by the Housing & Development Board (HDB) (Phang and Helble, 2016). Condominiums are private development. The handbook for Development control parameters for residential development and the master plan guides the urban development of Singapore. The residential sector in Singapore is categorized by registration instrument, density and housing type (URA, Oct 2017). Planning schemes and regulations are been regularly updated by the relevant authorities therefore this study refers to the document updated last in October 2017.

4. Methodology

The study is conducted in the following phases depicted in figure 1.

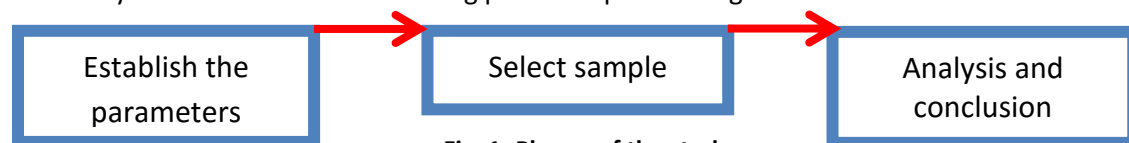


Fig. 1- Phases of the study

4.1 Parameters for assessment of green space within condominium developments

Taking in to account the literature in section 2, the following parameters were selected to assess the green space within high-rise condominium development in Sri Lanka.

Parameters for assessment of green space in condominiums.

1. **Site extent**
2. **Plot coverage**
3. **Floor Area Ratio (FAR)**
4. **Landscape**
5. **Communal open to sky space at ground level**

6. Green buffer

At present only the first three parameters site extent, plot coverage and FAR are enforced in the current regulations for condominium developments. Landscape, communal open to sky space at ground level and green buffer do not make part of the current local regulations.

Site extent

A large site has the capacity for a larger greenspace. The concept of condominium tenure in practical terms needs a large site to operate as it has to provide spacious common facilities for a large number of residents. Therefore, the minimum site extent for condominium development given by the planning regulations in the country ensures adequate space is available for the common facilities including green space.

The minimum site extent for condominium development in Colombo city is given in Form C1 in the city of Colombo development plan (Amendment) 2008 in relation to the road width, building lines and FAR. In planning and building regulations 2008-2020 the site extent is given in Schedule 6 of Form C and Schedule 8 of form C. Development Plans also state a minimum site extent for zones. In Sri Lanka though, high-rise condominiums are large scale buildings, they come up in very small sites because there is no minimum site extent given specifically for the development of condominiums. In Singapore the minimum site extent specifically for condominium development is 4000m² (URA, Oct 2017). In the city of Colombo, a ten-storey condominium is allowed in sites of less than 1000m² if the road width is adequate.

Plot coverage

Percentage of total plinth area of a building in relation to the total land area in the plot where the building is situated is taken as the plot coverage of a building (UDA, 2008). The current planning regulations identify separate plot coverage for commercial and residential buildings. The maximum plot coverage for high-rise condominium development ranges from 50% to 65% according to the height of the building in the local planning regulations. The similar term used in Singapore for plot coverage is site coverage. In Singapore the maximum site coverage is 40% for Condominiums and flats including covered car parks (URA, Oct 2017). Sri Lanka has 90 times the land cover of Singapore. Even though Singapore is a very small country, the government has committed to keeping 60% of the condominium development as un-built area. Low plot coverage ensures that adequate green space can be provided for the residents as well as increase the green cover as a whole for the city.

Floor Area Ratio (FAR)

The gross floor area of all buildings on a lot divided by the area of such lot is termed the Floor Area Ratio (UDA, 2008). The FAR for condominium development in the city of Colombo is given in Form C1 in the city of Colombo development plan (Amendment) 2008 in relation to the road width, building lines and site extent. The similar term for FAR in Singapore is Gross Plot Ratio (GPR). The GPR of a site is the ratio of the gross floor area of a building(s) to the land area of the site. For planning purposes and as a general guide, GPR is given for various housing densities in Singapore as seen in table 1. The guiding GPR is superseded by the GPR in the zoning regulations.

Table 1- Housing density in terms of GPR in Singapore (as a general guide)

DENSITY	GPR
Very High Density	>2.8
High Density	up to 2.8
Medium High Density	up to 2.1
Medium Density	up to 1.6
Low Density	up to 1.4
Landed Housing (low density)	(resultant from height)

Source: Urban Redevelopment Authority of Singapore. (2017). The handbook Development control parameters for residential development. Retrieved from <https://www.ura.gov.sg/uol/publications/technical/dc-handbooks>. Accessed on 27/10/2017.

The maximum FAR for residential buildings in Colombo city is very high in comparison to Singapore. There is an “unlimited” FAR for sites above 3500 m² within Colombo city and suburbs. Sri Lanka is looking forward to a future of continuous concrete masses in its cities with very high FAR.

Landscape

Current local planning and building regulations do not have mandatory landscaping provisions. This has led to neglect in landscaping in condominium complexes. In the Melbourne city planning scheme landscaping at the ground level is a mandatory requirement for apartments under clause 58. The following table gives the requirements for deep soil areas and canopy trees for high rise housing developments in Melbourne.

Table 2- Deep soil areas and canopy trees in the Melbourne city planning scheme

Site area	Deep soil areas Minimum	tree provision
750 – 1000m ²	5% of site area (minimum dimension of 3m)	1 small tree (6-8 m) per 30 m ² of deep soil
1001 – 1500m ²	7.5% of site area (minimum dimension of 3m)	1 medium tree (8-12 m) per 50 m ² of deep soil Or 1 large tree per 90 m ² of deep soil
1501 – 2500m ²	10% of site area (minimum dimension of 6m)	1 large tree (at least 12 m) per 90 m ² of deep soil or 2 medium trees per 90 m ² of deep soil

>2500m ²	15% of site area (minimum dimension of 6m)	1 large tree (at least 12 metres) per 90 m ² of deep soil or 2 medium trees per 90 m ² of deep soil
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Note: Where an existing canopy tree over 8m can be retained on a lot greater than 1000 m² without damage during the construction period, the minimum deep soil requirement is 7% of the site area.

Source: Department of Environment, Land, Water and Planning, Victoria State Government. (2017). The Melbourne city planning scheme retrieved from <http://planningschemes.dpcd.vic.gov.au/schemes/melbourne>. Accessed on 27/10/2017.

Adhering to the provisions for landscape in table 2 will ensure a green Melbourne city for the present and future citizens of Melbourne.

In Singapore too, the landscaping requirement takes a prominent place in the regulations. The provision for greenery in the condominium development is termed landscape replacement area policy. The new Landscape Replacement Area requirements (LRA) for non-landed residential developments Redevelopment Authority of Singapore specifically target the provision of communal greenery and the levels of greenery provision will be tiered according to the development's intensity as shown in Table 3.

Table 3-New Landscape Replacement Area requirements (LRA) for non-landed residential developments in Singapore

LRA requirements in non-landed Residential developments	GPR ≤ 1.4	1.4 < GPR < 2.8	GPR ≥ 2.8
Overall greenery provision (as % of site area)	30	35	40
On-ground greenery provision (as % of site area)	20	30	35

Source: Urban Redevelopment Authority of Singapore, (2017). The handbook Development control parameters for residential development. Retrieved from <https://www.ura.gov.sg/uol/publications/technical/dc-handbooks>. Accessed on 27/10/2017.

Communal open to sky space at ground level

There is no requirement for a communal open space at ground level for condominiums according to the current planning regulations. The CMA has requirements for common spaces but not particularly a requirement for a communal "open to sky space" at ground level in a Condominium, leading to many condominiums interpreting the concrete rooftop as the communal space. Green space can enhance the visual and functional aspects of the communal space for residents of condominiums.

The Melbourne planning schemes require under clause 58, for every high rise housing development with 40 or more units to provide a minimum area of communal open space of 2.5m² per unit or 250m², whichever is lesser.

The reason given by the URA in Singapore for the minimum site extent of 4000m² for condominiums is to provide generous provisions for communal and recreational facilities in a luxurious green setting. For small sites, there could be only space for one apartment block up to the allowable height, but with generous provision of communal and recreational facilities. However, there is no specific communal Open Space (COS) requirement for condominium developments in Singapore.

Green buffer

Green buffer is a commonly used planning regulation in order to create a green barrier between the road and the building. In the draft - Megapolis Regulations and Guidelines - Planning, Zoning, Environmental and Building, the following green buffer is proposed for Colombo core area.

Table 4-Buffer requirements along roads for Colombo core area in the Megapolis Regulations and Guidelines

Road Category	Proposed Use/Development ¹	Road Buffer (minimum)	Green Buffer (within road buffer)
Road Category A	Residential/educational (6 storeys or above)	50m	5m
	Residential/Educational (up to 5 storeys)	24m	5m
	Commercial/Industrial/Institutional/Multi-storey car park(MSCP)/Place of worship	15m	5m
Road Category B	Residential/Educational (6 storeys or above)	15m	5m
	Residential/Educational (up to 5 storeys)	12m	5m
	Commercial/Industrial/Institutional/Multi-storey car park, Place of worship	7.5m	3m
Road Category C	Residential/Educational (6 storeys or above)	10m	3m
	Residential/Educational (up to 5 storeys)	7.5m	3
	Commercial/Industrial/Institutional/Place of worship	5m	3m
Other Roads	Residential/ Educational	7.5m	3m
	Commercial/Industry/Institution/Place of Worship	5m	3m

Source: Western Region and Megapolis Planning Authority of Sri Lanka, Megapolis Regulations and Guidelines - Planning, Zoning, Environmental and Building Draft retrieved from <https://megapolis.gov.lk/downloads/>. Accessed on 27/10/2017.

In Singapore currently, there is a regulation for the green buffer within the road buffer. All developments fronting a road in Singapore must observe a certain green buffer distance and building setback distance from the road. The buffer requirement depends on the hierarchy of the road, type of development and the building height. For residential developments, the buffer varies from 7.5m to 30m wide (URA, Oct 2017).

Data for the study

This study was a joint project by the Condominium Management Authority and the Department of Architecture of the University of Moratuwa, in order to investigate the impact of condominium developments on sustainability in Sri Lanka.

The preliminary data set for this study was obtained from the CMA. This study took in to account high rise condominiums in Colombo city and its suburbs. 1115 condominiums were issued certificates by the CMA by 2017 September. However, it was noted that 72% of the condominiums had less than 15 units making them less likely to have ground plus 4 floors.

For the purpose of this study a high rise condominium is a condominium with ground plus 4 or above. The numbers of high rise condominiums have been less in the past; however it is worth to note, that from 2015 onwards the numbers of high rise condominiums have been increasing.

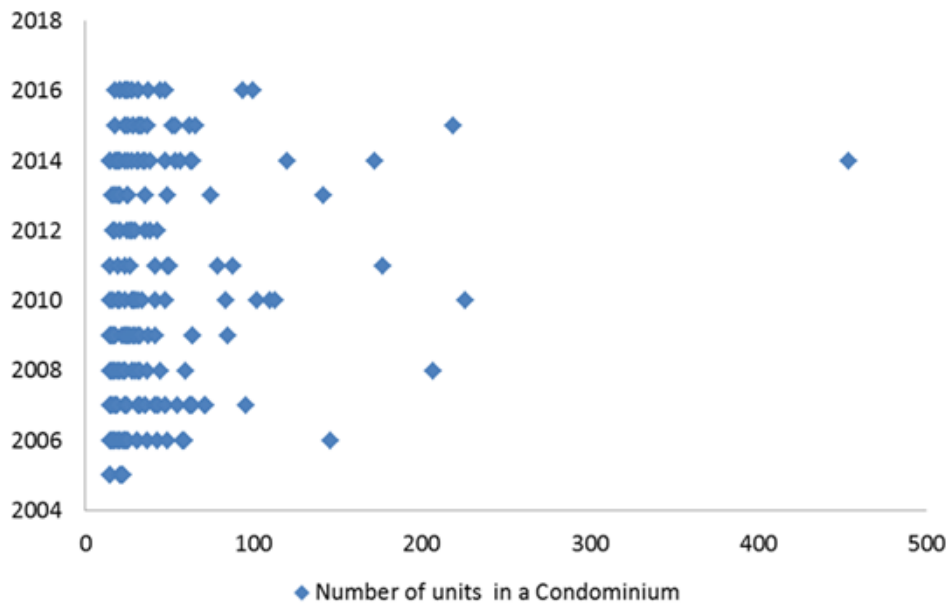


Fig. 2-Number of units in high-rise condominiums 2005-2016

238 private high rise condominiums with over 15 units in Colombo city and its suburbs certified before 2017 were taken as the population for this study. From the 238 condominiums it was noted that close to 90% of condominiums had between 15-65 units while close to 10% had over 65 units as seen in figure 2.

212 certified condominiums had between 15 and 65 units. It was also noted that these condominiums had similar compact forms. Therefore, 31 case studies from condominiums with units ranging from 15-65 were selected for the study.

26 Condominiums with 65 units or above have received certification by CMA. Therefore, all 26 condominiums with units over 65 was selected for the survey as they had much more variability in building form.

The data collection process consisted of an interview with the manager of the condominium and detail analysis of the building plans. Many Condominium managements cooperated with the study with varying levels of success in data collection.

The analysis is conducted separately for small condominium developments (number of units between 15 and 65) and large condominium developments (number of units over 65). Table 5 consists of the minimum, maximum and median of number of units, number of floors and site extent of the condominium developments in the study. Condominiums within one site were considered as a single condominium development for the purpose of this study. Green space of

11 small condominium developments and 10 large condominium developments were calculated using the site plans.

Table 5- Sample statistics

		Min.	Max.	Median
Small Condominium developments (number of units between 15 and 65)	Units	16	48	32
	Floors	6	10	9
	Site extent	412m ²	1122m ²	689 m ²
Large Condominium developments (number of units over 65)	Units	66	420	142
	Floors	11	38	16
	Site extent	1044 m ²	66759m ²	5523 m ²

5. Analysis

The green space for the study was calculated as a percentage of the site extent. The green space at any level was divided by the site extent and presented a percentage. 90% of small condominium developments have less than 1% green space while 50% of large condominiums have less than 1% green space. Therefore, a lack of green space is identified mostly in small condominium developments (number of units between 15 to 65 units) in the study.

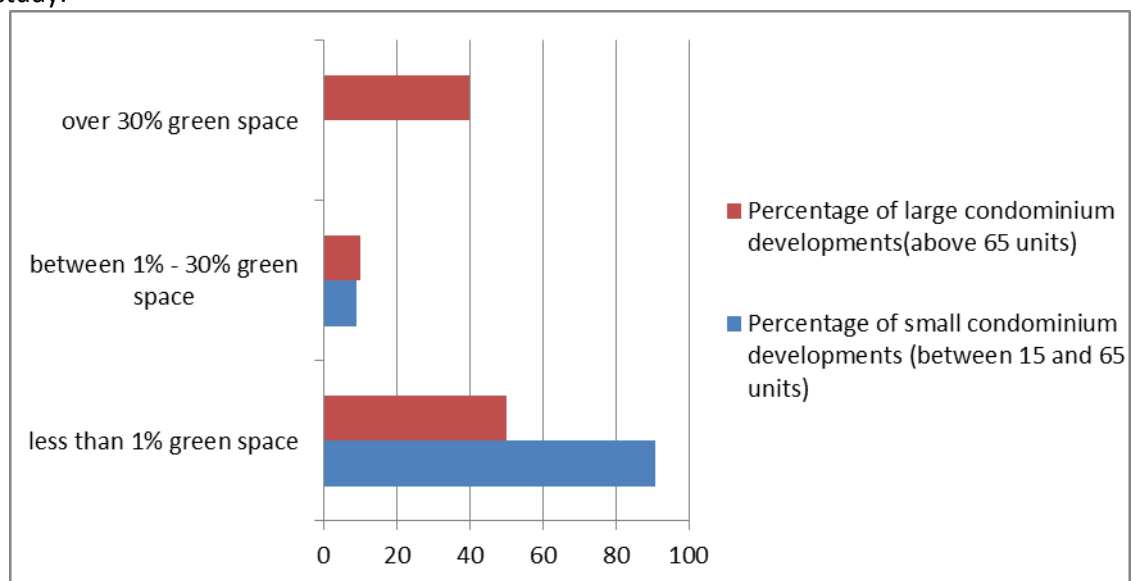


Fig. 3-Green space within condominium developments in the study

Site extent

For the purpose of analyzing site extents, the data were grouped in to three categories. Sites below 2000m², sites between 2000-4000m² and sites above 4000m². It is clear from figure 4 that sites of less than 2000m² lacks green space. Sites of over 4000m² had a higher percentage of green space in large condominium developments. Therefore, large sites have a positive impact on increasing green space in condominiums while small sites had a negative impact in the study.

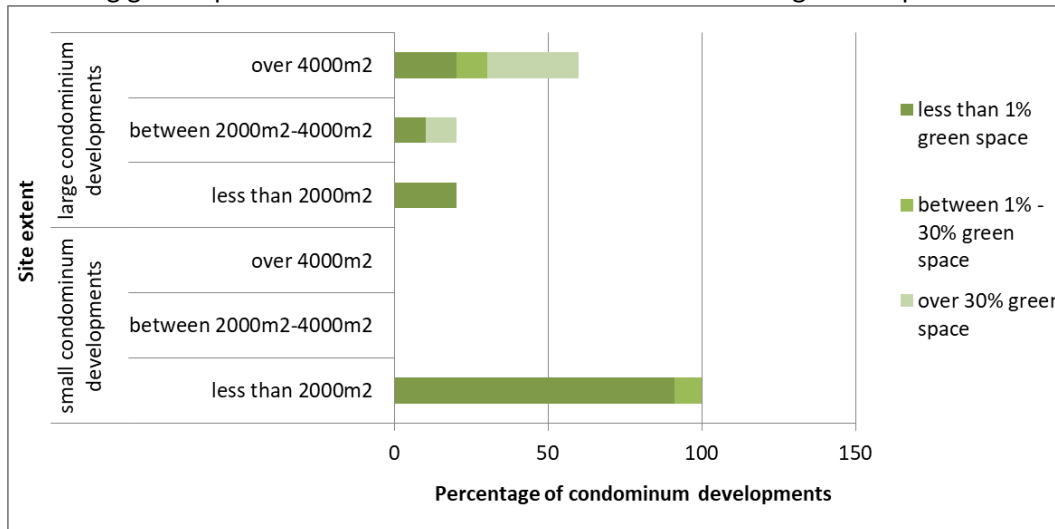


Fig. 4- Impact of site extent on green space in high rise condominium developments

Even though there are opportunities for allocating more green space in large sites, the current trend of site extent for condominium developments are less than 2000m². A closer investigation of building plans confirmed that condominiums of as much as 7 floors have been constructed in plots less than 500 m². Condominiums in practical terms are large scale development projects. In small sites adequate open and green space cannot be provided for the benefit of the residents. Therefore, a minimum site extent that can accommodate all needs of the resident including green space is required for condominium development sites.

Plot coverage

Local planning regulations limit residential development to maximum plot coverage between 50% and 65% based on the number of floors, road frontage and open space around the space. However, some condominiums in the study had plot coverage of over 65%. A closer investigation of building plans confirmed that some condominiums had over 80% plot coverage.

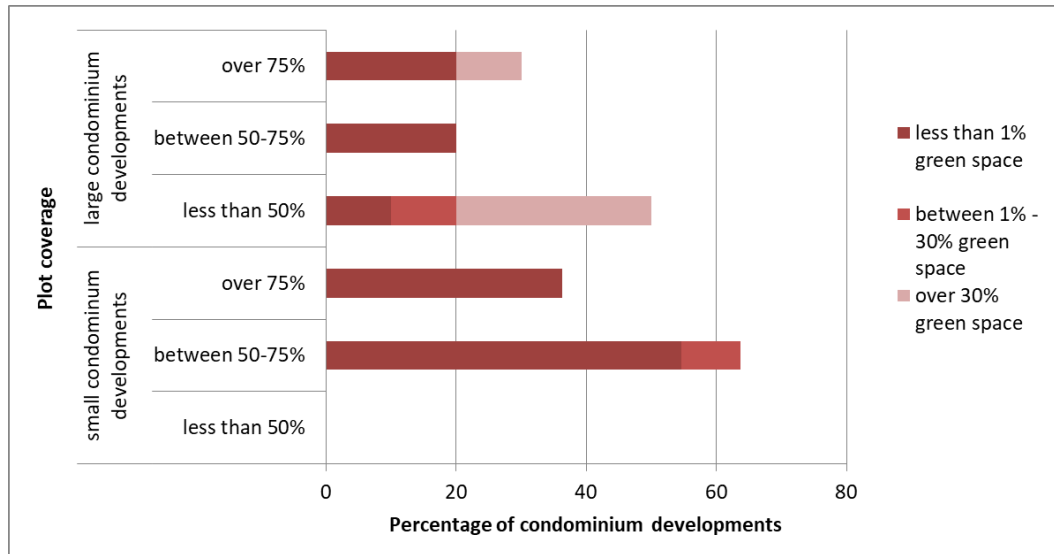


Fig.5- Impact of plot coverage on green space in high rise condominium developments

It is clear that high plot coverage reduces green space on site as per figure 5. According to figure 5, plot coverage of less than 50% is conducive for establishing green space of over 30% on site in large condominium developments. Very high plot coverage has resulted in a continuous mass of concrete buildings in areas such as Wellwatte and Dehiwela. A similar trend was also observed in Nugegoda and Nawala.

Floor Area Ratio (FAR)

High FARs for residential developments in Colombo city and its suburbs were observed in the condominium developments in the study. According to figure 6, large condominium developments with an FAR of less than 1:3 had more than 30% green space. 90% of small condominiums with a FAR of over 1:3 had less than 1% green space. Therefore, in this study a low FAR is conducive to more green space. However due to very high FAR values, Colombo is looking at compact masses of concrete without any greenery on site.

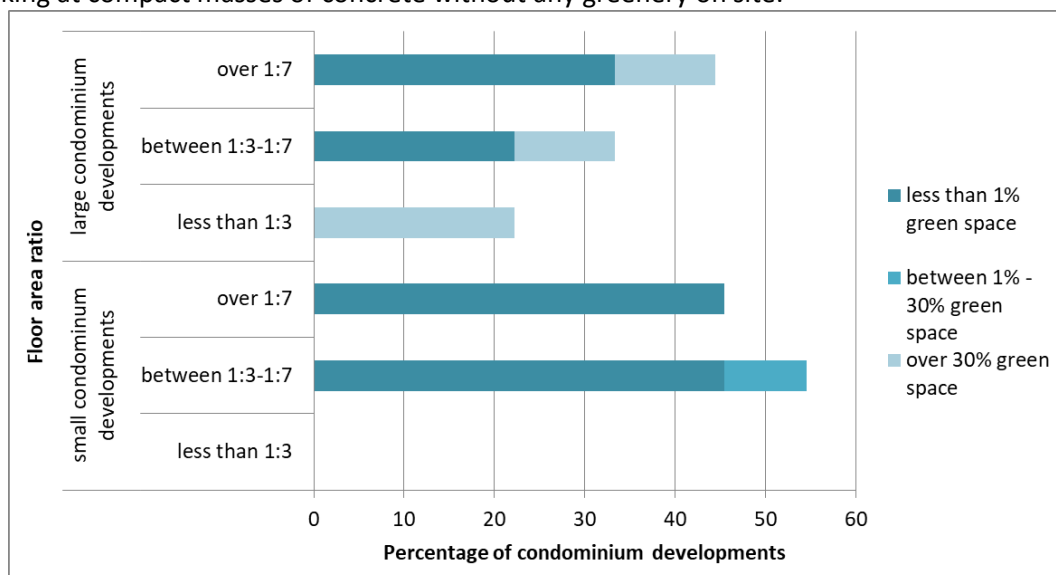


Fig. 6- Impact of FAR on green space in high rise condominium developments*

**Note: One large condominium development in the data set was not considered for the analysis of the Floor Area Ratio due to lack of data.*

Landscape

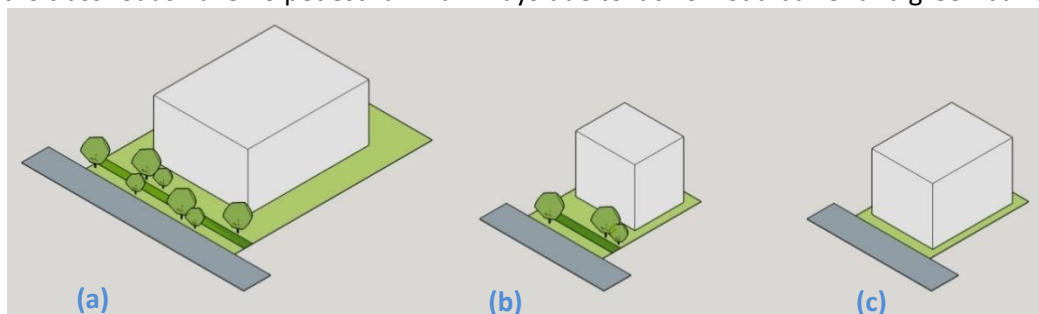
90% of small Condominium developments (number of units ranging from 15 to 65) and 50% of large condominium developments (with over 65 units) had less than 1% of green space on site. Lack of landscape requirement in regulations has resulted in ground floor area been fully developed as a car park in small condominium developments. Urban areas are developed as concrete landscapes, with inadequate greenery despite the country being located in a tropical zone and has much potential to be developed as a green city. The need for a regulation for landscaping within the site is essential for the sustainability of Colombo city.

Communal space at ground level

Most condominiums are interpreting the communal space as the roof top. In the local climate rooftops can only be accessed during the night time due to the hot climate during the day. Some swimming pools are also difficult to use due to windy conditions being located at higher levels. Due to lack of green space, young children living in most condominiums in the study are deprived of any connection to nature.

Green buffer

Building up to the road edge is allowed in selected urban areas in international cities due to highly concentrated commercial activities. In Sri Lanka building up to the road edge is visible in many cities and even suburbs that are not highly commercialized. In the context of condominium developments, a green buffer within a road buffer can ensure pedestrian friendly roads. Figure 7 illustrates how green buffer regulation creates walkable paths. In Sri Lanka many B and C class roads have no pedestrian walk ways due to lack of road buffer and green buffer.



- (a) Road buffer and green buffer for an “A” category road in Singapore on a site extent of 4000 m².*
- (b) Road buffer and green buffer proposed for residential buildings above 6 floors on “A” class roads on a site extent of 1000m² by the WRMP 2030. **
- (c) Front space requirement for an 8 storey residential building on a site extent of 1000m² according to schedule 6-form C in the Planning and Building regulations - 2008-2020.

*Source: <https://www.ura.gov.sg/uol/publications/technical/dc-handbooks/dc-parameters-for-residential-development> Accessed on 27/10/2017.

**Source: Megapolis regulations and guidelines- <https://megapolis.gov.lk/downloads/> Accessed on 27/10/2017.

Fig. 7- Illustrated green buffer regulations

6. Conclusion

The lack of green space in condominium development in Sri Lanka is highly visible in Colombo and its suburbs. This study documents the lack of green space and establishes its causes for the information of relevant authorities in order to direct towards increasing green and open space in condominiums in future developments.

The role of green and open space in creating a better life for the urban society is widely researched and accepted fact. This study discussed how countries such as Singapore and cities like Melbourne ensure that the city remains green while achieving economy development through the use of efficiently enforced planning tools.

The practice of allocating green space in high density housing developments in areas such as Colombo where land price is high is not an alien concept to Colombo city. For example, Elvitigala flats and Summit flats which were constructed in 1970's have a visibly high percentage of greenery within the site.

In the study all small condominiums had site extent of less than 2000m². This has resulted in 90% of the small condominiums having less than 1% green space. Establishing a minimum site extent that can accommodate adequate green space is the first step in steering condominium developments towards providing adequate green space.

The lack of conformity to the plot coverage regulation is clear in the study where some condominiums had over 80% plot coverage. Singapore and Melbourne have very strict enforcement of its regulations that protects the rights to green space. Mass et al, 2009 points out green and open space should not be considered a luxury which only the wealthy can afford, but an integral part of urban planning.

New regulations such as requirement for landscape, communal open space and green buffer needs to be established in order to make condominium developments livable for its residents as well as contribute to well-being of the society rather than become problematic case of high rise urban sprawl.

There is eminent need, to update current regulations for site extent, plot coverage, FAR, and introduce new regulations for landscape, communal open to sky space and green buffer for sustainable condominium development in Sri Lanka.

7. Limitations of the study

This study is limited to analyzing five parameters within a small data set. For future research using software such as Geographical Information Systems (GIS) a more expansive study for a large data set could be conducted for a wider number of parameters.

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